

American Recovery and Reinvestment Act of 2009: Bioenergy Technologies Office Investments

The Bioenergy Technologies Office has awarded about \$718 million in American Recovery and Reinvestment Act of 2009 (Recovery Act) funds.¹ The projects the Office is supporting are intended to

- Accelerate advanced biofuels research, development, and demonstration
- Speed the deployment and commercialization of advanced biofuels and bioproducts
- Further the U.S. bioindustry through market transformation and by creating or saving a range of jobs.

\$509 Million for Pilot- and Demonstration-Scale Integrated Biorefineries

The Bioenergy Technologies Office selected 18 projects under a funding opportunity announcement in December 2009. These projects include 2 research-and-development-scale efforts to complete preliminary engineering designs (one of which is now complete) for \$2.5 million each; 12 pilot-scale projects for \$18 million to \$25 million each; and 4 demonstration-scale projects for \$50 million each.² These projects are all cost shared; however, the funding mentioned reflects U.S. Department of Energy (DOE) investments and does not account for funding provided by private cost-share agreements. These geographically

and technically diverse projects aim to validate integrated biorefinery technologies that could produce advanced biofuels, bioproducts, and heat and power in an integrated system. For example, these projects intend to demonstrate the production of cellulosic ethanol, renewable diesel, and jet fuel, as well as other fuels and products.

The Bioenergy Technologies Office's integrated biorefinery projects funded through the Recovery Act are slated to be operational at the pilot and demonstration scale throughout the next three years. These integrated biorefineries will use domestically collected or produced biomass to sustainably generate a range of different biofuels, helping to reduce U.S. dependence on petroleum-based transportation fuels and chemicals. Pilot-level projects seek to validate the first integration of technologies and are intended to allow for accelerated scale up. Demonstration-level projects aim to provide data to help enable our partner companies to secure financing for commercial-scale replications. They are also intended to facilitate the development of an advanced biofuels industry with the capacity to meet federal Renewable Fuel Standard volumetric requirements for all advanced biofuels, which increase



from 1 billion gallons per year (bgy) in 2010 to 21 bgy in 2022.³

\$82 Million for a Commercial-Scale Biorefinery Project

The Bioenergy Technologies Office plans to dedicate about \$82 million in Recovery Act funds to an existing biorefinery project—specifically, to expedite its construction phase and to reduce risks associated with first-of-a-kind deployment. This Mississippi-based project intends to use municipal solid waste and wood waste to produce nearly 19 million gallons per year of biofuels and bioproducts.⁴

¹ Congress originally appropriated \$800 million to the Bioenergy Technologies Office; \$13.4 million was directed to expand the Integrated Biorefinery Research Facility at the National Renewable Energy Laboratory. Of the nearly \$787 million remaining available for Bioenergy projects, nearly \$69 million was directed to support Small Business Innovation Research/Small Business Technology Transfer programs and departmental staffing, management, and oversight activities.

² The funding amounts described here are DOE contributions. These projects are in addition to six current projects at demonstration-scale that the Office supports.

³ The 2022 Renewable Fuel Standard volumetric requirement for all renewable fuels is 36 bgy.

⁴ This project is in addition to four current projects for commercial-scale plants that the Office supports.

\$107 Million for Fundamental Research in Key Office Areas

The Bioenergy Technologies Office is investing about \$107 million in Recovery Act funds to support competitively awarded projects that aim to develop cutting-edge conversion technologies—including generating more desirable catalysts and fuel-producing microbes—as well as feedstocks.

These investments by the Bioenergy Technologies Office also include sustainability evaluations and process demonstrations and involve about 50 university, industry, and laboratory partners. The following information identifies the funding allocated:

