Growing America's Energy Future

The emerging U.S. bioenergy industry provides a secure and growing supply of transportation fuels, biopower, and bioproducts from a range of biomass resources. Abundant, renewable bioenergy can help secure America's energy future, reducing our dependence on foreign oil and ensuring American prosperity while protecting the environment. Bioenergy can also help mitigate growing concerns about climate change by having an impact in decreasing greenhouse gas emissions, which is essential to improving environmental sustainability.

Biomass is the only renewable energy source that can offer a viable substitute for petroleum-based liquid transportation fuels—such as gasoline, jet, and diesel fuel—in the near term. It can also be used to produce valuable chemicals for manufacturing, as well as power to supply the grid. The Energy Independence and Security Act of 2007 set aggressive goals to reduce greenhouse gas emissions and our dependence on fossil fuels. One such goal, the Renewable Fuel Standard (RFS), requires 36 billion gallons of renewable fuels production by 2022. In order to facilitate the industrial-scale production of renewable fuels set forth in this standard, the Bioenergy Technologies Office (BETO) is focused on research, development, and demonstration (RD&D) aimed at increasing the supply of advanced biofuels to 22 billion gallons per year by 2022. Meeting the RFS will require technological innovation, private investment, and clear government support in the U.S. biofuels industry over the next decade for advanced biofuels production from lignocellulosic and algal biomass.

Success will depend on the rapid development of efficient new systems and networks to sustainably produce, harvest, and transport large quantities of diverse feedstocks; advanced technologies to cost-effectively convert biomass to fuels; and an expanded and improved distribution and end-use infrastructure to deliver these fuels to consumers across the United States.

Strategic Approach

BETO primarily works with industry, academic, and laboratory partners to develop advanced technologies and real-world solutions to reduce costs and spur market growth. Through a multitude of RD&D projects, the U.S. Department of Energy (DOE) is enabling technology advancements that accelerate the sustainable production of clean, affordable energy. BETO takes an active role in selecting a diverse portfolio, overseeing its maturity, and reducing technical and financial risks to increase private investment. 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 include cellulosic ethanol and renewable gasoline, aviation, and diesel fuels. These resources will also produce biopower and bioproducts. The advanced testing and demonstration supported by DOE and its partners has already had an impact and is leading to the commercialization of economically-viable harvesting, production, and conversion processes.

BETO supports the design and scale-up of integrated biorefineries, such as this one near Vero Beach, Florida. These biorefineries will employ innovative conversion technologies using a wide variety of feedstocks to create cost-efficient, infrastructure-compatible biofuels. *Photo from INEOS Bio.*

OFFICE GOAL

Develop and transform our renewable biomass resources into commercially viable, high-performance biofuels, bioproducts, and biopower through targeted research, development, demonstration, and deployment.

Sustainability

DOE's sustainability efforts address environmental, social, and economic issues throughout the entire bioenergy supply chain. BETO is committed to maximizing environmental benefits while mitigating concerns and reducing potential negative impacts. Through field research, modeling, and advanced analysis, BETO investigates the life-cycle impacts of bioenergy production on greenhouse gas emissions, air quality, soil quality, water, biodiversity, and land use. BETO also performs extensive research and analysis to ensure that the development of bioenergy does not negatively affect the availability of food, feed, fiber, and water.

Integrated Biorefineries

Biofuels are produced in integrated biorefineries that efficiently convert a broad range of biomass feedstocks into affordable biofuels, bioproducts, and heat and power. BETO focuses its efforts on key supply chain challenges. By working to overcome

technical barriers both at the research bench and scaling these up through pilot and demonstration scale, innovations are leading to lower production costs.

Integrated Biorefinery Demonstration

BETO provides cost-shared support for construction and start-up of pilot-, demonstration-, and commercial-scale biorefineries that convert various feedstocks into advanced biofuels using multiple conversion pathways. These projects will validate technology integration at real engineering scale which will reduce technical and financial risks and encourage private investment.

