Preliminary Feasibility Report

Biomass Heating Analysis for Minerva Town Garage Complex

Minerva, NY
June 2011
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EXECUTIVE SUMMARY

The Minerva Town Garage complex includes a 7,000 square foot Garage used to store and maintain town vehicles and a 4,000 square foot Parks Department building used as a repair shop and to store equipment. The Garage is heated by two 230,000 Btu fuel oil boilers that provide low temperature hot water for a radiant slab. The Parks building is heated with an aging waste oil furnace that is nearing the end of its useful life.

The Town is interested in evaluating the feasibility of installing a central cordwood fired boiler to heat both buildings. The Town currently cuts a fair amount of cordwood during the course of its road and park maintenance activities and would like to find a way to use that wood constructively to offset their heating costs.

Last year the Town used 4,774 gallons of #2 fuel oil to heat the Garage. In addition 1,100 gallons of waste oil was used to heat the Parks building. The average price paid for fuel oil over the past year was $2.88 per gallon. If the Town were to replace the waste oil furnace with one that uses an equivalent amount of #2 fuel oil it would spend approximately $16,930 on fuel oil to heat the Garage complex this coming year.

This site appears to be an excellent candidate for a central cordwood fired boiler system. There is a very good location adjacent to the Parks building to install a boiler room and cordwood storage - it even has an existing slab. The Town is already cutting cordwood as part of its routine maintenance and could supply the complex with very low cost wood fuel. The existing waste oil furnace is at the end of its useful life, is dirty and needs replacement soon regardless of whether a biomass system is installed. A cordwood boiler system that is connected to the Town garage boilers will not only save on fuel costs, it will make both buildings much more functional.

The analysis provided in this report indicates that the Town of Minerva could save almost $55,000 in operating costs over 20 years in today’s dollars even when the cost of financing is included. The analysis shows more than $6,950 in fuel savings in the first year alone. The Town should also be able to avoid the cost of replacing the waste oil furnace altogether and may be able to extend the life of the other existing boilers.

Yellow Wood believes the Town should move ahead with a biomass boiler project and recommends the Town take the following steps to pursue this opportunity:

1. This project is probably too small to involve a mechanical engineer for design. Nevertheless, the Town may want to obtain several quotes from different manufacturers to make sure they are getting the best price on equipment for this project. Included in the Biomass and Green Building Resources Binder is product literature from several different vendors of cordwood heating
equipment. The Town may also want to contact local wood boiler suppliers. The important thing to consider with any cordwood boiler project is that significant thermal hot water storage (1,000 – 2,000 gallons) should be included in the project and the boiler should have induced draft fans. These features will allow the boiler to operate on high fire all of the time, which improves efficiencies and reduces maintenance. Typical outdoor wood boilers do not include these features and should be avoided.

2. The Town 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. The New York State Energy and Research Authority (NYSERDA) and/or the New York Power Authority (NYPA) should be engaged to develop comprehensive energy efficiency recommendations and proposals for incentives for efficiency upgrades before undertaking a major building project. This should be done regardless of whether or not the Town moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives are included in the *Biomass and Green Building Resources Binder* accompanying this report.

3. If the Garage has metal halide light fixtures, the Town should consider replacing these with high bay fluorescents. Unlike metal halides, these newer fixtures can be easily turned on and off and consume far less electricity when operating. The Town should check to see what incentives NYSERDA may be offering for replacing metal halide fixtures. Even without incentives, the high bay fluorescents have very good returns on investment. The Town may want to consider combining a biomass project with an extensive energy efficiency upgrade and present it to voters as a comprehensive energy initiative.

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 to help the Town accomplish this. One such tool is the EPA Energy Star *Portfolio Manager* software. It is free public domain software that helps facility managers track energy and water use. This software can be downloaded at:


5. Renewable energy and energy efficiency projects for rural communities such as Minerva may be eligible for grants and low-interest loans through USDA Rural Development. The Jefferson County Job Development Corporation may be able to help you put together a grant application. See the Project Funding Opportunities section of this report for more information.

