Replacing the Whole Barrel

The emerging U.S. bioenergy industry will provide a secure supply of advanced biofuels, biopower, and bioproducts from a range of biomass resources. Abundant, renewable bioenergy can help secure America's energy future, reduce our dependence on foreign oil, and support American prosperity while protecting the environment.

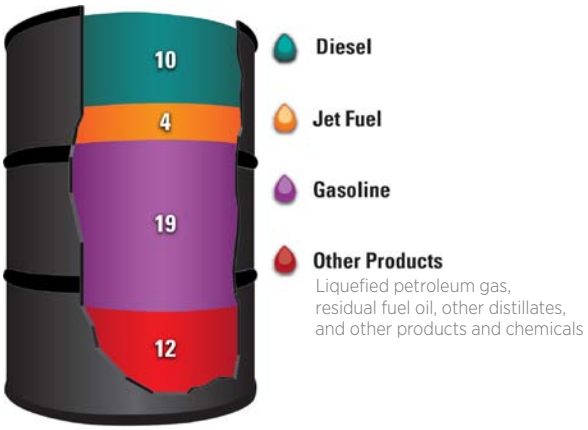
Expansion of the U.S. bioindustry relies on the research and development (R&D) of efficient new technologies and systems. Cost-effective systems are needed to sustainably produce, harvest, and transport large quantities of diverse feedstocks, convert biomass to infrastructure-compatible fuels, and efficiently deliver these fuels to consumers across the nation.

Strategic Approach

To reduce U.S. dependence on imported oil, the nation needs to displace the whole barrel. Since only about 40% of a barrel of crude goes toward conventional petroleum gasoline, technologies are needed to transform domestic, renewable resources into commodities that can displace diesel, jet fuel, heavy distillates, and a range of chemicals and products made from crude.

The U.S. Department of Energy's (DOE's) Biomass Program works with industry, academia, the national laboratories, and nonprofits to develop advanced technologies and real-world solutions to reduce costs and spur market growth. Through a broad portfolio of research, development, and demonstration (RD&D) projects, DOE is facilitating technology advancements that accelerate the sustainable production of clean, affordable biofuels.

Products Made from a Barrel of Crude Oil (Gallons) in 2010



Graphic by BCS Incorporated; Data from the U.S. Energy Information Administration

DOE's Biomass Program is accelerating development of a sustainable U.S. bioindustry to improve our nation's energy security, stimulate the economy, and reduce climate impacts. *Photos: iStock 000002167587, 000000499269, NREL/PIX 00102; montage by BCS Incorporated*

Unlocking the potential of diverse, non-food biomass resources—such as switchgrass, agricultural and forest residues, municipal waste, and algae—will yield advanced biofuels that are compatible with our existing vehicles and infrastructure. These advanced hydrocarbon or "drop-in" fuels include renewable gasoline, aviation, and diesel fuels.

Mission

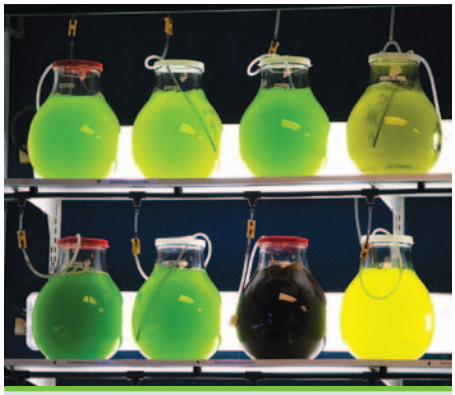
Develop and transform our renewable biomass resources into cost-competitive, high-performance biofuels, bioproducts, and biopower through targeted research, development, demonstration, and deployment supported through public and private partnerships.

