Federal Energy R&D: Bioenergy Technologies

BY COLIN CUNLIFF AND BATT ODGEREL | MARCH 2020

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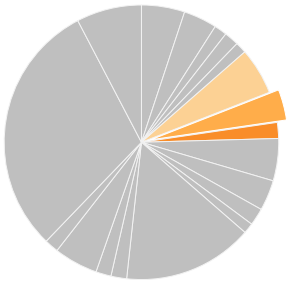
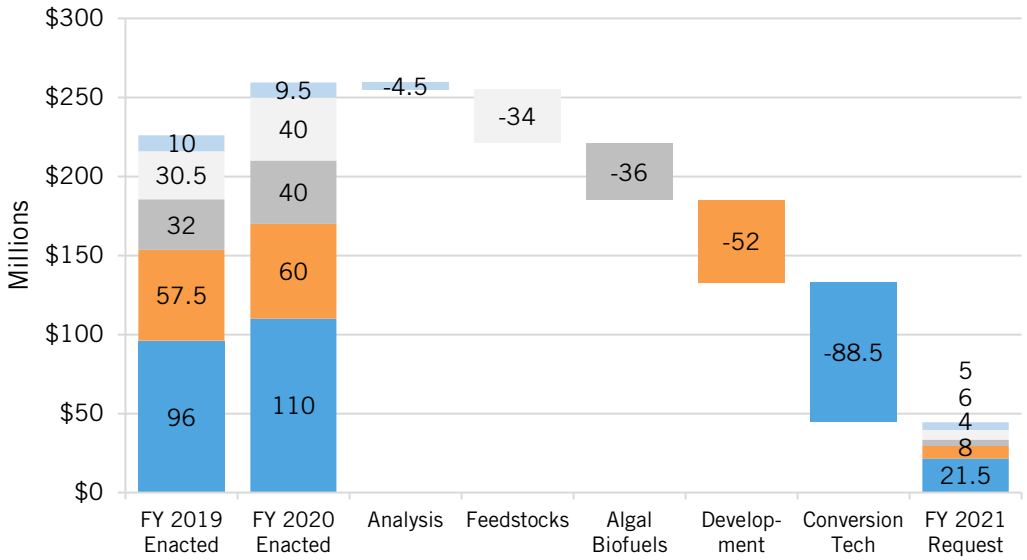


Bioenergy (orange)
Other Transportation (orange)
Energy R&D (light grey)

The Department of Energy's (DOE) Bioenergy Technologies Program (BETO) focuses on research and development (R&D) to develop sustainable bioenergy technologies capable of producing price-competitive biofuels from nonfood sources of biomass such as wastes and agricultural residues, and energy crops such as switchgrass and algae. The program's primary R&D focus is on creating "drop-in" biofuels that are compatible with existing fueling infrastructure and vehicles across a range of transportation modes, including renewable gasoline, diesel, and jet fuels. Transportation is the largest greenhouse gas-emitting sector in the United States, having surpassed electric power in 2016.[1]

Figure 1: The FY 2021 budget request would cut bioenergy technologies R&D by 83 percent[2]



What's at Risk

The United States has the resource potential to sustainably produce 1 billion dry tons of nonfood biomass resources by 2030 without disrupting agricultural markets for food and animal feed.[3] These resources could produce approximately 50 billion gallons of biofuels (25 percent of U.S. transportation fuels), 50 billion pounds of high-value chemicals and products, and 75 billion kilowatt-hours (kWh) of electricity—enough to power 7 million homes.[4] Algal biomass is an important kind of biomass due to its ability to grow quickly, use waste resources, and produce fuel precursors. Algal biofuels could potentially contribute up to 5 billion gallons per year (BGY)—about 20 percent of the current domestic jet-fuel market—by 2030, and 20 BGY in the long run.[5] And a number of bioenergy pathways,

combined with carbon sequestration technologies, offer the potential to remove carbon dioxide from the atmosphere, resulting in carbon-neutral or even carbon-negative bioproducts.[6]

Each of the bioenergy production and conversion targets within BETO was chosen to create new technology options that are more efficient than, and at least as affordable as, conventional technology. Achieving these targets would both improve transportation-energy affordability and take the United States one step closer to reaching its national goals in energy security, economic growth, and environmental stewardship. However, reductions in DOE R&D funding threaten to delay or even derail this progress.

Bioenergy Technologies R&D Subprograms

R&D in the Bioenergy program is distributed across these five subprograms:[7]

- **Feedstock Technologies** develops and improves strategies, technologies, and systems to provide consistent quality feedstock to biorefineries, while focusing on supply and logistics challenges to support further development of advanced biofuels. The Feedstock subprogram funds the Feedstock Conversion Interface Consortium (FCIC), a consortium of eight national laboratories focused on feedstock handling, preprocessing, and conversion opportunities to reduce the sales price of biofuel.
- **Advanced Algal Systems** supports R&D of algal-biomass production and logistics systems, with a focus on improving capabilities to predict, breed, and select the best-performing algal strains, harvest algae at high-throughputs, and extract and convert algal biomass components into fuels.
- **Conversion Technologies** focuses on converting biomass feedstocks into "drop-in" hydrocarbon transportation fuels and coproduced bioproducts, and explores both biological and thermochemical conversion pathways.
- **System Development and Integration** works to scale up integrated biorefinery systems, and focuses on both the development, testing, and verification of biorefinery processes, and the identification of new market opportunities for bioproducts.
- **Data, Modeling, and Analysis** provides quantitative analysis to inform BETO decisions regarding the future direction and scope of its R&D portfolio.

