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## Notice of Funding Opportunity

**Title:** Office of Energy Efficiency and Renewable Energy (EERE), Bioenergy Technologies Office (BETO) – FY21 Bioenergy Technologies Scale-up and Conversion FOA

**Website:** <https://eere-exchange.energy.gov/Default.aspx#Foald5295fbd3-50f4-4dfb-8c70-3f6911c5da10>

**Funding:** Total: \$61,380,000. Maximum awards: \$500K-\$5M, depending on project.

**Dates:** Informational Webinar (Topic Area 1 only): April 16, 2021 3PM  
Concept Papers Deadline: April 30, 2021  
Full Applications Deadline: June 21, 2021

**Summary:** This FOA supports high-impact technology research, development, demonstration, and deployment (RDD&D) to accelerate the bioeconomy and, in particular, the production of low-carbon fuels for the aviation industry. BETO is focusing on applied RDD&D to improve the performance and reduce cost of biofuel production technologies and scale-up production systems in partnership with industry. By reducing cost and technical risk, BETO can help pave the way for industry to deploy commercial-scale integrated biorefineries and reduce greenhouse gas emissions from hard to decarbonize sectors, such as aviation. The Program is focused on developing and demonstrating technologies that are capable of producing low-carbon drop-in biofuels at \$2.50 per gallon gasoline equivalent (GGE) by 2030, as well as associated renewable chemical co-products to achieve this target. BETO is focused on biofuel production pathways that can deliver at least 70% lower lifecycle greenhouse gas emissions than petroleum. The research and development (R&D) activities to be funded under this FOA will support the government-wide approach to the climate crisis by driving the innovation that can lead to the deployment of clean energy technologies, which are critical for climate protection. Specifically, this FOA will support high-impact RDD&D focusing on the production of low-GHG fuels for the aviation industry, as well as the long-haul trucking and marine industries by soliciting proposals to scale-up technologies; cost effectively produce biomass derived sugars as an intermediate for the production of biofuels and bioproducts; and support cost effective separation technologies. In addition, the FOA will support increasing the efficiency of residential wood heaters and the production of renewable natural gas.

### Project Topic Areas:

#### Topic Area 1: Scale-up of Biotechnologies

BETO is looking for bioenergy companies that are ready to move their technologies from the laboratory to the pilot and demonstration stage and eventual commercialization. To reach these goals, Topic Area 1 of this FOA will fund projects at various levels of technology readiness including pre-pilot, pilot, and demonstration scale, jointly ranging from Technology Readiness Level (TRL) 3 to 7. BETO will identify, evaluate, and select applications proposing the scale-up of key process steps from lab scale unit operations to industrially-relevant piece(s) of equipment, as well as applications proposing project definition, development and execution plans for the scaling of pre-pilot technologies to pilot scale and/or demonstration scale. Bioproducts are allowable as the primary product for proposed technologies under Subtopic Area 1a (pre-pilot) and 1b (pilot) as long as they enable biofuel development. Emphasis will be placed on projects with increasing potential fuel production volumes as the technology deploys to multiple commercial scale facilities and beyond.

#### *Subtopic Area 1a: Scale-up – Pre-Pilot for Biofuels and Bioproducts*

This subtopic area will scale up key process steps from lab scale unit operations (TRL 3) to industrially-relevant piece(s) of equipment (TRL 5). Engineering solutions for the key process steps can include a single or multiple unit operations moving from batch to continuous operation, utilizing real-world feed and recycle streams, as well as specialized engineering scale equipment. The proposed unit operation(s) within an application do not have to comprise a fully integrated pilot scale unit (TRL 6) by the end of the project, but rather can be utilized to support future integration of the entire process at pilot or demonstration scale. Anticipated technology approaches for Subtopic 1a include, but are not limited to: applications for sustainable aviation fuels and sustainable marine fuels; waste and underutilized carbon feedstocks; biorefinery technologies taking advantage of existing assets and infrastructure; development of predictive models and high performance computing as tools to accelerate scale-up; and bioproducts that can be shown to lower the accompanied biofuel selling price below \$2.75/GGE.

#### *Subtopic Area 1b: Scale-up – Pilot for Biofuels and Bioproducts*

#### *Subtopic Area 1c: Scale-up – Demonstration for Biofuels and Bioproducts*

These subtopic areas will seek applications proposing project definition, development, and execution plans for the scaling of pre-pilot and pilot biofuel and bioproduct technologies to pilot and demonstration scale including for: the manufacture of sustainable aviation and marine fuels; waste and underutilized carbon feedstocks; novel process technologies that leverage existing first generation, grain starch, biorefinery assets and infrastructure; novel process

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technologies that leverage US-produced, oilseed crops that meet all other metrics of the topic area, including achieving at least 70% GHG reductions.