This preliminary feasibility study was prepared by Yellow Wood Associates in collaboration with Richmond Energy Associates. 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 applications. Biomass heating technologies are being used quite successfully in over 40 public schools in Vermont alone and the concept of heating institutions with wood is catching on in several other areas of the United States and Canada. Good candidate facilities for biomass energy systems include those that have high heating bills, those that have either steam or hot water heating distribution systems and those that have ready access to reasonably priced biomass fuel.

This report is a pre-feasibility assessment specifically tailored to the Minerva Town Garage complex outlining whether or not installing a cordwood boiler makes sense for this facility from a practical perspective. In March of 2011, staff from Yellow Wood Associates traveled to Minerva, NY to tour the Town Garage complex. This assessment includes site specific fuel savings projections based on historic fuel consumption, and provides facility decision-makers suggestions and recommendations on next steps.

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

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

DESCRIPTION OF THE EXISTING HEATING SYSTEMS

There are two main buildings in close proximity to one another at the Minerva Town Garage complex. One is a 7,000 square foot Town Garage where snowplows and other town vehicles are stored and maintained. The second building is 4,000 square feet and includes a repair shop space for the Town Parks Department to store equipment. The Town Garage is currently heated by two 230,000 Btu boilers which provide low temperature hot water for a radiant slab. The Parks Building is heated with a waste oil furnace that is near the end of its useful life. The Town has recently had trouble with the waste oil furnace and is looking to replace this unit.

DESCRIPTION OF THE PROPOSED BIOMASS SYSTEM

In this report we are characterizing a 425,000 Btu cord wood boiler to heat both buildings at the Town Garage complex. We are recommending a 320 square foot boiler room and a 500 square foot covered woodshed to be built on the east side of the Parks building. There is an existing concrete pad that lies on the east side of the Parks building that can act as the base for both the boiler room and wood storage area. The analysis in this report includes costs for building a simple boiler room and a covered woodshed (open on the sides). While costs for these structures were included in the analysis, the Town may be able to reduce overall project costs by incorporating a boiler room within the Parks building and storing the wood outside on the slab (without the shed roof). Cordwood can be stored effectively with a tarp or similar type of cover to keep the snow and rain off.

Hot water from the new cordwood boiler will be piped through underground piping to the existing boiler room in the Garage. This cordwood boiler will supplement the existing hot water heat (generated by the fuel oil boilers) for the radiant slab in the Garage building.

We are also recommending the addition of three ceiling mounted fan coil furnaces in each building. These units will also run on hot water produced by the new cordwood boiler. In the Garage building, the fan coil furnaces will provide quicker heat recovery when the garage doors are opened in the winter and should help to reduce some of the condensation issues the Town has experienced in the building. The fan coil furnaces in the Parks building will improve the heat distribution in this building and make it much more useful in the winter. We are recommending that the existing boilers in the Town Garage be tied together with the wood boiler and used to provide back-up and supplemental heat for the entire complex.

This configuration will require two sets of buried insulated supply and return pipes to connect the wood boiler to the Garage building. One set of supply and return pipes will connect with the existing fuel oil boilers. The other set will bypass the fuel oil boilers and connect with the ceiling mounted fan coil units.
The distance between the Garage and Parks buildings is approximately 50 feet, so we are estimating a total of 100 linear feet of insulated piping to be buried between the biomass boiler room and the Garage. Since the boiler room is attached to the Parks building, the fan coil furnaces in that building can be connected directly to the boiler.

The boiler that was characterized for this project has an integral 2,000 gallon water jacket that acts as thermal storage. Thermal storage can increase the efficiency and overall ease of operation of biomass hot water heating systems. At times of low heat demand by the building, heat is diverted to a heat storage tank that is full of water. This allows the boiler to operate in a high fire state at peak efficiency through the entire burn cycle. When the thermal storage tank is subsequently depleted of useable heat, the boiler is re-fired.

