Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE)

FY19 BIOENERGY TECHNOLOGIES OFFICE MULTI-TOPIC FUNDING OPPORTUNITY ANNOUNCEMENT

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002029
FOA Type: Initial
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FOA Issue Date:	05/03/2019
Submission Deadline for Concept Papers:	5:00pm ET on 06/03/2019
Submission Deadline for Full Applications:	5:00pm ET on 07/22/2019
Expected Submission Deadline for Replies to Reviewer Comments:	5:00pm ET on 08/23/2019
Expected Date for EERE Selection Notifications:	09/30/2019
Expected Timeframe for Award Negotiations:	October – November 2019

- Applicants must submit a Concept Paper by 5:00pm ET the due date listed above to be eligible to submit a Full Application.

- To apply to this FOA, applicants must register with and submit application materials through EERE Exchange at https://eere-Exchange.energy.gov, EERE's online application portal.

- Applicants must designate primary and backup points-of-contact in EERE Exchange with whom EERE will communicate to conduct award negotiations. If an application is selected for award negotiations, it is not a commitment to issue an award. It is imperative that the applicant/selectee be responsive during award negotiations and meet negotiation deadlines. Failure to do so may result in cancelation of further award negotiations and rescission of the Selection.

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I. Funding Opportunity Description

A. Background and Context

i. Background and Purpose

The U.S. Department of Energy's (DOE's) Bioenergy Technologies Office (BETO) develops technologies that convert domestic biomass and other waste resources into fuels, products, and power to enable affordable energy, economic growth, and innovation in renewable energy and chemicals production. The United States has the capacity to produce more than one billion tons [1] of sustainable biomass, which can be used to produce fuels for cars, trucks, and jets that result in lower emissions; renewable chemicals; and renewable power to supply the grid. BETO's work will enhance U.S. energy security by augmenting domestic energy supplies and reducing imports of foreign oil. These efforts also support the growth of the domestic bioeconomy, create American jobs, and secure the nation's global leadership in advanced bioenergy and clean energy technologies.

To ensure our nation's competitive advantage in the emerging bioeconomy, BETO funds research and development (R&D) of technologies to produce advanced bioenergy from terrestrial and algal biomass, biogas, and other waste streams. As part of DOE's Office of Energy Efficiency and Renewable Energy (EERE), BETO invests in high-impact, high-value bioenergy technology R&D that industry would be unable to pursue independently due to the high level of risk and technology uncertainty. BETO focuses on applied R&D to bolster the body of scientific and engineering knowledge that can enable industry to demonstrate and deploy high-performing drop-in biofuels and renewable chemicals at $3 per gallon gasoline equivalent ($3/GGE) in the near-term[2].

This Funding Opportunity Announcement (FOA) will provide funding to address the highest priority R&D areas within biofuel technologies, bioproducts, and biopower. It includes Areas of Interest (AOIs) from all five BETO programs: Feedstock Supply and Logistics; Advanced Algal Systems; Conversion; Advanced Development and Optimization; and Sustainability and Strategic Analysis. Each AOI supports BETO's objectives to reduce the minimum selling price of drop-in biofuels, lower the cost of biopower, enable high-value products from biomass or waste resources, and

[1] U.S. Department of Energy (2011), *U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry*, R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2011/224, Oak Ridge National Laboratory, Oak Ridge, TN, 227p., http://www.energy.gov/sites/prod/files/2015/01/f19/billion_ton_update_0.pdf.
[2] U.S. Department of Energy (2016), Bioenergy Technologies Office Multi-Year Program Plan, DOE/EE-1385. https://www.energy.gov/sites/prod/files/2016/07/f33/mypp_march2016.pdf

improve the quality of feedstock characterization and reliability of biorefinery operations.

ii. Technology Space and Strategic Goals

BETO manages a diverse portfolio of technologies covering the full spectrum of bioenergy production, from the feedstock source to end use. Potential end products include biofuels for ground transportation (both light-duty vehicles and heavy-duty trucks), biofuels for off-road transportation (commercial aviation and marine vessels), biogas, renewable home heating oil, bioproducts, and biopower. Although BETO focuses on bioenergy, it also pursues strategies to develop high-value bioproducts that can lower the cost and accelerate the development of bioenergy technologies. Figure 1, below, shows how BETO program areas cover the full spectrum of bioenergy technology development.

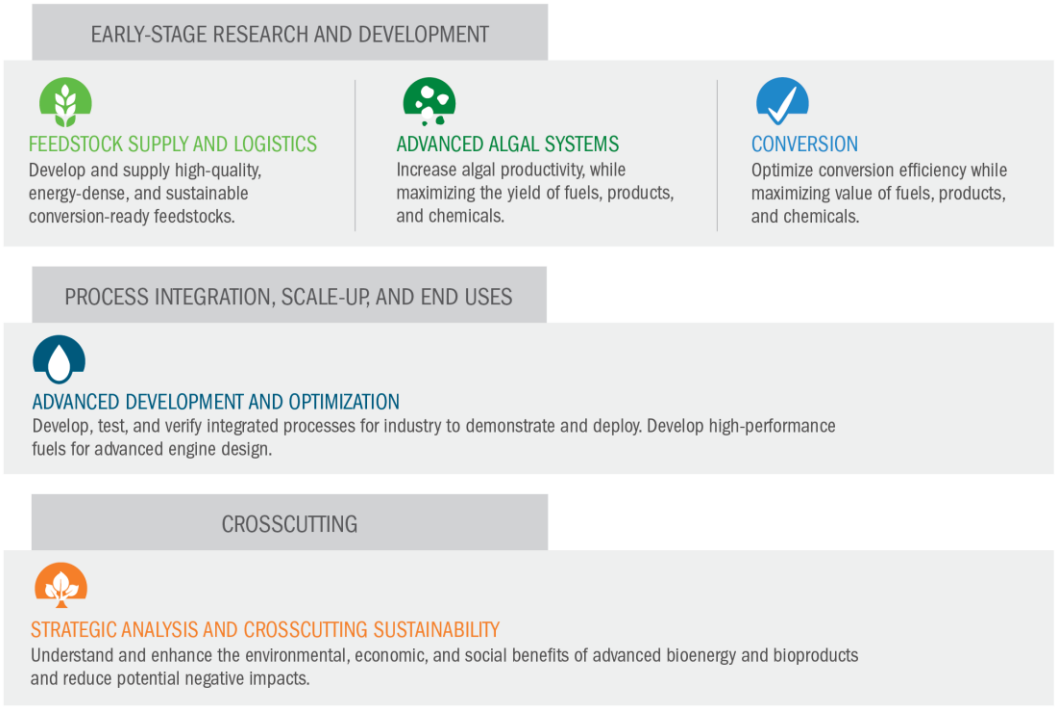

Figure 1: BETO's Critical Program Areas

Biofuels and bioproducts are produced via a variety of technology configurations called technology pathways. Each technology pathway includes a specific feedstock and conversion technology combination to produce a product slate of biofuels, biopower, and/or bioproducts. BETO programs focus on overcoming key technology barriers that affect multiple technology pathways.

Technology pathway progress is assessed annually using techno-economic analyses (TEA), which translate technology development into cost improvements. These results, along with supply chain sustainability analyses, which estimate the environmental impact of improvements, are referred to as the state of technology (SOT). Figure 2 illustrates technology development progress representing a 42% reduction in the modeled Minimum Fuel Selling Price (MFSP) in 4 years and projections of future improvements for one example technology pathway, wood biomass via catalytic fast pyrolysis with upgrading to hydrocarbon fuel.

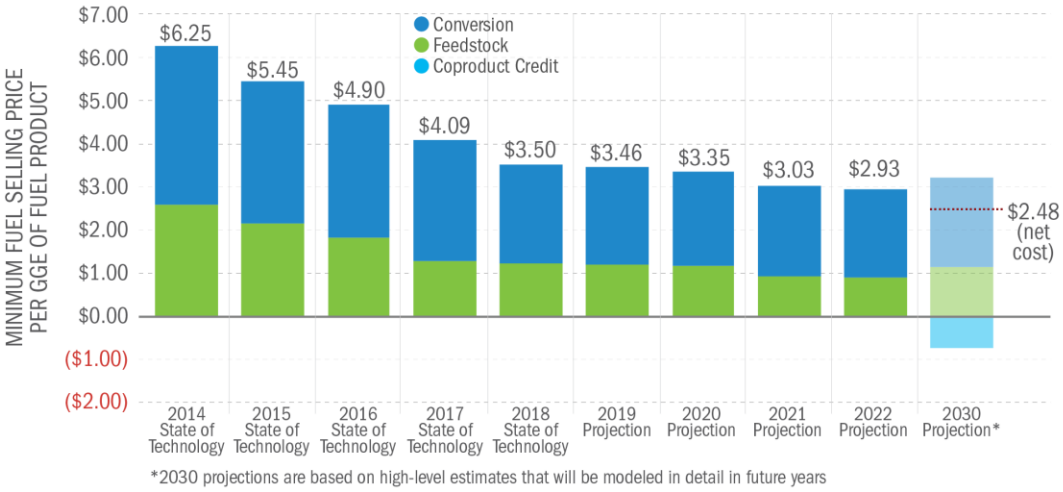

Figure 2: Illustrative biofuel pathway progress toward $3/GGE (woody feedstocks via catalytic fast pyrolysis and upgrading pathway)

There is significant R&D that is still required in order to reach the ultimate trajectory of a modeled mature MFSP of $2.5/GGE such as:

- R&D of feedstock supply systems that can reliably deliver industrially relevant quantities of quality feedstocks
- R&D of high productivity advanced algal systems
- R&D of conversion technologies able to efficiently process diverse and variable feedstocks into biofuels (e.g., gasoline, diesel, jet, and marine fuels), bioproducts, and biopower
- Development of integrated processes, tested and verified at engineering scale, to reduce technology uncertainties and enable industry deployment
- Crosscutting sustainability and strategic analysis of economic, social, and environmental effects to identify emerging opportunities

The Areas of Interest in this Funding Opportunity Announcement directly seek to address these R&D needs.

B. Areas of Interest

AOI Number	Area of Interest (AOI)
1	Cultivation Intensification Processes for Algae
2	Biomass Component Variability and Feedstock Conversion Interface
2a	Relating Biomass Physical and Chemical Characteristics to Feedstock Performance in Handling and Conversion Operations
2b	Impact of Storage and Handling on Biomass Characteristics
2c	Improving Economics and Development of Coproducts
3	Efficient Wood Heaters
4	Systems Research of Hydrocarbon Biofuel Technologies
5	Optimization of Bio-Derived Jet Fuel Blends
6	Renewable Energy from Urban and Suburban Wastes
7	Advanced Bioprocessing and Agile BioFoundry
7a	Advanced Bioprocessing
7b	Agile BioFoundry
8	Plastics in the Circular Carbon Economy
8a	Designing Highly Recyclable Plastics
8b	Designing Novel Methods for Deconstructing and Upcycling Existing Plastics
9	Rethinking Anaerobic Digestion
10	Reducing Water, Energy, and Emissions in Bioenergy

Requirements Applicable to all Areas of Interest:
As described in Section III.A.ii of this FOA, DOE/NNSA Federally Funded Research and Development Centers (FFRDCs) are eligible to participate as Subrecipients, but are not eligible to apply as a Prime Recipient. Work performed by these National Laboratory partners can make up no more than 49% of the proposed or approved work budget.

Where required, applicants must provide a baseline discussion of sustainability, life cycle assessment (LCA), and TEA for the applicant's proposed research. Projects proposing systems that are not sustainable (excessive freshwater, energy-intensive unit operations, etc.) and/or are not economical when scaled for commercial operations will not be considered. Applicants must plan for performing ongoing TEA and LCA throughout the project in order to ensure the most impactful areas for R&D in the applicant's pathway are addressed.

Applications submitted under any AOI must present a strong and convincing technology development strategy, including a feasible pathway to transition the

application results to the next logical stage of R&D and/or commercial demonstration. Applications must meet this requirement by establishing a baseline for their current state of technology (by providing the information set forth in the AOI specific requirements), as well as including intermediate and final technical and economic target metrics with the proposed Workplan.

All applications must utilize approved feedstocks for their AOI, as outlined in Appendix D which has specific definitions of each feedstock for the purposes of this FOA.

A list of final products that are not allowable under this FOA can be found in Section I.C. Exceptions regarding allowable final products are described within each AOI.

In addition, projects in the following AOIs will be subject to Verification by a third party as described in Section I.D of the FOA:

- AOI 1: Cultivation Intensification Processes for Algae
- AOI 2: Biomass Component Variability and Feedstock Conversion Interface
- AOI 3: Efficient Wood Heaters
- AOI 4: Systems Research of Hydrocarbon Biofuel Technologies
- AOI 5: Optimization of Bio-Derived Jet Fuel Blends
- AOI 7: Advanced Bioprocessing and Agile BioFoundry
- AOI 8: Plastics in the Circular Carbon Economy
- AOI 9: Rethinking Anaerobic Digestion

Furthermore, all selected projects that receive awards will be required to participate in BETO's Peer Review process. Currently, the Peer Review process is a biennial review that includes preparation of a presentation and participation/presentation at the Peer Review Meeting. This activity must be accounted for within each applicant's scope, schedule and budget.

All work under EERE funding agreements must be performed in the United States. All prime recipients receiving funding under this FOA 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. To request a waiver of either of these requirements, an applicant must submit an explicit waiver request in the Full Application. See Section IV.J.iii and Appendix C.

i. AOI 1: Cultivation Intensification Processes for Algae

The objective of BETO's Advanced Algal Systems (AAS) program is to accelerate the development of technologies for cultivating photosynthetic algae to make algal biofuels and bioproducts. The AAS strategy supports early-stage, applied R&D projects to overcome barriers identified in the National Algal Biofuels Technology Roadmap.[3] By overcoming these barriers, the cost of algal biofuels will decrease and products made from algae will have the potential to contribute to biofuel and bioproduct markets. The AAS Program strategy contributes to BETO's goals for biofuel modeled MFSP of $3/GGE with a trajectory to $2.50/GGE.

Developers of algal biofuel technologies face significant challenges in translating results between laboratory research systems and larger-scale outdoors (or mass culture) systems. These difficulties limit reliable experimental durations, adequate and representative experimental volumes of material, and results that can be reproduced reliably. By overcoming the challenge in translating results between laboratory and mass cultures, the objective of AOI 1 is to increase the harvest yield, robustness, and quality of algae cultivation for biofuels and bioproducts.

AOI 1 specific areas of interest:

1. Strain/trait of interest characterization and adaptation of novel and/or existing strains to novel cultivation conditions in an indoor/outdoor/indoor iterative experimental framework (novel strain isolation is not necessarily required to meet the objective).
2. Novel cultivation systems and innovative strategies to operate cultivation systems that improve data collection and overall culture performance.
3. Beneficial management and control of cultivation ecology.
4. Development of tools and sensors for monitoring of cultivation ecology and health paired with cultivation management operations/interventions.
5. Management of media (e.g., water, nutrients, and carbon) delivery and reuse/recycle to maintain and/or improve cultivation performance.
6. Improvement of stability and reproducibility of high-performance cultivation outcomes.

Successful applications: will accomplish the objective by showing closer correlation between promising laboratory results and "mass culture" campaigns resulting in "high-performance" cultivation outcomes to grow and harvest kilograms of algae and/or equivalent amounts of secreted algae products in a cultivation campaign (see definitions in specific requirements below). Specifically, successful applications will:

[3] 2016 National Algal Biofuels Technology Review at http://www.energy.gov/eere/bioenergy/downloads/2016-national-algal-biofuels-technology-review

- Identify algae strain traits of interest and show that the trait(s) of interest can be reproduced in outdoor, field-scale research;
- Undergo multiple indoor/outdoor/indoor cycles to develop, test, and optimize practices and technologies that enable delivery of the expected performance in the largest scale field trials;
- Generate data from cultivation campaigns that could be used in techno-economic models to result in lower algal biofuel minimum fuel selling prices and in lifecycle models to assess energy balance and energy return on investment; and
- Disseminate results to broader audiences.

