United States Department of Agriculture **Forest Service** **Northeastern Area State and Private Forestry** **180 Canfield Street Morgantown, WV 26505-3101**

File Code: 3000
Date: April 7, 2010

Dear Facility Owner or Operator:

The USDA Forest Service Wood Education and Resource Center (WERC) is interested in helping you assess the potential for the use of renewable wood energy at your facility. WERC wood energy specialists will evaluate your facility's energy use and provide you with a specific wood energy feasibility analysis for your site. These analyses are provided for public facilities and privately operated commercial and industrial facilities (individual family residences are not included unless they are part of a district energy development). If your facility uses fuel oil or propane as an energy source, or if your natural gas bill is greater than $150,000 per year, you may want to consider wood energy. Wood offers a renewable, cost effective, and environmentally beneficial alternative to fossil fuels.

WERC's mission is to facilitate interaction and information exchange with the forest products industry to enhance opportunities for sustained forest products production in the 35-state eastern hardwood forest region of the United States. Improving the efficiency of wood product use across this region is a key goal of WERC. The WERC is focused on improving the efficiency of the use of wood for energy. The use of Advance Wood Combustion (AWC) technologies and strategies is the focus of the WERC wood energy program.

To access the WERC wood energy consulting services, the owner or operator of a public or private facility must complete an energy system profile and provide 2 years of energy use data (see enclosed form) to WERC support staff (address listed on the energy system survey form).

Upon receipt of this information, WERC support staff will contact the owner/operators representative to discuss the application in detail and to set up on-site visits as required. The initial phone interview will include an in-depth review of building energy systems, current HVAC systems, and planned changes to energy use at the site. WERC staff will also work with your State Forester to identify local wood fuel vendors that can provide the quality and quantity of necessary wood fuel.

There is no charge for the preliminary feasibility assessment at your site. If this pre-feasibility study proves positive and you want further assistance on the project, the facility owner/operator must cover the costs of additional on-site visits to the facility by WERC wood energy specialists.

If you have further questions about this effort please contact me at (304)285-1538 or at lmccreery@fs.fed.us

Thank you for your interest in AWC systems and renewable wood energy.

Sincerely,

Lew R. McCreery

LEW R. McCREERY
WERC Woody Biomass Coordinator

US Forest Service Wood Education and Resource Center
Wood Energy Technical Assistance Program

Wood Energy Project Data Collection

Facility Information:		
Facility name and mailing address	**Size of heated space in square feet:**	
	Year of construction:	
	Years of major renovation(s)	
	First renovation:	
	Second renovation:	
□ **Public or** □ **Private**		
Contact person for questions regarding this form:	**Type of facility (check one)**	**No. of students or occupants**
Name:	□ School	
Title:	□ College/University	
Phone :	□ Hospital	
Fax :	□ Prison	
E-mail address:	□ Other _____	
Date form was completed:		

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

Name of building	**Size in square feet**	**Central boiler?**
Ex. Franklin elementary school	**25,000**	yes

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? If so please describe below.

Heating System

How is heat delivered to rooms? (check all that are applicable)	**How is heat generated?**
□ **Hot water**	□ **Hot water boiler**
□ **Steam**	□ **Steam boiler**
□ **Ducted air**	□ **Hot air furnace**
□ **Electric resistance**	□ **Electric baseboard**
□ **One heating plant in one location?**	□ **Electric duct coils**
□ **Different heating plants in multiple locations?**	□ **Rooftop packaged units**
□ **Individual, room by room heating systems?**	□ **Heat pumps**

Heating equipment		
List each piece of heating equipment separately below. Include size in boiler horse power or BTU, state what fuel it uses, i.e. Natural Gas, #2 fuel oil, heavy oil, LPG, Coal, other and when it was installed.		
Size	***Type of Heater***	***Fuel Type and year installed***
Ex. 3.5 MBtu or 200 BHP	*Hot water boiler*	*#2 fuel oil, installed in 1998*
If buried steam lines or hot water lines are used to connect multiple buildings to a central boiler plant, what condition are the lines? Circle one: **Poor Fair Good Excellent**		

Other information		
Describe your fuel storage for each heating fuel storage tank		
Tank Capacity	***Date installed***	***Fuel Type***
Ex. 10,000 gallon buried	*1953*	*#2 fuel oil*
Is your domestic hot water heated from a central boiler? ☐ ***Yes*** ☐ ***No***		
Has your facility recently undergone an energy audit? If so when?		

