BIOMASS-FUELED POWER PLANTS, AN OVERVIEW

PRESENTED BY

Richard P. Ellis
Business Development Manager
Utility Engineering Corporation
Richard.P.Ellis@ue-corp.com

INTRODUCTION

Today, there is a much stronger demand by customers, communities and various regulators placed upon electric utilities to provide ever increasing amounts of renewable energy. Biomass fueled steam and electric power plants are significant contributors of renewable energy production in the United States The high price of natural gas is also causing many owners to look at the feasibility of changing to biomass. The Energy Policy Act of 2005 provides for additional incentives for the use of biomass fuels.

Twenty-two states and Washington, D.C. have some type of renewable energy requirement or renewable portfolio standard. The type of material that can qualify as a fuel to generate renewable energy varies by state. Recently, Minnesota revised its definition of renewable energy to include electricity produced from municipal waste as a fuel. According to the U. S. Energy Information Administration, there is approximately 5,000 MW of biomass fueled electrical generating capacity in the United States.

During this presentation I will discuss biomass applications, boiler technologies, fuel sources, fuel quality and some of the challenges of ensuring a reliable fuel supply.

BENEFITS OF USING BIOMASS

Burning biomass has three major beneficial effects on the economy and environment. First, using biomass as a fuel significantly reduces the amount of waste that must otherwise be placed in landfills. Instead of land filling waste sawdust, bark, chips and municipal trash, using these materials as a fuel can decrease the volume of waste from one hundred percent to about three percent, depending on the type of material converted to a fuel.

Second, the use of wood as a fuel decreases the amount of sulfur dioxide emitted when producing electricity. As a comparison, about 250 tons of Wyoming coal with 8,750 BTU/lb and 0.2% sulfur will produce one ton of sulfur dioxide. To produce that same ton of sulfur dioxide, it takes about 1,700 tons of wood with 5,000 BTU/lb and 0.03 % sulfur. When compared on a BTU basis, wood-fired generation produces about one-fourth of the sulfur dioxide of the Wyoming coal.

Third, by converting waste streams to a fuel, a plant operator can help lower a biomass fuel supplier's cost of operations and allow them to be more competitive. This helps stimulate the economy of a region.

BIOMASS FUEL USES

Biomass fuel is used to produce process steam, steam to produce electricity, steam for cogeneration and also in combined heat and power applications. Biomass fuels can be co-fired with other solid fuels. Some utilities successfully co-fire wood in various types of coal-fired boilers to produce steam.

DECIDING ON HOW TO USE BIOMASS

An Owner considering adding a biomass fueled unit or converting an existing unit to burn biomass will undergo a complex decision making process. After an Owner has developed a plan to use biomass, they should select an engineering firm to support their efforts to perform an economical analysis, select a site and identify the appropriate fuel and combustion technology.

One method employed by engineering companies to select the appropriate technology to use biomass fuel is to use a project design manual for a biomass reference plant. The design basis will include the number and size of units, and the boiler and steam turbine-generator technologies.

The project design manual should include engineering, design, specifications, drawings, schedule, procurement, expediting, reporting and coordination to design, procure, build and start-up the facility and provide an overview of the following major systems:

- Fuel receiving, storage and handling
- Turbine-generator
- Steam generator
- Condensate and boiler feed water
- Steam piping
- Heat rejection
- Heater drains
- Steam cycle sampling and analysis
- Air quality control equipment
- Ash handling and disposal
- Water supply, treatment and disposal
- Fire protection
- AC and DC power supply
- Electrical systems
- Substation
- Controls and instrumentation
- Plant buildings and structures
- Miscellaneous plant services and site work

From a general engineering perspective, the design manual should also include design codes, basic design criteria, a typical site general arrangement drawing, electrical one-line, preliminary P&IDs and a project schedule.

Additional process steps include:

- Adapt the plant to the Owner's needs
- Develop a schedule to identify development, permitting, design, equipment procurement, construction, commissioning, start-up, turnover and commercial operation

- Estimate a price
- Select a construction method
- Issue requests for quotations
- Select major equipment
- Select contractors

BOILER TYPES

Typical boiler types that burn biomass fuels include stoker-fired, bubbling fluidized bed and circulating fluidized bed. Biomass is co-fired with other solid fuels in pulverized fuel and cyclone boilers. Generally speaking, when compared to fluidized bed boilers, stoker-fired boilers can be lower in cost to procure, install and maintain. Fluidized bed boilers provide much more fuel flexibility than stoker-fired boilers.

