FY 2019 BETO-Wide RFI (DE-FOA-00002150)

DATE: August 6, 2019

SUBJECT: Request for Information (RFI)

Description

The U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy's (EERE's) Bioenergy Technologies Office (BETO) is requesting information on the following research opportunities to help inform its priorities and funding strategies: advanced processes and retrofits to co-produce cellulosic biofuels and other products at existing corn-starch ethanol production facilities; the utilization of waste food streams to produce fuels and chemicals; potential efforts to collect and publish existing under-used or economically stranded bioenergy datasets; and algal biomass feedstock quality and conversion research and development (R&D) for biofuels and bioproducts. This is solely an information request and is not a Funding Opportunity Announcement or indicative of future funding decisions. No applications for funding will be accepted with this RFI.

Purpose

BETO seeks information to help inform its research priorities, as part of its annual planning process. The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders to help ensure research areas are relevant, timely, appropriate for federal government funding, and aligned with Administration priorities.

Specifically, BETO is seeking information related to the following 4 topic areas:

Topic 1: Leveraging First Generation Bioethanol Production Facilities

BETO is seeking information related to the development and integration of technologies that could increase the production of cellulosic fuels, cellulosic sugars, and chemicals from corn fiber. BETO, in coordination with DOE's Office of Fossil Energy (FE) is also seeking information about technologies to convert or activate gaseous carbon dioxide (CO_2) emitted from fermentation of corn-starch feedstocks, as well as other gaseous emissions from other biorefinery processes. BETO is particularly interested in information on the development and verification of innovative process technologies to enable integration and retrofit into existing first generation corn-starch ethanol plants. Such technologies could facilitate the cost-competitive production of cellulosic biofuels and bioproducts from corn kernel fiber, and

increase renewable fuel production from existing domestic production facilities while also reducing waste and emissions from these facilities.

Topic 2: Systems to Handle Commingled Food Waste Streams

BETO is soliciting feedback to help understand the quantity, quality, and sources of generation of food waste in America, as well as options for converting that waste into value-added fuels, chemicals, and power. BETO is seeking information related to specific R&D challenges for technologies designed to utilize waste food streams to produce fuels and chemicals that could benefit from federal R&D efforts.

Topic 3: Bridging Industry & Government to Publish Existing High-Impact Data

BETO is seeking information regarding efforts to collect, and potentially pay for, existing high-quality bioenergy datasets that are under-used or economically stranded in order to publish on established public databases. Collecting and analyzing datasets that are not business sensitive or proprietary, and making this data available publicly could help researchers and industry capitalize on past successes (and/or learn from failures), as well as avoid duplicating research or pursuing ideas shown not to work. If successful, this effort could bolster the growing bioeconomy with industrially relevant data across the supply chain, and result in accelerated development and utilization of technologies.

Topic 4: Algal Biomass Feedstock Quality and Conversion Interface for Biofuels and Bioproducts

Algal biofuels research has made significant progress in recent years on improving algae productivity, or the quantity of algal biomass produced in the lab and in open ponds. To further advance the state of algal biomass technology, BETO is seeking information on the effects and importance of algal biomass composition (i.e., feedstock quality) on conversion efficiency and yields of biofuels and/or bioproducts. BETO is specifically interested in information on how stakeholders evaluate the quality of their biomass supply chain and conversion processes, in relation to conducting impactful bioproducts R&D that enables the algal biofuels industry.

Disclaimer and Important Notes

This RFI is not a FOA; therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of EERE funded awards, will be subject to Congressional appropriations and direction.

Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a

formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

Proprietary Information

Because information received in response to this RFI may be used to structure future programs and FOAs and/or otherwise be made available to the public, **respondents are strongly advised to NOT include any information in their responses that might be considered business sensitive, proprietary, or otherwise confidential.** If, however, a respondent chooses to submit business sensitive, proprietary, or otherwise confidential information, it must be clearly and conspicuously marked as such in the response.

