Biomass: Electricity Generation and Transportation Fuel

ScottMadden Assists Firms in Creating the Business Case for Biomass Electricity Generation and Biofuels

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Biomass

◆ Biomass is a broad term used to describe material of recent biological origin that can be used either as a source of energy or for its chemical components
  — Biomass includes trees, crops, algae, and other plants, as well as agricultural and forest residues
  — Biomass also includes many materials that are considered as wastes by our society including food and drink manufacturing effluents, sludge, manures, industrial (organic) by-products and the organic fraction of household waste
  — Biomass also includes corn, cereal grains, vegetable oils, fatty acids, tallow, and yellow grease
  — Finally, advanced biomass feedstock include algae, Camelina, and Jatropha

◆ Biomass has two “general” uses from an energy perspective
  — Use in electricity through power generation, cogeneration, or gasification
  — Use in transportation as a biofuel

◆ Recent legislation and energy/environmental policy actions have created incentives for use of biomass for electricity and for transportation fuel through biodiesel. Utilities, power generating companies, fuel companies, and others have an incentive to take a look at biomass
  — The United States government passed the Renewable Fuels Standard in 2005 (renewed it in 2007) calling for a mandated fuel production of biofuel escalating to 36 billion gallons by 2022
  — The United States Congress is currently considering a Renewable Portfolio Standard, mandating that portions of an electric utilities portfolio come from non-hydro renewables
  — 29 states + DC and PR have an RPS and 7 other states have goals
  — There are multiple regional greenhouse gas initiatives such as RGGI

◆ There are four basic approaches to sourcing biomass feedstock
  — Growing plants specifically for energy use (closed-loop)
  — Using the residues from plants that are used for other (open-loop)
  — Harvesting feedstock crops
  — Processing vegetable oils and rendering products
Biomass for Electricity Generation

- Biomass is an important and growing source of electricity consumption. In the United States in 2009, biomass generated 3,900,070 billion BTUs, representing 5.3% of total domestic energy production and 50% of the renewable energy profile. This is an increase from 1999, when biomass generated 2,965,132 billion BTUs representing 4.1% of total domestic energy consumption.

- Three of the primary forms of Bio-power production are direct-fired, cogeneration, and gasification.

- Direct fired generation
  - Similar to fossil-fuel fired power plants. The biomass fuel is burned in a boiler to produce high-pressure steam, which powers a steam turbine connected to an electric generator.
  - Biomass boilers are typically sized at 20-50MW and the conversion efficiency is around 20%.

- Co-firing generation
  - Substitute biomass for a portion of coal in a coal fired generating unit, reducing SO$_2$, NOx, mercury, CO$_2$, and other emissions.
  - Co-firing typically substitutes up to 5% of BTU input (varies by region), and the conversion efficiency is around 33-37%.

- Gasification
  - The heating of biomass to the point where it breaks down to a flammable gas.
  - Once biogas is cleaned and filtered, biogas is useable in combined cycle power generation. Plant efficiency with biomass gasification is around 60%.

- The biomass value chain is an involved process with several players and levels. The primary cost driver in the biomass value chain is feedstock. Feedstock costs vary widely, and supply is sometimes limited.

Biomass Feedstock

- Feedstock is the primary cost driver in biomass. Feedstock availability, transportability, competition, and costs all need to be a major consideration in a biomass project.

- In biofuels, feedstock accounts for ~80% of the cost of the final product. In electricity generation for biomass, the feedstock is also a significant cost driver and the costs vary widely depending on region, season, and availability.

**Feedstock sources are inherently localized**

- Traditional crops (and residues) are concentrated, as expected, in the Midwest.

- Wood harvest (and residues) are largely in the South; the Pacific Northwest; northern Minnesota, Wisconsin, and Michigan; and northern New England.

**Biomass supply has some uncertainties**

- Value of competing uses of biomass materials.

- Impact of biomass removal on soil quality.

- Forest fire prevention policies (whether removal of vegetation is encouraged).

Using biomass as a transportation fuel (biofuel) is another increasing trend in renewable energy. The Renewable Fuels Standard, originally passed with the Energy Policy Act of 2005 (EPACT) and increased with the Energy Independence and Security Act of 2007, calls for a mandated increase in renewable fuel mixed with conventional fuel. The RFS mandates the volume to go from 9 billion gallons in 2008 to 36 billion gallons in 2022. This standard has led to several government incentives for the production and use of biofuels. The two primary biofuels are ethanol and biodiesel.

**Ethanol**
- In the United States, ethanol is generally produced from domestic corn and replaces gasoline. Cellulosic ethanol is also a developing technology. Cellulosic ethanol is derived from “non-edible plant parts” such as grasses and woodchips. Ethanol will typically be blended with gasoline in a ratio of either 10% (E10) or 85% (E85). E85 requires a “flex fuel” vehicle for use.
- Ethanol generally distributes a heat content of 68% of the gasoline it replaces.

**Biodiesel**
- In the United States, biodiesel is generally produced from soybean oil or waste animal oils and replaces diesel fuel. Diesel fuel is typically blended in 2% (B2), 5% (B5), 10% (B10), and 20% (B20) blends.
- Biodiesel provides the heat content of 91% of conventional diesel fuel per gallon.

The value chain for biofuels is several steps and complex. The primary cost driver is feedstock (>80%).

The Renewable Fuels Standard established Renewable Identification Numbers (RINs). The RIN is a 38 digit number that gives information of the producer or supplier, the batch and year of the fuel, and the mount and worth of the renewable fuel used. All producers must meet a certain number of RINs in order to comply with the RFS program.