Key Elements of the FY 2021 Budget Proposal

- **No new funding for integration of CO_2 Direct Air Capture (DAC) with algal biofuel production.** Direct air capture (DAC) technologies remove carbon dioxide directly from the atmosphere, offering the potential for carbon-neutral or even carbon-negative applications. Algal bioenergy systems often use carbon dioxide as a feedstock. In FY 2020, DOE issued a new competitive funding opportunity to integrate DAC technologies with algal bioproduct systems, with

the goal of reducing both algae biomass production costs and net carbon emissions.[8]

- **An 87 percent reduction in System Development and Integration,** including the elimination of research on bio-based fuels for spark-ignition; no additional funding for integrated process development and pilot-scale systems research; no funding for demonstration scale projects; and no funding for sustainable aviation fuels or marine biofuels.

- **A 90 percent reduction in Advanced Algal Systems,** including no funding for research on integration of algae with wastewater treatment; and reduced funding in microalgal resource assessment modeling, and algal and terrestrial feedstock blending.

- **An 80 percent reduction in Conversion Technologies R&D,** including no funding for research on biological upgrading of sugars and aqueous waste streams, and improving biological process operations; no funding for competitively selected projects on community-scale digesters; no funding for aerobic upgrading; no funding for the Feedstock Conversion Interface Consortium or the joint bioenergy research initiative with the U.S. Department of Agriculture; reduced funding for the Agile BioFoundry; and reduced funding for waste feedstock utilization.

- **An 85 percent reduction in Feedstock Technologies,** including no funding for competitive research to reduce the costs of feedstock logistics; reduced funding for FCIC; and reduced funding for R&D on harvest logistics and quality assurance, biomass densification, and biomass analytics.

- **A 47 percent reduction in Data, Modeling, and Analysis**, including no funding for analysis of integrated landscape management strategies to reduce biofuel costs; and no funding for testing energy crops that improve soil quality and water retention.

ENDNOTES

1. U.S. Department of Energy (DOE), "FY 2021 Congressional Budget Justification," Volume 3 Part 1, (DOE/CF-0163, February 2020), 45–46, https://www.energy.gov/sites/prod/files/2020/02/f72/doe-fy2021-budget-volume-3-part-1.pdf.
2. DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 49.
3. DOE, "U.S. Billion-Ton Report," Volume 1 (Washington, D.C.: DOE, July 2016), https://energy.gov/sites/prod/files/2016/12/f34/2016_billion_ton_report_12.2.16_0.pdf.
4. DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 45–46.
5. Hui Xu et al., "Assessment of algal biofuel resource potential in the United States with consideration of regional water stress" (Elsevier, November 2018), https://doi.org/10.1016/j.algal.2018.11.002.; Johnathan Holladay, Zia Abdullah, and Josh Heyne, "Sustainable Aviation Fuel" (Pacific Northwest

National Laboratory, August 2019), https://www.pnnl.gov/sites/default/files/media/file/Sustainable%20Aviation%20Fuel.pdf .

6. Daniel L. Sanchez et al., "Chapter 5: Hybrid Biological and Engineered Solutions," in *Building a New Carbon Economy: An Innovation Plan* (Carbon180 and the New Carbon Economy Consortium), https://carbon180.org/s/ccr02innovationplanFNL.pdf; Colin Cunliff, "An Innovation Agenda for Deep Decarbonization: Bridging Gaps in the Federal Energy RD&D Portfolio" (Information Technology and Innovation Foundation, November 2018), 40–43, http://www2.itif.org/2018-innovation-agenda-decarbonization.pdf.
7. DOE, "FY 2021 Congressional Budget Justification" Volume 3 Part 1, 52–66.
8. DOE, "DE-FOA-0002203: FY20 Bioenergy Technologies Multi-Topic FOA," Topic 3: Algae Bioproducts and CO2 Direct-Air Capture Efficiency, https://eere-exchange.energy.gov/default.aspx#FoaId23bcb339-aa53-4821-9421-d109747cb168.

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ABOUT THE AUTHORS

Colin Cunliff is a senior policy analyst for clean energy innovation with the Information Technology and Innovation Foundation. He previously worked at the U.S. Department of Energy (DOE) Office of Energy Policy and Systems Analysis (EPSA), with a portfolio focused on energy sector resilience and emissions mitigation. He holds a Ph.D. in physics from the University of California, Davis.

Batt Odgerel is a policy fellow for clean energy innovation at the Information Technology and Innovation Foundation. He previously worked for the Energy Policy Research Foundation and Smart Electric Power Alliance. He holds a master's degree in energy policy from Johns Hopkins University.

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