

Biopower Program, Activities Overview



Introduction to Biopower

Biomass power provides two valuable services: it is the second most important source of renewable energy in the United States, and it is an important part of our waste management infrastructure. Biomass is a substantial renewable resource that can be used as a fuel for producing electric power, steam, and heat. Biomass fuel used in today's power plants includes wood, agricultural, and food processing residues. In the future, farms cultivating high-yielding energy crops (such as trees and grasses) will significantly expand our supply of biomass. These energy crops, coupled with high-efficiency conversion technologies, can supplement our consumption of fossil fuels and help us respond to global climate change concerns.

Biomass is a proven option for electricity generation. Currently, more than 7,000 megawatts (MW) of biomass power capacity are installed at more than 350 plants in the United States. A diverse range of biopower producers

includes electric utilities, independent power producers, and the pulp and paper industry.

To help expand opportunities for biomass power production, the U.S. Department of Energy (DOE) established the Biopower Program, originally called the Biomass Power Program, and is sponsoring efforts to increase the productivity of dedicated energy crops. The Program aims to double biomass conversion efficiencies, thus reducing biomass power generation costs. These efforts will promote industrial and agricultural growth, improve the environment, create jobs, increase U.S. energy security, and provide new export markets.

Where Is Biomass Power Headed?

The Biopower Program strives to integrate sustainable farms and forests with efficient biomass power production to provide significant, cost-competitive power. The Program's goals include:

- Develop and produce environmentally acceptable energy crops.
- Commercialize high-efficiency biomass power conversion technologies.
- Implement biomass resources to provide electricity at the highest standards of environmental performance.
- Enhance public understanding of the technical, environmental, and economic attributes of biomass power.
- Support the establishment of biomass power as a credible and attractive option for power producers, marketers, and buyers.

Biopower Benefits

Energy produced from renewable crops such as trees and grasses offers many benefits to power producers and marketers, consumers, and communities.

Environmental Benefits of Biopower

Biomass power is a carbon-neutral electric power generation option. Biomass absorbs carbon dioxide from the atmosphere during its growth and then emits an equal amount of carbon dioxide when it is processed to generate electricity. Thus, biomass fuels "recycle" atmospheric carbon, and may reduce global warming impacts.



Warren Greitz, NREL/PIX08349

Switchgrass—a high-yield energy crop.



Warren Greitz, NREL/PIX06359

McNeil Power Generating Station in Burlington, Vermont

Biomass fuels produce virtually no sulfur emissions that can form acid rain. Biomass directly reduces sulfur emissions when it is cofired with coal.

The use of waste biomass reduces the volume of material sent to landfills, which extends their lives.

Biomass combustion results in less ash per Btu than coal, reducing ash disposal costs and landfill space requirements. The biomass ash can also be used as a soil amendment.

Perennial energy crops (grasses and trees) have distinctly lower environmental impacts than conventional farm crops. Energy crops require less fertilizer and herbicide. They offer year-round vegetative cover, provide protection against soil erosion, guard against watershed deterioration, and improve wildlife habitat.

Economic Benefits of Biomass Power

By reducing sulfur emissions, biomass power creates sulfur emissions credits that can be sold. By 2020, more than 30,000 MW of biomass power could be installed; about 60% of the fuel would be supplied from more than 10 million acres of energy crops and the remainder from biomass residues. This would support more than 150,000 U.S. jobs and would substantially revitalize rural economies.

Biomass energy crops can be profitable for farmers because they will complement, not compete with, existing crops and thus provide additional income for the agricultural industry. They will probably be grown on currently underutilized agricultural land.

In addition to rural jobs, expanded biomass power will create high-skill, high-value job opportunities for utility and power equipment vendors, power plant owners and operators, and agricultural equipment vendors.

Biopower Program Activities – Private Sector Participation Pushes Biomass Energy Forward

The private sector is collaborating with the Biopower Program to validate next-generation advanced biomass power technologies and integrated biomass energy systems.

Biomass Gasification

The Biopower Program is working with a private sector team on a major biomass gasification demonstration project in Vermont. The Vermont Biomass Gasifier Project is demonstrating the integration of the Battelle “indirect” gasifier with a high-efficiency gas turbine at the 50-MW, wood-fired McNeil Power Generating Station in Burlington, Vermont. Wood chips fuel the gasifier and the resulting “biogas” is piped to the power plant. This gasifier will provide a showcase to demonstrate how this efficient technology can be used to generate clean electricity from wood.

Biomass Power for Rural Development

DOE and the U.S. Department of Agriculture (USDA) are partnering to enhance the development of electricity generation systems that use biomass instead of fossil fuels.

Using biomass for energy production is beneficial to the nation, especially to rural areas. National benefits include lower acid rain-producing emissions, reduced greenhouse



Daniel Peck/PIX05084

Dedicated crops of fast-growing trees, like these willows, can be mechanically harvested every three years for a ready supply of biomass to generate electricity.

gas emissions, and less dependence on fossil fuels. Rural benefits include new sources of income for farmers, more jobs, and economic development, all achieved while preserving a high quality of life, local control, and lack of pollution. When economic development does not harm the environment or jeopardize our children's future, we call it sustainable development. In the projects established throughout the nation to demonstrate and validate biopower production, we hope to embody the principles of sustainable development at its best.