Thermal storage allows the boiler to be run hot for longer periods of time. Biomass boilers burn most efficiently and cleanly when they are burned hot. It also allows operators to use the biomass boiler more effectively during the warmer spring and fall months. In some cases a biomass boiler with thermal storage might even be used during the summer if there is substantial hot water demand.

Since the wood boiler needs to be stoked frequently during the coldest weather and since staff is not available 24 hours per day at anytime during the year, we are projecting that the wood boiler will cover about 50% of the total annual heat load for the complex. The other 50% will be covered by the existing fuel oil boilers located in the Garage building.

It is important to note that additional costs for new heating equipment and structures are included in the analysis. These additional costs will improve the comfort in both buildings and make the operation and maintenance of the biomass system easier. These are real project costs, but are not entirely necessary and work against the return on investment for a biomass alternative. Yellow Wood can run the analysis with different assumptions if the Town would like to see the return on investment associated with different construction cost estimates.

**Figure 1: Site Plan**

![Site Plan Diagram]

Minerva Town Garage Complex Biomass Pre-Feasibility Report
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 20-year horizon and takes into consideration life cycle cost factors. A 20-year time frame is used because it is the expected life of a new cordwood boiler.

The alternative biomass scenario envisions installing a new cordwood boiler system that would serve the Minerva Town Garage complex. The scenario includes all ancillary equipment and interconnection costs. Under the biomass scenario, the existing fuel oil boilers would still be used to provide supplemental heat 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 cordwood boiler. Yellow Wood worked with one vendor to develop realistic cost estimates, but neither the US Forest Service nor Yellow Wood endorses any particular technology. It is
recommended that for a project of this type, the Town get several estimates from various vendors in order to compare costs. Product literature for several vendors is included in the Biomass and Green Building Resources Binder accompanying this report. The capital costs used for the biomass scenario should be considered generic estimates based on our experience with similar scale projects.

**FUEL OIL COST ASSUMPTIONS**

During the past year, the Garage building used an estimated 4,774 gallons of #2 fuel oil for heat and hot water. An additional estimated 1,100 gallons of waste oil was used in the Parks building. Waste oil has slightly less energy content than #2 fuel oil. Because the Town does not have accurate consumption records for the waste oil and the differences in energy content are minor, the waste oil load is converted to fuel oil in this report. This was also done because it is likely that the Town will be replacing the waste oil furnace soon with a #2 fuel oil furnace that would consume an amount of fuel similar to what the waste oil unit now uses. A total of 5,874 gallons of #2 fuel oil (the sum of the annual fuel oil use and waste oil use) is the assumed annual fuel consumption for the site that was used for the base case in the analysis.

According to the NY Office of General Services database for state and local government fuel prices, the average price paid for fuel oil in Essex County over the past year was $2.88 per gallon. This is the assumed first-year fuel oil price used in the analysis. At this price, the Town will spend more than $16,930 to heat the garage complex next year.

**CORDWOOD COST ASSUMPTIONS**

It was assumed that the cordwood boiler would be used to cover approximately 50% of heating needs in both buildings and the existing fuel oil boilers would be used to provide the remainder of the heat.

On-site staff indicated that the Town would be able to obtain much of the wood needed for the new boiler from road clearing and park maintenance. We felt we needed to include a cost for wood fuel in order to more accurately characterize a cordwood system. After consulting with on-site staff we are projecting a first year cost of $80 per cord for firewood, which is equivalent to about $.60 per gallon for fuel oil. That price was inflated each year at same rate as general inflation. Refer to the Sensitivity Analysis at the end of this report to see how the fuel savings costs would increase if cordwood was obtained for less than $80 per cord.

**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 twenty-year analysis, some rate of inflation needs to be applied to future fuel costs.

We looked retrospectively over the last 20 years (1990 to 2010) using US Energy Information Agency data and found that the average annual increase for fuel oil in NY was 7.2% per year. The analysis projects this average inflation rate for fuel oil forward over the thirty-year analysis period. The Town’s fuel rate of $2.88 per gallon was used for the first year of the analysis and then inflated each year at 7.2%.