RINs serve as a currency for trade, credits, and compliance with the RFS program. Producers and importers can obtain RINs by purchasing biofuel on the RIN market. If the amount of renewable fuels produced is not sufficient to meet the RFS mandate, then the demand for RINs will increase as producers strive to meet their RIN objectives. An increased demand for RINs increases the RIN price, which improves the relative attractiveness of buying biofuels instead of RINs.
Biofuels

- As mentioned, the new Renewable Fuel Standard (RFS2) creates vast incentives for the refining of corn ethanol, biomass diesel, and cellulosic biofuels
- The RFS2 aggressively calls an escalating annual scale with 36 billion gallons of renewable fuels to be produced by 2022
- The EISA also calls for a reevaluation of the renewable fuels standard qualifying fuels by the EPA to determine lifetime GHG emissions. This impacts the incentives and qualifications for individual fuels.
- The EPA administrator has authority to temporarily waive or change the renewable fuels standard, if the standard will have a "major negative market effect"
- Food versus Fuel: A debate rages about using "food sources" such as corn and soy in fuel generation. Currently, around 1/3 of the corn crop in the United States is used for biofuel. When evaluating a biofuels project, it is important to understand this dynamic and debate

The RFS program was created under the Energy Policy Act (EPAct) of 2005. Under the Energy Independence and Security Act of 2007 (EISA), the RFS program was expanded to include biodiesel in addition to gasoline. Other expansions include:
- Increasing the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022
- Establishing new categories of renewable fuels and set separate volume requirements
- Requiring EPA to apply lifecycle greenhouse gas performance threshold standards to ensure that each category of renewable fuel emits fewer greenhouse gases than the fuel it replaces

Biofuels Feedstock

Feedstock is the primary cost driver for biomass and biofuel. It is important when developing a biomass plant or biofuels refinery to understand the various types of feedstock available.

Feedstock availability often shifts by region, climate, and season.

Once a proper feedstock has been chosen, a firm needs to develop a pricing model based on the forecasted price of the feedstock.

Various feedstock for biofuels typically have a strong correlation in price with each other, as is shown by the graph above.

The graph to the left shows the average prices for various feedstock over an eight-year period.

Previous prices and relationships serve as a guide to future prices, however, to have a full understanding, it is important to understand competition for the feedstock, the commercial market, and transportation limitations.

Sources: Jacobsen Feedstock Database: http://www.thejacobsen.com/
Creating the Business Case for Biomass

◆ When looking at creating a biomass energy facility or a biofuels plant, an intense study of the business case is required

◆ Feedstock is one of the largest expenses for either a biofuels refinery or a biomass energy facility. This cost driver is likely to be a key input to ensure an adequate return on the investment. To make the business case, a firm must:
  — *Examine regional feedstock supply*. Feedstock availability, whether it is crops, woodchips, trapped grease or other biomass, is an important issue in regards to the business plan. Biomass feedstock does not “travel” well and the distance to the sources will affect economics
  — *Examine existing and potential competitors*. Competition for biomass feedstock is increasing. Potential competitors include pulp and paper mills, the logging industry, utilities seeking to meet a renewable portfolio standard, wood pellet companies, livestock feed companies, and new ones each day. Understanding the competitive landscape, not just for the end product but for feedstock, is essential
  — *Run price forecasts and sensitivities*. Feedstock prices can vary widely regionally and seasonally. A thorough analysis of what the feedstock price will be and how it might move is important to understand break evens. It is also important to run a sensitivity analysis of this pricing model

◆ Understanding the market for the finished good (biofuel, especially) is also important in proving the business case. Government mandated renewable energy percentages and renewable fuels standards have made the market for these products strong, but have also led to more entrants in the market

◆ A full risk analysis should be completed. Large-scale energy investments are not without risk and it is important for a firm looking to invest in biomass technology to understand the risks and limitations from more than just a financial perspective

◆ A key to the business case is understanding the regulatory market that exists. The renewable fuels standard and the renewable energy mandate are just two parts of a local, state, and national regulatory framework surrounding energy and biomass. The regulations within this market are constantly evolving and being challenged. A proper knowledge and understanding of these regulations is essential to project justification

◆ An understanding of the relevant tax credits, grants and incentives. Through the American Recovery and Reinvestment Act and other congressional action, spending and tax credits for renewable energy have increased. However, it is important for a firm to have all the facts and documentation on these incentives before making assumptions in the plan
For nearly 30 years, ScottMadden has been a leader in energy consulting serving more than 200 energy organizations, including 90% of the top 20 utilities, and has completed thousands of projects. ScottMadden is active in renewable energy and clean tech opportunities for both utilities and biofuel companies.

Some of ScottMadden’s renewable energy qualifications and experiences include:

- Qualified by DOE to evaluate loan guarantee applications and has been selected to perform application reviews including one involving a biofuels refinery.
- Worked with a large utility to assess key elements of the surrounding biomass industry and to establish a strategy for developing new biomass capacity.
- Assisted a large national energy retailer in a renewable technologies strategic analysis and financial modeling for wind, solar, biomass, landfill gas, biofuels, carbon sequestration, and anaerobic digestion.
- Assisted a large manufacturing company in developing a renewables strategy leveraging their natural resource assets and assessing their existing skill sets to position them for entering the southeast U.S. biomass market.
- Assisted a CleanTech company in developing and submitting a DOE loan guarantee application.
- Assisted three CleanTech manufacturers in applying for and receiving Advanced Energy Manufacturing Tax Credits (AEMTC).
- Assisted a large utility with developing a Generation Development strategy to establish a wind and solar business model and develop these renewable assets.
For more information on Biomass, please contact us.

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