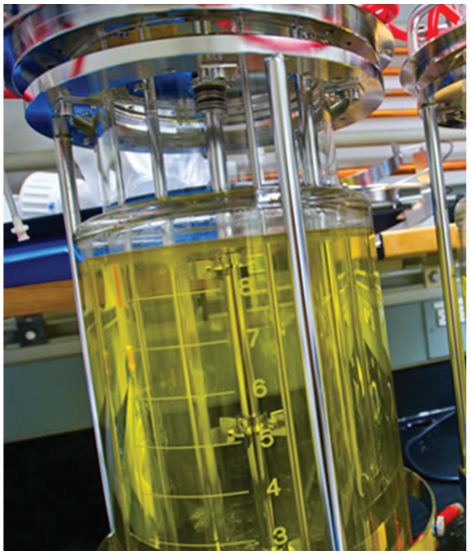
Delivering Advanced Biofuels to the Marketplace

A Progress Report from the Department of Energy Bioenergy Research Centers



The Bioenergy Research Center Charge

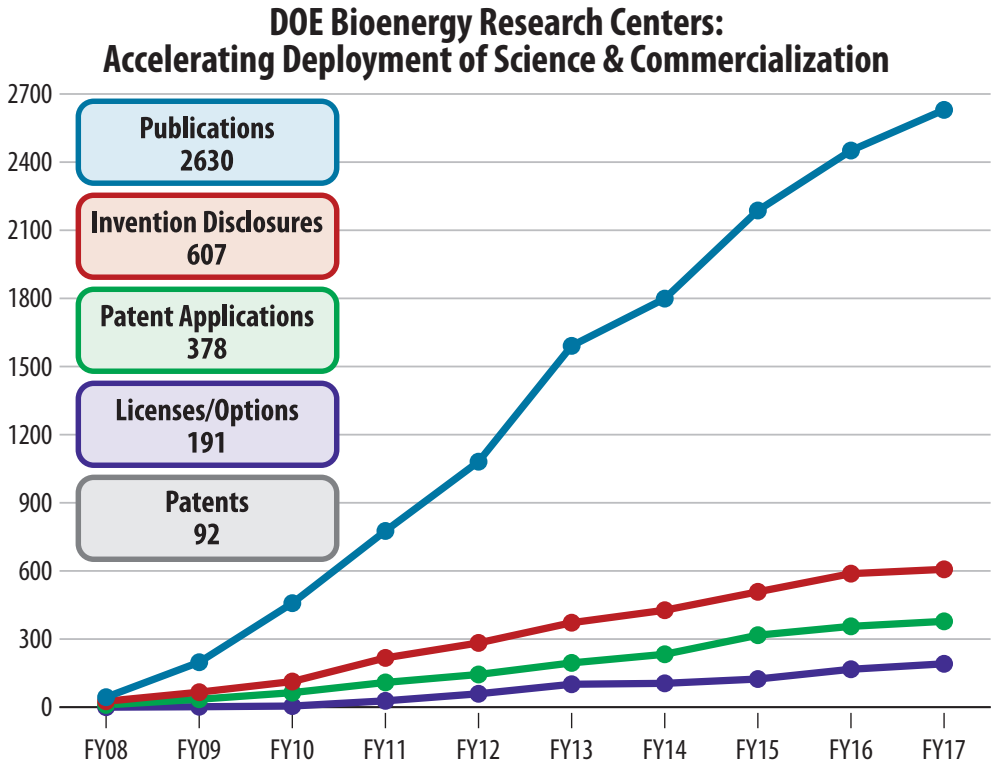
In 2007, the U.S. Department of Energy (DOE), through the Office of Biological and Environmental Research (BER), funded three Bioenergy Research Centers (BRCs). Their mission, broadly stated, is to advance science, engineering and technology to support conversion of lignocellulosic biomass to liquid transportation fuels.

BER explicitly recognized the integrative nature of the disciplines needed to address the complex issues facing biomass conversion to fuels, and chose to fund centers in place of individual grants as a forward-thinking approach to supporting this integration. Each BRC represents a multidisciplinary partnership involving experts from many areas of science and engineering, as well as economics, government and industry.