Responses containing confidential, proprietary, or privileged information must be conspicuously marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Federal Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

If your response contains confidential, proprietary, or privileged information, you must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

> **Notice of Restriction on Disclosure and Use of Data:**
> Pages [List Applicable Pages] of this response may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this RFI DE-FOA-0002150. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure" and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

Evaluation and Administration by Federal and Non-Federal Personnel

Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Request for Information Topics and Questions

Respondents are welcome to address any or all of the following questions, as well as share insights on information not presented in the questions.

To streamline the processing of your inputs, each topic contains a number of questions that cover the subject areas. Please respond to as many of the specific questions or topics as may be deemed appropriate. Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development. DOE will not respond to individual submissions or make public a compendium of responses, except as required by applicable law. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed. DOE will not compensate for information provided under this RFI. This RFI is not accepting applications for financial assistance or financial incentives. DOE has no obligation to respond to those who submit comments, and/or make available any feedback on any decision made based on the responses received. We greatly appreciate the time and consideration provided to enhance the relevance and timeliness of federally funded research.

Topic 1: Leveraging First Generation Bioethanol Production Facilities

Section 1: Generation 1.5 Cellulosic Ethanol Process Technology Development and Plant Integration

Generation 1.5 (Gen 1.5) refers to the conversion of residual fiber from the corn kernel to ethanol. The fiber may be converted *in-situ* along with starch in primary fermentation or separately downstream of fermentation. BETO is requesting information on process technology solutions for Gen 1.5 production and the integration with existing first generation, corn-starch ethanol plant / process systems.

1. Describe promising technologies for fiber conversion that maximizes yield of cellulosic ethanol with low operating cost and low capital investment.
2. What is the state of the art and maturity of the proposed Gen 1.5 process technology?

3. Describe how to address integration challenges with existing plant systems to minimize capital cost (shorten payback period), minimize energy and water consumption, and minimize waste / effluent generation?
4. Describe the advantages and disadvantages of *in-situ vs*. separate fiber conversion process options.
5. For *ex-situ* implementations, would it be better to have a dedicated separation and dehydration setup for the cellulosic ethanol or can the cellulosic ethanol be combined to the existing separation and dehydration section of the plant?
6. Describe the degree to which Federal R&D funding would accelerate transformational technology advances that industry by itself is not likely to undertake because of technical and financial uncertainty.

Section 2: Analytical methods for *in-situ* corn kernel fiber conversion

Robust analytical methods are essential to appropriately qualify as well as quantify ethanol production from the cellulosic fraction of corn kernel fiber co-processed with starch in a first generation facility. Processes that convert fiber separately do not face a similar challenge as there is *de minimis* level of unconverted corn starch down stream of fermentation.[1]

7. Describe barriers for corn kernel fiber co-processing that could be addressed with new or improved analytical methods.
8. What analytical technologies or techniques would provide the most improvement to current methods in corn kernel fiber co-processing?
9. Describe the degree to which Federal R&D funding could address critical scientific challenges and would accelerate transformational technology advances that industry by itself is not likely to undertake because of technical and financial uncertainty.

Section 3: Opportunities in Management of CO_2 and Other Gaseous Emissions

For every molecule of ethanol produced at a corn ethanol biorefinery an equivalent of carbon dioxide (CO_2) is also evolved during fermentation, producing a concentrated industrial point-source of CO_2. Other biorefinery processes, such as anaerobic digestion of wet waste streams, may result in other gaseous emissions, including methane and other hydrocarbons. Management of these emissions offers an opportunity to add value to what have traditionally been viewed as major waste streams by improving the carbon intensity and greenhouse gas emissions profile of ethanol or creating additional revenue streams by co-producing a secondary product. For example, CO_2 utilization from biorefineries for enhanced oil recovery is already in commercial operation, and DOE's Office of Fossil Energy (FE) has already

[1] Environmental Protection Agency, 40 CFR Part 80, Regulation of Fuels and Fuel Additives; RFS Pathways II, and Technical Amendments to the RFS Standards and E15 Misfueling Mitigation Requirements; Final Rule. Federal Register, Vol. 19. No. 138, 2014.

