



A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

The mission of the U.S. Department of Energy (DOE) Office of the Biomass Program (OBP) is to partner with industry to foster research and development on advanced technologies that will transform our abundant biomass resources into clean, affordable, and domestically-produced biofuels, biopower, and high-value bioproducts.

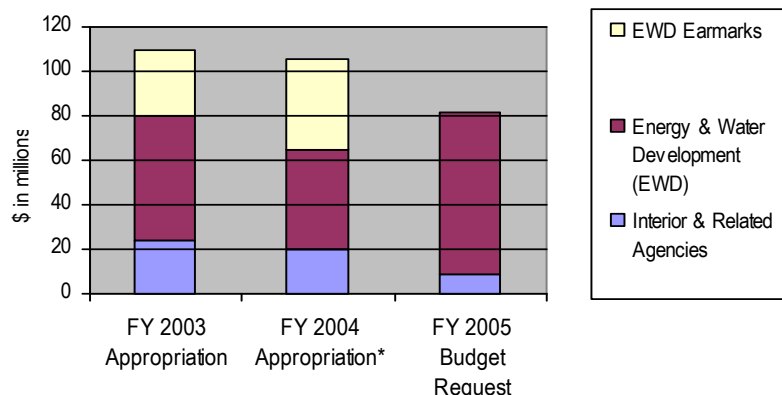
The results will improve economic development, expand energy supply, and increase energy security in the United States. To carry out its mission, the Program funds research, development, and deployment projects and activities with industry, academia, DOE National Laboratories, and state and local partners. R&D projects are mainly funded through competitive solicitations and use merit reviews to award proposals in alignment with Program goals and objectives. Program R&D is cost shared with industry, ranging from 20 percent in the early stages of R&D to 50 percent or more as the research moves closer to commercial development.

One of the Program's legislative drivers, the *Biomass Research and Development Act of 2000*, directs DOE and the U.S. Department of Agriculture (USDA) to increase cooperation and collaboration related to biomass research in order to foster a domestic bioindustry. The *Biomass R&D Act* also established a Technical Advisory Committee that created *Vision* and *Roadmap* documents, which set far-reaching goals and pathways to increase the role of biomass in the U.S. economy by 2020: 10 percent of transportation fuels; 5 percent of electricity and heat demand in utilities and industry; and 18 percent of chemicals and materials produced in the U.S. R&D projects in the Program's multi-year technical plan (MYTP)

address technical barriers to biomass production in order to help industry achieve the goals set by the congressionally-mandated Technical Advisory Committee. The MYTP is revised annually, based on progress made towards program goals and budget availability.

In FY 2005, DOE is requesting \$81.3 million for Biomass Program activities (see *Figure 1*). The FY 2004 Energy and Water Development biomass appropriation included nearly \$41 million in congressionally-directed activities.

Figure 1: Office of the Biomass Program Budget History



* Reflects \$4.9M from the Industrial Technologies Program for gasification managed by OBP

The Biomass Program is guided by:

- The President's National Energy Policy
- The Biomass R&D Act of 2000
- U.S. Department of Energy and Office of Energy Efficiency and Renewable Energy strategic plans
- The Biomass R&D Technical Advisory Committee
- Technical Peer Reviews

Program R&D Strategy

The Program has five core R&D areas that can be categorized as either pre-commercialization or systems validation (see *Figure 2*). There are four pre-commercialization R&D areas: Feedstock Interface core R&D; Sugar Platform core R&D; Thermochemical Platform core R&D; and Products core R&D. The fifth R&D area, Integrated Biorefineries, is considered a large-scale systems validation effort and is exclusively industry-led. The Program's work breakdown structure provides an overview of the types of activities within the five core R&D elements (see *Figure 3*).

Biomass Feedstock Interface R&D

The Biomass Feedstock Interface R&D objective is to develop sustainable technologies capable of providing the necessary large supply of low-cost, high-quality lignocellulosic biomass to biorefineries that produce fuels, combined heat and power, chemicals, and other materials. The goal is to develop the technologies and methods necessary in the feedstock infrastructure to produce one billion tons of cellulosic feedstock per year in a sustainable manner at \$35 per ton or less, with a near-term objective of 150 million dry metric tons per year by 2010. The long-term objective of one billion tons of sustainable biomass supply is based on an estimate of the amount of biomass it would take to meet one-third of the current demand for gasoline in the United States.