Advances resulting from the BRCs will provide the crucial knowledge needed to develop new bio-based products, methods and tools that the emerging biofuel industry can use. In short, the BRCs collectively provide a portfolio of diverse and complementary scientific strategies that address the challenges of biomass conversion to fuel on a scale far greater than any effort to date.

"To meet the energy needs of a growing vehicle fleet, a diverse set of transportation fuels will be required. We look to BRC researchers for new knowledge and scientific discoveries that will support the sustainable production of advanced biofuels."

Candace Wheeler,
Technical Fellow at General Motors Research and Development Center



Success Stories

BioEnergy Science Center (BESC) | bioenergycenter.org

BESC has made crucial progress toward understanding, manipulating and managing plant cell wall recalcitrance and conversion. Notably, the BESC team has proven that multiple genes control plant cell wall recalcitrance and furthermore, that manipulation of these genes has the potential to yield perennial bioenergy feedstocks with enhanced deconstruction properties. Further, BESC has successfully demonstrated the ability to combine the processes of cellulose digestion and fermentation of released sugars into biofuel in a single microbial organism. These discoveries not only represent significant progress toward the goal of developing improved feedstocks and microbial deconstruction methodologies for advanced biofuel production, but they have also redefined the scientific basis of the phenomenon of biomass recalcitrance.

Technology Contact: Brian H. Davison - davisonbh@ornl.gov

Great Lakes Bioenergy Research Center (GLBRC) | glbrc.org

Sustainability is not just one of GLBRC's research areas, but an overarching theme of its work. In the field, researchers are developing a fundamental understanding of nitrogen and carbon cycling, which is essential for creating sustainable biofuel landscapes. In the lab, GLBRC is pursuing economic sustainability via biological and chemical routes to low-cost sugars. Recently, researchers have developed unique pretreatment methods that release lignin for potential conversion to fuel precursors and value-added co-products. Producing fuels and chemicals from both the sugar and lignin components of plant biomass could provide added value and increase the profitability of cellulosic biofuels.

Technology Contact: Jennifer Gottwald - jennifer@warf.org

Joint BioEnergy Institute (JBEI) | jbei.org

At JBEI, scientists and engineers are using the latest tools in molecular biology and chemical engineering, including computational and robotic technologies, to transform biomass sugars into energy-rich fuels. JBEI has successfully altered biomass composition in model plants and crops, reducing inhibitors that impact downstream processing and making lignin more readily depolymerized. JBEI research has shown that new solvents, such as ionic liquids, permit near-complete dissolution of plant biomass, thereby facilitating its enzymatic conversion to sugars. JBEI's pioneering work in synthetic biology has enabled microbes to produce a variety of molecules from these sugars that can serve as jet, diesel and gasoline blendstocks.

Technology Contact: Peter Matlock - pymatlock@lbl.gov

Scaling Up

Creating a Knowledgebase for Future Biofuels Technologies

The Bioenergy Research Centers are working together to address some of the most significant technical challenges to large-scale cellulosic biofuel production. Collectively, the BRCs are studying biomass pretreatment processes that make it easier for enzymes to break plant material into smaller sugar components. Researchers are testing unique pretreatment strategies on a wide range of biomass feedstocks to advance the current state of biomass conversion technologies.

Through these collaborations, the BRCs have amassed thousands of genomes from cellulose-degrading environments in nature to identify novel enzymes and microbes that could significantly improve biomass breakdown, thereby facilitating cellulosic biofuel production. Using functional screens, researchers have identified a short list of promising candidate genes. These were moved to the DOE Joint Genome Institute (JGI) for DNA synthesis, and back to the BRCs for protein expression and characterization. Once this vast array of genomic data was narrowed, synthesized and expressed, scientists used a new high-throughput screening platform to test the performance of the individual genes to allow the best to be selected for biomass processing.

"As the biofuels industry picks up speed, the private sector is counting on federally-funded basic research like the DOE Bioenergy Research Centers to provide new insight that will help us meet the broad challenges of reducing cost and meeting demand for advanced biofuels."

William D. Provine, DuPont Science & Technology Director - Open Innovation & Globalization