#### Topic Area 2: Affordable, Clean Cellulosic Sugars for High Yield Conversion

This topic area aims to lower the price of cellulosic sugars and de-risk their use by downstream partners through increased availability and performance. It is designed to attract companies that produce and seek to sell cellulosic sugars. These technologies could include a variety of low severity pretreatment processes, detoxification/impurity removal technologies, amongst others. The topic area also may include funding for downstream partners that are critical to evaluating the quality and convertibility of these sugars. The potential topic area seeks a variety of downstream upgrading approaches (biological, chemical, and electrochemical catalysis) to gain a diverse understanding of the quality of these substrates.

#### Topic Area 3: Separations to Enable Biomass Conversion

Separations are energy-intensive and critical to the economics of a bioprocess, and can account for up to 50% of the cost of producing biomass-based chemicals and fuels. In a biorefinery, bioprocess separations isolate a specific component from a complex mixture and are a critical part of a bioprocess and are often overlooked during technology development. New bioprocesses introduce many variables that may prevent existing separations technologies from being readily deployed. Therefore, co-development of separations with up- and down-stream processes is key to the success of the overall bioprocess.

##### *Subtopic Area 3a: Separations to Improve Arrested Anaerobic Digestion Process Development*

This subtopic area seeks to develop efficient and cost-effective separations approaches to isolate and potentially upgrade organic acids and products of interest from digesters.

##### *Subtopic Area 3b: Separations to Enable Biomass Conversion (Bioprocessing Separations Consortium)*

This subtopic area seeks to improve availability of data that will support separations development, as well as to develop supporting technologies to improve bioprocessing separations. This subtopic area will provide funding for collaborative projects between an applicant and the Bioprocessing Separations Consortium to address critical bioprocess separations challenges.

#### Topic Area 4: Residential Wood Heaters

This topic area will support the development and testing of low-emission, high efficiency, and cost competitive residential wood heaters. Categories of residential wood heaters of interest include room heaters, hydronic central heaters, and forced air central heaters.

#### Topic Area 5: Renewable Natural Gas

Renewable natural gas (RNG) is rapidly emerging as a solution to simultaneously address local waste management problems and decarbonize energy sectors that rely on natural gas, such as residential heating or industrial applications. In the United States, there are more than 100 operational RNG projects, with nearly 100 more under construction or advanced development/feasibility. Anaerobic digestion of organic waste at landfills and large dairy or swine operations are the most common sites for these projects. Another strategy for the production of renewable natural gas, referred to as "power-to-gas" (P2G), is also emerging as an attractive energy storage and ancillary services solution. Note that improvements to anaerobic digestion, such as membrane bioreactors, pretreatments, etc. are not of interest to this topic area.

##### *Subtopic Area 5a: Renewable Natural Gas (R&D)*

Subtopic Area 5a is targeted at bench-scale research and development to produce RNG and specifically to develop new technologies for upgrading biogas and carbon dioxide/hydrogen to pipeline quality renewable natural gas. Subtopic 5a is designed to develop new technologies to: Efficiently remove impurities from biogas to RNG (biogas upgrading) through the use of advanced sorbents, membranes, and/or process intensification and separations strategies; and Develop and demonstrate technologies for conversion of carbon dioxide in biogas and hydrogen to methane. Note that waste carbon dioxide streams other than biogas are not permitted, such as those from the fermentation of ethanol at a biorefinery.

##### *Subtopic Area 5b: Renewable Natural Gas (Pilot Scale)*

Subtopic Area 5b seeks to advance the technology readiness of next generation biogas upgrading and RNG production technologies through piloting, integrated operations, and increased duration of continuous run-time. Applicants are encouraged to pilot their technology on-site with a biogas or biogas/hydrogen source to the extent possible. Subtopic Area 5b is designed to develop new technologies to: Pilot biogas upgrading and processes for the conversion to methane that are more economically and energetically efficient compared to incumbent processes; Assist technologies in maturing from bench/engineering scale (less than TRL 5) to pilot scale (TRL 6); and Demonstrate integration of the process in a continuous fashion.

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EERE expects to make a total of approximately \$61,380,000 of federal funding available for new awards under this FOA in FY21. EERE anticipates making approximately 11 to 27 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between \$500,000 and \$5,000,000 for FY21 selected projects across all Topic Areas. EERE anticipates making awards that will run from 12 months up to 60 months in length, comprised of one or more budget periods. EERE will accept only new applications under this FOA. EERE will not consider applications for renewals of existing EERE-funded awards through this FOA.