demonstrated the technology for saline storage at a corn ethanol biorefinery. Further, FE has been implementing a research, development, and demonstration (RD&D) program on carbon capture, storage and utilization for 20 years, which has applicability for power plants and industrial sources, including biorefineries. FE and BETO are requesting information on the barriers associated with deploying such technologies across bioeconomy. Specifically, FE and BETO are interested in the following:

10. What is the overall interest in leveraging these process emissions gases, including carbon oxide capture and utilization provisions of § 45Q of the Internal Revenue Code, as amended within the Bipartisan Budget Act of 2018? Are the tax credits associated with 45Q sufficient to deploy carbon capture and/or utilization technologies at existing biorefineries? Are there other state or federal directives which are notable to consider when discussing such technologies?
11. What are the major barriers to deploying such technologies at biorefineries?
12. Describe the degree to which federal R&D funding would accelerate transformational technology advances in ethanol process emissions at the biorefinery scale (20+ million gallon per year) that industry by itself is not likely to undertake because of technical and financial uncertainty. BETO and FE are specifically not interested in CO_2 utilization in the form of enhanced oil recovery. BETO and FE are seeking inputs particularly on the following:
    - 12a. innovative technology to activate CO_2 and utilize the molecular building blocks to make fuels and products from biorefineries.
    - 12b. innovative technology to activate CO_2 and utilize the molecular building blocks to make fuels and products from other power industrial sources.
    - 12c. innovative technology to convert other gaseous emissions, such as methane and other hydrocarbons, to make fuels and products.

Topic 2: Systems to Handle Commingled Food Waste Streams

There are multiple logistical challenges associated with energy and resource recovery from food waste including:

- Food waste is an inherently distributed resource correlated with population and seasons.
- Food waste collection, sorting, aggregation, and disposal practices vary widely at a local (often municipality) level
- Food waste is often contaminated or is commingled with other organic waste streams (e.g., plastics, paper)
- Transportation of food waste is cost prohibitive given the high (>70%) moisture content

BETO is interested in stakeholder input about current food waste practices as well as specific opportunities that may improve the technical and economic viability of energy and resource

recovery from food waste. Additionally, BETO is interested in the challenges, opportunities, and R&D needs in lowering the energy consumption and costs of processing these waste streams into value-added fuels and products.

Respondents are welcome to address any or all of the following questions, as well as share insights on technological hurdles not presented below but are still relevant to food waste characterization and utilization.

For information received to be as useful as possible, BETO requests input that is specific, measurable, achievable, relevant, and time-bound. If applicable, respondents are encouraged to describe their current process and state of technology regarding food waste utilization and how precise R&D and analysis efforts would improve specific metrics relevant to their process.

Section 1: Producers and users of food waste

1. What type of entity are you (e.g., food waste producer, food waste customer, waste management company)?
2. Briefly describe the role you have in the food waste management supply chain.
3. How much food waste do you process/manage on an annual basis (tons/year)?
    a. What are the major sources of the food waste you manage?
    b. What stream(s) are commingled with the food waste you manage?
    c. How much do you typically pay (per ton) to manage your food waste?
4. Describe any key local and state requirements (e.g., point-source separation, landfill organics bans) that govern your food waste handling and management practices.
    a. How do you anticipate the quantity and quality of food waste you process will change over time?
    b. How do you anticipate the ultimate fate of food waste you process will change over time? (e.g., increase in composting, increase in second use products)?

Section 2: Logistics and current practices of acquiring food / agricultural waste

5. What is/are the major logistical challenges associated with food waste in your jurisdiction/municipality/region (e.g., cost of transport, economies of scale)?
6. What are the technical hurdles for separating the food waste from existing MSW streams to prevent it from entering a landfill?
7. Is co-digestion of food waste with other organic waste from farms or biomass residues a logistically viable option for food waste in your jurisdiction/municipality/region? Why or why not?
8. Are dedicated (food waste only) anaerobic digesters a logistically viable option for food waste in your jurisdiction/municipality/region? Why or why not?

9. What other options do you have (or are currently employed) for managing food waste in your jurisdiction/municipality/region? (e.g., compost, incineration, other thermal treatments)?