Sustainability and Strategic Analysis

DOE's sustainability efforts address environmental, social, and economic issues along the entire bioenergy supply chain. The Biomass Program uses analytical tools, data, and methodologies to support decision making across a range of biofuels scenarios, to focus research on pathways with the best potential for commercialization, and to demonstrate progress toward goals. Through field- and laboratory-based research, computer modeling, and advanced analysis, the program investigates the life-cycle impacts of bioenergy production on greenhouse gas emissions, air quality, soil quality, water, biodiversity, and land use.

Terrestrial and Aquatic Feedstocks

The success of the U.S. bioenergy industry depends in part on the quantity and quality of biomass available, as well as the industry's ability to collect, store, and cost-effectively transport it. In cooperation with several partners, the program is identifying sustainable biomass feedstock resources; developing economically viable and environmentally sound production methods; and designing, building, and demonstrating feedstock logistics systems to ensure resource readiness at an appropriate cost. While the program focuses on several types



Algae R&D focuses on genetics, strain development, cultivation strategies, harvesting, and dewatering, as well as sustainability and siting considerations. *Photo from iStock/5312772*

of herbaceous and woody feedstocks and residues, it also supports algal feedstock R&D. Advances in algal research may lead to the sustainable production of algae-derived biofuels, opening up another potential source of abundant, cost-effective, and sustainable domestic biomass supply. The challenges in using algae as a feedstock are to lower the cost of its production, harvesting, and extraction.

Conversion Processes

Biomass Program conversion efforts focus on pathways to deconstruct biomass into either sugars (or carbohydrate derivatives) or bio-oils and to subsequently upgrade both types of intermediates into biofuels and bioproducts.

Deconstruction into Sugars or Carbohydrate Derivatives

Pretreatment and enzymatic saccharification. Pretreatment breaks down plant cell walls, making lignocellulosic biomass accessible for catalytic enzymes, microorganisms, and other catalysts to process into sugars.

Non-enzymatic routes to carbohydrates. This pathway typically requires a mechanical system to fractionate a biomass slurry (using various reagents) under varying temperatures and pressures. Such systems offer the potential to rapidly hydrolyze biomass-based sugars—yet impose the need to economically recycle reagents in a closed-loop system.

Upgrading Sugars to Biofuels and Bioproducts

Microbial conversion of carbohydrates to biofuels. Micro-organisms that naturally produce fatty acids or other energy-rich molecules directly from sugars can be engineered to emphasize production of structurally tailored fatty acids and other biofuel precursors—which can then be extracted and readily upgraded to hydrocarbon biofuels.

Catalytic processes for converting carbohydrates to biofuels. Chemical conversion represents a relatively new route to hydrocarbon fuels—one that uses a wide range of sugars and sugar-derived intermediates.

Deconstruction into Bio-Oils

Bio-oils can be produced from various types of biomass using pyrolysis or liquefaction. These bio-oils can have high oxygen content and other destabilizing components that must be removed. Lipids from algae, however, require minimal cleaning and stabilizing. A better understanding of pyrolysis is needed to engineer the production of bio-oils with desirable qualities.

Upgrading Bio-Oils to Biofuels and Bioproducts

Bio-oils can be converted to biofuels via hydrotreating, hydroprocessing, or hydrocracking in stand-alone facilities or potentially via traditional petroleum refineries. The use of existing refineries would leverage their economies of scale and current infrastructure—though some modification may be needed to the bio-oil products or the refinery processes.

Integrated Biorefinery Demonstrations

The Biomass Program provides cost-shared support for construction and start-up of pilot, demonstration, and commercial-scale biorefineries that convert various feedstocks to advanced biofuels using multiple conversion pathways. These projects will validate new technology integration to produce advanced biofuels, bioproducts, and heat and power, which will reduce technical and financial risks and encourage the private investment required for commercial replication.

Bioenergy Industry Creates Green Jobs

A robust bioenergy industry will be the source of a variety of jobs across several sectors, from plant breeding, farming, and trucking to biochemical engineering and microbiology. The sector has stimulated significant job growth and is projected to continue to do so over the next 10–15 years.

Learn More

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