The Future of Woody Biomass in a Renewable Economy

As the United States uses less fossil fuel and more renewable energy, using woody biomass to produce energy and liquid fuel will likely become more commonplace. Using biomass to produce energy and fuels has been discussed since the 1970s, but little work has been done to advance this potential resource. Two reasons for the lack of work on renewable energy sources have been the resurgence of low-cost crude oil and its seemingly plentiful supply. Biomass research and development should be continued and expanded to ensure the use of woody biomass. This is particularly important for the southeastern U.S., where woody biomass is extremely abundant.

Biomass is plant material, such as wood or annual crops, that can be used in the production of energy or fuel. Biomass is a renewable resource and almost carbon-neutral. By definition, carbon neutral means that the amount of CO_2 released during the production of energy is either less or equal to the amount of CO_2 absorbed by the plant during growth. This is important, as the United States is focused on reducing CO_2 emissions.

Woody Biomass

The Energy Information Administration (EIA) specifically includes wood and wood waste in its definition of biomass. In addition to biomass, the EIA lists geothermal energy, wind, sun, and conventional hydropower as sources of renewable energy.

The Department of Energy (DOE) lists the Southeastern U.S. as the key geographic area for biomass production. The U.S. Department of Agriculture (USDA), DOE, and the U.S. Department of the Interior (DOI) define woody biomass as trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment, that are the by-products of restoration and hazardous fuel reduction treatments. They define woody biomass utilization as the harvest, sale, offer, trade, or utilization of woody biomass to produce the full range of wood products, including timber, engineered lumber, paper and pulp, furniture and value-added commodities, and bio-energy or bio-based products such as ethanol and diesel.

Uses of Wood for Energy

Using wood as a source of energy is certainly not new. The pulp and paper industry has long used wood as both a source of raw material and as an energy source, which helps to defray the cost of mill operations. Mills burn bark, wood fragments, unusable chips, and black liquor to produce steam energy. Woody biomass can also be used to generate electricity, create liquid biofuel, heat homes and businesses, and process energy. Biomass and biomass-derived gases supplied nearly 55,000 gigawatt hours (GWh), or one billion watt hours of electricity, in 2006. Biomass was made into nearly 6.5 billion gallons of ethanol nationwide in 2007.

Second-generation biofuels use woody biomass as raw material in developing liquid fuels such as ethanol, gasoline, and diesel. While the technology has been shown to work, the economic viability is still somewhat questionable.

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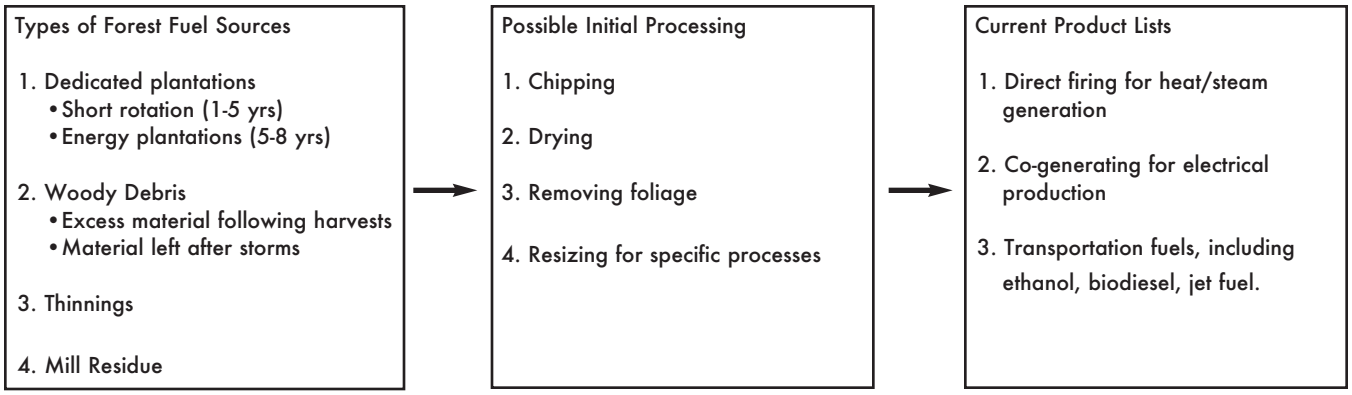

Generalized flowchart showing type of forest material that can be used for bioenergy production, possible initial processes, and current and possible future products.

However, there are currently several commercial-scale biorefinery projects under construction that will use wood as a source of fuel. These second-generation biofuel processes can convert woody biomass into higher-value fuels, such as clean diesel and jet fuel, as opposed to lower-value cellulosic ethanol (see flowchart).

The Sustainable Energy Research Center at Mississippi State University is developing a pilot facility to demonstrate technology to produce biofuels from forest and agricultural biomass. This technology has been proven in the laboratory. The first step in the production of fuels is to cause the thermal degradation of biomass in the absence of air. The term for this process is "pyrolyze." Pyrolyzing reduces the biomass to approximately 65 to 70 percent of its original weight and turns it into bio-oil. Bio-oil is a dark, acidic liquid. Its viscosity varies over time because it contains so many reactive chemicals. The pyrolysis process degrades small (2 to 4 mm or 0.08 to 0.16 in) biomass particles in less than 2 seconds at approximately 500ºC. Then, the liquid is condensed just as quickly to produce the final, raw bio-oil.