Section 3: Composition and utilization of food waste for anaerobic digestion / co-digestion

10. What are the technological innovations needed to increase the utility of existing urban anaerobic digestion facilities?
11. What are the technological innovations needed to increase the utility of existing rural anaerobic digestion facilities?
12. How does the composition of food waste streams destined for composting or anaerobic digestion alter compost or digester conditions?
13. What opportunities exist for blending food with other organic waste (such as yard trimmings or unrecyclable paper products) to increase the use of anaerobic digestion?
14. What are the most common contaminants in the food waste stream that negatively impact composting or anaerobic digestion and how can these contaminants be reduced or eliminated?
15. Plastic packaging is a significant contaminant in food waste streams. What is the current state of the art in compostable packaging and what research is needed to improve compostable plastic?
16. What value added coproducts are, or should be, targeted at anaerobic digestion facilities (excluding fertilizer / land based applications)?

Section 4: Composition and utilization of food waste for other energy applications (excluding anaerobic digestion and co-digestion)

17. What conversion technologies exist that can convert food waste and blends of food waste and other organic wastes into liquid biofuels and/or bioproducts?
18. In what ways does the technology(s) identified in your answer to question 4.1 mitigate the challenges identified in the RFI background section (i.e., because food waste is a distributed resource, because food waste contains a high moisture content)?
19. What technical barriers must be overcome to reduce the risk of implementing the technology(s) identified in your answer to question 4.1?
20. What barriers must be overcome to improve the economic viability of the technology(s) identified in your answer to question 4.1?

Topic 3: Bridging Industry & Government to Publish Existing High-Impact Data

BETO is seeking information regarding efforts to collect, and potentially pay for, existing high-quality bioenergy datasets that are under-used or economically stranded in order to publish on established public databases. Collecting and analyzing datasets that are not business sensitive or proprietary, and making this data available publicly could help researchers and industry

capitalize on past successes (and/or learn from failures), as well as avoid duplicating research or pursuing ideas shown not to work. If successful, this effort could bolster the growing bioeconomy with industrially relevant data across the supply chain, and result in accelerated development and utilization of technologies.

Section 1: Data Quantity

1. For data suppliers:
    - Are you aware of existing under-used datasets within your current or previous organization (including methods, operating parameters, innovations, market analyses, resource assessments, references, etc.) that would be useful to others in your field? If so, please include as many specifics as possible about the data and the data quality including the best point of contact for the data.
    - Describe the type(s) of unpublished data that you would be: a) willing to make publically accessible and b) unwilling to make publically accessible. If unwilling, what incentives would you consider (e.g., acknowledgements, hiring of data producers to assure quality, modest fee to release the data, control of IP)?
2. For data users: Please list any existing or potentially-existing data or information that would be particularly useful to you, including specific companies of interest if known. Please clarify the proposed positive impact you could derive from access to the data.

Section 2: Data Quality

3. What are the best ways to measure and/or ensure quality of existing datasets (e.g., sign-off from scientists/engineers who collected it, ability to obtain missing metadata, repeatability of design, corroborations with other public datasets)?
4. What is the best way to incentivize institutions to share both "negative" results as well as their most innovative breakthroughs?

Section 3: Data Acquisition

5. What would be the biggest challenges in obtaining under-used datasets and how could these challenges be overcome?
6. What type(s) of impactful data would be the easiest to obtain?

Section 4: Data Valorization

7. What are strategies to adequately determine the value of data given the extremely large number of variables (e.g., potential impact, return on investment, level of interest, age of the data, completeness of metadata, type of data)?
8. Would data users be willing to pay a fee to access the data?
9. Would individuals be willing to provide data if their compensation was dependent on the number of users? Would a one-time fee upfront for the data be preferred?

Topic 4: Algal Biomass Feedstock Quality and Conversion Interface for Biofuels and Bioproducts

Algal biofuels research has made significant progress in recent years on improving algae productivity, or the quantity of algal biomass produced in the lab and in open ponds. To further advance the state of algal biomass technology, BETO is seeking information on the effects and importance of algal biomass composition (i.e., feedstock quality) on conversion efficiency and yields of biofuels and/or bioproducts. BETO is specifically interested in information on how stakeholders evaluate the quality of their biomass supply chain and conversion processes, in relation to conducting impactful bioproducts R&D that enables the algal biofuels industry.

