2. Basic First Steps and Considerations

Biomass is any organic matter, typically plant-based matter, that is available on a renewable or recurring basis. Biomass resources include forest and mill residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residues, aquatic plants, fast-growing trees and plants, and municipal and industrial wastes. Biomass can be used in its solid form or gasified for heating applications or electricity generation, or it can be converted into liquid or gaseous fuels.

In almost all cases, the production of electricity from biomass resources is most economic when the resulting waste heat is also captured and used as useful thermal energy—known as CHP. The lowest cost forms of biomass for generating electricity are residues. Residues are the organic byproducts of food, fiber, and forest production, such as sawdust, rice husks, wheat straw, corn stalks, and bagasse (the residue remaining after juice has been extracted from sugar cane). Wood is the most commonly used biomass fuel for heat and power. The most economic sources of wood fuels are wood residues from manufacturing, discarded wood products diverted from landfills, and non-hazardous wood debris from construction and demolition activities. Generating energy with these materials can recoup the energy value in the material and avoid the environmental and monetary costs of disposal or open burning.

Biomass is plentiful in various forms across the country. Certain forms of biomass are more plentiful in specific regions where climate conditions are more favorable for their growth. The biomass feedstocks discussed in this report vary widely in their sources and fuel characteristics and therefore vary in typical considerations for their utilization. The various biomass resources can require different approaches to collection, storage, and transportation, as well as different considerations regarding the power generation technology that they would most effectively fuel.

The U.S. Energy Information Administration (EIA) estimates that 590 million wet tons (equivalent to 413 million dry tons) of biomass resources are available in the United States on an annual basis. EIA forecasts that biomass will generate 76.5 billion kilowatt-hours (kWh) of electricity, or 1.7 percent of the United States' forecasted total generation, in 2010.[4]

To turn a biomass resource into productive heat and/or electricity requires a number of steps and considerations, most notably evaluating the availability of suitable biomass resources; determining the economics of collection, storage, and transportation; and evaluating available technology options for converting biomass into useful heat or electricity.

2.1 Survey Availability of Local Resources

The availability of biomass feedstocks in close proximity to a biomass power project is a critical factor in their efficient utilization. An in-depth evaluation of the available quantity of a given resource should be conducted to determine initial feasibility of a project, as well as subsequent fuel availability issues. The primary reasons for failure of biomass power projects are changes in fuel supply or demand (wrongly assumed during the planning stage) and changes in fuel quality.[5] Fuel considerations that should be analyzed in a preliminary evaluation include:

- Typical moisture content (including the effects of storage options)
- Typical yield
- Seasonality of the resource
- Proximity to the power generation site

[4] Energy Information Administration, 2006.
[5] Schmidt and Pinapati, 2000.

- Alternative uses of the resource that could affect future availability or price
- Range of fuel quality (i.e., contaminants that could affect power generation equipment)
- Weather-related issues
- For agricultural residues: percentage of farmers contracted to sell residues

An introduction to the typical characteristics and regional availability of a variety of rural and urban feedstocks is included in Chapter 3.

It is important to be as accurate as possible when making fuel availability assumptions because miscalculations can greatly impact the successful operation of biomass power projects. When fuel availability is known to be an issue in the planning stage, a power generation technology that can handle varying degrees of moisture content and particle size can be selected. Technologies that can handle several fuels in a broad category, such as agricultural residues, provide security in operation without adversely affecting combustion efficiency, operations and maintenance costs, emissions levels, and reliability. Information on fuel flexibility is included in the technology characterizations in Chapter 5 of this report.

2.2 Cost Considerations

Collection Method

The amount of a biomass resource that can be collected at a given time depends on a variety of factors. For agricultural residues and energy crops, these considerations include the type and sequence of collection operations, the efficiency of collection equipment, tillage and crop management practices, and environmental restrictions, such as the need to control erosion, maintain soil productivity, and maintain soil carbon levels.[6] The collection mechanism used for agricultural residues and switchgrass is similar to what is currently used to collect hay. Different systems have varying collection efficiencies, driving the cost of collection to approximately 20 to 25 percent of total delivered cost, typically $5 to $7/ton.