AOI 1 specific requirements: The following requirements (1-6) must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V. A. ii.):

1) A single project must integrate existing intellectual and physical infrastructure to grow algae strains in "high-performance" cultivation campaigns at "field-research" scale reproducibly.
   - "High-performance" cultivation means growing strains outdoors while achieving traits of interest such as high areal productivity throughout a cultivation campaign, specific quality (i.e., biochemical composition) at harvest, and maintaining robustness throughout the campaign duration.
     - The project plan must support increasing achieved annual average harvest yield as measured by grams of harvested algae biomass or equivalent secreted product per meter squared per day ash free dry weight ($g/m^2/d$ AFDW). Methods for calculating annual average harvest yield must include productivity from field-research in representative growing seasons during the course of the applicants envisioned growing year.
     - The project plan must measure and support increasing specific quality towards the applicant's targets for biochemical composition and conversion yield to be achieved in cultivation campaigns.
     - The project plan must support increasing the robustness of "field-research" cultivation campaigns and must propose a robustness metric (e.g., reduction in mean time between failures, reduction in harvests yields significantly less than the average and/or predicted harvest yield, and increase in percent of achieved cultivation uptime).
   - "Field-research" refers to a minimum of 3 independent biological replicates subjected to stochastic environmental conditions including natural sunlight and seasonal variations in climate associated with outdoor or greenhouse

conditions as well as non-sterile culturing vessels (e.g., ponds and photobioreactors) and growth media, and capable of extended (weeks to months) cultivation and harvest campaigns.

2) Applicants must discuss their readiness for "mass culture" of algae and in this context provide their "internal baseline" for the performance of their proposed system.
   - "Mass culturing" refers to the capacity to recover kilograms of algae (on an ash-free dry weight basis) and/or equivalent measure of secreted algal product from a continuous, semi-batch, or batch field-research campaign.
   - "Internal baseline" refers to prior experiments performed and cultivation data gathered by members of the project team. The baseline must include data describing the growth of the algae strain(s) under actual or simulated climate conditions, media composition, analytical standard operating procedures and quality controls, and a history of prior growth of liquid cultures of strain(s), at the facilities proposed.
     - If novel technologies (e.g., strains and cultivation equipment) are proposed where no baseline exists, the applicant is required to discuss the methods, assays, and other evaluation criteria that are proposed to differentiate the new technology from the applicant's internal baseline. Proposing novel technologies does not preclude the requirement for an internal baseline.
   - The applicant's discussion of their internal baseline must correspond to the information provided in the required technical datasheet.
     - The internal baseline initial values must match or exceed the BETO 2016 SOT value for annual average productivity of 9.1 g/m^2/d AFDW.[4]
     - The progress towards final targets must match or exceed the AOI metrics.
3) The applicant must discuss their experimental cultivation equipment in the context of the system design of the largest-scale field-research trials (e.g., for each scale of research, the volume and/or area of cultivation reactors, gas and media delivery, and mixing and harvesting equipment).
4) Proposed algae strains must grow in saline, brackish, or otherwise non-potable water to align with BETO's vision for sustainable biomass production. Applicants must justify their strain selection(s) with a discussion of the potential strain performance in non-potable water, the previous work in growing or enhancing the proposed strain(s), the impact of and mitigation strategies for variable water

[4] Bioenergy Technologies Office Multi-Year Program Plan, DOE/EE-1385, March 2016. https://www.energy.gov/sites/prod/files/2016/07/f33/mypp_march2016.pdf

chemistry across experiments, and the assays that will be used to detect differences in strain performance.

- If applicants propose to use different water sources for laboratory and field-research, a thorough discussion of the impact of variable water chemistry (e.g., salinity, total suspended solids, and trace elements) on indoor/outdoor/indoor iterations must show that the applicant understands the risks of the experimental approach and has accounted for them in the accompanying scope, schedule, and budget.

5) Applicants must describe a vision for an integrated system of technologies for growing algae to make biofuel(s) and identify the system components being developed or improved in the scope of the current application. There must be a discussion of the capital and operating costs, as well as anticipated lifecycle impacts of the technology configurations for biofuel and bioproducts production (such as nutrient use and energy requirements), when commercial deployment is achieved. The discussion must include an analysis that shows the technology development included in the application supports producing an affordable biofuel. The energy return on investment for the envisioned algal biofuel(s) must be positive.
6) If an applicant proposes targeted genetic engineering of strains, the applicant must provide data that shows experience with the transformation characteristics of the strain(s) including at a minimum: transformation method(s); timeline for transformation detection and recovery; transformation efficiency; if proposing heterologous protein expression, evidence of prior heterologous protein-expression and detection in the application strain(s); a discussion of trait stability; developed phenotype assays; as well as genetic targets of interest. No genetic engineering of previously untransformed strains is allowable. Work plans including outdoor open release of genetically engineered algae must have sufficient schedule and budget for seeking an EPA Toxic Substances Control Act Environmental Release Application (TERA) permit.

Specific requirements below relate to the responsiveness of the application. Applications that do not meet these requirements are non-responsive and will not be reviewed:

7) Applicants must complete the technical datasheet (See Appendix E).
8) Applications must propose to work with algae. Proposing research activities on biofuels and bioproducts derived from lignocellulosic biomass (e.g., agricultural residues, woody biomass) is considered non-responsive. Cellulosic biomass and

derivatives and other non-food organic carbon substrates may be used for mixotrophic growth strategies.[5]

- Algae is defined as sunlight-driven photosynthetically grown microalgae, macroalgae, and cyanobacteria.
- Mixotrophic growth strategies means algae cultures grown using both inorganic carbon fixed through sunlight-driven photosynthesis paired with the continuous or intermittent addition of allowable sources of organic carbon.

9) All projects must undergo external verification after selection, an interim verification separating budget periods, and at the end of the projects; applications must account for these verifications in the project scope, schedule, and budget (verification requirements are described below in section I.D). A specific verification requirement is that at the initial verification, projects must show prior cultivation of the proposed strain(s) of interest.

AOI 1 Applications specifically not of interest:

- Those that do not meet the requirements for the AOI 1 and/or the general FOA.
- Those identified in Section I.C of the FOA.
- Those that propose to develop technologies for which the envisioned commercial-scale does not support the production of algal biofuels because of:
  - unfavorable mass and energy balances; use of artificial light for algae production; energy-intensive mixing velocities and other water-moving processes; lack of harvest media (e.g., water) reuse; lack of scalable cultivation design; and technology development solely suitable for niche markets such as pharmaceuticals and nutraceuticals.
- Those that propose to undertake construction or groundbreaking for new research facilities (installation of new experimental equipment is allowable).
- Those that propose algae cultivation at scales larger than mass culture requirements for field-research described above.

AOI 1 Metrics: By the end of the project, projects must show their technology and operational strategies can successfully predict that high-performance strains and traits of interest can be reproducibly cultivated in field-research campaigns. This will allow projects to achieve a 50% improvement in harvest yield (g/m2/d AFDW) and robustness as compared to the applicant's internal baseline paired with a 20%

[5] Allowable sources of organic carbon for mixotrophy are lignocellulosic feedstocks and wet wastes, as defined in Appendix D.

improvement in quality (i.e., achieved cultivation compositions), enabling at least 80 GGE per ton conversion yield using literature-based conversion efficiencies.

Metrics	Unit	Minimum	Stretch
Harvest yield ($g/m^2/d$ AFDW)	% improvement	50% improvement from internal baseline	100% improvement from internal baseline
Robust cultures	Days of "high-performance" cultivation	50% improvement from internal baseline	100% improvement from internal baseline
Conversion yield	variable	20% improvement from internal baseline	50% improvement from internal baseline

Table 1: AOI 1 Performance Metrics

AOI 1 Special Deliverables:
In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

ii. AOI 2: Biomass Component Variability and Feedstock Conversion Interface

BETO's Feedstock Supply and Logistics (FSL) program develops science-based strategies and technologies, and defines requirements and specifications to reduce the cost, improve the quality, and increase the quantity of conversion-ready feedstocks. The United States has the potential for over one billion tons of biomass to be available for domestic bioenergy applications by 2030[6].

The FSL program makes a clear distinction between "biomass" and "feedstock." For purposes of this AOI, "biomass" is defined as the raw material obtained at the site of production, collection, or cultivation. The term "feedstock" is used to denote biomass materials that have undergone one or more preprocessing operations (e.g., drying, grinding, milling, chopping, size fractionation, de-ashing, blending, formulation, densification, and extraction) to ensure that the physical

[6] 2016 Billion-Ton Report is accessible at: https://www.energy.gov/sites/prod/files/2016/12/f34/2016_billion_ton_report_12.2.16_0.pdf

and chemical quality specifications are acceptable for feeding into a biorefinery process.

FSL's R&D strategy for lowering the cost of biomass harvesting, handling, collection, storage and transport requires significant technology development and advances along the supply chain to achieve the target modelled MFSP, which is described in detail in the BETO Multi-Year Plan[7]. FSL R&D includes three areas: (1) feedstock supply, focusing on supply chain analysis identifying and quantifying current and future renewable carbon sources and costs associated with their production; (2) feedstock logistics, supporting the development of integrated and efficient purpose-designed supply systems that are capable of reliably harvesting, collecting, handling, storing, and delivering conversion-ready feedstocks that meet or exceed the quality and cost specifications required by a variety of conversion processes; and (3) Feedstock-Conversion Interface Consortium (FCIC)[8], increasing the understanding of the complexity and variability of biomass and feedstocks to improve the reliability of preprocessing and conversion systems, while meeting performance and cost targets.

AOI 2 will provide funding for early stage R&D to investigate (a) the physical and chemical characteristics associated with individual tissue components of certain types of biomass (e.g., rind, pith, leaves, and cobs from corn stover; and needles, juvenile wood, and bark from southern pine forest residues), (b) how biomass characteristics change during storage, handling, and when undergoing preprocessing and conversion, and (c) the utilization of this knowledge to improve feedstock performance (and therefore reduce costs) during preprocessing and conversion. Corn stover and pine forest residues were selected as they are the target ("proof of concept") feedstocks for the FCIC.

Projects under three sub-AOIs will therefore be considered for funding:

AOI 2a. Relating Biomass Physical and Chemical Characteristics to Feedstock Performance in Handling and Conversion Operations;

- Strategy design for field research-scale approaches to evaluating (a) the connection between biomass tissue type and composition, and (b) the potential for contamination (fertilizer, pesticides, herbicides, and soil) based on biomass tissue type
- Novel harvesting, collection, or sorting approaches for management and positive control of physical and chemical characteristics of biomass and the resulting feedstock

[7] 2016 BETO Multi-Year Program Plan is accessible at: http://energy.gov/sites/prod/files/2016/03/f30/mypp_beto_march2016_2.pdf

[8] Feedstock Conversion Interface Consortium (FCIC) information is accessible at: https://fcic.inl.gov/

- New technologies and/or analytical tools to relate moisture-holding characteristics, soil contamination, inorganic species/ash, and particle-size distribution of plant tissue components to performance in preprocessing or conversion operations
- Novel methods and resulting predictive models for relating plant tissue types in corn stover or forest residues to biomass composition[9]
- Management and positive control methods for addressing variation in biomass tissue components performance during milling
- Early stage research on variability in friction and adhesion of biomass particles relative to tissue type
- Strategy design for representative sampling of biomass solids at all stages of milling/grinding
- New sensors, tools, or novel predictive models connecting chemical and physical characterization of biomass-derived feedstock with efficiencies in preprocessing and/or conversion
- Development of techniques to improve the stability and reproducibility of any existing sensors, tools, or analytical methods connecting chemical and physical characterization of biomass-derived feedstock with efficiencies in preprocessing and/or conversion
- Development of techniques to improve the stability and reproducibility of any existing technologies, sensors, and/or analytical tools to predict biomass composition (carbon, cellulose, hemicellulos, lignin, inorganic species/ash, etc.) at the biorefinery or depot gate

AOI 2b. Impact of Storage and Handling on Biomass Characteristics;

- Novel storage and handling approaches for management and positive control of physical and chemical characteristics of the biomass and resulting feedstock
- New technologies and/or analytical tools to relate moisture-holding characteristics, soil contamination, inorganic species/ash, and particle-size distribution of plant tissue components to performance in storage and handling, and to relate plant components/tissue types to intrinsic inorganic element content
- Strategy design for field research-scale approaches for evaluating the effect of biomass transport on segregation of biomass by tissue type and/or compaction of biomass constituents

[9]Examples of biomass may include cellulose, hemicellulose, lignin, extractive, inorganic element speciation, ratio of amorphous- to crystalline-cellulose, and glass transition temperature for polymers.

AOI 2c. Improving Economics and Development of Coproducts;

- Proof of concept, laboratory-scale studies on the production of coproducts from off-specification material, fines, extractives, inorganic species/ash, and sources of contamination (fertilizer and soil)
- Novel separation from biomass, handling, and storage strategies and technologies for off specification materials, fines, extractives, inorganic species/ash, contaminants (fertilizer and soil), and water
- Strategy for the integration of a novel coproduction into an existing conversion technology

AOI 2 specific requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

1. Applicants must provide their internal baseline for the performance of their proposed system. In the context of this AOI, an internal baseline refers to experiments performed and data gathered directly by members of the project team.
2. The internal baseline must show proficiency in the supply chain component of focus, including, but not limited to, analytical standard operating procedures and quality control, and prior handling of the biomass type of interest at the location proposed.
3. For AOI 2A. Relating Biomass Physical and Chemical Characteristics to Feedstock Performance in Handling and Conversion Operations, applicants must:
   - Clearly identify the type of biomass resource investigated (corn stover and/or southern pine forest residue)).
   - Identify biomass tissues[10] and physical and chemical characteristics[11] of interest.
   - Specify the feedstock performance metrics in handling and conversion operations of focus[12].

[10] Examples of biomass tissue are: rind, pith, leaves, cobs from corn stover; needles, juvenile wood, bark for southern pine forest residues.

[11] Examples of physical and chemical characteristics include, but are not limited to: composition (cellulose, hemicellulose, lignin, ash, extractives or C, N, H, and O); Contamination (soil, fertilizer, pesticides, herbicides); inorganic species/ash speciation; energy content; moisture content

[12] Possible feedstock performance metrics include, but are not limited to: mean particle size and particle size distribution; particle flow characteristics such as angle of repose; energy use in feedstock movement or production; and conversion statistics in a well-defined conversion technology (e.g., hydrolysis, pyrolysis, gasification).

4. For AOI 2B. Impact of Storage and Handling on Biomass Characteristics, applicants must:
   - Clearly identify which of the two biomass resources (corn stover, southern pine forest residue, or both) will be used.
   - Define the biomass tissues and physical and/or chemical characteristics of interest.
   - Define storage and handling metrics[13].
5. For AOI 2C, Improving Economics and Development of Coproducts, applicants must:
   - Clearly define proposed coproduct(s) and their specifications.
   - Provide a potential estimate of the portion of material in the biomass that can be used to produce the coproduct.
   - Identify material separation techniques and their estimated efficiency
   - Laboratory scale proof of concept of coproduct production
   - Techno-economic analysis including potential market analysis
   - Relate the potential reduction in biomass cost to the fuels conversion process through a techno-economic analysis of the coproduct.

Specific requirements below relate to the responsiveness of the application. Applications that do not meet these requirements are non-responsive and will not be reviewed:

1. The application must justify why the applicant believes their proposed technologies are currently at a minimum of Technology Readiness Level (TRL) 2 and will reach no more than TRL 4 by the end of the project. (Please refer to Appendix I for TRL definitions.)
2. Applications must propose projects that work on corn stover and/or pine residue.