Required Attachments

1. *If the facility has multiple heating plants in separate locations, please provide a rough sketch on a separate page of the community or campus and locate each heating system on the sketch. Feel free to use a pre-printed community or campus map or building floor plan if one is available. Provide size of heating plant in boiler horse power or Btu for each system and state what fuel is used for each system. Place on map location of any storage tanks used for heating fuels and their size.*

2. *Please provide at least two full years of heating fuel records with volumes of fuel used* ***for each heating plant****. For example if some buildings are heated from a central boiler plant using natural gas and others have stand-alone fuel oil boilers, list each separately with volumes for each. If your domestic hot water is not provided by a central boiler, list each account separately and identify which fuel is used for which equipment. Often it is easiest to get this information from your fuel dealer as a printout of fuel deliveries.*

3. *Please provide at least two years of electric bills for all buildings on site.*

4. *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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Mail or fax completed application form and attachments to:

USFS WERC Wood Energy Technical Assistance
c/o Yellow Wood Associates, Inc.
228 North Main Street
St. Albans, VT 05478
Fax 802-524-6643
Phone 802-524-6141

IS YOUR FACILITY A GOOD CANDIDATE FOR A WOODY BIOMASS HEATING SYSTEM?

Introduction

There are a number of reasons why facility owners and operators may wish to consider installing a woody biomass energy system. Using woody biomass may help reduce energy costs, increase energy independence, support local economies, and reduce carbon footprints. However, not all facilities are equally well-suited to the use of woody biomass. This presentation discusses some of the key factors for identifying commercial, educational, industrial, health care, and multi-unit residential facilities that are good candidates for biomass heating systems.

Some of these key factors include: the size of the facility's current annual fuel bill, the type and condition of its heating distribution system, whether there is a capable champion or institutional support for the concept, whether there are any near term expansion plans and whether the facility has access to affordable biomass fuel. These factors are discussed in more detail below. Each facility that meets these fundamental criteria should be more thoroughly evaluated on a case-by-case basis before decisions are made.

Annual Fuel Bill and Conditioned Space

The most important factors in considering the viability of a biomass heating project is the size of the facility, the size of the current annual fuel bill and the relative cost of the fossil fuel being replaced. Good candidates for biomass heating systems can include hospitals with year round heating loads, campus type settings with multiple heat users, school buildings, industries with heat loads such as food processing or drying loads, community pools or natatoriums, government or private office centers.

A general rule is that for similar heat use, projects replacing electric resistance heat, fuel oil or propane have a better return than projects replacing natural gas, and facilities in colder climates make better candidates as these tend to lead to higher fuel bills. Biomass fuels are far less expensive than fossil fuels on a cost per Btu basis. On the other hand biomass heating systems require sizable investments. Therefore, if annual heating bills are not large enough, it will be difficult to offset the cost of the biomass system with fuel cost savings.

Wood chips are a very low cost heating fuel. Wood chip fuel cost can range from $35/ton to $60/ton depending on the region of the country and the distance of a facility from the wood fuel supplier. To put fuel costs into perspective, $50/ton for green hardwood chips is equivalent to about $0.80/gallon fuel oil. But in order to use this low cost fuel effectively a facility must invest in new biomass boiler equipment as well as in wood chip fuel storage and fuel handling equipment. Therefore, the facility's fuel bills need to be large enough to allow the fuel cost savings to offset the higher initial capital cost for the biomass system within a reasonable period of time.

Whether a biomass heating project is cost effective is largely dependent on the size of the heating bill. Generally good prospects for **wood chip** heating projects will need to have over

50,000 ft² of conditioned space and/or have annual fuel bills of at least $50,000 in order to be cost effective.

Pellets are a more processed fuel than wood chips and therefore cost more to make than wood chips. Pellet boiler equipment tends to be less expensive than wood chip boiler equipment, requires less space for both the boiler and fuel storage and pellet fuel handling equipment is relatively inexpensive. While pellets cost about twice the amount of wood chips on a cost per Btu basis, a pellet heating system may cost half as much to install, or less. Good prospects for pellet fuel heating projects will have between 5,000 ft² and 50,000 ft² of conditioned space and annual fuel bills between $10,000 and $50,000.