For wood resources, the cost of collection is one of the largest costs of delivered wood fuel. Forest residues can be collected easily by equipment that is already in the forest collecting timber, whereas forest thinnings can be more difficult to harvest due to site accessibility issues.

For gaseous biomass fuels, such as LFG and wastewater treatment gas, regulatory requirements might have already mandated the collection of methane generated by these applications. Therefore the collection cost does not factor into a power generation project because it is a sunk cost that would be present regardless. However, as outlined in Table 4-3, collection costs for an LFG energy project can be significant (close to $1 million per 500 cubic feet per minute [cfm]) and should be factored into the economic evaluation of a potential project that is not required due to regulations.

Resource Cost

Some biomass resources do not involve compensating an owner for removal. However, payment (a "farmer premium") may have to be made to a farmer for agricultural residues and some energy crops, like switchgrass, if collected from an individual's land. The amount of the payment varies, but is designed to compensate the farmer for the value of the removed nutrients and compensate for potential soil compaction and decreased surface organic matter. Structuring payment based on distance from the plant is common, with farmer premiums of up to $15/ton for haul distances within 15 miles or $7/ton or less for distances around 50 miles.

[6] Perlack and Turhollow, 2002.

Transportation

Biomass transportation costs are site specific and depend on the distance from the plant as well as the amount of biomass to be transported. Recent data are not readily available; however, in 2002, transportation costs for agricultural crops typically ranged from $7 to $10/dry ton for conventional bales and between $4 to $7/dry ton for compacted bales.[7] For wood feedstocks, costs between $8 and $15/ton were typical.[8] As a comparison, average trucking costs for coal in 2001 were approximately $11.70/ton for a 50-mile haul.[9]

Storage

There are three common storage options for biomass feedstocks, each with its own benefits and challenges:

1. Feedstock is hauled directly to the plant with no storage at the production site.
2. Feedstock is stored at the production site and then transported to the plant as needed.
3. Feedstock is stored at a collective storage facility and then transported to the plant from the intermediate storage location.

The type of storage system used at the production site, intermediate site, or plant can greatly affect the cost and the quality of the fuel. Storage systems that maintain high fuel quality also cost the most. Typical storage systems, ranked from highest cost to lowest cost, include:

- Enclosed structure with crushed rock floor ($10 to $15/ton)
- Open structure with crushed rock floor ($6 to $8/ton)
- Reusable tarp on crushed rock ($3/ton)
- Outside unprotected on crushed rock ($1/ton)
- Outside unprotected on ground ($0/ton)[10]

Chapter 4 of this report provides an overview of storage area requirements at a biomass conversion facility. For example, wood burning facilities typically store up to a month of fuel supply on site to carry the plant through possible supply shortages in the spring or winter seasons. Depending on the size of the facility, this storage could require a significant amount of space. For other feedstocks such as agricultural residues that have harvesting seasons of little more than two months, a large amount of storage is required. For these fuels, it is typical to have intermediate storage facilities that are either at the farm of origin or in staging areas off site. The land requirements for a storage facility depend on the size of the plant as well as the storage density of the feedstock. For a 2,000 ton/day plant, 50 storage areas of 8 acres each for round bales or 3 acres each for compacted bales would be needed.[11]

Facility Size

As biomass power projects increase in size, economies of scale are partially offset by increased transportation costs associated with hauling biomass feedstocks farther distances. When assuming a circular collection area around a plant, the average feedstock haul distance increases by about 41 percent

[7] Perlack and Turhollow, 2002.
[8] Resource Dynamics Corporation, 2004.
[9] Energy Information Administration, 2004.
[10] Iowa State University, 2002.
[11] Perlack and Turhollow, 2002.

with every doubling of facility size.[12] The subsequent increase in hauling costs is not linear because the collection area increases exponentially as distance increases.

Government Support and Incentives

Many incentives are available for using biomass feedstocks in power generation applications, which can substantially help the economics of using biomass as a fuel source. A good resource for information on biomass incentives is the EPA CHP Web site (www.epa.gov/chp/funding/bio.html), where almost 100 incentives are listed by state, along with information on how to qualify and apply for each incentive.

[12] Perlack and Turhollow, 2002.