AOI 2 Applications specifically not of interest are:

- Those identified in Section I.C. of the FOA.
- Those that do not meet the requirements listed above.
- Those that propose to conduct field work, pilot or demonstration-level development, or undertake construction or development of new facilities and/or equipment.
- Those that propose the use of feedstocks other than corn stover or southern pine forest residues.

[13] Possible storage and handling metrics include, but are not limited to: dry matter loss; percent change in composition constituents (cellulose, hemicellulose, lignin, inorganic species/ash, extractives, etc.); change in moisture content; change in contamination (soil); change in particle decompression; compaction during transportation (density); and particle segregation during transportation.

AOI 2 Metrics:

AOI 2A: Relate Biomass Physical and Chemical Characteristics to Feedstock Performance in Handling and Conversion Operations

Metric: Achieve R-squared value of >80% when relating biomass physical and chemical characteristics to feedstock handling and operations data.

AOI 2B: Impact of Storage and Handling on Biomass Characteristics

Metric: Achieve R-squared value of >80% when relating biomass physical and chemical characteristics to decomposition rates in storage and particle size distribution from standard comminution methods.

AOI 2C: Improving Economics and Development of Coproducts

Metric: Reduce biomass cost by 20% through the development of coproducts from inorganic species/ash, soil, water, and off-specification materials.

AOI 2 Special Deliverables:

In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

iii. AOI 3: Efficient Wood Heaters

Wood is an abundant and renewable source of fuel for residential heat in the United States. Residential wood heaters (excluding open fireplaces) are used in approximately 10% of U.S. households with 2% using wood as a primary source of heat. Smoke emissions from residential wood heaters are a significant national air pollution and health issue. These emissions contain fine particulate matter (PM) along with other pollutants including carbon monoxide (CO), volatile organic compounds (VOCs), toxic air pollutants (e.g., benzene and formaldehyde), and black carbon. Improvements in the design and automation of wood heaters has the potential to significantly reduce emissions and increase efficiency. In addition to wood heater design, proper installation and operation also determine the level of emissions and efficiency of residential wood heaters.

In 2015, the Environmental Protection Agency (EPA) established standards of performance for residential wood heater particulate matter emissions.[14] In the U.S., residential wood heater manufacturers must certify compliance with EPA emission limits via performance testing in an accredited laboratory.[15] This 2015 EPA ruling (2015 Rule) set forth test methods for categories of residential wood heaters, and references industry standards for wood heater performance and emissions testing.

The objective of this AOI is to promote the development of technologies to advance the state-of-the-art in residential wood heater and residential central heater design to reduce emissions and improve efficiency. Categories of residential wood heaters of interest include room heaters, hydronic central heaters, and forced air central heaters.

Room Heater is an enclosed, wood burning appliance for residential space heating with optional water heating. This includes free-standing wood heaters, fireplace insert wood heaters, and built-in wood heaters. Wood heaters may utilize wood pellets, wood chips, or cord wood as the fuel source.

Central Heater is a fuel burning device designed to burn wood or wood pellet fuel that warms a space other than the space where the heater is located. Heat is distributed by forced air or liquid circulation (hydronic). Central heaters may utilize wood pellets, wood chips, or cord wood as the fuel source.

AOI 3 Specific areas of interest:

- Novel and innovative residential wood heater designs to improve combustion chamber geometry, combustion air flow distribution, mixing of combustion air with gasification products, stove baffling designs, and insulation strategies to control stove temperatures in critical locations.
- Improvements in automation of stoves to optimize combustion control:
    - Air inlet / feed control
    - Wood feed systems and control
    - Robust sensing technologies
    - Process/system control strategies to enable wood heater control over a wide range of operating conditions (startup to shutdown)
    - Secure remote control and real-time performance monitoring

[14] Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces. Federal Register, Vol. 80, No. 50, Monday, March 16, 2015.

[15] A current list of EPA accredited laboratories may be found here https://www.epa.gov/burnwise/epa-approved-test-labs-and-third-party-certifiers-residential-wood-heaters .

- Wood heater power generation via thermoelectric module integration
- Improvements in catalyst technologies for emissions reduction
    - Novel catalysts and or catalyst structures for improved performance and durability
    - Catalyst integration into wood heater design

AOI 3 Specific Requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.) :

- Applicants must provide in the full technical application the **"Required Wood Heater Data"** and **"Baseline Wood Heater Performance Data"** as indicated in Appendix F. This data establishes the baseline / as-is performance of the wood heater technology that will be improved upon during the proposed project.
- The maximum baseline emission limits for wood heaters and central heaters is the Step 1 limit defined in the 2015 Rule[16]:

Residential Wood Heater	**Particulate Matter Emissions Limit**
Room Heater	4.5 g/hr
Central Hydronic	0.32 lb/mmBtu heat output (weighted average)
Central Forced-Air	0.93 lb/mmBtu heat output (weighted average)

Table 2: Maximum baseline (starting) wood heater particulate emissions.

- Final performance testing of integrated residential wood heater designs in prototype form is required. At a minimum, testing must evaluate:
    - Reductions in PM, reductions in CO, and efficiency improvement.
    - Testing must be in accordance with relevant criteria (specific to the wood heater type) established in the 2015 Rule[4] to quantify emissions reduction and efficiency improvements.
- Applicants proposing novel residential wood heater component development (e.g., novel/improved catalyst, improved sensors, and

[16] Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces. Federal Register, Vol. 80, No. 50, Monday, March 16, 2015.

retrofit devices) must propose quantifiable performance metrics and test methods for baseline and final performance testing.

AOI 3 Optional performance testing:

- Applicants are encouraged to expand the testing regimen to evaluate performance over the full cycle of residential wood heater operating conditions (representative of how homeowners actually use their residential wood heaters with representative wood feedstocks). Examples of typical operating conditions include, but are not limited to:
    - Cold start up;
    - Steady-State;
    - Over feeding;
    - Overnight burn; and
    - Burn out.

AOI 3 Applications specifically not of interest:

- Those identified in Section I.C of the FOA.
- Open fireplaces, cook stoves, camp stoves, non-residential wood heaters;
- Non-innovative adaptation of a proven technology for the limited purpose of residential wood heater certification compliance testing;
- Residential heaters developed to burn fuels other than wood chips, cord wood, or wood pellet including, but not limited to corn kernels, manure, materials containing plastic, waste petroleum products, coal, trash, grass, residential or commercial garbage, lawn clippings or yard waste, paper products, railroad ties or pressure treated lumber, wood charcoal, torrefied wood or biomass, and construction debris;
- Commercial scale wood heaters or wood heating systems;
- Co-firing of wood and other fuels; and
- Detailed engineering and capital investment for the purpose of transitioning a prototype wood heater or wood heater technology into manufacturing.

AOI 3 Performance Targets:

By the end of the project period, all projects will be required to show:

- 50 – 80% reductions in emissions relative to their current baseline residential wood heater design; and
- 5 – 15% improvement in efficiency for residential wood heaters relative to their current baseline residential wood heater design.

AOI 3 Special Deliverables:
In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

iv. AOI 4: Systems Research of Hydrocarbon Biofuel Technologies

Consistent with BETO's Advanced Development and Optimization program focus, the objective of AOI 4 is to verify innovative technologies at engineering-scale to enable cost-competitive integrated biofuels technology pathways. Under this AOI, BETO seeks applications for integrated systems research projects - combining technology components, unit operations, or subsystems, testing those under integrated operations, and verifying the integrated process at engineering scale. Engineering scale refers to production systems that employ new process technologies to produce small volumes of products, to learn about the performance of new technologies, and to accelerate robust system optimization. Verifying technologies at appropriate partially or fully integrated scales is essential to reducing technology uncertainty and overcoming operational challenges. In addition, testing components or subsystems in an experimental prototype and in a relevant operating environment may identify further earlier-stage R&D needs that must be addressed before scale-up. Engineering-scale verification data is critical to evaluating R&D techno-economics and sustainability progress.

Applications may also address strategies using biogas, algal biomass, or cellulosic biomass to produce an intermediate that would further be upgraded to fuels and products in an existing petroleum refinery. Applications must address how at least 50% of the biogenic carbon would be converted to a biofuel and how this would be measured. Applicants are required to show how the renewable fraction would be distributed across the refinery's product suite, and continue to meet all applicable regulatory requirements both during production and also through distribution and use.

BETO has previously made substantial capital investments at numerous Federally Funded Research and Development Centers. Industry and academia are highly encouraged to utilize these FFRDC capabilities. In order to leverage these prior investments, funding is available at the following FFRDC facilities for the purpose of this AOI, however, no preference will be given to projects partnering with these FFRDCs. All FOA requirements and merit considerations apply equally to all applications, whether or not an FFRDC partners with the applicant. Under this

FOA, FFRDCs are not eligible as applicants or Prime Recipients. Additional information on eligible FFRDC facilities can be found through the following links:

- LBNL Advanced Biofuels and Bioproducts Process Development Unit (http://abpdu.lbl.gov/)
- PNNL Modular Hydrothermal Liquefaction System (https://chembioprocess.pnnl.gov/resources/resource_description.asp?id=147&type=labs)
- INL Biomass National Feedstock User Facility Process Development Unit (https://bfnuf.inl.gov/SitePages/BFNUF%20Home.aspx)
- NREL Integrated Biorefinery Research Facility (https://www.nrel.gov/bioenergy/ibrf.html)
- NREL Thermochemical Process Development Unit (https://www.nrel.gov/bioenergy/tcpdu.html)

AOI 4 Specific areas of interest:
Applications proposing the use of economically advantaged feedstocks, or other process improvements likely to achieve $2.50/GGE with a maximum reduction in emissions relative to petroleum-derived fuels by 2030, are specifically encouraged to apply.

AOI 4 Specific Requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

- A block flow data template is included with the FOA as Appendix G. Applicants are required to submit the information requested in the block flow diagram at the time of application. **Applications submitted without the appropriate technical data as defined in the block flow data will be deemed non-responsive and excluded from further review under this FOA**.
- Clearly uses an acceptable biomass feedstock (see Appendix D);
- The Primary Product from the proposed process is a biofuel with a maximum reduction in greenhouse gas (GHG) emissions and also a liquid at standard temperature and pressure (STP).
    - American Society for Testing and Materials (ASTM) approved drop-in fuel pathways are eligible to apply under AOI 4 of this FOA. Pathways pending approval are eligible to apply under AOI 4, as long as they can show during the project that the fuel has a reasonable chance of receiving ASTM approval.
    - Primary Products must qualify as biofuels with a maximum reduction in greenhouse gas (GHG) emissions. Life-cycle assessment (LCA), such as output from Argonne National Laboratory's Greenhouse Gases,

Regulated Emissions, and Energy Use in Transportation (GREET) Model, or similar, may be used to provide this justification.
    - The Primary Product biofuel stream(s) must contain at least 50% of the biogenic carbon.
    - Bioproducts and biopower are acceptable as coproducts.
- Applicants must have completed a reasonable and verifiable amount of prior scale work to justify moving to engineering-scale.
    - Selected projects will be subject to verification immediately after award. The verification will address all elements of the process as described in the Block Flow Diagram.
- The application describes a credible path to accumulate 100 gallons of biofuel product, prior to any blending, and 500 hours on stream, with a minimum of 100 continuous hours.
- Applications must clearly describe the applicant's ability to access all physical and intellectual property necessary to complete the proposed scope.
- The applicant clearly describes plans to utilize industrially relevant equipment and materials in the application (e.g., use of cellulosic derived materials, as opposed to model compounds).
- Applications that do not propose greater than 10% of the total project budget for earlier stage R&D such as limited research and development (R&D) including expenses for equipment, salaries, and supplies. All project costs, including any preparatory R&D work, will be subject to the cost share requirement.

AOI 4 Applications specifically not of interest:

- Those identified in Section I.C of the FOA.
- Processes that will not be economical when scaled to industrially relevant size.
- Those that use mock, model, synthetic, or simulated feedstocks.
- Those that propose using feedstocks that contain any plant based material that is generally intended for use as food or animal feed.
- Applications only proposing to produce alcohols or other intermediates without conversion to finished biofuels or other products.
- Applications that propose to develop and/or utilize artificial lighting-based cultivation of algae.
- Traditional anaerobic digestion is a commercial technology, and is therefore not of interest. However, alternative reactor designs such as anaerobic membrane bioreactors or other novel configurations that are not commercial, and otherwise meet the requirements, may merit consideration.
- Applications only proposing to produce biogas without further processing into biopower, biofuels, and/or bioproducts.

- "Biodiesel" or other diesel-equivalent fuel derived from renewable biomass, including vegetable oil and animal fat, is specifically excluded, unless derived from a non-food feedstock.

AOI 4 Performance Targets:

Metric:	Unit:	Minimum:	Stretch Target
Fuel Selling Price	GGE	$3.00	$2.50
Cumulative time on stream	Hours	500	1000
Continuous time on stream	Hours	100	250
Biofuel product accumulated	Gallons	100	250
Reduction in emissions relative to petroleum-derived fuels		Maximum	Maximum

Table 3: AOI 4 Performance Metrics

AOI 4 Special Deliverables: In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.
- A publicly releasable final technical report describing the project's progress towards the BETO 2022 goal of $3.00/GGE MFSP

v. AOI 5: Optimization of Bio-Derived Jet Fuel Blends

The market penetration for alternative jet fuels (AJFs), despite the approval of six pathways for commercial aviation use, has not been fully realized due to large gaps in their prices relative to conventional jet fuel (CJF). CJF is composed of thousands of molecules which can be largely classified into four categories: *n*-alkanes, *iso*-alkanes, *cyclo*-alkanes, and aromatics. Not all of these molecules play a significant role in jet combustion operability and performance characteristics. In fact, the ASTM International has established ranges of various physical and energy properties/attributes that define 'drop-in' fuel (ASTM D7566, ASTM D4054, and ASTM D1655). These 'drop-in' property ranges offer opportunities for molecular selectivity to optimize fuel operability while being fully compatible with aircraft engine hardware. Certain categories of molecules

could maximize engine performance and fuel efficiency, and provide avenues to reduce the cost of fuel production. Increasing fuel performance may offer an opportunity for airlines to partially offset upfront fuel purchase costs through less fuel volume purchased, higher fuel efficiency, reduced emissions and lower engine maintenance costs.

Some compounds in CJF (e.g., *n*-alkanes) contribute to high specific energy while *iso*-alkanes and *cyclo*-alkanes provide good fuel flow properties at low temperatures which are critical requirements for jet fuel operability. Aromatics have low specific energy relative to the other family of compounds in jet fuels, negatively impacting fuel performance and efficiency, and they contribute to higher emissions of PM. Minimum levels of aromatics (8% by volume) in blended fuel are needed in order to maintain seal swelling requirements of O-rings used in aircraft engines. Recent studies have highlighted that certain cyclic alkane molecules[17], for example decalin[18], offer potential replacements for aromatics in jet fuels that could result in higher blending levels of AJFs thereby increasing performance, and decreasing PM emissions.

AOI 5 Specific areas of interest include but are not limited to:

- The identification and production of molecules (or categories of molecules) from biomass or waste resources to develop jet fuel blend-stock with reduced or zero aromatics. These molecules should have good compatibility with polymeric seals, increase specific performance attributes (i.e., energy content), offer fuel cost reduction potential, and should be fully compatible with existing fuel system components and infrastructure.
- The utilization of (including lignins) and waste feedstocks (e.g., fats, oils, and greases (FOG), sewage sludge, industrial process generated waste gases, biogas from landfills, low value biomass municipal solid waste). Biogas mixed with synthesis gas and natural gas as a feedstock is acceptable only if the lifecycle greenhouse gas emissions reduction is maximized compared to CJF.