DOE and USDA collaborated on several projects in rural America under the Energy Partnerships for a Strong Economy Program. The projects aim to establish the viability of dedicated biomass crops as fuel sources by demonstrating and deploying integrated biomass power systems. Crops in the study included switchgrass, poplar trees, and willow trees. Each project contained three phases:

- Engineering Design (Phase 1)—integrated system development, engineering, permitting, and licensing.
- Demonstration (Phase 2)—establishment of biomass crops, facility construction, and system testing.
- Commercialization (Phase 3)—economically sustained commercial enterprise.

Green Power

People often refer to Green Power as power systems that have a positive environmental impact relative to coal-, oil-, or nuclear-fueled systems, and that use a renewable

fuel. Some states' legislation will mandate Green Power in renewable energy portfolios. In other legislation, Green Power will be an option for which consumers will pay a premium price. Growth in the popularity and acceptance of Green Power provides an opportunity for increased use of biopower.

Small Modular

Small modular biomass power systems have the potential to supply electricity to more than 2.5 billion people who presently live without it. Biopower also has a great potential for distributed applications (small electricity sources attached to the electrical grid and close to the point of use) in industrialized regions. Small modular systems are factory built with power capacities in the range of 5 kW to 5 MW. DOE's Small Modular Systems Project works with industry to develop efficient and clean small biopower systems.

Cofiring

An important focus of the Biopower Program is to help foster cofiring of biomass in coal-fired power plants. Cofiring is a low-cost option for addressing global climate change concerns that substitutes some biomass for coal and does not expand capacity. It is commercially used or being actively tested at 19 facilities in the United States. A key issue with regard to cofiring relates to uses for fly ash. Electric utilities often sell a portion of their fly ash for use as an additive in cement and concrete applications. However, the coal fly ash must meet specifications in an American Society for Testing and Materials standard (C618) for these applications. Tests are underway to determine whether biomass power ash will meet the standard, or whether a new standard for this useful by-product is in order. The biomass power industry may also look to ash from other combustion applications for examples of productive outlets.

Marketing

Green Power is one focus of Biopower Program marketing efforts. Biomass is well suited to meeting the renewable energy requirements inherent in the definition of Green Power. Target customers include energy consumers, power producers and marketers, government policy and legislative experts, and regulatory agencies.

The Biopower Program marketing tools include:

- Technical papers
- Life cycle studies
- Economic studies
- Environmental studies
- Cofiring and small modular systems development



Warren Gretz NREL/PIX04157

The Thermochemical Users Facility, where research into biomass power generation is carried out by the NREL researchers.

- Information dissemination
- Green Power support

NREL Biomass Power Update

The National Renewable Energy Laboratory (NREL) develops efficient integrated biomass power technologies for domestic baseload power and export opportunities. NREL works with industrial partners to demonstrate the economic and technical viability of advanced biomass power technologies.

Thermochemical Research and Development

NREL works to improve the performance of advanced conversion technologies for gas turbines using biomass-derived gas, demonstrate the technical merit of gasifiers and fuel cells, and collaborate with industry to improve the design of combustion systems.

Systems Development

NREL systems development work includes process engineering, assessment of integrated resource supply systems, pre-feasibility studies of new systems, demonstrations, and technical support for rural commercial projects.

Communications Center

Information about demonstration and R&D projects, which underscores biomass power's advantages, is available through NREL's Communications Center. This information could be beneficial to a diverse audience, including the power industry, regulatory and government agencies, the agricultural industry, and consumers in the residential, commercial, and industrial sectors, especially in rural areas. Information is available on the Internet at www.eren.doe.gov/biopower. This site also gives direct access to many publications on biomass power and DOE's Biopower Program. Some of these publications are listed below.

Recent Publications

- Mann, M.K.; Spath, P.L., *Life Cycle Assessment of a Biomass Gasification Combined-Cycle System*
- Spath, P.L.; Mann, M.K.; Kerr, D.R., *Life Cycle Assessment of Coal-Fired Power Production*
- Morris, G., *The Value of the Benefits of U.S. Biomass Power*
- Wiltsee, G., *Urban Wood Waste Resource Assessment*
- Robinson, A.; Baxter, L.; Junker, H.; Shaddix, C.; Freeman, M.; James, R.; Dayton, D., *Fireside Issues Associated with Coal-Biomass Cofiring*
- Overend, R.P., *Production of Electricity from Biomass Crops—U.S. Perspective*
- DOE Biomass Power Program Strategic Plan: 1996–2015.*
DOE/GO-10096-345, DE97000081, December 1996

For More Information

Visit the Biopower Web Site:

<http://www.eren.doe.gov/biopower>

For copies of print documents on renewable energy, call DOE's Energy Efficiency and Renewable Energy Clearinghouse (EREC) 1-800-DOE-EREC (1-800-363-3732)