The overall Consumer Price Index for the period between 1990 and 2010 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.

Figure 2: Woodchip and Fossil Fuel Inflation

![NY Heating Fuels vs. VT Wood Fuel Price History](image)

OPERATION AND MAINTENANCE ASSUMPTIONS

Cordwood systems require a significant investment of labor to operate and maintain. It was assumed that the Town would purchase cordwood at $80/cord (this price can also account for some labor costs if the wood is actually obtained at no cost by the Town). Whatever the purchase price, the wood will still need to be stacked, the boiler will need to be fed several times per day and annual maintenance will need
to be performed on the boiler. The assumptions for how much labor would be involved are outlined below.

It will be necessary to load the boiler with firewood at least four times per day during the coldest winter months. It was assumed that each load would take fifteen minutes and therefore it was assumed an hour per day of daily maintenance for every day the boiler was used. It was assumed that the cordwood boiler would be used approximately 100 days per year to provide heat. At a loaded labor rate of $25/hr, this equals $2,500 annually. In addition, routine annual maintenance is included at $250 per year. This $250 is then inflated at the general annual inflation rate.

Under any biomass scenario, a case could be made that the existing heating equipment will require less maintenance and may last longer since it will be used less. In this case we are recommending retiring the waste oil burner entirely. It is at the end of its useful life and is a dirty and messy way to heat the building. Connecting the heating systems of both buildings together and using a wood boiler and the existing boilers in the garage to heat the entire complex could actually reduce some maintenance costs. Nevertheless, 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 boilers might be delayed. For these reasons, no annual maintenance, scheduled repair or planned replacement costs for the existing boilers was taken into consideration as these are considered costs that the Town would have paid anyway. It was assumed that all costs for the operation and maintenance of a cordwood 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 Town will finance the entire cost of the biomass project with a low interest 5% loan. At this time the analysis does not take into account any potential grants or lower interest loans. Other financing schedules could create more favorable cash flows depending on how much of the project costs are actually financed. See the section in this report on Project Funding Opportunities to learn about alternative funding and financing options. Refer to the Sensitivity Analysis in the appendices to this report to see the relative life cycle cost savings under various financing scenarios. If the Town would like to see other cash flows using different financing schemes, Yellow Wood can provide additional analysis.
BIOMASS SCENARIO ANALYSIS

The analysis shows that Town of Minerva could save nearly $55,000 in today’s dollars in operating costs over the next 20 years by installing a cordwood heating system. Annual fuel savings alone are projected to be more than $6,950 per year in the first year and will increase over time as fuel oil prices continue to climb.

Table 1: Biomass Scenario Analysis Assumptions

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<tr>
<th>Capital Cost Assumptions</th>
<th>Cost (USD)</th>
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<tr>
<td>425,000 BTU wood hot water boiler system including installation</td>
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<td>Boiler house 320 SF $50 /SF</td>
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<tr>
<td>Woodshed 500 SF $15 /SF</td>
<td>7,500</td>
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<tr>
<td>Fan coil hanging furnaces 6 $1,500 /each</td>
<td>9,000</td>
</tr>
<tr>
<td>Piping to distribution furnaces</td>
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<tr>
<td>Pex Pipe (2&quot; supply and return) 100 LF $75 LF</td>
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<tr>
<td>Interconnection to existing boiler room</td>
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<td>Construction contingency at 10%</td>
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<td>Total estimated project costs</td>
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<td>1st full year debt service</td>
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<td>Current annual fuel oil use (gal)</td>
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<td>Assumed fuel oil price in 1st year (average price paid this past heating season (NY -OGS)</td>
<td>2.88</td>
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<td>Projected annual fuel oil bill</td>
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<td>Percentage of wood utilization</td>
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<td>Assumed wood price in 1st year (per cord)</td>
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<td>Projected 1st year wood fuel bill</td>
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<td>General inflation rate (twenty year average CPI)</td>
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<td>Fuel oil inflation rate (twenty year average EIA)</td>
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<td>Annual Wood O&amp;M cost</td>
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<td>Routine Annual Maintenance</td>
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<th>Savings</th>
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<td>Return on Investment from fuel savings</td>
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<td>Total 20 year NPV cumulative savings</td>
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Figure 3: Annual Cash Flow Graph for Biomass Scenario
### Table 2: 30-Year Life Cycle Analysis Spreadsheet for Biomass Scenario