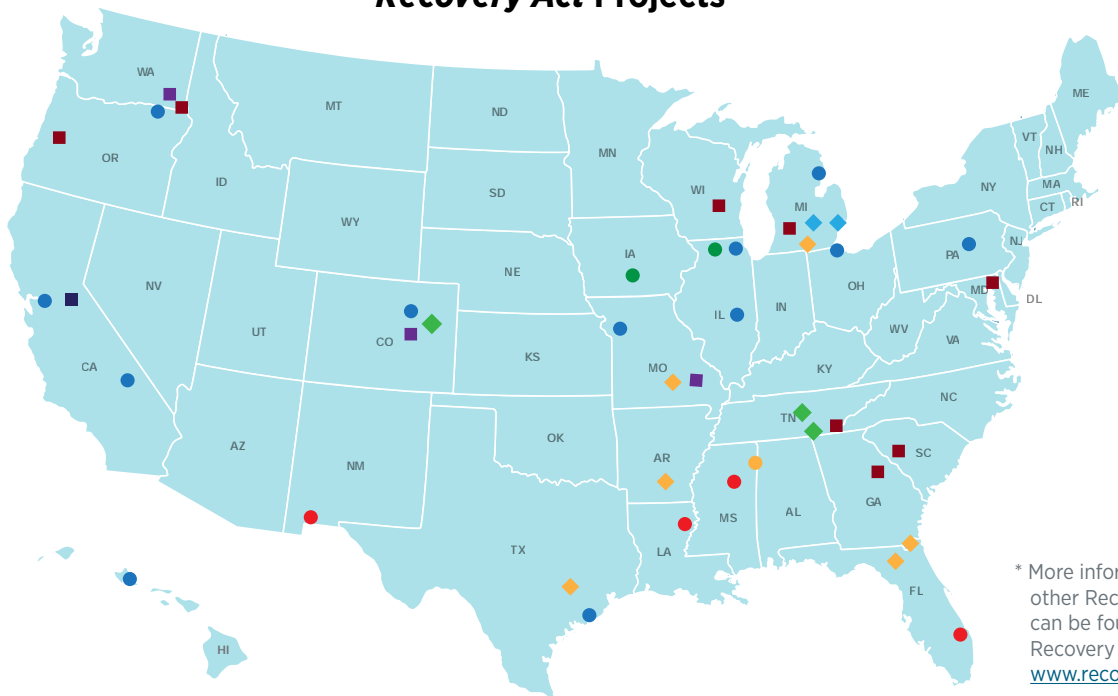
- \$49 million with \$17 million in cost share for the National Alliance for Advanced Biofuels and Bioproducts (NAABB). NAABB is the flagship research and development (R&D) enterprise of the Bioenergy Technologies Office's Algal Biofuels Initiative. Funded to reduce the cost of algal biofuels and overcome key barriers related to feedstock supply, logistics, and conversion, NAABB is developing and demonstrating the science and technologies that will significantly increase production of algal biomass and lipids; efficiently harvest and extract algae and algal products; and establish valuable conversion routes to fuels and co-products. These activities are conducted at more than 40 member institutions. In its first two years, NAABB team members have authored more than 100 original research publications, filed 22 invention disclosures, forged several international alliances, and created a new peer-reviewed research

journal titled "Algal Research." Members of NAABB have also established a new annual technical conference titled "International Conference on Algal Biomass, Biofuels and Bioproducts" and completed a rigorous internal technology evaluation and down-selection process for harvesting and extracting technologies based on system engineering principles. The efforts of NAABB management and researchers have also been recognized by prestigious organizations, including the White House, the R&D100 Awards, and the National Academy of Sciences.

- \$35 million with about \$15 million in cost-share investments for the National Advanced Biofuels Consortium (NABC). NABC was funded to investigate six technology pathways—including biochemical, thermochemical, and hybrid technologies—to produce biofuels that are compatible with today's transportation infrastructure. Additionally, the consortium conducts cross-cutting research on feedstock logistics, pretreatments, separations, upgrading, engineering and sustainability analysis, and refinery integration. Stage I led to the selection of two pathways for development to a "pilot-ready" state over two years (Stage II). Two pathways with a longer projected time to commercialization were also selected for smaller R&D projects in Stage II. NABC is led by the National Renewable Energy Laboratory in Golden, Colorado, and the Pacific Northwest National Laboratory in Richland, Washington, with 18 academic, industry, and other DOE laboratory partners.

- More than \$5 million to expand the resources available for sustainability research, including five projects that aim to do the following:
 - Evaluate nutrient and carbon cycling, as well as water quality, under a range of biofuels production systems
 - Understand hydrologic impacts of growing and harvesting short-rotation woody crops
 - Develop a comprehensive framework, enabling the analysis of biomass cropping in reference to land-use requirements and competition, environmental consequences, and competing energy technologies.
- Nearly \$18 million to establish a process development unit for national laboratories, academia, and industry partners to demonstrate advanced biofuels processes—and to provide maximum flexibility for scale-up of multiple routes to produce a variety of biofuels. This user facility intends to enable the translation of a range of technologies from laboratory scale to applied demonstrations in its operation. Its planned capabilities include
 - Unique pretreatment of biomass
 - Enzyme production
 - Fermentation to several fuels
 - Product purification in quantities sufficient for engine testing at partner institutions.