BIOMASS CHARACTERISTICS

Wood fuels can come from many different sources. Some of the highest volume sources are sawmill bark and sawdust, tree farm harvest, forest residue, storm damage, diseased tree removal, urban cleanup, construction recycling, manufacturing waste streams and shredded railroad ties. Wood is usually chipped or ground to a maximum size of three inches for use as a fuel in stoker-fired or fluidized bed boilers. When wood is co-fired in pulverized coal boilers it may include1/4 inch sawdust or1 inch ground material. One recent application in a cyclone boiler used ¼ inch dry wood shavings.

Municipal waste is generally burned in mass-burn facilities or processed to produce refuse derived fuel (RDF). RDF is produced using shredders, magnets, screens and air classification. RDF is usually sized to a maximum of 6 inches.

The following table shows typical characteristics of wood, RDF and shredded railroad ties.

		Wood Chips		
	BTU/lb	**Moisture**	**Ash**	**Sulfur**
Average	**5,000**	**43%**	**3.6%**	**.02%**
Range	**3,702 – 7,639**	**10 % - 56 %**	**2 % - 8 %**	**.02 % - .06%**
		RDF		
Average	**6,500**	**24%**	**11%**	**.2%**
Range	**4,500 – 8,000**	**5% - 36%**	**1% - 19%**	**.09% - .54%**
		Railroad Ties		
Average	**6,800**	**26%**	**1.7%**	**.1%**
Range	**5,893 – 7,570**	**16% - 35%**	**.7% - 13%**	**.01% - .17%**

LOCATING THE FUEL

One of the most dynamic aspects of a biomass project is the development of a reliable and economic fuel supply for the life of the project. Recently Utility Engineering (UE) worked with several clients and conducted fuel studies to identify the location, volume, transportation methods and pricing for biomass fuels.

UE starts each study by collaborating with the Owner to define the fuel types needed to be evaluated. Together, the Owner and UE define fuel types and the initial geographical area to be studied.

The study also includes the following:

- Methodology to collect, analyze and report data
- Database of contacts, fuel types, locations and transportation modes
- Fuel processing requirements
- Survey methods
- Executive summary
- Results

Depending on the type and quantities of fuel needed for a project, a geographical area may include several states and may extend several hundred miles from the project site. Two of the results from a fuel study are the fuel available within the study area and a supply curve that identifies the tons of fuel available on a dollar per ton delivered price basis.

Using these methods, we have been able to provide the information necessary for an Owner to decide whether to proceed with a project. There have been cases where Owners have decided not to proceed with projects because the supply volumes were insufficient to sustain operations and delivered costs caused the project to be too expensive. On the other hand, with the information provided from the fuel study, there are cases where Owners have decided to proceed with biomass fueled projects.

It is important to point out the ongoing fuel supply for a plant can change rapidly. In order to obtain a reliable, economical supply of fuel, the Owner must dedicate resources to work with suppliers, processors and transporters. In one case, a plant relied entirely on local sawmill sawdust and bark. Shortly after the plant started operations, sawmills started to sell the bark to landscape companies for mulch. The bark used for mulch became much more valuable than fuel and the supply dwindled.

The Owner solved the supply situation by contracting with an additional processor and obtained a reliable supply of shredded railroad ties.

BIOMASS PRICING

Price is based on a combination of factors. They include current and projected disposal costs for suppliers, transportation distances and costs, volumes from suppliers, reliability, quality and processing costs. The value of the fuel is derived from the total plant production cost, including ash disposal, to produce steam and/or electricity.

Because wood-fired units need to be competitive in order to operate, the delivered fuel cost plays an important role. In some cases, the price paid to suppliers may not allow the supplier to recover all of the transportation costs to deliver the wood to the plant and, at the same time, the supplier does not receive any money for the wood

fuel itself. These suppliers may continue to choose to deliver wood fuel to the plants because other alternatives are more expensive.

EMERGING USES OF BIOMASS

Fibrowatt Ltd., a United Kingdom based company, burns poultry litter in plants to produce electricity. In the summer of 2005, they started construction of a 55 MW plant to burn turkey litter. The $202 million plant, located in Benson, Minnesota, is scheduled for completion in 2007 and is expected to burn up to 700,000 tons per year of litter. Xcel Energy, Inc. will purchase the output.

CONCLUSION

Biomass fuels can serve an important role in a utility's model to produce renewable energy. With careful planning and execution, an Owner can successfully integrate biomass fueled plants into its generation mix.

There are several reliable technologies Owners may adopt to burn biomass. Equipment manufacturers continually offer new innovations to handle, store, transport and burn biomass fuels.

Biomass fuels present unique challenges for all users. Care must be taken to choose and locate the appropriate fuel to meet a facility's needs, and also choose the appropriate equipment to ensure long-term economical plant operations. Owners should dedicate resources to continuously work with suppliers, processors and transporters to develop new supply options.