Conversion Processes

BETO is exploring new ways to convert feedstocks into cost-competitive liquid renewable transportation fuels. In order to accommodate and efficiently process the diverse biomass resources available, the Office pursues a priority pathway approach that will lead to the development and advancement of multiple conversion technologies. BETO conducts R&D in collaboration with industry, academia, and the National Laboratories that involves gasification, pyrolysis, biochemical, and hybrid conversion technologies. Each of these conversion processes is being investigated to better understand the technoeconomics in order to meet the RFS goal.

Biochemical conversion entails breaking down biomass to make carbohydrates available for conversion into sugars, which can then be converted into biofuels and bioproducts using microorganisms and other catalysts. Researchers are working to drive down the cost of pretreatment and enzymatic hydrolysis processes. They are also exploring robust new fermentation microorganisms. Future research will explore biological and chemical catalysis integration to produce a wider range of advanced fuels and products.

Gasification conversion breaks down lignocellulosic feedstocks using a high temperature/high pressure process. The feedstock is partially oxidized or reformed with a gasifying agent, which produces a synthetic gas. The resulting gas—known as an intermediate—goes through a clean-up and conditioning process that removes contaminants and prepares it for use as a biofuel.

Pyrolysis conversion breaks down biomass feedstocks using a lower heat temperature in the absence of a gasifying agent. This process creates a bio-oil that goes through filtration, hydrotreating, and hydrocracking to reduce its oxygen content; this final refining process converts the bio-oil into a hydrocarbon fuel product. For both pyrolysis and gasification conversion processes, researchers are focused on producing biofuels that are compatible with existing petroleum infrastructure.

Feedstock Supply and Logistics

The successful integration of biofuels into commercialized usage relies on many factors, including a reliable supply of biomass at an affordable cost. R&D in feedstock supply and logistics impacts all facets of BETO's work; no other R&D area can succeed without continued efforts to improve access to viable feedstocks. Securing the supply requires development at all levels of the chain—from plant breeding and genomics; to crop production and harvesting processes; to biomass preprocessing, transport, and storage systems.

Feedstock supply involves developing a variety of feedstocks that can be used to produce energy and biobased products. BETO engages in rigorous research to assess all potential resources while considering such factors as sustainability, cost, and environmental impact. This research has informed BETO's approach to selecting feedstock supply projects for development and demonstration.

Feedstock logistics encompasses all of the operations needed to collect and transport feedstock to a biorefinery for conversion, all while maintaining necessary quality standards. Cross-cutting research is performed to improve quality, increase productivity, and reduce costs for harvesting and transporting feedstock for use. Streamlined supply systems are being designed, developed, and demonstrated as a major component of BETO's portfolio. Success in feedstock logistics improves the overall viability of biofuels and biopower.

Bioenergy Industry Creates Green Jobs

A robust bioenergy industry will be the source of a variety of U.S. jobs across several sectors, from farming and trucking to biochemical engineering and microbiology. Employment in the U.S. biofuels industry has grown by 8.9% annually since 2004.[1] One industry report estimates that production, construction, and research in the ethanol industry supported the creation of more than 401,000 jobs across the economy in 2011.[2] Combined spending for operations, research, and agriculture in 2011 added $42.4 billion to the nation's gross domestic product.[3] The sector is projected to stimulate significant job growth in the future: nearly two million new jobs could be added across the economy in the next 12–18 years.[4]

[1] *Brookings-Battelle Clean Economy Database, http://www.brookings.edu/about/programs/metro/clean-economy*

[2] *John A. Urbanchuck, Contribution of the Ethanol Industry to the Economy of the United States, Renewable Fuel Association, 2 Feb 2012.*

[3] *John A. Urbanchuck, Contribution of the Ethanol Industry to the Economy of the United States, Renewable Fuel Association, 2 Feb 2012.*

[4] *Economic Impact of the Energy Independence and Security Act of 2007, John M. Urbanchuk, LECG, LLC, January 2008; Green Jobs in the U.S. Metro Areas, U.S. Metro Economies, October 2008; U.S. Economic Impact of Advanced Biofuels Production: Perspectives to 2030, BioEconomic Research Associates, Feb. 2009.*

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