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<th>Finance Cost for Entire Project</th>
<th>Cordwood Cost</th>
<th>Partial Fuel Oil Cost</th>
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**Totals:**
- $709,533 Cost for Entire Project
- $100,431 Finance Cost
- $39,044 Partial Fuel Oil Cost
- $394,766 O&M Cost
- $64,508 Total Cost
- $6,451 Annual Cashflow
- $565,201 Cumulative Cashflow

**Discount Rate:** 5%
- **20 Yr NPV:** $395,577
- **20 Yr ROI:** 9.0%
- **20 Yr NPV Savings:** $54,469
- **Annual ROI:**
ADDITIONAL ISSUES TO CONSIDER

ENERGY MANAGEMENT

In order to effectively manage energy use and to identify efficiency opportunities in buildings it is very important to track energy usage. Unless energy consumption is measured over time, it is difficult or impossible to know the impact of efficiency improvements or renewable energy investments. The 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 Town of Minerva 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 Town Garage converts to biomass or stays with fuel oil, the facility should use its heating fuel efficiently. The New York State Energy Research and Development Authority (NYSERDA) and/or the New York Power Authority (NYPA) can help identify and prioritize appropriate energy efficiency projects that will improve the Town’s infrastructure and save money. Both of these agencies can help with the evaluation of energy efficiency opportunities and provide financial incentives to upgrade and improve equipment efficiencies. If the Town decides to move forward with a biomass energy project, it should work with one of these agencies to identify other efficiency projects that could be completed at the same time.

General information on NYSERDA and NYPA programs is included in the Biomass and Green Building Resources binder accompanying this report.

CARBON OFFSETS

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

USDA FUNDING OPPORTUNITIES

2008 Farm Bill

The 2008 Farm Bill has a number of provisions that may help rural communities consider and implement renewable energy and energy efficiency projects.

- **Section 9009** provides grants for the purpose of enabling rural communities to increase their energy self-sufficiency.
- **Section 9013** provides grants to state and local governments to acquire wood energy systems.

These grants and loan guarantee programs are competitive. The Town should check with the local USDA office to express interest and to get program updates.

Rural Community Facilities Grant and Loan Program

The USDA provides grants and loans to assist the development of essential community facilities. Grants can be used to construct, enlarge or improve community facilities for health care, public safety and other community and public services. The amount of grant assistance depends on the median household income and the population of the community where the project is located.

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

Information on programs and contact information is provided in the *Biomass and Green Building Resources Binder*. For more information about USDA programs and services, contact your local USDA office at:

*Greenwich Area Office*
2530 State Route 40
Greenwich, NY 12834-9627
518-692-9940, ext. 4, FAX 518-692-2203

The *Jefferson County Job Development Corporation* may be able to help you put together a grant application.

Jefferson County Job Development Corporation
800 Starbuck Avenue, Suite 800
Watertown, New York 13601
(315)782-5865
[www.jcjdc.net/web/]
MUNICIPAL LEASE / PURCHASE

As a municipal entity, the Town of Minerva 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 leasing is included in the *Biomass and Green Building Resources Binder* accompanying this report.
CONCLUSIONS AND RECOMMENDATIONS

This site appears to be an excellent candidate for a central cordwood fired boiler system. There is a very good location on site adjacent to the Parks building to install a boiler house and cordwood storage. It even has an existing slab. The Town is already cutting cordwood as part of its routine maintenance and could supply the complex with very low cost wood fuel. The existing waste oil furnace is at the end of its useful life, is dirty and needs replacement soon regardless. A cordwood boiler system that is connected to the town garage boilers will not only save on fuel costs, it will make both buildings much more functional.