AOI 5 Specific Requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V. A. ii.):

[17] https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/reports/media/Boeing_Alt_Fuels_Final.pdf

[18] Advances in Mechanical Engineering Volume 2012, Article ID 127430, 13 pages doi: 10.1155/2012/127430

- Applicants must integrate discoveries of novel classes of molecules with process economics in order to select feasible cost-competitive production pathways while meeting BETO requirements for MFSP[19] and other environmental constraints as stated in this announcement.
- Applicants must produce a minimum of 2 gallons of fuel blend-stock and carry out ASTM tests (e.g., two-dimensional gas chromatography (GCxGC), Infrared (IR) Absorption, Nuclear Magnetic Resonance (NMR), Derived Cetane Number (DCN), density, distillation curve, viscosity, surface tension, swelling tests for O-ring seals and sealants etc.) to show achievability of 'drop-in' requirements.
- Applicants are required to conduct experiments and analyses to determine their optimum 'drop-in' blend proportion with conventional jet fuel.
- Applicants are required to undertake analyses of economic benefits, environmental, and resource assessment metrics.
- A block flow data template is included with the FOA as Appendix G. Applicants are required to submit the information requested in the block flow diagram at the time of application. **Applications submitted without the appropriate technical data as defined in the block flow data will be deemed non-responsive and excluded from further review under this FOA**.

AOI 5 Applications specifically not of interest:

- Those identified in Section I.C of the FOA.

AOI 5 Metrics:

By the end of the project period, all projects will be required to produce:

- A minimum of 2 gallons of neat jet fuel blend-stock and carry out ASTM tests as mentioned above for fuel suitability and operability purposes;
- A bio-derived fuel blend with zero or minimal (8%) aromatics content that does not compromise seal swell requirement of O rings;
- A neat synthesized jet fuel that exhibits at least 4% net increase in combined (specific (MJ/kg) and volumetric (MJ/L)) energy content without impacting 'drop-in' fuel requirement; and
- A blended fuel that meets BETO programmatic metrics requirement for MFSP and a maximum reduction in greenhouse gas (GHG) emissions.

[19] Fuel production cost only. Includes capital amortization, feedstock cost, and operating/maintenance costs. Excludes taxes, distribution, or tax credits.

AOI 5 Special Deliverables:
In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

vi. AOI 6: Renewable Energy from Urban and Suburban Wastes

Historically, the concept of "waste-to-energy" has referred to any of a number of highly mature technologies (e.g., incineration or anaerobic digestion) utilized as a means to decrease waste volumes while generating energy and/or heat. Limited landfill capacity, increasingly stringent disposal regulations, and related issues associated with landfilling are necessitating novel waste management solutions. In particular, the notion that waste streams represent valuable feedstocks for the production of bioenergy and bioproducts is gaining currency. Conversion of feedstocks such as inedible fats and greases, biogas from landfills, dairies, wastewater treatment plants, and the organic fraction of municipal solid wastes into renewable natural gas, diesel, and aviation fuels is just beginning to gain market traction, and represents a significant opportunity for additional expansion.

Waste streams represent a significant and underutilized set of feedstocks for biofuels, bioproducts, and biopower. They are available now, in many cases represent a disposal problem which constitutes an avoided cost opportunity, and are unlikely to diminish in volume in the near future. As a result, they may represent a low-cost set of feedstocks that could help jump start the Bioeconomy via niche markets.

Congress has issued specific direction in the conference report for FY 2019 appropriations (115-929), BETO is instructed to "establish a multi-university partnership to conduct research and enhance educational programs that improve alternative energy production derived from urban and suburban waste". The goal of this AOI is to carry out this Congressional direction.

BETO recently published a report on Biofuels and Bioproducts from Wet and Gaseous Waste Streams, which might be helpful in formulating applications[20]. However, this AOI is open to a range of conversion technologies and feedstock/product combinations.

[20] https://www.energy.gov/eere/bioenergy/downloads/biofuels-and-bioproducts-wet-and-gaseous-waste-streams-challenges-and

AOI 6 Specific Areas of Interest:
This AOI seeks novel strategies to produce bioenergy and bioproducts from relevant urban and suburban waste feedstocks. Successful applications will offer a compelling value proposition for their particular approach(es). Convincing private sector partnerships to aid in bringing product to market will be viewed positively. This AOI is open to applications that focus on producing a specific biofuel or bioproduct from an eligible set of feedstocks, or those that include multiple feedstocks and/or coproducts.

This AOI is interested in applications investigating the following research strategies:

- Anaerobic processes economically suitable for operation at scales at or below 5 dry tons of feedstocks per day, roughly equivalent to 5 million gallons/day of municipal wastewater. The possibility to produce more valuable products than methane might also provide research opportunities at this scale.
- Alternatives to traditional anaerobic digestion with potential for direct production of higher value products than biogas from wet waste feedstocks. Emphasis will be placed on processes that minimize the need for both drying and transportation of wet materials, have the potential to either reduce disposal costs or meet local organics diversion requirements, and are economically competitive with existing practices.
- Novel system designs for anaerobic digestion or other relevant waste conversion processes that accommodate the addition of reducing equivalents in the form of electricity, or an electricity-derived chemical intermediate such as hydrogen or formate to enable substantially greater product generation by limiting CO_2 evolution.
- Lower-cost biogas cleanup approaches (relative to incumbent technologies such as pressure swing adsorption) or enhancement to produce pipeline-quality renewable natural gas or compressed natural gas for vehicle use, as well as higher-value biofuels and bioproducts.
- Innovations in gasification of eligible feedstocks, including but not limited to more cost-effective syngas cleanup. Consideration of non-recycled waste plastics as a feedstock as an element of urban and suburban waste streams, might be an area for additional exploration.
- Combinations of exoelectrogenic bacteria with other components of energy recovery from wet waste streams, including but not limited to synergistic interactions between exoelectrogenic and methanogenic organisms.
- Investigations of practical combinations of microbial electrosynthesis with other waste treatment operations in order to deliver techno-economically relevant results.

- Any novel approaches or alternative strategies that meet both the quantitative improvement criteria set forth above, and the requirement to integrate research and educational objectives.

This AOI is interested in applications that include the following educational efforts related to renewable energy from urban and suburban wastes:

- Direct graduate student and post-doctoral researcher participation in research projects, including junior leadership roles.
- Internship programs for undergraduates involving hands-on scientific experiences.
- Cross-disciplinary forums for students, post-doctoral researchers, and faculty to share challenges and results in facilitative environments.
- Outreach programs to partner universities, including vocational and junior colleges.
- Intensive summer engagement programs for undergraduates from institutions outside of the project core.
- Other programs directed towards preparing the next generation of researchers in support of the application's research objectives.

AOI 6 Specific Requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

- This AOI requires a partnership of at least two universities, with one university designated as the project lead.
- The lead university (or project lead) must execute at least 50 percent of the proposed project budget.
- Private sector entities, national labs, and non-profit organizations are allowed as sub-recipients.
- Applicants must show how their proposed approach both utilizes relevant feedstocks, as defined in Appendix D, and produces valuable bioenergy and/or bioproducts.
- All applications must include a quantitative baseline and project goals.
- Applications under this AOI must propose a combined research and educational effort. BETO seeks applications that articulate a coherent set of research objectives that span multiple disciplines and partners. All of the individual research and educational components should contribute towards a synergistic set of quantifiable goals.
- The research component of applications must comprise roughly 80-90% of the proposed project budget, and 10-20% of the proposed budget should support the educational elements.

- The educational elements must directly support the quantitative research objectives. Overall, the integration of proposed educational activities with the research objectives stated in the application will be a key criterion of project evaluation, both in terms of initial applications, and throughout the project duration.
- Applications must provide a coherent management plan, including a plan to provide dedicated staff during the establishment of the partnership and throughout the duration of the project.

AOI 6 Applications specifically not of interest are:

- Applications that do not use an acceptable feedstock as defined in Appendix D.
- Those identified in Section I.C of this FOA document.
- Applications which propose any of the following feedstocks:
  - Used oils of any kind, including yellow or brown grease.
  - Biodiesel.
  - Edible foodstuffs.
  - Aquatic plants, including, but not limited to, water hyacinth, duckweed, and eelgrass.
  - Commonly recycled paper, cardboard and recycled plastics.
  - Algal biomass, or any intermediate derived from algal biomass, even if nourished by municipal wastewater.
- Applications that propose any of the following end products:
  - Hydrogen (except as a component of syngas under AOI 3), ethanol, biogas, dimethyl ether, and methanol. Note: while these are not acceptable as end products, they are acceptable as intermediates, if the application is clear how the intermediates will be incorporated into processes to produce biofuels, bioproducts, or biopower by project completion.

AOI 6 Metrics:

By the end of the performance period, all projects will be required to show a minimum 25% cost improvement over a 4-5 year project performance period. Novel combinations of these metrics are encouraged:

- Levelized Cost of Energy Production (LCOE) – detailed specifications are included below.
- Minimum Fuel Selling Price (MFSP) – Applications that select this metric must show a credible pathway to meet or exceed BETO's targets of $3.0/GGE by 2022, or $2.5/GGE by 2030.
- Net Levelized Cost of Disposal (LCOD) – For waste applications, solutions to disposal problems for existing streams are often a key economic

driver. Net calculations include potential revenue streams, and an amplified definition is included below.

The proposed educational goals must be directly related to these performance objectives.

Metric	Description
nLCOD	$$nLCOD = \frac{Total\ Life\ Cycle\ Costs}{Waste\ (Discounted)} = \frac{\sum_{t=1}^{N} \frac{Capex + Opex + Disposal\ Cost - CoProduct\ Revenue}{(1+i)^t}}{\sum_{t=1}^{N} \frac{Waste\ Generated}{(1+i)^t}} = \frac{\$}{wet\ ton}$$ • Applications must include baseline calculations for the *current* levelized cost of disposal for the proposed technological system. ○ Capital Expenditures (Capex) must include all capital costs (using straight line depreciation) with the proposed process, including but not limited to any handling equipment, conversion operations, separations processes, and fuels, products, or combustion systems. Capex should not include existing infrastructure (e.g., the wastewater treatment system that is producing the waste) ○ Operating Expenditures (Opex) must include all operating costs including but not limited to utilities, chemicals, and disposal of byproducts. ○ Disposal cost must include the cost of disposing any remaining wet waste feedstocks, including but not limited to short term storage, long term storage, drying, dewatering, incineration, transportation, and any tipping fees that must be paid to dispose of the material. For example, if a process receives 5 tons of waste (per unit time), and converts 4 tons of that waste, the disposal cost here should be for the remaining 1 ton of material that must be disposed. ○ CoProduct Revenue must include any coproduct credits resulting from the waste converted by the proposed technology. In the above example, the coproduct credit should be any revenues from the 4 tons of waste that was converted. Note that if the CoProduct Revenue is sufficiently large, the nLCOD may be negative. ○ Waste Generated must be the total amount of waste processed. In the above example, this would be 5 tons of waste per unit time. ○ In all of the above calculations, applicants must use the ultimate system design size for the estimations. The assumptions used in the above calculation will be reviewed as part of the application review process.
LCOE	$$LCOE = \frac{Total\ Life\ Cycle\ Costs}{\sum_{t=1}^{N} \frac{System\ Energy\ Output}{(1+i)^t}} = \frac{\sum_{t=1}^{N} \frac{After\ Tax\ Cash\ Flow}{(1+i)^t}}{\sum_{t=1}^{N} \frac{System\ Energy\ Output}{(1+i)^t}} = \frac{\$}{kWh\ or\ MMBtu}$$

	Where: i is the discount rate t is the year N is the system lifetime in years

Table 4: AOI 6 Performance Metrics

vii. AOI 7: Advanced Bioprocessing and Agile BioFoundry

Companies seeking to introduce new biologically-produced molecules into the fuels and chemicals market have encountered a variety of challenges. The R&D required to ensure that a molecule is ready for a commercial process is expensive and time-consuming. Furthermore, traditional batch fermentation processes are challenging and often limit the types of molecules that can be economically produced at scale.

DOE is interested in addressing challenges with the cost and time to bring a new biologically produced molecule to market and challenges with traditional batch fermentations through the use of the DOE Agile BioFoundry (ABF), and advanced bioprocessing techniques respectively. The Advanced Bioprocessing and Agile BioFoundry AOI contains two sub-areas of interest:

- AOI 7a, which seeks to use advanced bioprocessing techniques to dramatically improve bioprocessing productivity, lower capital costs, and expand the range of potential bioproducts. AOI 7a contains three specific focus areas detailed below:
  - Utilization of a cell-free system for production of a final product;
  - Utilization of continuous or semi-continuous fermentation showing large increases in productivity;
  - Utilization of systems which decouple organism growth and product production leading to an extended production phase and increased yield;
- AOI 7b, which seeks to create partnerships with the ABF to engineer more efficient production hosts at a reduced time and cost.

AOI 7a: Advanced Bioprocessing

Traditional batch fermentation to produce fuels and chemicals is often slow and mass-yield inefficient compared to chemical catalysis. In addition, to achieve the economies of scale necessary to produce cost-competitive commodity chemicals, traditional batch fermentation is typically expensive. To expand the variety of fuels and chemicals that can be produced economically from biomass, novel approaches to biomanufacturing are needed which address these issues. BETO has identified several areas of interest through listening days such as the

Cell-Free Synthetic Biology and Biocatalysis Listening Day[21]. These fall broadly into three main categories: cell-free systems, continuous or semi-continuous fermentation systems, and systems that decouple organism growth and product production.

Cell-free systems have the potential to dramatically improve yield and productivity when compared to traditional fermentations since feedstock can be converted exclusively to product given a stable set of enzyme catalysts and cofactors. In addition, cell-free systems can expand the possible range of products able to be produced from biomass since intermediates and products that may be toxic to a cell, may not be toxic to a purely enzymatic system.

Continuous and semi-continuous fermentation systems also have the potential to dramatically enhance productivity and lower capital costs. The size of the fermentation system can be decreased substantially with continuous fermentations compared to traditional batch fermentation with the same productivity. In addition, continuous systems can experience little to no down-time between batches and have other processing advantages leading to increased productivity.

Lastly, advanced methods to separate the growth phase from the production phase can lead to large increases in the overall yield of a bioprocess and can potential extend fermentation times given a robust production organism. In some ways these systems can function similarly to cell-free systems by shutting down growth associated pathways and shunting all carbon to product during the production phase.

Applications for AOI 7a are invited that address early stage R&D challenges in the specific areas described above.

AOI 7a Specific Areas of Interest:

- Utilization of a cell-free system for production of a final product;
- Utilization of continuous or semi-continuous fermentation showing large increases in productivity; and
- Utilization of systems which decouple organism growth and product production leading to an extended production phase and increased yield.

AOI 7a Specific requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V. A. ii.):

[21] https://www.energy.gov/eere/bioenergy/cell-free-synthetic-biology-and-biocatalysis-listening-day

- Development of a process that falls under one of the specific areas of interest for AOI 7a directly above;
- Use of an acceptable biomass feedstock (see Appendix D);
- Development of an industrially-relevant bioprocess (applicants must include justification for how the proposed project will increase the commercial relevance of an existing process, or allow the applicant to expand into a new area of interest); and
- Performance of verification and milestone testing in process relevant conditions (e.g., bioreactors versus shake flasks).

AOI 7a Applications specifically not of interest:

- Those identified in Section I.C of this FOA.
- Batch fermentation processes which move only incrementally toward one of the specific areas of interest;
- Processes targeting small, niche, fine chemical markets, pharmaceutical markets, or nutraceutical markets;
- Processes that will not be economical when scaled to an industrially relevant size; and
- Processes that offer no advantage over traditional batch fermentation in terms of titer, rate, yield or capital expenditure.

AOI 7a Metrics:

Applications must address the metric for their specific sub-area as follows:

- Utilization of a cell-free system for production of a final product*:* Projects must demonstrate production of a target product at 500 mg/L/h during a production phase lasting at least 72 hours at a 50 mL scale.
- Utilization of continuous or semi-continuous fermentation showing large increases in productivity: Projects must demonstrate production of a target product at 2 g/L/h during a production phase lasting at least 72 hours at a 500 mL scale.
- Utilization of systems which decouple organism growth and product production leading to an extended production phase and increased yield*:* Projects must demonstrate production of a target product at 2 g/L/h during a production phase lasting at least 72 hours at a 500 mL scale.