The Program is working with industry and university partners to remove technical barriers to achieving this goal in the areas of emerging

In 2000, DOE established the National Bioenergy Center (NBC) to unify all the relevant biomass laboratory resources, provide technical assistance, and manage the core research activities of OBP. NBC, which is managed by the National Renewable Energy Laboratory (NREL), includes research and development supported by OBP that is carried out at NREL, Oak Ridge National Laboratory (ORNL), Pacific Northwest National Laboratory (PNNL), Idaho National Engineering and Environmental Laboratory (INEEL), and Argonne National Laboratory (ANL). Each national laboratory has primary capabilities to support OBP R&D.

and advanced feedstocks and feedstock supply chain analysis. Program R&D is making progress on improving feedstock infrastructure technology, along with analysis and modeling tools, to forecast feedstock supplies and supply chain costs from an agricultural setting to a biorefinery. The Program also works closely with USDA to overcome feedstock barriers, such as the lack of a sustainable biomass supply.

Sugar Platform Core R&D

The Sugar Platform involves the breakdown of biomass into raw component sugars using a range of chemical and biological processes. The objective of the Sugar Platform is to develop the capability of biomass to produce inexpensive sugar streams that can be used to make fuels, chemicals, and other materials that are cost competitive with conventional commodities. The residues from this process can also be used for power or to make other products.

Figure 2: Biomass Program's Five Core R&D Areas

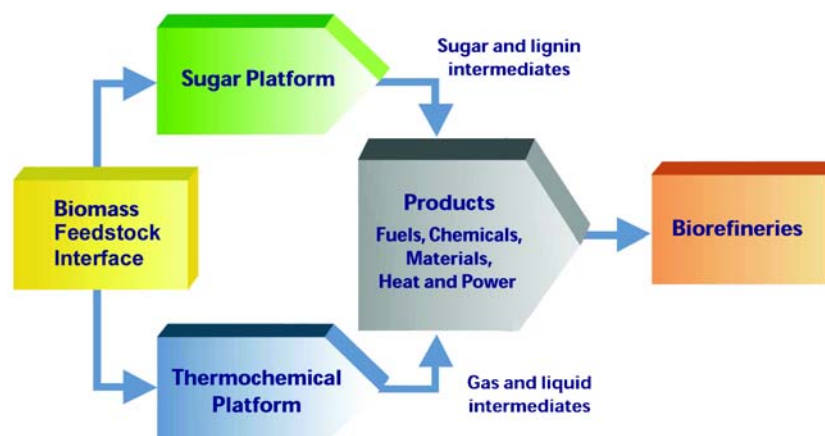
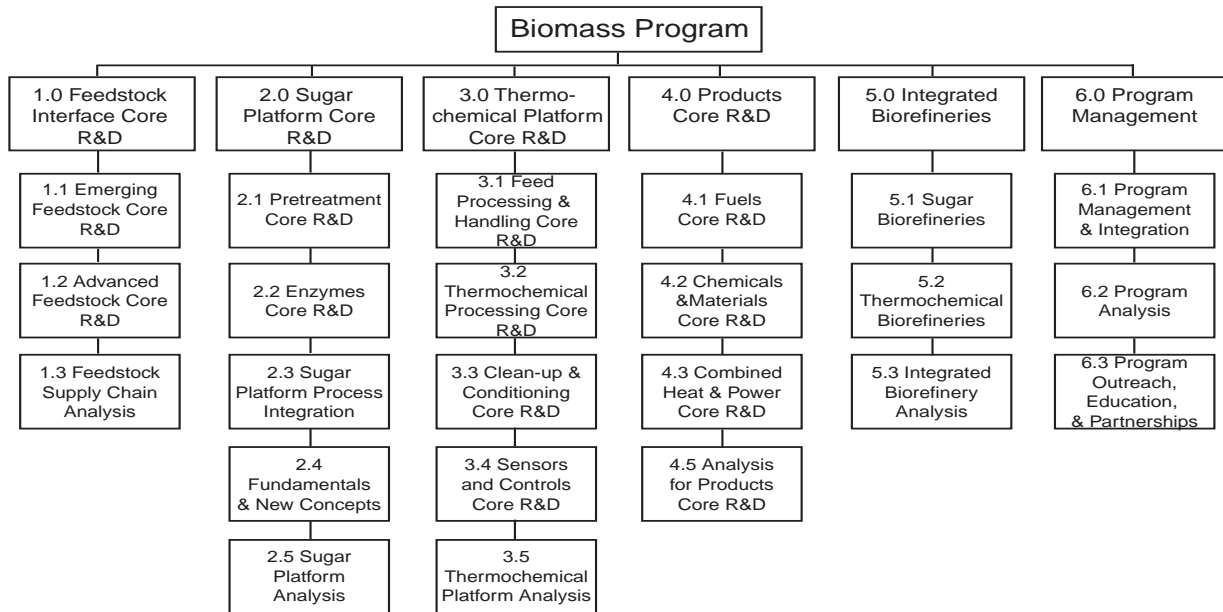


Figure 3: Biomass Program Work Breakdown Structure



To be competitive with fossil fuels, the technical goal is to reduce the cost of sugar feedstock streams suitable for fermentation from the 2003 estimated cost of \$0.14/lb to \$0.10/lb by 2012. This cost decrease, combined with private industry's work on improving fermentation strains, could produce ethanol that is cost competitive in the current fuel ethanol markets.