The analysis provided in this report indicates that the Town of Minerva could save almost $55,000 in operating costs over 20 years in today’s dollars even when the cost of financing is included. The analysis shows more than $6,950 in fuel savings in the first year alone. The Town should also be able to avoid the cost of replacing the waste oil furnace altogether and may be able to extend the life of the other existing boilers.

Yellow Wood believes the Town should move ahead with a biomass boiler project and recommends the Town take the following steps to pursue this opportunity:

1. This project is probably too small to involve a mechanical engineer for design. Nevertheless, the Town may want to obtain several quotes from different manufacturers to make sure they are getting the best price on equipment for this project. Included in the Biomass and Green Building Resources Binder is product literature from several different vendors of cordwood heating equipment. The Town may also want to contact local wood boiler suppliers. The important thing to consider with any cordwood boiler project is that significant hot water storage (1,000 – 2,000 gallons) should be included in the project and the boiler should have induced draft fans. These features will allow the boiler to operate on high fire all of the time, which improves efficiencies and reduces maintenance. Typical outdoor wood boilers do not include these features and should be avoided.

2. The Town 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. The New York State Energy and Research Authority (NYSERDA) and/or the New York Power Authority (NYPA) should be engaged to develop comprehensive energy efficiency recommendations and proposals for incentives for efficiency upgrades before undertaking a major building project. This should be done regardless of whether or not the Town moves ahead with a biomass project at this time. Information on energy efficiency programs and incentives are included in the Biomass and Green Building Resources Binder accompanying this report.

3. If the Garage has metal halide light fixtures, the Town should consider replacing these with high bay fluorescents. Unlike metal halides, these newer fixtures can be easily turned on and off and
consume far less electricity when operating. The Town should check to see what incentives NYSERDA may be offering for replacing metal halide fixtures. Even without incentives, the high bay fluorescents have very good returns on investment. The Town may want to consider combining a biomass project with an extensive energy efficiency upgrade and present it to voters as a comprehensive energy initiative.

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 to help the Town accomplish this. One such tool is the EPA Energy Star Portfolio Manager software. It is free public domain software that helps facility managers track energy and water use. This software can be downloaded at: http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

5. Renewable energy and energy efficiency projects for rural communities such as Minerva may be eligible for grants and low-interest loans through USDA Rural Development. The Jefferson County Job Development Corporation may be able to help you put together a grant application. See the Project Funding Opportunities section of this report for more information.
WHO WE ARE

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

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

DISCUSSION OF CORDWOOD HEATING SYSTEMS AND FIREWOOD

Purchasing and burning cordwood is an entirely different exercise than purchasing fuel oil. There are good and very bad cordwood boiler technologies on the market. Most wood burning appliances fail to create high combustion efficiency for two reasons: not enough heat to burn all of the fuel and cutting the air supply to try to control the rate of combustion. The last is intuitive for anyone who has ever seen the air cut off from a fire - the result is a lot of smoke and reduced heat.

In order to get a clean and efficient burn, the cordwood heating system should include induced draft. Substantial thermal storage should also be designed into the system to allow for a high temperature burn. Wood fuel should be seasoned and dry. Wood storage needs to be carefully thought out so that the driest wood is easy to use and freshly stacked wood is not in the way of seasoned wood. Below is a quick primer on elements to consider when designing a cordwood heating system for a user that will use more than ten cords of wood.

Below are two examples of cord wood hot water boilers. Information on potential Vendors and models is available in the *Biomass and Green Building Resources Binder*.

![Figure 4: Cord Wood Hot Water Boiler](source: www.garn.com/showmedia.wml/storeid/4656/filename/Garn-In-Action1.JPG)

![Figure 5: Cord Wood Hot Water Boiler](source: www.newhorizongstore.com/Products/89-biomass-gasification-boiler.aspx)
INDUCED DRAFT

One of the most challenging aspects of heating with cordwood is controlling the output of the heating appliance. An induced draft system includes a fan that drives air into the combustion chamber. This ensures there is adequate combustion air for a high temperature burn.