Recovery Act Projects*



* More information on these and other Recovery Act projects can be found by state on the Recovery Act website: www.recovery.gov

Integrated Biorefineries

● **Commercial-Scale Refinery**

- BlueFire Ethanol, Inc.; Fulton, Mississippi

● **Demonstration-Scale Refinery**

- Myriant; Lake Providence, Louisiana
- Enerkem in Pontotoc, Mississippi
- INEOS New Planet Bioenergy, LLC; Vero Beach, Florida
- Sapphire Energy, Inc.; Columbus, New Mexico

● **Pilot-Scale**

- Algenol Biofuels, Inc.; Fort Meyers, Florida
- American Process, Inc.; Alpena, Michigan
- Amyris Biotechnologies, Inc.; Emeryville, California
- Archer Daniels Midland; Decatur, Illinois
- ClearFuels Technology; Commerce City, Colorado
- Haldor Topsoe, Inc.; Des Plaines, Illinois
- ICM, Inc.; St. Joseph, Missouri
- Logos Technologies; Visalia, California
- Renewable Energy Institute International; Toledo, Ohio
- Solazyme, Inc.; Peoria, Illinois
- UOP, LLC; Kapolei, Hawaii
- ZeaChem, Inc.; Boardman, Oregon

● **Research-Scale Project**

- Elevance Renewable Sciences; Newton, Iowa
- Gas Technology Institute; Des Plaines, Illinois

Infrastructure

◆ **Intermediate Ethanol Blend Testing**

- Oak Ridge National Laboratory; Oak Ridge, Tennessee
- National Renewable Energy Laboratory; Golden, Colorado

◆ **E85 and/or Blender Pumps***

- Protec Fuel Management, LLC (Arkansas, Florida, Georgia, Texas)
- Clean Energy Coalition (Michigan)
- Missouri Corn Merchandising Council (Missouri)

◆ **E85 Engine Optimization**

- General Motors, Detroit, Michigan; and Bosch, Farmington Hills, Michigan
- Delphi; Auburn Hills, Michigan

* All companies in this category received funds to modify 44 total pumps to dispense higher ethanol blends

Fundamental Research

■ **Biofuel Consortia**

- National Advanced Biofuels Consortium; National Renewable Energy Laboratory, Golden, Colorado; and Pacific Northwest National Laboratory; Richland, Washington
- National Alliance for Advanced Biofuels and Bioproducts; Donald Danforth Plant Science Center; St. Louis, Missouri

■ **User Facility**

- Advanced Biofuels Process Development Unit, Lawrence Berkeley National Laboratory; Berkeley, California

■ **Sustainability Collaborations**

- Great Lakes Bioenergy Regional Center, working with Pacific Northwest National Laboratory, Oak Ridge National Laboratory (ORNL), and university partners in Michigan, Wisconsin, and Ohio on soil carbon dynamics, water quality and direct greenhouse gas fluxes, and land-use change modeling
- ORNL working with the Forest Service at the Savannah River South Carolina site, University of Georgia, and Oregon State University on the hydrologic impact of woody biomass utilization



Bioenergy Technologies Office Recovery Act Highlights

- More than 35 projects ranging from \$200,000 to \$50 million, representing at least 20 recipient states
- More than 65 industry, university, laboratory, and state partners
- Cost shares required for a majority of project recipients
- An overall investment that represents more than three times the Office's recent annual appropriations
- A minimum estimated 2,600 jobs created or saved over the 2009–2014 period
- As of fiscal year 2012, full total cost share investments accounted for \$693 million toward projects

More than \$19 Million for Research Optimizing Ethanol Use and Supporting Its Infrastructure

The Bioenergy Technologies Office has awarded Recovery Act funding to support the following efforts:

- About \$16 million to evaluate the impact of higher ethanol blends on a range of conventional vehicles—including small engines and off-road vehicles—for emissions, catalyst temperature, durability, and fuel economy, as well as materials and infrastructure component compatibility

- Nearly \$3 million for engine optimization to improve the performance of flex-fuel vehicles operating on fuels blends of up to 85% ethanol (E85)
- \$1 million to modify several existing retail fueling stations with pumps—and associated infrastructure, such as storage tanks, hoses, and piping monitoring systems—to dispense ethanol blends up to E85.

Project Management, Oversight, and Reporting

The Office has experienced a substantial increase in activity as a result of new Recovery Act financial assistance awards coupled with the required accelerated funds distribution and expenditure timeframes.

To manage and oversee the Bioenergy Technologies Office's Recovery Act portfolio, we have extended, enhanced, and integrated the well-established, graded approach we use for our traditional project portfolio. We have also continued to ensure that proper selection, monitoring, and assessments are conducted.

In addition, the Recovery Act includes considerable commitments to transparency and accountability are required. As such, DOE recipients to report certain information to the Office of Management and Budget via FederalReporting.gov. This government-wide reporting

requirement focuses on job creation and financial information. In some cases, DOE is also collecting more detailed project management data on a quarterly or monthly basis at an aggregated level. This information is related to financial targets, impact metrics, projected milestones, and the number of jobs created or saved. Gathering this data will help to enhance our ability to measure progress.

“Developing the next generation of biofuels is key to our effort to end our dependence on foreign oil and address the climate crisis—while creating millions of new jobs that can't be outsourced. With American investment and ingenuity—and resources grown right here at home—we can lead the way toward a new green-energy economy.”

– Department of Energy
Secretary Steven Chu

For additional information, visit biomass.energy.gov.

U.S. DEPARTMENT OF
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Energy Efficiency &
Renewable Energy

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