Section 1: Interface of algal cultivation and conversion

1. Algal biomass supplies can come from intentionally cultivated biomass from algae farms, algae grown as a service for another industry like waste water treatment, and naturally occurring algal blooms. Are there other significant sources of algal biomass supply? What are the important factors to evaluate when considering using one of these or other supplies for a conversion R&D project?
2. Does your research group have ready and consistent access to the quantity and quality of algal biomass required to conduct meaningful processing and conversion R&D? If so, how do you evaluate and forecast the quantity and quality of your biomass supply? In your answer consider the source of your algae biomass supply (i.e. intentionally cultivated, grown for services, naturally occurring blooms) and seasonal variation.
3. Biomass quality includes many factors like biochemical composition of the harvested material, percentage dewatering of the biomass, and storage parameters. What biomass quality characteristics are most important to you when evaluating the quality of your algal biomass supply for processing and conversion into finished products? What metrics do you use to evaluate those characteristics? In your answer, please specify your intended source(s) of biomass (intentionally cultivated, algae from services, naturally occurring algae blooms).
4. What are the most important economic and sustainability criteria to consider when collecting your biomass supply for a conversion R&D project? In your answer, please specify your intended source(s) of biomass (intentionally cultivated, algae from services, naturally occurring algae blooms).
5. Consider the continued reduction of electricity costs in the U.S. and the increasing relative proportions of renewable energy contributing to the U.S. national electricity supply. What are there changes in the cultivation, harvesting, and conversion processes you would implement that increases the economic viability of algae biofuels and commodity scale bioproducts while maintaining positive energy balances?

Section 2: Improving conversion of algal biomass to biofuels and bioproducts

6. When considering conversion approaches applied today, are there any overlooked parameters that must be considered to ensure the development of efficient conversion processes that are economically viable and environmentally sustainable?
7. What are the most important metrics for evaluating progress in processing and converting algal biomass supply to bioproducts for an R&D project? Do these metrics change if they are for an algae system that co-produces fuels and products?
8. What minimum quantity of algal biomass is required to conduct meaningful processing and conversion R&D? What is the minimum amount of conversion product required in an R&D project to evaluate quality?
9. What are the benefits and drawbacks of conducting conversion R&D on material collected from outdoor cultivation campaigns? To what extent do you rely on biomass produced under laboratory conditions to perform conversion R&D? How valuable is conversion data from a laboratory biomass supply compared to conversion data from an outdoor biomass supply?

Section 3: Ensuring industrially relevant research and development

10. At a commercial scale, how much product volume and biomass supply would your system require to have a positive return on investment?
11. If your current system design only produces bioproducts from algal biomass: how should the potential of your system to enable algal biofuels be evaluated? What is or would be your strategy to transition to bioproducts and biofuels system or biofuels only system? How do the needed R&D improvements in efficiencies and economies of your current system design correlate with a bioproducts and biofuels system or biofuels only system?
12. How do you calculate the levelized cost of energy (LCOE) or Energy Return on Investment (EROI) for your envisioned commercial system, and what do those metrics need to be for the system to be economically and environmentally sustainable?
13. How should benefits for converting biomass supplies from services (i.e., wastewater treatment, carbon dioxide utilization from power plants) and remediating naturally occurring algal blooms be accounted for in evaluating commercialization potential of a bioproduct from algal biomass? How should the supply chain risks for the algal biomass also be accounted for in evaluating commercialization potential?
14. The end use of a bioproduct largely shapes the process quality requirements for cultivation and conversion. When considering your bioproduct, the biomass source, and likely quality specifications for the sale of your product, are there unique factors pertinent to your cultivation, harvesting, and conversion processes?

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to EERE_Bioenergy@ee.doe.gov no later than 5:00pm (ET) on September 6, 2019. Responses must be attached to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to

ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email, and no more than 6 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

EERE will not respond to individual submissions or publicly publish a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name;
- Company / institution contact; and
- Contact's address, phone number, and e-mail address.