System Sizing

Biomass boilers need to be more accurately sized for the intended loads than fossil fuel boilers. Fossil fuel boilers are typically sized on peak demand with a margin for error as they can be ramped up and ramped down more easily and more efficiently. Biomass boilers are slower to respond to changes in demand; when coupled with thermal storage, (see below for more on thermal storage), properly sized biomass equipment is more responsive and efficient. These boilers operate more cleanly and efficiently when they are working near their peak heat output and typically operate effectively within 100% to 20% of their rated capacity.

The designer must first decide if biomass will be the only fuel or if the system will utilize both biomass and fossil fuels. If biomass will be the only fuel, an accurate heating load profile needs to be determined, and the system must be designed to account for varying heating requirements over the year. For a biomass only system, this may require two combustion units of differing sizes that can operate individually or in tandem to cover the full range of system heating requirements. Often it is more cost effective to size biomass boilers to cover a base load and provide fossil fuel boilers for peaks above the base loads and lower seasonal loads; or in some cases use a solar thermal system to cover shoulder heating months and peaks above the base system.

Wood chip boilers are not currently commercially available below 250,000 Btu. The materials handling systems available for wood chip storage and fuel feeding are more costly than such systems for wood pellets. At present it may be more cost effective to use pellets for applications less than 500,000btus/hour and consider chips for those systems over 500,000 btus/hour. In either case, the cost comparison and availability of biomass and fossil fuels may have a bearing on which type of biomass system is selected for use. Much smaller pellet boiler equipment is commercially available. There are good quality residential scale pellet boilers down to about 100,000 Btu. For some pellet boiler installations, the pellet boiler can be the sole source of heat. This is due to uniform dry fuel which allows for precise fuel control and automatic starting systems, and generally smaller sizes that have less thermal mass. Pellet boiler systems have lower cost storage and delivery systems and can cost effectively provide longer operation between fuel deliveries than wood chip systems.

Heating Distribution System

The existing heating distribution system is also an important consideration when evaluating the potential for biomass heating systems. Buildings with central heating systems can significantly reduce the cost of installing a biomass system. Both wood chip and pellet boiler systems require

some kind of hydronic (water or steam-based) heating distribution systems. The biomass system is connected to the hot water or steam distribution system and then heat is piped throughout a building. If a facility has a central hot air system it can be connected to the biomass boiler with hot water coils (heat exchanger), and heated air is directed throughout the building using the existing ductwork. If a facility does not have central heating distribution, a new distribution system will have to be designed and installed which can add substantially to project costs.

Existing Heating Equipment

A back-up heating system in good working condition is generally recommended in addition to a wood chip or pellet heating system. The biomass boiler becomes the primary boiler and the fossil fuel boiler provides back-up or supplemental heat as necessary. As noted above, it is often more efficient to heat with fossil fuels during the shoulder seasons because fossil fuel boilers can reach required temperatures and cool down more quickly and more efficiently than wood chip systems. Using currently installed central systems as backup or incorporating new fossil fuel systems into the biomass design can both be cost effective solutions.

Hot Water Thermal Storage

Hot water thermal storage provides improved performance and efficiency for both pellet and wood chip systems. In particular, wood chip systems can benefit from thermal storage since the thermal mass of the fuel and boiler make system modulation less responsive (i.e. responding to changing heating needs during the day). Thermal storage assists in meeting short term demand until the boiler can ramp up to higher heat demands and storage also provides an energy heat sink to maintain boiler combustion efficiency as system heat demand decreases.. A rule of thumb for sizing thermal storage is 75 gallons per 100,000 Btu of furnace output. Use of thermal storage also allows integration of solar thermal heating systems (solar panels) which can improve overall efficiency and assist with shoulder season heating requirements and summer domestic hot water (DHW) loads.

Access to Fuel

Good access to reasonably priced fuel is an important factor to consider no matter what type of biomass system is being considered. Biomass fuels are bulky and relatively expensive to transport. Fuel transportation costs will impact the viability and success of a biomass heating system. Wood chip fuel can come from sawmill waste or from logging operations or from brokers that consolidate round wood and chip to order. The best wood chip candidate sites have potential wood chip fuel suppliers within a 50-mile radius.

For commercial-scale pellet boiler systems, bulk delivery of pellets can reduce both the cost and labor of heating with pellets. Few commercial or institutional sites will have the staffing available to handle bagged pellets and to load boilers manually. Pellet fuel can be stored in agricultural grade grain bins and handled with bulk delivery grain equipment. Pellet manufacturing facilities that deliver in bulk need to be identified and minimum delivery volumes and delivery prices need to be considered before a bulk pellet system is built.