Many outdoor wood boilers on the market control heat output by dampening down combustion air. When a fire is starved of combustion air, it smolders and smokes. In addition to wasting wood fuel, a smoldering, smoky fire can produce tremendous quantities of fine particulates, which are the pollutant of most concern from wood burning appliances. Minimizing particulate emissions should always be one of the goals of any biomass heating application.

THERMAL STORAGE

The best way to burn chunk firewood hot is to have a hot fire and to control the heat output of the system by storing heat in a large water tank. An induced fan will help produce a high temperature burn. The heat energy can then be transferred to a large insulated hot water storage tank. Building demand can be regulated through a heat exchanger in the storage tank. There are many reasons why thermal storage for a cordwood boiler system is desirable.

- It eliminates short cycling which reduces emissions. In conventional wood heating equipment wood combustion produces maximum emissions during the “idle” cycle.
- Minimizing the on/off cycle reduces maintenance.
- Batch burning with controlled combustion into thermal storage allows any burner to be set up for steady state continuous peak combustion efficiency because the burner does not have to cycle as demand for heat increases. The burner simply “charges” the thermal storage.
- Thermal storage allows a continuous exact match of heat output to widely varying loads of any building or process. This is very important during the “fringes” of any heating season when a typical wood burner is grossly oversized because it is based upon the largest heating load during winter conditions.

Figure 6: Pex flexible piping ready for installation and being installed
Source: http://www.garn.com/showmedia.wml/storeid/4656/filename
• Thermal storage allows for burner maintenance, repair or cleaning without a loss of heating ability because the thermal storage can carry the load for a period of hours without burner input.

Thermal energy storage may be provided via a separate storage tank piped to the burner unit (boiler), or as an integral unit with the burner.

When vendors are asked to provide a quote for this project, thermal storage should be included in the project specifications.

HOW TO BURN FIREWOOD

Transporting wood in New York State

The New York State Department of Environmental Conservation regulates the transport of firewood within New York. Firewood may not be transported more than 50 miles from its point of origin unless it has been kiln-dried by a process that raises the wood’s core temperature to at least 160 degrees Fahrenheit for 75 minutes. The Biomass and Green Building Resources Binder contains additional information on New York State firewood transport regulations.

Species of wood

The species of wood you receive makes a significant difference. The potential heat value of wood is directly proportional to its weight, and there is wide variation in weight for equal volumes of wood. For example, a cord of pine weighs about 2,700 pounds at 20 percent moisture content. An equal volume of oak weighs about 3,700 pounds at 20 percent moisture content. The pine, therefore, has about 73% of the potential heat value as the oak, yet you may pay the same price for the wood.

The term "mixed hardwoods" has very little meaning because the energy contained in a cord of hardwood varies widely by species. The Biomass and Green Building Resources Binder contains additional information on the energy content of various New York species used for firewood.

Moisture content of cordwood

Moisture content is another important factor to consider if you use wood as an energy source and want to operate at maximum efficiency. When trees are cut, the wood contains a lot of water. This quantity of water is generally called the "green moisture content." The amount of water in green wood varies with species. After cordwood is cut to length, split, and stacked in a sunny and well ventilated spot, it loses moisture rapidly. Wood dried for one year may be near the 20 percent moisture content. At this level, it is considered air dried.
When you buy wood, assume it is green and dry accordingly. Green wood burns more slowly than air dried wood and may be somewhat slower on the "uptake" when you start a fire. If you burn green wood, you stand to lose 10 to 12 percent of the original heat potential of the wood.

**Cordwood storage**

Cordwood should be air dried or “seasoned” under cover for at least six months before it is burned. Woodshed storage should be carefully designed so that it is easy to stack and manage dry and fresh wood. It should allow for plenty of air movement to promote drying. The woodshed should be sized to store a full year’s worth of wood if possible and should allow for rotation so that fresh wood isn’t in the way of seasoned dry wood.