AOI 7b: Agile BioFoundry

The ABF develops and integrates tools, technologies, software, and instrumentation across the DOE National Laboratory system for the robust and predictive engineering of biology. The ABF creates new pathways and organisms engineered to produce biofuels and renewable chemicals from domestic, non-food lignocellulosic biomass. Central to this effort is developing robust host organisms and new microbiology techniques, in conjunction with databases and

machine learning methods to enable better, automated design of bioprocesses with predictable performance and scaling, as well as significantly increased conversion efficiency. These efforts are incorporated into a Design-Build-Test-Learn (DBTL) methodology to enable faster, and more efficient bioproduct development cycles. More information on the ABF can be found at https://agilebiofoundry.org/. Development of an improved DBTL cycle including the development of superior hosts and techniques will enable new biofuels and bioproducts to be brought to market in half the time and cost of traditional bioengineering while significantly increasing conversion efficiency.

AOI 7b will provide funding for collaborative projects between an applicant and the ABF to address critical biomanufacturing challenges. The applicant must clearly state which ABF National Laboratory partner(s) they plan to work with and the capabilities that they plan to use. More information on the capabilities of the ABF laboratories can be found at https://agilebiofoundry.org/capabilities/. Partnerships will be negotiated though mandatory use of the ABF Cooperative Research and Development Agreement (CRADA) which can be found at https://agilebiofoundry.org/work-with-us. Interested parties should reach out to the Agile BioFoundry prior to submission of the full application using the contact information at: https://agilebiofoundry.org/work-with-us. The partner laboratories in the ABF consortium are:

- Lawrence Berkeley National Laboratory
- National Renewable Energy Laboratory
- Pacific Northwest National Laboratory
- Idaho National Laboratory
- Sandia National Laboratory
- Oak Ridge National Laboratory
- Los Alamos National Laboratory
- Argonne National Laboratory

AOI 7b Specific areas of interest include, but are not limited to:

- Utilization of the tools developed by the Agile BioFoundry to show increases in the efficiency of the DBTL cycle;
- Early stage R&D addressed by the capabilities (equipment, personnel, synthetic biology tools, and knowledge) of the Agile BioFoundry consortium;
- Development of tools which can be incorporated into the Agile BioFoundry to decrease cycle time for a broad variety of host organisms; and

- Production of data sets that will enable Agile BioFoundry's Learn methodologies[22], which seek to use machine learning and other approaches to improve subsequent rounds of design.

AOI 7b Specific requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

- Utilization of a non-model host organism with industrially-relevant production advantages over *E. coli* and *S. cerevisiae* for production of a target molecule or class of molecules (e.g., low-pH, high flux to a key metabolic node, low aeration requirements, utilization of a broad substrate scope, robustness, etc.);
- Utilization of an acceptable biomass feedstock (see Appendix D);
- Utilization of the unique capabilities of the Agile BioFoundry consortium;
- Development of an industrially-relevant bioprocess (applicants must include justification for how the proposed project will increase the commercial relevance of an existing process, or allow the applicant to expand into a new area of interest);
- Performance of verification and milestone testing in process relevant conditions (e.g., bioreactors versus shake flasks).

AOI 7b Applications specifically not of interest:

- Those identified in Section I.C of this FOA document;
- Processes targeting small, niche, fine chemical markets, pharmaceutical markets, or nutraceutical markets;
- Processes that will not be economical when scaled to industrially relevant size;
- Applications that do not clearly state which National Laboratory(ies) in the ABF consortium and which capabilities the applicant seeks to use in the project;
- Applications that intend to use *E. coli* or *S. cerevisiae* as the final production organism.

AOI 7b Metrics:

- By the end of the project period, applicants must demonstrate an increase in the efficiency of a DBTL cycle of 30% over the current state of technology for the selected organism, including a final cycle time of less than 4 months. A DBTL cycle is defined as the time required for computer-aided design software to design 100 constructs, build those

[22] https://agilebiofoundry.org/wp-content/uploads/2018/09/ABF_Capabilities_All.pdf

constructs, transform constructs into a host strain (achieving at least 40 engineered host strains), test the host strain for output (which at minimum includes cell growth and product titer), and to analyze the data in a way that is fully useable for the next design cycle. An increase in efficiency is defined as the amount of improvement in a target production metric per cycle per time.

AOI 7 Special Deliverables:
In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

viii. AOI 8: Plastics in the Circular Carbon Economy

Consumer use of plastics is projected to grow over the coming decades, yet currently only about 2% of plastics are recycled into the same or similar-quality applications. This Area of Interest will focus on two areas of R&D: Designing highly recyclable plastics, and designing novel chemical and biological methods for deconstructing and upcycling existing plastics.

AOI 8a: Designing Highly Recyclable Plastics
Modern plastics must be designed with their end-of-life in mind, particularly recyclability. Biobased feedstocks are well-suited for designing the plastics of the future due to their composition and structure. Unlike traditional feedstocks, which contain primarily carbon-carbon and carbon-hydrogen bonds, biobased feedstocks contain more easily breakable carbon-oxygen bonds that could be incorporated into the design of new plastics, essentially introducing “molecular zippers” that allow for easy deconstruction at the end of the product’s life. In addition, biobased feedstocks can allow access to chemical structures that are not economical to produce from petroleum, potentially providing new avenues to create performance-advantaged materials with novel and improved properties.

Currently, plastics are rarely recycled via chemical processes that allow the recovery of plastic monomers, or building blocks. Recovering pure monomer streams with properties similar to virgin materials could have many benefits, including producing higher-quality recycled plastics, providing a stronger economic incentive for recycling, and decoupling plastics prices from oil prices.

AOI 8a Specific Areas of interest include, but are not limited to:

- Development of novel biobased plastics that have improved performance attributes over a comparable incumbent plastic and can be cost-effectively chemically recycled (e.g., catalytically deconstructed into monomers).

AOI 8a Specific requirements

The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

- Applicants must propose the design, synthesis, and testing of novel biobased plastic(s) that can be recycled via a chemical process. Applicants must propose to chemically recycle the plastic(s) and propose quantitative milestones for the improvement of the recyclability of the plastic over the course of the project.
- Proposed plastics must contain at least 50% by mass biobased feedstocks. See Appendix D for definitions of acceptable feedstocks.
- Applicants may use model compounds for initial testing of their plastic; however, the plastic synthesized and tested at the end of the project must be synthesized from biobased feedstocks.
- Applicants must propose to perform techno-economic analysis and life cycle analysis of the proposed plastic production and recycling processes. Processes that have no path to economic feasibility will not be considered.
- Applicants must discuss end-of-life considerations. This includes methods to quantitatively characterize the end-of-life properties of the proposed material.

Optional:

- Applicants are encouraged to explore performance-advantaged plastics that, in addition to superior end-of-life considerations, can outperform traditional plastics for a specific, chosen application.

AOI 8a Applications specifically not of interest:

- Those identified in Section I.C of this FOA.
- Development of biobased monomers for plastics without developing a final plastic product and testing for end of life properties.
- Processes that will not be economical when scaled to industrially relevant size.

AOI 8a Metrics

By the end of the project period, all projects must achieve the minimum targets in the table below.

Metric	Unit	Minimum	Stretch Target
Biobased content	% by mass	50%	100%
Chemically recyclable, as measured by % recovered monomers	% improvement over state of the art	10%	30%
Performance advantage (outperform traditional plastics for a specific application; in this case performance advantage cannot be end-of-life properties or biobased content)	Variable	10% improvement	20% improvement

Table 5: AOI 8a Performance Metrics

AOI 8b: Designing novel methods for deconstructing and upcycling existing plastics

Only a small fraction of the 60 million tonnes of plastic used in the United States each year is recycled. An even smaller fraction of that is made into products of similar quality to the original plastic due to a loss in material properties during the recycling process. The non-recycled fraction of plastic waste typically ends up in either landfills or the environment, often causing ecological damage. Better methods are needed to address the large waste-disposal problem presented by currently used plastics. This AOI will focus on ways to remake our current systems for plastic disposal and recycling with a focus on developing biological and chemical processes for utilizing an array of plastics as feedstocks for value-added applications. The DOE is seeking applications for biological and chemical approaches for selective C-O, C-N, and C-C chemistry, crystallinity, feedstock contamination, breakdown rate, and other innovative ideas to address difficulties with plastic degradation and upcycling.

AOI 8b Specific areas of interest include, but are not limited to:

- Biological, low-temperature (<300 °C) chemical, or hybrid systems capable of one of the following:
    - Breaking plastics down into low molecular weight streams which are either consumable by an organism, or are easily separable;

- Breaking down a plastic stream into intermediates which can be upgraded into high value products;
- Breaking down multiple plastic streams simultaneously or sequentially; and
- Tolerating contaminants generally found in mixed plastic waste streams.

Optional:

- Applicants are encouraged to target mixed or contaminated waste plastic streams though partnership with a waste management or other industry partner.

AOI 8b Specific requirements

The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

- Proposed systems must target biological, low-temperature (<300 °C) chemical, or hybrid approaches to deconstructing waste plastic streams including but not limited to, polyethylene, polypropylene, polystyrene, polyethylene terephthalate, polyurethanes, nylons, polyamides, and polylactams.
- Intermediate and final verifications must be performed in realistic conditions (>1L or equivalent depending on technology), using a plastic stream provided through a partnership with a waste management or other industry partner.
- Techno-economic analysis and life cycle analysis of the processes must be part of the proposed scope of work. Processes that appear to have no path to economic feasibility based on preliminary calculations will not be considered.
- Proposed systems must target a high-value end product. "High-value," in this case, does not need to be associated with a specific price per kilogram, but applicants must justify how their product would improve the state of technology for plastics upcycling.

AOI 8b Applications specifically not of interest:

- Those identified in Section I.C. of the FOA.
- Processes that can only work on near-pure (>99%) plastic substrates.
- High-temperature (>300 °C) pyrolysis or gasification of plastic streams
- Processes that will not be economical when scaled to industrially relevant size.

AOI 8b Metrics

By the end of the project period, all projects must achieve the minimum targets in one or both of the categories in the table below:

Metric	Unit	Minimum	Stretch Target
Increased rate of degradation over state of technology	Mass/time	20% improvement	100% improvement
Ability to degrade mixed plastic streams simultaneously or sequentially (>2 plastic streams)	Mass of each plastic stream at the end of 7 days	50% remaining	20% remaining

Table 6: AOI 8b Performance Metrics

AOI 8 Special Deliverables:

In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

ix. AOI 9: Rethinking Anaerobic Digestion

Wet organic waste streams represent valuable potential feedstocks for the bioeconomy. They include, but are not limited to, municipal sludges and biosolids, industrial, commercial, and residential food wastes, manure and manure slurries, and fats, oils, and greases. These feedstocks often present disposal problems for municipalities and local governments. In most cases, they are already being collected, and in some cases, separated as part of existing waste management practices. While some of the available energy is currently being captured, a significant amount remains untapped[23,24]. These resources

[23] EPA. Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012, 2013. Available at: http://www.epa.gov/waste/nonhaz/municipal/pubs/2012_msw_fs.pdf, Accessed on 11/26, 2014.

[24] Shen, Y, Linville, JL, Urgun-Demirtas, M, Mintz, MM and Snyder, SW. An overview of biogas production and utilization at full-scale wastewater treatment plants (WWTPs) in the United States: Challenges and opportunities towards energy-neutral WWTPs. Renewable & Sustainable Energy Reviews, 2015; 50:346-362.

offer a potential opportunity for conversion into biofuels, bioproducts, and biopower.

Anaerobic digestion is a proven technology for the conversion of heterogeneous and dynamic mixtures of wet wastes to biogas. However, the required capital expense for traditional anaerobic digestion systems presents challenges at scales smaller than 5 dry tons/day[25]. Wastes are produced and managed locally, so anaerobic digestion systems need be economically viable at relevant scales and be designed to most efficiently integrate into appropriate waste management and energy infrastructure. This AOI seeks to develop technologies that leverage anaerobic processes for wet-waste conversion, and/or present novel alternatives that substantially enhance overall carbon conversion efficiency and/or reduce disposal costs, and could be economically viable at relevant scales.

A primary challenge of processing wet-wastes as feedstock streams, especially at smaller scales (less than 5 dry tons/day), is one of costs. There are at least four ways to address this challenge, which are not mutually exclusive:

1. Reducing the cost of disposal of final residuals.
2. Producing higher-value coproducts that might offset disposal costs.
3. Pursuing strategies that would optimize the carbon conversion efficiency from raw waste feedstocks to final products.
4. Combining the above, conversion options that produce outputs of higher value than the biogas produced by traditional anaerobic digestion would be of merit.

Novel solutions must compete with existing practices[26,27] and show resilience to changing energy and economic trends. Therefore, applications must illustrate awareness of their competitive position with respect to incumbent technologies and waste management practices as well as positioning for the future. One possibility for doing so could be enhancing the carbon conversion efficiency of anaerobic conversion through the strategic use of low cost electricity. The availability of low cost and low carbon electricity could present an opportunity to increase valuable product generation and/or offer opportunities to enhance grid reliability and stability.

[25] WERF. Utilities of the Future Energy Findings, (Water Environment Research Foundation, Alexandria, VA, 2014), pp. 86.
[26] Smith, AL, Stadler, LB, Cao, L, Love, NG, Raskin, L and Skerlos, SJ. Navigating Wastewater Energy Recovery Strategies: A Life Cycle Comparison of Anaerobic Membrane Bioreactor and Conventional Treatment Systems with Anaerobic Digestion. Environmental Science & Technology, 2014; 48(10):5972-5981.
[27] Puyol, D, Batstone, D, Hulsen, T, Astals, S, Peces, M and Kromer, JO. Resource Recovery from Wastewater by Biological Technologies: Opportunities, Challenges, and Prospects. Frontiers in Microbiology, 2017; 7.

AOI 9 Specific Areas of Interest:

- Anaerobic wet-waste systems engineered to accommodate the real time addition of reducing equivalents in the form of electricity, or electricity-derived chemical intermediates such as hydrogen or formate to enable substantially greater product generation by avoiding CO_2 evolution. These systems could offer opportunities for local electrical grid and natural gas pipeline integration, thereby linking wet waste to energy systems to local sustainable energy infrastructure. For the purposes of this AOI, DOE encourages approaches that can provide competitive results on a TEA basis within the project timeframe.
- Novel biological, thermochemical, and/or electrochemical processes, including, but not limited to, arresting methanogenesis, anaerobic membrane bioreactors, or other innovative approaches with the potential for substantially improving carbon conversion efficiency and/or efficiently producing higher value products than biogas from wet waste feedstocks. BETO encourages applications that include processes that have the potential to reduce disposal costs and/or meet common organics diversion requirements. For configurations employing arrested methanogenesis, strategies for real-time volatile fatty acids separations to avoid product inhibition are of particular interest. All proposed system technologies should be economically suitable for operation at scales at or below 5 dry tons of feedstocks per day, roughly equivalent to 5 million gallons/day of municipal wastewater. These volumes have not proven profitable for traditional forms of anaerobic digestion and this topic aims to catalyze more carbon efficient conversion of wet-waste, including municipal sludges and biosolids, food wastes, and manures while enhancing the viability of smaller-scale operations.

AOI 9 specific requirements: The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V.A.ii.):

- Proposed systems must utilize wet organic waste streams (or blends thereof) as the primary feedstock (at least 90% dry weight) to produce fuels, products, or fuel and product mixtures. Proposed projects must employ actual (rather than model or synthetic) waste streams as feedstocks, including for baseline, intermediate, and final verifications.
- Successful applications will propose to develop and run systems at a relevant scale (e.g., 5–50 L reactor volume).
- By the end of the project period, applicants will be required to show continuous runs of at least 100 hours under realistic conditions.

