

Benefits of Biofuel Production and Use Series—Spotlight on Ohio

The U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO) enables the development of novel technologies that can establish Ohio as one of the leaders in the growing bioeconomy. Ohio can leverage its extensive biomass resources and existing infrastructure to increase output of advanced biofuels.

Setting the Stage for Biofuels

In 2015, Ohio consumed 219 million barrels of petroleum while producing only 26 million barrels (with transportation accounting for 79% of consumption). Locally produced biofuels can reduce this high dependence on imported petroleum.

- **Economy**

Ohio's transportation sector spent about \$17.8 billion on petroleum-based fuels in 2015. Expanding the state's production of biofuels could keep more of these dollars in Ohio, stimulating economic growth and adding to the state's jobs in bioenergy and biobased products industries.

- **Energy**

Ohio has the eighth-largest ethanol production capacity in the nation (2016). Upgrading this infrastructure to utilize readily available agricultural residues could establish Ohio as a leader in advanced biofuels production and help meet a larger portion of the state's growing energy needs.



Ohio State University researcher Yebo Li specializes in the development of bioenergy and bioproducts from waste and biomass. *Photo credit: Ken Chamberlain.*

- **Environment**

In 2014, petroleum use in Ohio's transportation sector released 63 million metric tons of carbon dioxide. On a life-cycle basis, advanced biofuels can reduce harmful emissions by >50% compared to petroleum—helping to reduce environmental impacts.

- **Feedstocks**

Ohio's first-generation biofuel facilities could be upgraded to increase productivity using cellulosic agricultural residues. Energy crops, such as native Ohio switchgrass, flax, miscanthus, and camelina, can help Ohio farms increase income diversity, sustainability, and productivity.

Bringing Technology to Market

Strategic policies and investments help bridge the gap between promising research and large-scale production of advanced biofuels.

- Ohio's Alternative Fuel Transportation Program and alternative fuel requirements for new state agency vehicles demonstrate the state's commitment to increasing the use of biofuels to improve air quality and reduce petroleum dependence.
- DOE has awarded more than \$40 million to university and industrial partners in Ohio to research, develop, and deploy biobased fuels and products since 2005.

Research at Universities

DOE has helped fund cutting-edge research at several Ohio universities to advance the bioeconomy.

- **Ohio State University (OSU):** OSU is working on a collaborative effort to develop a cellulosic biobutanol production process. Advanced bioenergy and biobased products represent a core focus area of OSU's Agricultural Research and Development Center.
- **Ohio University (OU) in Athens:** In 2015, OU received \$1.5 million to develop an electrochemical reactor for upgrading biorefinery waste to industrial chemicals and hydrogen.
- **The University of Toledo (UT):** UT's Department of Chemical and Environmental Engineering conducted research to integrate nutrient and water recycling systems with sustainable algal biorefineries. UT's portion of this BETO-funded \$3 million project was \$1.1 million.
- **University of Akron (UA):** UA conducted research and development on supercritical methods for biorefinery of rubber-bearing guayule biomass through a project jointly funded by DOE and the U.S. Department of Agriculture (USDA) at \$0.7 million.

Why Ohio?

- **Robust Agricultural Industry**

Ohio's robust agricultural industry can potentially provide 8.5 million dry tons of locally sourced biomass annually to produce biofuels and products. Developing in-state resources, such as the 7.1 million dry tons of biomass resources currently available annually, helps meet energy needs and reduces dependence on petroleum.

- **Jobs and Economy**

In 2013, Ohio's biobased products industry contributed 52,930 direct jobs (117,370 total jobs) and \$4.3 billion in direct value (\$9.7 billion in total value). In 2015, Ohio's ethanol industry generated about 370 direct jobs and 5,670 total jobs.¹

- **Infrastructure**

Existing non-cellulosic ethanol facilities can be upgraded to utilize non-food-based feedstocks and contribute to advanced biofuels production.²

- **Collaborative Research**

DOE has supported research and development at Ohio universities. This research improves the productivity of bioenergy feedstocks and maximizes the benefits of biofuels and bioproducts.

Other BETO Projects with Universities

- **Ohio State University**

Biomass Gasification for Chemicals Production Using Chemical Looping Techniques: This OSU project was funded through the Biomass Research and Development Initiative (BRDI) at \$1.7 million.³ The project focused on developing the biomass-to-syngas chemical looping process for efficient production of value-added chemicals and liquid fuels in a single step, with a potential to reduce capital costs for syngas production by 44% compared to conventional processes.

Engineering Clostridia for n-Butanol Production from Lignocellulosic Biomass and Carbon Dioxide: The goal of this project, which was funded by BETO at \$1.2 million, is to develop engineered clostridia strains and a fermentation process that can directly utilize cellulose and fix carbon dioxide for n-butanol production from lignocellulosic biomass. The engineered strains will be used in a consolidated bioprocess integrated with *in situ* butanol separation to alleviate butanol toxicity and reduce energy consumption.

- **Ohio University**

Biorefining for Energy Security: OU developed technology to produce algae that could be used not only to produce oils for biodiesel production, but also to remove large quantities of potentially harmful emissions from the atmosphere. The goal of this project, funded at \$1.9 million, was to further the development of the technology needed to produce the algae and to educate students and the public.

- **University of Toledo**

A Novel Simultaneous-Saccharification-Fermentation Strategy Development: This project, funded by BETO at \$0.5 million, focused on addressing development of cost-effective biocatalysts capable of increasing product yield in the biological conversion of lignocellulosic biomass. The project used a novel enzyme pellet scheme for efficient fermentation of both five-carbon and six-carbon sugars.

Innovations in Algae Technology: Under a new BETO project, UT, in partnership with Montana State University and the University of North Carolina, will cultivate microalgae in high-salinity and high-alkalinity media to achieve productivities without needing to add concentrated carbon dioxide. ■

¹ Ethanol industry job numbers are based on the National Renewable Energy Laboratory's Jobs and Economic Development Impact (JEDI) model job estimates, which are full-time equivalent employees per year.

² In 2016, Ohio ranked eighth (13 million barrels) among 26 ethanol-producing states in the United States. Ohio's biodiesel annual production capacity is 65 million gallons.

³ BRDI is a joint DOE-USDA program that helps develop economically and environmentally sustainable sources of biomass and increase the availability of renewable fuels and biobased products, reducing the need for gasoline and diesel fuels and diversifying our energy portfolio.

For more information on Ohio's energy portfolio and the economic and environmental benefits of biofuels, visit:

[Ohio state profile and energy estimates](#)

[USDA analysis on economic impact of U.S. biobased products industry](#)

[U.S. petroleum consumption by sector – 2015](#)

[U.S. petroleum expenditures by sector – 2015](#)

[State carbon dioxide emissions – 2014](#)

[2016 Billion-Ton Report state biomass resources download tool](#)

[U.S. ethanol capacity and production by states – 2016](#)

[Biodiesel production capacity](#)

[Biomass R&D Board](#)

For more information on the environmental benefits of biofuels for Ohio, visit:

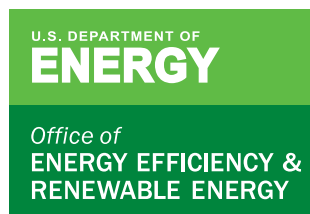
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For more information, visit energy.gov/eere/bioenergy