In order to correctly size a wood storage shed, a definition for cordwood must be understood. As defined by the National Conference on Weights and Measures and New York State Department of Agriculture & Markets Bureau of Weights and Measures, a gross cord of firewood is the amount of wood, ranked and well stowed, contained in a space of 128 cubic feet. "Ranked and well stowed" means pieces are placed in a line or row with pieces touching on their ends and parallel to each other and stacked in a compact manner. Wood storage can be a very inexpensive pole barn type structure. It can even have a dirt floor if there is good drainage. But it should be carefully thought out so that it is easy to load, is easy to access from the boiler room and so that any fresh wood does not get in the way of using the driest wood.

A cord of wood is typically 4 feet wide by 4 feet tall by 8 feet long or 128 cubic feet once it is stacked. For the purposes of the analysis done in this study we assumed a cord of wood was 128 cubic feet of seasoned hardwood dried to a 20% moisture content. Wood can be stacked somewhat higher than 4 feet to reduce the footprint of a woodshed, but stacking wood higher than 6 feet is not recommended. Therefore the smallest recommended footprint for a cord of wood is 21 square feet. For 20 cords of wood we recommend at least 500 square feet of wood storage under cover.

If possible the woodshed should be adjacent to the boiler room so that the boiler can be loaded while remaining under cover. Wood can be stacked so as to form “walls” to minimize exposure to the elements. Careful thought should be given to the pattern of stacking so that the first stacked is the first used.

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1 Other descriptions of volumes of cordwood such as rick, rank, pickup load, and face cord should not be used. The only legal terms are "cord" and fractions of a cord.
SENSITIVITY ANALYSIS

Table 3 is a sensitivity analysis comparing annual fuel savings from the installation of a cordwood boiler based on varying prices for wood and #2 fuel oil. In this analysis the assumed loan interest rate of 5% and the inflation rates outlined in the assumptions are held constant. For example, if the Town is able to procure all of the required cordwood at no cost and fuel oil rises to $3.00 per gallon – the annual fuel savings for a cordwood boiler characterized in this analysis would be $8,811.

Table 3: Annual Fuel Savings When Wood and Fuel Oil Prices Vary

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Table 4 is a sensitivity analysis showing the Net Present Value (NPV) of the installation of a cordwood boiler based on varying financing interest rates and fuel inflation rates. In this analysis the cost of cordwood ($80 per cord) and the General Inflation rate of 2.6% are held constant.

Table 4: 20-Year Net Present Value (NPV) when Interest and Fuel Oil Inflation Vary

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BIOMASS AND GREEN BUILDING RESOURCES BINDER

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- Financing Resources
  - USDA Rural Energy For America Program (REAP)
  - NYSERDA Existing Facilities Program
  - EPA Innovative Financing Solutions
  - Financing Energy Efficient Projects - Municipal Leasing Consultants

- Efficiency Resources
  - Reference Guide for EPA Portfolio Manager software
  - NYSERDA Flexible Technical Assistance Information
  - NYPA Energy Efficiency Programs
  - Advanced Energy Design Guide (ON ENCLOSED CD)
  - Guideline to the Commissioning Process for Existing Buildings - NYSERDA (ON ENCLOSED CD)

- Biomass Equipment Vendors
  - Alternate Heating
  - BIOHEAT
  - Econoburn
  - Garn Wood Heat Stoves
  - New Horizon Corporation
  - Viessmann

- Biomass Energy Resources
  - Carbon Dioxide and Biomass Energy
  - Air Emissions from Modern Wood Energy Systems
  - Information on Air Pollution Control Technology for Woody Biomass Boilers
  - EPA Institutional Boilers Fact Sheet for Area and Major Source Facilities
  - Ratings of firewood species in New York State
  - Frequently Asked Questions for Firewood Regulation
  - Don’t Get Burned when Buying Firewood
  - 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)