AOI 9 Applications specifically not of interest:

- Those identified in Section I.C. of the FOA.
- Applications that propose waste feedstocks from non-food industrial processes (e.g., ethanol plants, pulp and paper processing, or forest products).
- Those identified in Section I.C of the FOA.

AOI 9 Metrics:

- Improve carbon conversion efficiency by at least 50%; and/or
- Reduce disposal costs of the wet-waste feedstock streams in question by 25% or more.

In both cases, successful applications must define and justify both a credible starting baseline, and a clear R&D path toward achieving the required improvements. Both baseline claims and milestone objectives will be subject to DOE's verification procedures as described in Section I.D.

AOI 9 Special Deliverables:
In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under this AOI:

- Applications submitted under this AOI are required to participate in a Verification as described in Section I.D.

x. AOI 10: Reducing Water, Energy, and Emissions in Bioenergy

The development and success of a thriving bioeconomy requires the protection of natural resources and the realization of environmental and economic benefits. This necessitates continued and proactive analyses that can steer R&D towards the most beneficial products and technologies. To this effect, analyses are needed to highlight pathways with the potential to enhance the environmental benefits of biofuel and bioproducts compared to existing conventional fuel or products.

BETO's Analysis and Sustainability program supports a broad portfolio of work to understand and enhance the environmental, economic, and social benefits of advanced bioenergy and bioproducts and reduce potential negative impacts. BETO is interested in bringing new ideas into the existing portfolio.

AOI 10 will provide funding for analysis projects that identify biofuel and/or bioproduct pathways with the greatest potential to reduce water consumption, energy consumption, and emissions relative to the current state of the art.

Projects must illustrate potential for improvement of at least two of the metrics listed below for a specific biofuel or bioproduct pathway.

AOI 10 Specific areas of interest include and are limited to analysis that illustrates:

- Reduction in water consumption for biofuels or bioproducts compared to existing conventional fuels or products;
- Reduction in energy consumption for biofuels or bioproducts compared to existing conventional fuels or products;
- Reduction in greenhouse gas emissions for biofuels or bioproducts compared to existing conventional fuels or products; and
- Reduction in pollutant emissions for biofuels or bioproducts compared to existing conventional fuels or products.

AOI 10 specific requirements

The following requirements must be addressed in the narrative of the application and the strength of the applicant's discussion will be evaluated by the independent technical review panel for scientific merit (see evaluation criteria in section V. A. ii.):

- Must use an acceptable biomass feedstock or bioproduct in the analysis (see Appendix D);
- Must meet at least two of required metrics for improvement;
- Must consider the magnitude of impact of a mature technology;
- Must include a techno-economic analysis that shows costs within 20% of the conventional fuel or product;
- A sensitivity analysis is required to point out the highest priority research areas for impact; and
- Must vet analysis approach and assumptions with an external review panel.

AOI 10 Applications specifically not of interest are:

- Those identified in Section I.C. of the FOA;
- Analyses on processes targeting small, niche, fine chemical markets, pharmaceutical markets, or nutraceutical markets;
- Analyses on processes that will not be economical when scaled to industrially relevant size;
- Analyses conducted on only one metric.

AOI 10 Metrics

By the end of the performance period, projects must meet **at least two** of the following metrics for improvement compared to the existing conventional fuel or product without detriment to the other metrics:

- **Reduction in Water Consumption:** 10%-30% improvement over convention fuel or product (gal/gal or gal/ton).
- **Reduction in Energy Consumption**: 20%-60% improvement over conventional fuel or product (MJ/gal or MJ/ton).
- **Reduction in Greenhouse Gas Emissions**: 50%-80% improvement over conventional fuel or product (gCO_2e/gal).
  Reduction in Pollutant Emissions (e.g. CO, SOx, NOx, PM): 10%-30% improvement over conventional fuel or product.

For metrics that are not targeted for improvement, the analysis must show comparable performance relative to the existing conventional fuel or product.

C. Applications Specifically Not of Interest

In addition to the Applications Specifically Not of Interest previously described in Sections I.B.i.-x. above for AOIs 1-10, the following types of applications will be deemed nonresponsive and will not be reviewed or considered (See Section III.D. of the FOA):

Technical:

- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Processes, products, or technologies that will not be economical when scaled to industrially relevant size or production scale;
- Applications that fall outside the technical parameters specified in Sections I.A. and I.B. of the FOA.
- Applications that fail to include the required data and information specified in the AOI.

Feedstock:

- Applications that do not use an acceptable feedstock as defined in Appendix D.
- Applications that propose the use of food or feed carbohydrates, lipids, or proteins (e.g., maize or wheat dextrose, beet sucrose, sugar cane or grain sorghum syrup, soybean oil or meal), and/or derivatives (e.g., amino acids from maize dextrose, glycerol from the transesterification of soybean oil).
- Applications that propose the production of biodiesel produced from transesterification or hydrotreating or hydrocracking of agronomic, natural plant oils (e.g., soybeans, palm, coconut, safflower, castor).
- Applications that propose the use of pure sugar feeds and/or 'model' intermediate feeds such as avicel, cane and starch sugar or model lignin compounds and mixtures for their final process. Note that using model compounds in portions of the project is acceptable as long as acceptable

feedstocks (as defined by Appendix D) are used to achieve project metrics and goals.

D. Verification

Applications submitted under AOI's 1-5 and 7-9 for this FOA are required to participate in a verification process led by NREL and/or external third-party non-conflicted personnel performing the verifications (BETO's verification team). The scientists at NREL leading this effort are firewalled from the rest of the laboratory and the data provided will be protected under its applicable conflict of interest policies and M&O Contract provisions. This verification process provides technical assistance to both the funding agency 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.

The objectives of the verification effort are to:

- Verify the applicant's technical data/performance metrics/targets as described in the original application.
- Establish a framework to evaluate and track progress over time.
- Update the data in the Technical and Economic Tables Template (described below) to specifically match the project scope.
- Establish benchmark/baseline and associated target values.
- Identify potential major showstoppers.
- Align project goals with BETO's expectations.

There are typically three verification periods throughout the lifetime of the project: the "Initial Verification," conducted at the beginning of the project (months 0-3), the "Intermediate Verification," conducted in the middle of the project (~18 months), and the "Final Verification," conducted at the end of the project (within 3 months of closeout). The verification team will perform some or all of these verifications at the recipient's facility to verify the data included in the application or Technical Table and/or Block Flow Data attached to this FOA (Appendix E-G, for AOI 1, AOI 3, AOI 4 & AOI 5, and described in more detail below).

The specific objectives of these verifications are set forth below:

- The initial verification is to confirm the benchmark data and assumptions provided in the application, which will establish the baseline against which future performance and cost improvements will be evaluated. A Go/No-Go decision is made after this verification based on whether the data is verified. During the initial verification step, the validation team will work closely with the project team to discuss the project effort in detail, initiate the review of data, metrics, and procedures as provided in the original application, and set the date for the on-site meeting. This is an iterative process between the two

teams and establishes the agenda for the on-site meeting. The initial validation will verify the applicant's proposed technical baseline by direct observation and reproduction of laboratory tests, as well as verification of experimental procedures and data records.

- The intermediate verification will be conducted prior to a Go/No-Go review of the project to assess progress relative to the intermediate performance and cost targets. A Go/No-Go decision is made after this verification based on whether the data is verified.
- The final verification will be scheduled if a successful 'GO" decision was achieved after the intermediate verification. The objective of this final verification is to assess whether the final targets were achieved, document the challenges overcome, and record the technical or economic challenges that remain.

Technical Tables and Block Flow Data:

The Technical Tables and Block Flow Data included with the FOA (Appendix E-G), applicable only to AOI 1, AOI 3, AOI 4 and AOI 5, 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 technical data as defined in the AOI will be deemed non-responsive and excluded from further review under this FOA**. In addition, the data provided will be used as the basis for review and discussion during the initial verification and will be considered the project's baseline. As such, it is expected the project will be able to reproduce this data when/if the verification team travels to the site to perform the verification. It is also expected the data will have been experimentally produced by the applicant in the applicant's facilities. However, if literature data needs to be used for parts of the process, those metrics based on literature data should be marked appropriately.

Verification Timeline:

The initial verification period, including on-site observation of experiments (if applicable) and report creation, can take up to three months. Applicants must include this time in their schedule. Selected projects that receive a 'Go' decision at the conclusion of the initial verification effort will be subject to both an intermediate and a final verification. The time required for the intermediate and final verifications will be considerably less than the initial verification. However, the applicant must also consider that time should be allocated to collect data for these verifications.

Verification Task:

All applicants must include the initial verification task within their scope as Task 1. It must be separated from the rest of the scope of work by a Go/No-Go decision point, and applicants should estimate a three-month duration for the verification effort. This task, Task 1, will also be within a separate budget period, Budget Period 1 (BP1), from the remainder of the project. By way of example, the inclusion of the verification in the scope could include something like the following:

'Task 1. Initial Verification. At the beginning of the project, the baseline data and project targets provided in the Technical Tables will be experimentally verified. Process information and data will be provided to DOE (when applicable) to support the process claims within the original application. Technical metrics for project progress will be tailored to the project as needed. These metrics may include additional Go/No-Go decision points that will be incorporated into the overall project and Statement of Project Objectives (SOPO). Experiments will be conducted at the on-site verification visit to replicate the benchmark data provided in the application as described in the Technical and Economic Tables Template.

There will be a Go/No-Go associated with Task 1.1 as follows: Process information and data supporting the technology readiness level of the overall process, the unit operations within the process, and the original application. Technical metrics are based on preliminary data and represent a meaningful baseline and set of targets.

Upon successful completion of the initial verification effort and Go/No-Go decision point, the project will commence with work on the Priority Areas as discussed.'

Similar provisions must be included for the Intermediate Verification as a task that will occur mid-way through the project (~18 months) and the final verification that will occur at the end of the projects (within 3 months of completion).

Verification Conflict of Interest/Proprietary Information:

All of the technical and economic information requested will be disclosed to non-conflicted DOE National Laboratory (NREL) personnel and/or external third-party non-conflicted validators performing the verifications (BETO's verification team) as well as non-conflicted third-party reviewers potentially participating in the Go/No Go review process and/or interim review meetings. It is expected that developments and advancements in technical performance made during the course of the project will be shared with the public via technical publications in journals or conference proceedings. It is also anticipated the initial verification may, if necessary, involve pre-existing intellectual property of which DOE will not require publication. Data access, deliverables and dissemination requirements will be negotiated and set forth

in the Statement of Project Objectives and will be consistent with Section VIII.M. of this FOA. DOE and those working on DOE's behalf, such as support service contractors, NREL personnel, Independent Engineers, validators, and reviewers, must be able to have sufficient access to these data, including but not limited to raw technical and financial data, to assess the baseline performance of the technology – subject to appropriate non-disclosure agreements or other protections.

Verification Process:

The verification effort generally includes three steps: pre-verification, on-site verification (when applicable), and post-verification. The verification effort will be adapted to be appropriate for the technology readiness level and funding available to the project. However, the details provided below establish the framework for the process.

All steps are performed in concert with BETO's verification team and the project management team. During the pre-verification step, the verification team will work closely with the project team to discuss the effort in detail, initiate the review of the data from the Technical Table or Block Flow Data Template and metrics as provided in the original application, and set the date for the on-site meeting. This is an iterative process between the two teams and establishes the agenda for the on-site meeting. During the on-site verification meeting, the verification team will observe key experiments performed by the project team in order to replicate benchmark/baseline data provided in the application and Technical Table or Block Flow Data (Appendix E-G, for AOI 1, AOI 3, AOI 4, & AOI 5 only). In addition, the two teams will work together to discuss the goals and performance metrics, ideas for tracking project progress, and alignment with BETO's goals. At the conclusion of the on-site meeting, both teams will have the information needed to proceed forward – the project team will complete revisions to the Technical and Economic Tables Template previously submitted and resubmit it to DOE, and the verification team will prepare the report-out to the Technology Manager working with the teams. The post-verification step includes the verification team reporting to DOE and the DOE personnel working through the Go/No-Go decision point.

At the conclusion of the verification effort and once a Go/No-Go decision has been made, the DOE Technology Manager and Contracting Officer will send a formal document to the recipient regarding the 'Go/No Go' decision and activities will proceed from there (based on the decision). If a 'Go' decision is reached, the project team and DOE Technology Manager will proceed with the necessary steps to release the remaining scope and associated funding for the project. A 'No-Go' decision may result in termination of the project or re-direction of scope.

Key Verification Requirements:

- During the initial verification effort, no additional experimental or project work, beyond that associated with the verification, may commence within the proposed scope. Only work associated with the verification – typically project management and data gathering activities – are allowed during the verification. The budget associated with the verification effort should correspond only to these types of activities and is typically minimal compared to the remaining project scope and budget.
- It is anticipated that the intermediate and final verifications will include the applicant (now recipient) presenting the project progress toward the targets established during the initial verification. Both the intermediate and final verifications must be noted and accounted for within the scope, schedule, and budget, so that if a project is selected and receives a 'Go' decision at the conclusion of the initial verification effort, the schedule and budget will already account for the intermediate and final verifications.

E. Authorizing Statutes

The programmatic authorizing statute is EPAct 2005, Title IX, Subtitle C Section 931 and Section 932.

Awards made under this announcement will fall under the purview of 2 Code of Federal Regulation (CFR) Part 200 as amended by 2 CFR Part 910.

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make approximately $79.3M of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 28-49 awards under this FOA. Individual awards may vary between $0.3M and $10M million.

The anticipated total federal funding and the approximate maximum and minimum federal share for any one individual award made under this announcement are set forth in the table below. EERE / BETO may issue awards in one, multiple, or none of the following areas of interest:

AOI Number	Area of Interest (AOI)	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
1	Cultivation Intensification Processes for Algae	$3,000,000	$5,000,000	$15,500,000
2a	Relating Biomass Physical and Chemical Characteristics to Feedstock Performance in Handling and Conversion Operations	$600,000	$3,520,000	$3,520,000
2b	Biomass Characteristic Interaction with Storage and Handling	$600,000	$3,520,000	$3,520,000
2c	Improving Economics and Development of Coproducts	$300,000	$1,760,000	$1,760,000
3	Efficient Wood Heaters	$500,000	$1,000,000	$5,000,000
4	Systems Research of Hydrocarbon Biofuel Technologies	$1,300,000	$2,600,000	$8,000,000
5	Optimization of Bio-Derived Jet Fuel Blends	$1,000,000	$2,000,000	$5,000,000
6	Renewable Energy from Urban and Suburban Wastes	$5,000,000	$10,000,000	$10,000,000
7a	Agile BioFoundry	$1,500,000	$2,500,000	$5,000,000
7b	Advanced Bioprocessing	$1,500,000	$2,500,000	$5,000,000
8a	Designing Highly Recyclable Plastics	$1,500,000	$2,500,000	$5,000,000
8b	Designing Novel Methods for Deconstructing and Upcycling Existing Plastics	$1,500,000	$2,500,000	$5,000,000
9	Rethinking Anaerobic Digestion	$1,500,000	$3,000,000	$5,000,000
10	Reducing Water, Energy, and Emissions in Bioenergy	$500,000	$1,000,000	$2,000, 000

EERE may establish more than one budget period for each award and fund only the initial budget period(s). Funding for all budget periods, including the initial budget period, is not guaranteed. Before the expiration of the initial budget period(s), EERE may perform a down-select among different recipients and provide additional funding only to a subset of recipients.

ii. Period of Performance

EERE anticipates making awards that will run up to 12-60 months in length, comprised of one or more budget periods. Project continuation will be contingent upon satisfactory performance and 'Go/No-Go' decision review. At the 'Go/No-Go' decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, EERE will make a determination to continue to fund the project, recommend re-direction of work under the project, place a hold on federal funding for the project, or discontinue funding the project.