Today, the industrial sugar platform exists in the corn processing industry (wet and dry corn mill operations) and in the nearly three-billion gallon per year fuel ethanol industry. These industries are a foundation for next generation technology that will produce products from lower cost sugar sources (e.g. corn stover). The Program is working with industry and university partners on R&D that addresses the barriers to achieving technical goals. This includes work on pretreatment, enzymes, process integration, and fundamental knowledge of recalcitrance.

Thermochemical Platform R&D

The Thermochemical Platform's emphasis is on converting biomass or biomass-derived biorefinery residues to intermediates such as pyrolysis oil and syngas. These intermediates can be used directly as raw fuels or products, or may be further refined to produce fuels and products that are interchangeable with existing commercial commodities such as oils, gasoline, diesel, synthetic natural gas, and high-purity hydrogen.

The main technical barrier to achieving the objective of the Thermochemical Platform is reducing the cost and improving the quality of intermediates, in order to make final products cost competitive with existing commercial commodities. For example, one of the Program's goals is to reduce the cost of producing syngas from \$9.00/MMBtu (2003 estimated cost) to \$7.38/MMBtu (our intermediate target) by 2012, to be competitive with fossil fuels. Syngas could also be upgraded to hydrogen, at an additional cost.

R&D projects in gasification, pyrolysis, and hydrothermal processing have been identified to address the Thermochemical Platform's technical barriers. The Program is partnering with industry to leverage its experience with these technologies.

Products R&D

The area of biobased products represents a major new market opportunity for domestically-grown biomass resources. The Products R&D goals, along with the projects addressing technical barriers to achieving these goals, are linked to the Sugar and Thermochemical Platform outputs. For example, the Products R&D portfolio targets conversion of platform intermediates (i.e. sugar, syngas, and pyrolysis oil) to final products such as fuels and chemicals.

Product R&D also has the goal of developing three commodity-scale chemicals that can be produced in an integrated biorefinery – to prove

the concept that multiple products can be produced in one biorefinery. Although the focus will be on products with large-volume, value-added markets, the Program's R&D portfolio includes developing new technology to increase the value of more complex and lower-value platform outputs such as lignin, char, and protein residues. The Program expects that technology for each of these three products will be developed by industry, with support from DOE National Laboratories. Companies will then build biorefineries that optimize profits by adjusting product ranges to meet market demands. Because of this expectation, Products R&D projects are cost shared with industry partners.

Integrated Biorefineries

An Integrated Biorefinery is the ultimate deployment strategy for the Program. A biorefinery embodies a facility that uses biomass to make a range of fuels, combined heat and power, chemicals, and materials in order to maximize the value of biomass. The Program is taking a systems integration approach that translates the technical successes achieved in each of the other four core R&D areas to an integrated market-ready biorefinery. The Program will leverage partnerships with industry and academia in order to: 1) complete technology development necessary for start-up demonstration of an integrated biorefinery by 2007; and 2) help U.S. industry establish the first large-scale sugar biorefinery based on agricultural residues by 2010.

The barriers to an integrated biorefinery are largely addressed through the other core R&D areas. However, certain barriers are specific to the demonstration and deployment of a commercially successful biorefinery, such as the challenge of feed-to-product process integration and the inherent financial and engineering risks of pioneer technology. In 2002, the Program awarded funds to six major biorefinery development projects in partnership with U.S. industry. These projects focus on new technologies for integrating the production of biomass-derived fuels and other diverse products into a single facility. Activities range from research on feedstock-specific catalysts to integration of new technology into the biorefinery.

Measuring Results

The R&D portfolio is linked to the Program's goals, objectives, and technical barriers aimed at reducing U.S. dependence on foreign sources of oil and creating a domestic biobased industry. The Program manages its project portfolio using Stage Gate Management, a proven process for screening, selecting, and evaluating R&D investments. The Program also performs peer reviews to obtain input on its R&D portfolio from key stakeholders and technical experts. Additionally, the Technical Advisory Committee evaluates and performs strategic planning on Program activities, advises the Secretary of Energy and the Secretary of Agriculture on the technical focus and review process for the joint solicitation, and facilitates partnerships among key stakeholders. Moreover, the benefits of the Program's investments are reported to Congress in the DOE's Office of Energy Efficiency and Renewable Energy (EERE) annual Government Performance and Results Act (GPRA) response.

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Visit the Biomass Program Web site at:
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Or, visit the Biomass R&D Initiative Web site at:
www.bioproducts-bioenergy.gov.

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