Topic Area Number	Anticipated Minimum Award Size for Any One Individual Award (Fed Share)	Anticipated Maximum Award Size for Any One Individual Award (Fed Share)	Approximate Total Federal Funding Available for All Awards	Cost Share Requirement
1a	\$3,000,000	\$4,000,000	FY21: \$30,280,000	20%
1b (Phase 1 and 2)	\$500,000 for 1b (Phase 1); TBD for 1b (Phase 2)	\$1,000,000 for 1b (Phase 1); TBD for 1b (Phase 2)	An estimated federal share of \$30,280,000 of FY21 funds will be split across all three Subtopic Areas, 1a, 1b, and 1c. Depending on the strength of applications, none, some, or all funding may be directed to a single subtopic.	50%
1c (Phase 1 and 2)	\$500,000 for 1c (Phase 1); TBD for 1c (Phase 2)	\$1,000,000 for 1c (Phase 1); TBD for 1c (Phase 2)		50%
2	\$2,000,000	\$3,500,000		\$8,500,000
3a	\$2,000,000	\$3,500,000	\$8,000,000	20%
3b	\$2,000,000	\$3,500,000	Funding will be split between 3a and 3b depending on strength of applications.	20%
4	\$1,000,000	\$2,500,000	\$5,000,000	20%
5a	\$2,300,000	\$2,300,000	\$4,600,000	20%
5b	\$5,000,000	\$5,000,000	\$5,000,000	50%

**Project Requirements:**

All applications selected for award negotiations under this FOA are required to participate in a verification process led by DOE’s identified external third-party non-conflicted verification team. This verification process provides technical assistance to both the DOE BETO and the project by providing an in-depth analysis of key technical and economic metrics to ensure transparency and increase the likelihood of project success. Given the high cost and complexity of pilot scale projects, recipients in Topic Areas 1 and 5 will undergo an extended 12 month Verification & Design Basis Definition period to validate prior scale data (Phase 1). DOE will conduct a Go/No-Go review process at the end of phase 1. Only when projects receive a “Go” decision will they be authorized to move into the design / construction / operation phase of the project (Phase 2). The Supplemental Content Requirements included with the FOA (Appendix H), were designed to guide applicants in providing information to assess the technical validity of the technology being developed within the selected project. Applications submitted without the appropriate supplemental content as defined in the Topic Area and Subtopic Area will be deemed non-responsive and excluded from further review under this FOA. The varied requirements and deliverables within each subtopic must be addressed in the application and the strength of the applicant’s discussion will be evaluated by the independent technical review panel for engineering and scientific merit. Each application must possess an Allowable Feedstock identified in the corresponding subtopic area. All work under EERE funding agreements, such as those awarded as a result of this FOA, must be performed in the United States.

**Eligible Applicants:**

U.S. citizens and lawful permanent residents; State, local, and tribal government entities; Incorporated consortia, which may include domestic and/or foreign entities; For-profit entities, educational institutions, and nonprofits that are incorporated (or otherwise formed) under the laws of a particular state or territory of the United States and have a physical location for business operations in the United States are eligible to apply for funding as a prime recipient or subrecipient. Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995 are not eligible to apply for funding. Federal agencies and instrumentalities (other than DOE) are eligible to apply for funding as a subrecipient, but are not eligible to apply as a prime recipient. Foreign entities, whether for-profit or otherwise, may receive funding as a subrecipient and must be incorporated (or otherwise formed) under the laws of a state or territory of the United States and have a physical location for business operations in the United States. Unincorporated Consortia, which may include domestic and foreign entities, must designate one member of the consortium to serve as the prime recipient/consortium representative. The prime recipient/consortium representative must be incorporated (or otherwise formed) under the laws of a state or territory of the United States. DOE/National Nuclear Security Administration (NNSA) Federally Funded Research and Development Centers (FFRDCs) are eligible to apply for funding as a prime recipient or subrecipient under Topic Area 2 only. In all other topic areas and subtopic areas (1a, 1b, 1c, 3a, 3b, 4, 5a, and 5b) DOE/NNSA and non-DOE/NNSA FFRDCs are restricted from applying for funding as a Prime Recipient, but are eligible to participate as a Subrecipient. Each FFRDC is permitted to participate as a Subrecipient with effort equivalent to up to 50% of the total estimated cost of the project; however, in aggregate, total FFRDC effort shall not exceed 50% of the total estimated cost of the project.