AOI Number	Area of Interest (AOI)	Anticipated Number of Awards	Anticipated Period of Performance
1	Cultivation Intensification Processes for Algae	4-7	48 months
2a	Relating Biomass Physical and Chemical Characteristics to Feedstock Performance in Handling and Conversion Operations	1-6	12-36 months
2b	Biomass Characteristic Interaction with Storage and Handling	1-6	12-36 months
2c	Improving Economics and Development of Coproducts	1-6	12-36 months
3	Efficient Wood Heaters	5-7	24-36 months
4	Systems Research of Hydrocarbon Biofuel Technologies	3-6	12-36 months
5	Optimization of Bio-Derived Jet Fuel Blends	3-4	12-36 months
6	Renewable Energy from Urban and Suburban Wastes	1-2	60 months
7a	Agile BioFoundry	2-4	12-36 months
7b	Advanced Bioprocessing	2-4	12-36 months
8a	Designing Highly Recyclable Plastics	2-5	12-36 months
8b	Designing Novel Methods for Deconstructing and Upcycling Existing Plastics	2-5	12-36 months
9	Rethinking Anaerobic Digestion	2-3	12-36 months
10	Reducing Water, Energy, and Emissions in Bioenergy	2-4	12-36 months

Table 8: Period of Performance

iii. New Applications Only

EERE will accept only new applications under this FOA. EERE will not consider applications for renewals of existing EERE-funded awards through this FOA.

B. EERE Funding Agreements

Through Cooperative Agreements and other similar agreements, EERE provides financial and other support to projects that have the potential to realize the FOA objectives. EERE does not use such agreements to acquire property or services for the direct benefit or use of the United States Government.

i. Cooperative Agreements

EERE generally uses Cooperative Agreements to provide financial and other support to prime recipients.

Through Cooperative Agreements, EERE provides financial or other support to accomplish a public purpose of support or stimulation authorized by federal statute. Under Cooperative Agreements, the Government and prime recipients share responsibility for the direction of projects.

EERE has substantial involvement in all projects funded via Cooperative Agreement. See Section VI.B.ix of the FOA for more information on what substantial involvement may involve.

ii. Funding Agreements with Federally Funded Research and Development Center (FFRDCs)

In most cases, FFRDCs are funded independently of the remainder of the Project Team. The FFRDC then executes an agreement with any non-FFRDC Project Team members to arrange work structure, project execution, and any other matters. Regardless of these arrangements, the entity that applied as the prime recipient for the project will remain the prime recipient for the project.

III. Eligibility Information

Unless otherwise specified, to be considered for substantive evaluation, an applicant's submission must meet the criteria set forth below. If the application does not meet these eligibility requirements, it will be considered ineligible and removed from further evaluation.

A. Eligible Applicants

i. Individuals

U.S. citizens and lawful permanent residents are eligible to apply for funding as a prime recipient or participate as a subrecipient.

ii. Domestic 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 participate as a 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.

State, local, and tribal government entities are eligible to apply for funding as a prime recipient or participate as a subrecipient.

DOE/NNSA FFRDCs are eligible to participate as a subrecipient, but are not eligible to apply as a prime recipient. BETO provides substantial funding through non-competitive Annual Operating Plans (AOPs) to support R&D efforts at the National Laboratories. There is a significant potential for private industry to advance R&D efforts in the bioenergy space and these Areas of Interest will provide the opportunity for such private companies to compete for Federal funds while allowing the National Laboratories to receive funding as Subrecipients.

Non-DOE/NNSA FFRDCs are eligible to participate as a subrecipient, but are not eligible to apply as a prime recipient. BETO provides substantial funding through non-competitive Annual Operating Plans (AOPs) to its DOE/NNSA FFRDCs to support R&D efforts at the National Laboratories. There is a significant potential for private industry to advance R&D efforts in the bioenergy space and these Areas of Interest will provide the opportunity for such private companies to compete for Federal funds while allowing the National Laboratories to receive funding as Subrecipients.

Federal agencies and instrumentalities (other than DOE) are eligible to participate as a subrecipient, but are not eligible to apply as a prime recipient.

iii. Foreign Entities

Foreign entities, whether for-profit or otherwise, are eligible to apply for funding under this FOA. Other than as provided in the “Individuals” or “Domestic Entities” sections above, all prime recipients receiving funding under this FOA

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. If a foreign entity applies for funding as a prime recipient, it must designate in the Full Application a subsidiary or affiliate incorporated (or otherwise formed) under the laws of a State or territory of the United States to be the prime recipient. The Full Application must state the nature of the corporate relationship between the foreign entity and domestic subsidiary or affiliate.

Foreign entities may request a waiver of the requirement to designate a subsidiary in the United States as the prime recipient in the Full Application (i.e., a foreign entity may request that it remains the prime recipient on an award). To do so, the applicant must submit an explicit written waiver request in the Full Application. Appendix C lists the necessary information that must be included in a request to waive this requirement. The applicant does not have the right to appeal EERE's decision concerning a waiver request.

In the waiver request, the applicant must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to have a foreign entity serve as the prime recipient. EERE may require additional information before considering the waiver request.

A foreign entity may receive funding as a subrecipient.

iv. Incorporated Consortia

Incorporated consortia, which may include domestic and/or foreign entities, are eligible to apply for funding as a prime recipient or participate as a subrecipient. For consortia incorporated (or otherwise formed) under the laws of a State or territory of the United States, please refer to "Domestic Entities" above. For consortia incorporated in foreign countries, please refer to the requirements in "Foreign Entities" above.

Each incorporated consortium must have an internal governance structure and a written set of internal rules. Upon request, the consortium must provide a written description of its internal governance structure and its internal rules to the EERE Contracting Officer.

v. Unincorporated Consortia

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. The eligibility of the consortium will be determined by the eligibility of the prime recipient/consortium representative under Section III.A. of the FOA.

Upon request, unincorporated consortia must provide the EERE Contracting Officer with a collaboration agreement, commonly referred to as the articles of collaboration, which sets out the rights and responsibilities of each consortium member. This agreement binds the individual consortium members together and should discuss, among other things, the consortium's:

- Management structure;
- Method of making payments to consortium members;
- Means of ensuring and overseeing members' efforts on the project;
- Provisions for members' cost sharing contributions; and
- Provisions for ownership and rights in intellectual property developed previously or under the agreement.

B. Cost Sharing

Cost Share 20%
The cost share must be at least 20% of the total allowable costs for research and development projects (i.e., the sum of the Government share, including FFRDC costs if applicable, and the recipient share of allowable costs equals the total allowable cost of the project) and must come from non-federal sources unless otherwise allowed by law. (See 2 CFR 200.306 and 2 CFR 910.130 for the applicable cost sharing requirements.)

AOI Number	Area of Interest (AOI)	Cost Share for Universities, Institutions of Higher Learning, and Non-Profits	Cost Share for all Other Applicants
1	Cultivation Intensification Processes for Algae	20%	20%
2	Biomass Component Variability and Feedstock Conversion Interface	20%	20%
3	Efficient Wood Heaters	20%	20%
4	Systems Research of Hydrocarbon Biofuel Technologies	20%	20%
5	Optimization of Bio-Derived Jet Fuel Blends	20%	20%

6	Renewable Energy from Urban and Suburban Wastes	20%	20%
7	Advanced Bioprocessing and Agile BioFoundry	20%	20%
8	Plastics in the Circular Carbon Economy	20%	20%
9	Rethinking Anaerobic Digestion	20%	20%
10	Reducing Water, Energy, and Emissions in Bioenergy	20%	20%

To assist applicants in calculating proper cost share amounts, EERE has included a cost share information sheet and sample cost share calculation as Appendices A and B to this FOA.

i. Legal Responsibility

Although the cost share requirement applies to the project as a whole, including work performed by members of the project team other than the prime recipient, the prime recipient is legally responsible for paying the entire cost share. If the funding agreement is terminated prior to the end of the project period, the prime recipient is required to contribute at least the cost share percentage of total expenditures incurred through the date of termination.

The prime recipient is solely responsible for managing cost share contributions by the project team and enforcing cost share obligation assumed by project team members in subawards or related agreements.

ii. Cost Share Allocation

Each project team is free to determine how best to allocate the cost share requirement among the team members. The amount contributed by individual project team members may vary, as long as the cost share requirement for the project as a whole is met.

iii. Cost Share Types and Allowability

Every cost share contribution must be allowable under the applicable federal cost principles, as described in Section IV.J.i of the FOA. In addition, cost share must be verifiable upon submission of the Full Application.

Project teams may provide cost share in the form of cash or in-kind contributions. Cost share may be provided by the prime recipient, subrecipients, or third parties (entities that do not have a role in performing the scope of work). Vendors/contractors may not provide cost share. Any partial donation of goods or services is considered a discount and is not allowable.

Cash contributions include, but are not limited to: personnel costs, fringe costs, supply and equipment costs, indirect costs and other direct costs.

In-kind contributions are those where a value of the contribution can be readily determined, verified and justified but where no actual cash is transacted in securing the good or service comprising the contribution. Allowable in-kind contributions include, but are not limited to: the donation of volunteer time or the donation of space or use of equipment.

Project teams may use funding or property received from state or local governments to meet the cost share requirement, so long as the funding was not provided to the state or local government by the federal government.

The prime recipient may not use the following sources to meet its cost share obligations including, but not limited to:

- Revenues or royalties from the prospective operation of an activity beyond the project period;
- Proceeds from the prospective sale of an asset of an activity;
- Federal funding or property (e.g., federal grants, equipment owned by the federal government); or
- Expenditures that were reimbursed under a separate federal program.

Project teams may not use the same cash or in-kind contributions to meet cost share requirements for more than one project or program.

Cost share contributions must be specified in the project budget, verifiable from the prime recipient's records, and necessary and reasonable for proper and efficient accomplishment of the project. As all sources of cost share are considered part of total project cost, the cost share dollars will be scrutinized under the same federal regulations as federal dollars to the project. Every cost share contribution must be reviewed and approved in advance by the Contracting Officer and incorporated into the project budget before the expenditures are incurred.

Applicants are encouraged to refer to 2 CFR 200.306 as amended by 2 CFR 910.130 for additional guidance on cost sharing.

iv. Cost Share Contributions by FFRDCs

Because FFRDCs are funded by the federal government, costs incurred by FFRDCs generally may not be used to meet the cost share requirement. FFRDCs may

contribute cost share only if the contributions are paid directly from the contractor's Management Fee or another non-federal source.

v. Cost Share Verification

Applicants are required to provide written assurance of their proposed cost share contributions in their Full Applications.

Upon selection for award negotiations, applicants are required to provide additional information and documentation regarding their cost share contributions. Please refer to Appendix A of the FOA.

vi. Cost Share Payment

EERE requires prime recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the prime recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a minimum, the cost sharing percentage negotiated). As FFRDC funding will be provided directly to the FFRDC(s) by DOE, prime recipients will be required to provide project cost share at a percentage commensurate with the FFRDC costs, on a budget period basis, resulting in a higher interim invoicing cost share ratio than the total award ratio.

In limited circumstances, and where it is in the government's interest, the EERE Contracting Officer may approve a request by the prime recipient to meet its cost share requirements on a less frequent basis, such as monthly or quarterly. Regardless of the interval requested, the prime recipient must be up-to-date on cost share at each interval. Such requests must be sent to the Contracting Officer during award negotiations and include the following information: (1) a detailed justification for the request; (2) a proposed schedule of payments, including amounts and dates; (3) a written commitment to meet that schedule; and (4) such evidence as necessary to demonstrate that the prime recipient has complied with its cost share obligations to date. The Contracting Officer must approve all such requests before they go into effect.

C. Compliance Criteria

Concept Papers, Full Applications and Replies to Reviewer Comments must meet all compliance criteria listed below or they will be considered noncompliant. EERE will not review or consider noncompliant submissions, including Concept Papers, Full Applications, and Replies to Reviewer Comments that were: submitted through means other than EERE Exchange; submitted after the applicable deadline; and/or

submitted incomplete. EERE will not extend the submission deadline for applicants that fail to submit required information due to server/connection congestion.

i. Compliance Criteria

1. *Concept Papers*

Concept Papers are deemed compliant if:

- The Concept Paper complies with the content and form requirements in Section IV.C. of the FOA; and
- The applicant successfully uploaded all required documents and clicked the "Submit" button in EERE Exchange by the deadline stated in this FOA.

2. *Full Applications*

Full Applications are deemed compliant if:

- The applicant submitted a compliant Concept Paper;
- The Full Application complies with the content and form requirements in Section IV.D. of the FOA; and
- The applicant successfully uploaded all required documents and clicked the "Submit" button in EERE Exchange by the deadline stated in the FOA.

3. *Replies to Reviewer Comments*

Replies to Reviewer Comments are deemed compliant if:

- The Reply to Reviewer Comments complies with the content and form requirements in Section IV.E. of the FOA; and
- The applicant successfully uploaded all required documents to EERE Exchange by the deadline stated in the FOA.

D. Responsiveness Criteria

All "Applications Specifically Not of Interest," as described in Section I.C. of the FOA, are deemed nonresponsive and are not reviewed or considered.

E. Other Eligibility Requirements

i. Requirements for DOE/NNSA and non-DOE/NNSA Federally Funded Research and Development Centers Included as a Subrecipient

DOE/NNSA and non-DOE/NNSA FFRDCs may be proposed as a subrecipient on another entity's application subject to the following guidelines:

1. *Authorization for non-DOE/NNSA FFRDCs*
   The federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The use of a FFRDC must be consistent with its authority under its award.

2. *Authorization for DOE/NNSA FFRDCs*
   The cognizant Contracting Officer for the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization:

   Authorization is granted for the Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complementary to the missions of the laboratory, and will not adversely impact execution of the DOE assigned programs at the laboratory.

3. *Value/Funding*
   The value of and funding for the FFRDC portion of the work will not normally be included in the award to a successful applicant. Usually, DOE will fund a DOE/NNSA FFRDC contractor through the DOE field work proposal (WP) system and non-DOE/NNSA FFRDC through an interagency agreement with the sponsoring agency.

4. *Cost Share*
   Although the FFRDC portion of the work is usually excluded from the award to a successful applicant, the applicant's cost share requirement will be based on the total cost of the project, including the applicant's, the subrecipient's, and the FFRDC's portions of the project.

5. *Responsibility*
   The prime recipient will be the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues including, but not limited to disputes and claims arising out of any agreement between the prime recipient and the FFRDC contractor.

6. *Limit on FFRDC Effort*
   The FFRDC effort, in aggregate, shall not exceed 49% of the total estimated cost of the project, including the applicant's and the FFRDC's portions of the effort.

F. Limitation on Number of Concept Papers and Full Applications Eligible for Review

An entity may submit more than one Concept Paper and Full Application to this FOA, provided that each application describes a unique, scientifically distinct project and provided that an eligible Concept Paper was submitted for each Full Application.

G. Questions Regarding Eligibility

EERE will not make eligibility determinations for potential applicants prior to the date on which applications to this FOA must be submitted. The decision whether to submit an application in response to this FOA lies solely with the applicant.

IV. Application and Submission Information

A. Application Process

The application process will include two phases: a Concept Paper phase and a Full Application phase. **Only applicants who have submitted an eligible Concept Paper will be eligible to submit a Full Application**. At each phase, EERE performs an initial eligibility review of the applicant submissions to determine whether they meet the eligibility requirements of Section III of the FOA. EERE will not review or consider submissions that do not meet the eligibility requirements of Section III. All submissions must conform to the following form and content requirements, including maximum page lengths (described below) and must be submitted via EERE Exchange at https://eere-exchange.energy.gov/, unless specifically stated otherwise. **EERE will not review or consider submissions submitted through means other than EERE Exchange, submissions submitted after the applicable deadline, or incomplete submissions**. EERE will not extend deadlines for applicants who fail to submit required information and documents due to server/connection congestion.

A **Control Number** will be issued when an applicant begins the EERE Exchange application process. This control number must be included with all application documents, as described below.

