Biopower

Power production from biomass can help meet renewable energy goals.

Generating electricity and thermal energy from biomass has the potential to help meet national goals for renewable energy. The forest products industry has used biomass for power and heat for many decades, yet widespread use of biomass to supply electricity to the U.S. power grid and other applications is relatively recent.

In 2008, the United States generated more than 11,000 megawatts of biopower from landfill gas, sorted municipal waste, wood residues, and other sources—primarily for use by the forest products industry, utilities, and large institutions.[1] After hydropower, biopower provides a larger share of the world's electricity than any other renewable energy resource.[2]

Electricity can be generated from a wide range of biomass, which is any organic matter like wood, plants, agricultural waste, and other materials. Biomass can be converted into electricity using processes similar to those used with fossil fuels, such as the following:

Direct-fired

Most biopower plants use direct-fired systems, which burn biomass directly to produce steam. The steam then drives a turbine, which turns a generator to convert the power into electricity.

Co-fired

Co-firing systems involve the mixing of biomass with fossil fuels in conventional power plants after some modification of the existing equipment.

Gasification

Through gasification, biomass is heated in an environment that enables the solids to be converted into a synthesis gas, which can then be burned in conventional boilers or used in turbines to produce electricity.

In converting biomass into biofuels and other products, integrated biorefineries can use lignin and other residues to generate biopower for use in processing or for sale to the grid.

These biomass technologies generate varying amounts of electricity depending on the size of the technology deployment and the biomass resource itself. Biomass can also be used in combined heat and power (CHP) systems to produce both heat and electricity. With system efficiencies as high as 60-80%,[3] CHP is an effective use of biomass and enables recovery of waste heat for use in heating or cooling. Modular or small systems provide power on a scale that is appropriate for use by communities, farms, commercial buildings, and small industry.[4]

Benefits of Biopower

- Provides a clean, domestic, dispatchable renewable source of power for the nation (life-cycle basis)
- Revitalizes rural economies
- Reduces impacts on the environment and climate (biomass can be carbon neutral and has lower sulfur content than coal)
- Provides energy on demand (the energy can be stored in the biomass until needed)
- Promotes healthy forests and use of residue, with little competition for agricultural land
- Creates diversified job market in agribusinesses, utility and power plant vendors, and equipment suppliers
- Increases the diversity of the U.S. energy supply

[1] Energy Information Administration. *Electric Power Annual 2008*. Table 1.1.A. Existing Net Summer Capacity of Other Renewables by Producer Type. January 2010.
[2] International Energy Agency, *Renewables and Waste in World in 2007*, www.iea.org/stats/renewdata.asp?COUNTRY_CODE=29.
[3] International Energy Agency, *Energy Technology Perspectives 2008*, p. 328.
[4] www.eere.energy.gov/biomass/abcs_biopower.html; www.nrel.gov/learning/re_biopower.html

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Trends and Drivers

Biomass is available across the United States, offering a renewable energy resource even in regions without other renewable options. It can also be transported and stored until use, providing a reliable resource for baseload power production. In addition, cofiring of biomass with coal can be an effective strategy to reduce carbon emissions or complement intermittent renewable energy sources, such as wind and solar.

Growth of the U.S. biopower industry relies on technology improvements and an adequate supply of suitable biomass—as well as favorable regulations, policies, and financial incentives. For example, more than half of all states have adopted Renewable Portfolio Standards, which require a minimum share of electricity to be produced from renewable sources. A Federal standard is currently under consideration, which could create additional demand for biopower. Future carbon legislation could also foster major expansion of the industry. Additional incentives are provided by production tax credits, investment tax credits, and stimulus funding.

Next Steps

In December 2009, the DOE/EERE Biomass Program held a *Biopower Technical Strategy Workshop* to explore biopower opportunities in the United States. Workshop participants explored the challenges and potential solutions to expand use of biopower, including technology research, development, and demonstration; policies; and other market transformation mechanisms. The participating experts from industry, academia, national laboratories, and government provided ideas and insight that are being used to inform the strategic planning process and to help map future research priorities in sustainable biopower.

The 2011 DOE budget request includes funding for a new initiative in biopower, but funds have not yet been appropriated. As with the Biomass Program's biorefinery projects, this new initiative would address the entire supply chain from feedstock cultivation to large-scale power generation, providing clean energy solutions for an emerging low-carbon economy.

Challenges Identified During the Biopower Workshop

- **Cost:** High cost of biopower relative to coal-based electricity
- **Sustainable Feedstock Supply:** Lack of reliable, consistent, year-round supplies of suitable biomass
- **Biomass Conversion and Performance:** Uncertain performance of feedstock impacts on existing boilers (e.g., corrosion, efficiency)
- **Policy Uncertainties:** Lack of a national Renewable Portfolio Standard, creating inconsistent incentives across regions, and other uncertainties, such as cap and trade legislation, greenhouse gas impacts, and permitting requirements
- **Disparate Tax Incentives and Policies:** Uneven tax parity for different renewable energy sources
- **Inadequate Techno-economic Analysis**: Lack of well-characterized, techno-economic impacts on life cycle and systems
- **Technology Demonstration:** Lack of demonstrated performance for all technologies at all scales (especially for co-firing, advanced biopower, next-generation feedstocks) to enhance investor confidence

Potential Path Forward

To move toward a widespread, sustainable U.S. biopower industry, possible activities may include:

- Supporting research and development on processing of biomass feedstock to achieve higher density, higher heating value, and better suitability for transport
- Validating and demonstrating low-carbon power generation technologies

For additional information visit: www.biomass.energy.gov

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