Site

Wood chip boilers are considerably larger than fossil fuel boilers of the same Btu output; in addition wood chip storage also requires a large footprint, usually requires the construction of a

new boiler house and chip storage building on site. Each candidate site needs to be evaluated for appropriate locations for a boiler house and chip storage building. Site considerations include proximity to the existing boiler room and heating systems and truck access for wood chip fuel delivery.

Pellet boiler systems are considerably smaller than wood chip boiler systems and in some cases can be incorporated into existing boiler rooms. This is ideal as it minimizes construction costs. Some pellet boiler systems come in a fully weatherized container that can be dropped on site and function as a complete stand-alone boiler house. These systems can then be interconnected to existing heating systems and reduce construction costs substantially. As with wood chip systems, the site needs to be evaluated for delivery truck access, but pellet deliveries are generally far less frequent than wood chip truck deliveries and pellets can be delivered in straight trucks, which do not require the same space for a turning radius.

Expansion Plans

Because installing a biomass heating system generally requires significant design and construction, it is much less costly to incorporate a biomass project into another major construction project. If a biomass project is done in conjunction with a building expansion project or a building renovation project there is much more flexibility of design and design fees and general condition costs can be shared. For any major construction project, heat loads need to be determined and additional heating capacity needs to be considered. These are ideal times to consider adding a biomass heating system to existing systems. In some cases it may make sense to wait on a biomass project if there is a major construction project anticipated a few years out.

Maintenance

Biomass heating systems require regular maintenance and the time required for maintenance depends on the type and size of the system. It is important to take into account staff time for maintaining the biomass system in considering overall operating costs. The best candidate sites already have on-site building maintenance personnel that can operate and maintain the biomass equipment. Modern biomass heating systems do not require much time, but they do require daily or weekly maintenance in order to operate effectively. Wood chip systems generally require about 30 minutes of maintenance per day and approximately 20 hours for scheduled maintenance over the summer. Wood pellet systems will require approximately 1 hour per week and 10 hours over the summer for general maintenance.

Combine Heat and Power (CHP)

The most common method of producing electricity using biomass as a fuel is a steam boiler connected to a steam turbine. There are also commercially available Organic Rankine Cycle, (ORC) systems that use high temperature thermal oils and an organic working fluid instead of steam to produce electric and hot water. Gasification technology that would use producer gas in a reciprocating engine or micro-turbine is on the horizon but is not currently commercially viable.

Backpressure Steam: A common application of CHP is back pressure steam generation. This system is used when the heating distribution system is fairly low pressure steam (below 100 psig).

Steam is produced at a higher pressure than needed for distribution and then the pressure is reduced by running the steam thru a turbine before entering the steam distribution header. The greater the steam pressure drop the greater the electric production. As a heat led system electricity can be produced for as little as 2 cents per kWh additional biomass input cost. Good candidates for these systems are hospitals and industry that have year round heating or process loads however systems can be cost effective for larger seasonal heating loads.

Condensing Steam: A second type of steam generation system is a steam to hot water or condensing steam turbine. These turbines usually operate with a very low or negative exit pressure; the steam then enters a shell and tube heat exchanger to condense the steam and heat water for space heating. Generally, these systems have to vary steam output based on the heat load to be cost effective in producing electricity. The value of the electricity produced has more to do with economic viability than the cost of the wood. Properly designed heat led CHP systems can exceed 85% in overall thermal efficiency with about 5% to 8% of the thermal input converted to electric output.

Organic Rankine Cycle: ORC CHP systems have higher electric yields (16%), per btu of heat input but similar or slightly less overall efficiency (80%). Because of higher capital costs and less flexible heat output ranges these systems have a fairly narrow range of application. They require a constant low grade (175 °F) or less year round heat demand to be cost effective.

Additional Considerations

Energy Efficiency: Adding a biomass boiler is a supply side solution to reducing heating costs. When any boiler system is being considered it is wise to also consider energy efficiency. Improving energy efficiency in a building can reduce initial capital costs because a more efficient building will need smaller boilers. Adding a biomass boiler system is a substantial investment and adding efficiency measures to the project can further reduce operating costs and provide additional savings.

Champion/Institutional Support: Most successful biomass projects have a champion who is interested in the technology and is continually advocating for and promoting the project. This person can be a maintenance person, board member, administrator or community member and does not have to be a biomass specialist. The champion will be dedicated to the project and continually promoting the concept in front of decision-makers.