At MSU, the bio-oil is then upgraded into either boiler or transportation fuels. Currently, boiler fuel is produced in the pyrolysis reactor at the same time bio-oil is produced. The boiler fuel produced is called esterified bio-oil. Yield is 98 percent with acidity of the bio-oil reduced by half and heating value increased by 30 percent. Boiler combustion tests show that the MSU formula and process for esterified bio-oil produce a boiler fuel that can fire any boiler type that has been modified slightly.

A second, and more complete, bio-oil upgrading process is performed by application of hydrodeoxygention (HDO) of raw bio-oil to produce a mixed hydrocarbon liquid containing approximately one-third each of gasoline, diesel, and jet fuel molecules. This fuel can be distilled for direct combustion in engines or can be refined into fuel usable by today's cars.

In 2010, MSU constructed a 10,000 square-foot building to house a 1-ton-per-day pyrolysis reactor and both esterified bio-oil fuel and hydrocarbon production systems. Larger amounts of the upgraded fuels will be produced and tested in commercial boilers and engines to inform future commercialization.

Twenty-one billion gallons per year of second-generation biofuels (cellulosic ethanol and other advanced biofuels) will have to be produced from woody biomass to meet the EIA mandate for 36 billion gallons per year of biofuels by 2022.

Advocates of woody biomass have at times overlooked or oversimplified the complexity of even the most basic processes required to build the biofuel industry. This potentially huge industry will require a way to collect, transport, and store biomass. Producing billions of gallons of ethanol will require millions of tons of woody biomass. Moving that material efficiently, safely, and with as little impact on infrastructure and the environment as possible will be a major challenge in the years ahead.

However, it is important that forests be harvested in an environmentally sound or sustainable manner. Under a sustainable management system, today's biomass harvests will not compromise tomorrow's biomass possibilities. Using natural forests or dedicated plantations to produce woody biomass can be productive as long as the practice does not harm crop production or existing environmentally sound forest management. These are some of the benefits of woody biomass:

- Requires fewer expensive conversion technologies
- Offers opportunities for regional energy self-sufficiency
- Is a viable alternative to fossil fuel
- Reduces greenhouse gas emissions
- Helps local farmers, entrepreneurs, and rural populations reach their potential for sustainability

Government Programs for Biomass Production for Biofuels

The Biomass Crop Assistance Program (BCAP), which was a new initiative in the 2008 Farm Bill, provides an economic incentive for producing renewable energy. However, as of February 2010, this program has been suspended pending a 60-day comment period. Based on an early report that the USDA would spend $517 million in the first quarter of 2010 alone, it was widely speculated that the program would cost $2 billion per year.

Proposed Rule Changes

The biggest change in the BCAP is likely to be the amount of the payments. In the original rules, suppliers to any facility that produced electricity either for sale to the grid or for its own use were eligible for a dollar-for-dollar matching payment for every dry ton of delivered eligible material, up to $45 per ton. The new rules recognize that this payment amount would make the program cost prohibitive.

Therefore, the proposed rules offer three options for structuring payments:

- A dollar-for-dollar per bone-dry ton (BDT) matching payment except for suppliers of facilities converting wood wastes and residues into heat or electricity for their own use. Suppliers to these facilities would receive dollar-for-dollar matching payments on eligible materials used to produce heat or electricity above their historic baseline. This payment structure encourages new renewable energy production but does not reward those who have been producing renewable energy.
- A tiered approach where suppliers to biofuels facilities would receive the dollar-for-dollar per BDT matching payment, not to exceed $45 per BDT. Suppliers to facilities producing heat, power, renewable energy, or biobased products would receive a lesser amount, roughly $16 per BDT, or an amount based on the value of lower carbon emissions. This approach favors biofuels production over other types of renewable energy.
- A dollar-for-dollar per BDT matching payment for all facilities based on production above an historic baseline. The full payment, up to $45 per BDT, would go to new facilities and facilities such as schools and public buildings that convert from fossil fuel to renewable biomass, for eligible materials showing exceptional promise and innovation, and for consumption above a baseline. Payments would be reduced for facilities that do not increase production over their historic levels. This structure would provide some reward to those who have historically produced their own heat and electricity from biomass.

Conclusion

The availability of fossil fuels and their volatile cost, especially transportation fuel, has driven nations from around the world to develop renewable sources of energy. The United States is certainly not immune to this affect as witnessed in the 1970s Arab oil embargo. The biomass industry is still in its infancy. Most biomass fuels are burned directly, such as pellets, wood/bark waste, and chips for use in co-firing. With advances in technology, woody forest biomass can be converted to liquid fuels as well as higher-valued products and chemicals.

The southeastern U.S. possesses the climate and land availability to produce a considerable amount of biomass, but this should not be at a loss of agricultural production or elimination or overuse of our existing natural forests. A combination of dedicated forest biomass plantations, thinnings from traditional plantations, and logging residue will provide the majority of the forest biomass.

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