The Concept Paper, Full Application, and Reply to Reviewer Comments must conform to the following requirements:

- Each must be submitted in Adobe PDF format unless stated otherwise;
- Each must be written in English;
- All pages must be formatted to fit on 8.5 x 11 inch paper with margins not less than one inch on every side. Use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures or tables, which may be 10 point font). A symbol font may be used to insert Greek letters or special

characters, but the font size requirement still applies. References must be included as footnotes or endnotes in a font size of 10 or larger. Footnotes and endnotes are counted toward the maximum page requirement;

- The Control Number must be prominently displayed on the upper right corner of the header of every page. Page numbers must be included in the footer of every page; and
- Each submission must not exceed the specified maximum page limit, including cover page, charts, graphs, maps, and photographs when printed using the formatting requirements set forth above and single spaced. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages.

Applicants are responsible for meeting each submission deadline. **Applicants are strongly encouraged to submit their Concept Papers and Full Applications at least 48 hours in advance of the submission deadline**. Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), applicants should allow at least 1 hour to submit a Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE Exchange, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made to any of these documents, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline.

EERE urges applicants to carefully review their Concept Papers, and Full Applications and to allow sufficient time for the submission of required information and documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V.A.ii. of the FOA.

i. Additional Information on EERE Exchange

EERE Exchange is designed to enforce the deadlines specified in this FOA. The "Apply" and "Submit" buttons will automatically disable at the defined submission deadlines. Should applicants experience problems with EERE Exchange, the following information may be helpful.

Applicants that experience issues with submission PRIOR to the FOA deadline: In the event that an applicant experiences technical difficulties with a submission, the applicant should contact the EERE Exchange helpdesk for assistance (EERE-ExchangeSupport@hq.doe.gov). The EERE Exchange helpdesk and/or the EERE Exchange system administrators will assist applicants in resolving issues.

Applicants that experience issues with submissions that result in late submissions: In the event that an applicant experiences technical difficulties so severe that they are unable to submit their application by the deadline, the applicant should contact the EERE Exchange helpdesk for assistance (EERE-ExchangeSupport@hq.doe.gov). The EERE Exchange helpdesk and/or the EERE Exchange system administrators will assist the applicant in resolving all issues (including finalizing submission on behalf of and with the applicant's concurrence). Please note, network traffic is at its heaviest during the final hours and minutes prior to submittal deadline. Applicants who experience this during the final hours or minutes and are unsuccessful in uploading documents will not be able to use this process.

B. Application Forms

The application forms and instructions are available on EERE Exchange. To access these materials, go to https://eere-Exchange.energy.gov and select the appropriate funding opportunity number.

Note: The maximum file size that can be uploaded to the EERE Exchange website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the FOA, it must be broken into parts and denoted to that effect. For example:
ControlNumber_LeadOrganization_Project_Part_1
ControlNumber_LeadOrganization_Project_Part_2

C. Content and Form of the Concept Paper

To be eligible to submit a Full Application, applicants must submit a Concept Paper by the specified due date and time.

i. Concept Paper Content Requirements

EERE will not review or consider ineligible Concept Papers (see Section III of the FOA).

Each Concept Paper must be limited to a single concept or technology. Unrelated concepts and technologies should not be consolidated into a single Concept Paper.

The Concept Paper must conform to the following content requirements:

Section	Page Limit	Description
Cover Page	1 page maximum	The cover page should include the project title, the specific FOA Area of Interest being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Technical Description and Impacts	2 pages maximum	Applicants are required to describe succinctly: • The proposed technology, including its basic operating principles and how it is unique and innovative; • The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target could be met); • The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; • The potential impact that the proposed project would have on the relevant field and application; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project.
Addendum	1 pages maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: • Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has worked together with its teaming partners on prior projects or programs; and • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities. Applicants may provide graphs, charts, or other data to supplement their Technology Description.

EERE makes an independent assessment of each Concept Paper based on the criteria in Section V.A.i. of the FOA. EERE will encourage a subset of applicants to submit Full Applications. Other applicants will be discouraged from

submitting a Full Application. An applicant who receives a "discouraged" notification may still submit a Full Application. EERE will review all eligible Full Applications. However, by discouraging the submission of a Full Application, EERE intends to convey its lack of programmatic interest in the proposed project in an effort to save the applicant the time and expense of preparing an application that is unlikely to be selected for award negotiations.

EERE may include general comments provided from reviewers on an applicant's Concept Paper in the encourage/discourage notification posted on EERE Exchange at the close of that phase.

D. Content and Form of the Full Application

Applicants must submit a Full Application by the specified due date and time to be considered for funding under this FOA. Applicants must complete the following application forms found on the EERE Exchange website at https://eere-Exchange.energy.gov/, in accordance with the instructions.

Applicants will have approximately 30 days from receipt of the Concept Paper Encourage/Discourage notification on EERE Exchange to prepare and submit a Full Application. Regardless of the date the applicant receives the Encourage/Discourage notification, the submission deadline for the Full Application remains the date and time stated on the FOA cover page.

All Full Application documents must be marked with the Control Number issued to the applicant. Applicants will receive a control number upon clicking the "Create Concept Paper" button in EERE Exchange, and should include that control number in the file name of their Full Application submission (i.e., *Control number_Applicant Name_Full Application*).

i. Full Application Content Requirements

EERE will not review or consider ineligible Full Applications (see Section III. of the FOA).

Each Full Application shall be limited to a single concept or technology. Unrelated concepts and technologies shall not be consolidated in a single Full Application. Full Applications must conform to the following requirements:

Submission	Components	File Name
Full Application (PDF, unless stated otherwise)	Technical Volume (PDF format. See Chart in Section IV.D.ii.)	ControlNumber_LeadOrganization_TechnicalVolume
	Statement of Project Objectives (SOPO) (Microsoft Word format. 5 page limit)	ControlNumber_LeadOrganization_SOPO
	SF-424 Application for Federal Assistance (PDF format)	ControlNumber_LeadOrganization_App424
	Budget Justification (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Budget_Justification
	Summary for Public Release (PDF format. 1 page limit)	ControlNumber_LeadOrganization_Summary
	Summary Slide (Microsoft PowerPoint format. 1 page limit)	ControlNumber_LeadOrganization_Slide
	Subrecipient Budget Justification, if applicable (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Subrecipient_Budget_Justification
	DOE WP for FFRDC, if applicable (PDF format. See DOE O 412.1A, Attachment 3)	ControlNumber_LeadOrganization_WP
	Authorization from cognizant Contracting Officer for FFRDC, if applicable (PDF format)	ControlNumber_LeadOrganization_FFRDCAuth
	SF-LLL Disclosure of Lobbying Activities Required for Prime applicant and sub recipients. (PDF format)	ControlNumber_LeadOrganization_SF-LLL
	Foreign Entity and Performance of Work in the United States waiver requests, if applicable (PDF format)	ControlNumber_LeadOrganization_Waiver
	U.S. Manufacturing Plan (PDF format)	ControlNumber_LeadOrganization_USMP
	AOI 1 Techdatasheet.xls (see Appendix E, AOI 1 only, Microsoft Excel format)	ControlNumber_LeadOrganization_AOI1_Techdatasheet
	Block Flow Diagram (see Appendix G, AOI 4 & 5 ONLY, PDF Format)	ControlNumber_LeadOrganization_BFD

Note: The maximum file size that can be uploaded to the EERE Exchange website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the FOA it must be broken into parts and denoted to that effect. For example:

ControlNumber_LeadOrganization_TechnicalVolume_Part_1
ControlNumber_LeadOrganization_TechnicalVolume_Part_2

EERE will not accept late submissions that resulted from technical difficulties due to uploading files that exceed 10MB.

EERE provides detailed guidance on the content and form of each component below.

ii. Technical Volume

The Technical Volume must be submitted in Adobe PDF format. The Technical Volume must conform to the following content and form requirements, including maximum page lengths. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages. This volume must address the Merit Review Criteria as discussed in Section V.A.ii. of the FOA. Save the Technical Volume in a single PDF file using the following convention for the title: "ControlNumber_LeadOrganization_TechnicalVolume".

Applicants must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical Volume. However, EERE and reviewers are under no obligation to review cited sources.

The Technical Volume to the Full Application may not be more than 25 pages, including the cover page, table of contents, and all citations, charts, graphs, maps, photos, or other graphics, and must include all of the information in the table below. The applicant should consider the weighting of each of the evaluation criteria (see Section V.A.ii of the FOA) when preparing the Technical Volume.

The Technical Volume should clearly describe and expand upon information provided in the Concept Paper. The Technical Volume must conform to the following content requirements:

SECTION/PAGE LIMIT	DESCRIPTION
Cover Page	The cover page should include the project title, the specific FOA Area of Interest being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.

Project Overview (This section should constitute approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact (This section should constitute approximately 30% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state of the art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state-of-the-art/technical baseline if the project is successful.
Workplan and Market Transformation Plan (This section should constitute approximately 40% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed SOPO is separately requested. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes. • Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on Go/No-Go decision points). The applicant should

	describe the specific expected end result of each performance period. • WBS and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard WBS for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this FOA. The summary provided should be consistent with the SOPO. The SOPO will contain a more detailed description of the WBS and tasks. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO. • Go/No-Go Decision Points: The applicant should provide a summary of project-wide Go/No-Go decision points at appropriate points in the Workplan. A Go/No-Go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of the project. The applicant should also provide the specific technical criteria to be used to make the Go/No-Go decision. The summary provided should be consistent with the SOPO. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone.

	• End of Project Goal: The applicant should provide a summary of the end of project goal(s). Unless otherwise specified in the FOA, the minimum requirement is that each project must have one SMART end of project goal. The summary provided should be consistent with the SOPO.
	• Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points.
	• Project Management: The applicant should discuss the team's proposed management plan, including the following:
	  ○ The overall approach to and organization for managing the work
	  ○ The roles of each Project Team member
	  ○ Any critical handoffs/interdependencies among Project Team members
	  ○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices
	  ○ The approach to project risk management
	  ○ A description of how project changes will be handled
	  ○ If applicable, the approach to Quality Assurance/Control
	  ○ How communications will be maintained among Project Team members
	• Market Transformation Plan: The applicant should provide a market transformation plan, including the following:
	  ○ Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan
	  ○ Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. manufacturing plan, and product distribution.

Technical Qualifications and Resources (Approximately 20% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • Describe the Project Team's unique qualifications and expertise, including those of key subrecipients. • Describe the Project Team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives.

	• Describe the time commitment of the key team members to support the project.
	• Attach one-page resumes for key participating team members as an appendix. Resumes do not count towards the page limit. Multi-page resumes are not allowed.
	• Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable.
	• Attach letters of commitment from all subrecipient/third party cost share providers as an appendix. Letters of commitment do not count towards the page limit.
	• Attach any letters of commitment from partners/end users as an appendix (1 page maximum per letter). Letters of commitment do not count towards the page limit.
	• For multi-organizational or multi-investigator projects, describe succinctly:
	  ○ The roles and the work to be performed by each PI and Key Participant;
	  ○ Business agreements between the applicant and each PI and Key Participant;
	  ○ How the various efforts will be integrated and managed;
	  ○ Process for making decisions on scientific/technical direction;
	  ○ Publication arrangements;
	  ○ Intellectual Property issues; and
	  ○ Communication plans

iii. Statement of Project Objectives (SOPO)

Applicants are required to complete a SOPO. A SOPO template is available on EERE Exchange at https://eere-Exchange.energy.gov/. The SOPO, excluding the Milestone Table, must not exceed 5 pages when printed using standard 8.5 x 11 paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point. The 5 page limit is to encourage applicants to provide a concise project summary focusing on the major milestone and scope of the project. Please note that while the SOPO template is several pages longer than the 5 page limit, the majority of the document consists of various examples and instructional text that should be removed. Save the SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_SOPO".

iv. SF-424: Application for Federal Assistance

Complete all required fields in accordance with the instructions on the form. The list of certifications and assurances in Field 21 can be found at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms, under Certifications and Assurances. Note: The dates and dollar amounts on the SF-424 are for the complete project period and not just the first project year, first phase

or other subset of the project period. Save the SF-424 in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_App424".

v. Budget Justification Workbook

- Applicants are required to complete the Budget Justification Workbook. This form is available on EERE Exchange at https://eere-Exchange.energy.gov/.
- Prime recipients must complete each tab of the Budget Justification Workbook for the project as a whole, including all work to be performed by the prime recipient and its subrecipients and contractors.
- Applicants should include costs associated with required annual audits and incurred cost proposals in their proposed budget documents. The "Instructions and Summary" included with the Budget Justification Workbook will auto-populate as the applicant enters information into the Workbook.
- Applicants must carefully read the "Instructions and Summary" tab provided within the Budget Justification Workbook.
- Save the Budget Justification Workbook in a single Microsoft Excel file using the following convention for the title "ControlNumber_LeadOrganization_Budget_Justification".

vi. Summary/Abstract for Public Release

Applicants are required to submit a one-page summary/abstract of their project. The project summary/abstract must contain a summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant, the project director/principal investigator(s), the project title, the objectives of the project, a description of the project, including methods to be employed, the potential impact of the project (e.g., benefits, outcomes), and major participants (for collaborative projects). This document must not include any proprietary or sensitive business information as DOE may make it available to the public after selections are made. The project summary must not exceed 1 page when printed using standard 8.5 x 11 paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point. Save the Summary for Public Release in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Summary".

vii. Summary Slide

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. The slide must be submitted in Microsoft PowerPoint format. This slide is used during the evaluation process. Save the Summary Slide in a

single file using the following convention for the title "ControlNumber_LeadOrganization_Slide".

The Summary Slide template requires the following information:

- A technology summary;
- A description of the technology's impact;
- Proposed project goals;
- Any key graphics (illustrations, charts and/or tables);
- The project's key idea/takeaway;
- Project title, prime recipient, Principal Investigator, and Key Participant information; and
- Requested EERE funds and proposed applicant cost share.

viii. Subrecipient Budget Justification (if applicable)

Applicants must provide a separate budget justification for each subrecipient that is expected to perform work estimated to be more than $250,000 or 25 percent of the total work effort (whichever is less). The budget justification must include the same justification information described in the "Budget Justification" section above. Save each subrecipient budget justification in a Microsoft Excel file using the following convention for the title "ControlNumber_LeadOrganization_Subrecipient_Budget_Justification".

ix. Budget for DOE/NNSA FFRDC (if applicable)

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE WP in accordance with the requirements in DOE Order 412.1A, Work Authorization System, Attachment 3, available at: https://www.directives.doe.gov/directives-documents/400-series/0412.1-BOrder-a/@@images/file. Save the WP in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_WP".

x. Authorization for non-DOE/NNSA or DOE/NNSA FFRDCs (if applicable)

The federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The use of a FFRDC must be consistent with the contractor's authority under its award. Save the Authorization in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_FFRDCAuth".

xi. SF-LLL: Disclosure of Lobbying Activities (required)

Prime recipients and subrecipients may not use any federal funds to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters.

Prime recipients and subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-federal funds have not been paid and will not be paid to any person for influencing or attempting to influence any of the following in connection with the application:

- An officer or employee of any federal agency;
- A Member of Congress;
- An officer or employee of Congress; or
- An employee of a Member of Congress.

Save the SF-LLL in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_SF-LLL".

xii. Waiver Requests: Foreign Entities and Performance of Work in the United States (if applicable)

1. **Foreign Entity Participation:**
   As set forth in Section III.A.iii., all prime recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. Appendix C lists the necessary information that must be included in a request to waive this requirement.

2. **Performance of Work in the United States**
   As set forth in Section IV.J.iii., all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the prime recipient should make every effort to purchase supplies and equipment within the United States. Appendix C lists the necessary information that must be included in a request to waive the Performance of Work in the United States requirement.

Save the Waivers in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Waiver".

xiii. U.S. Manufacturing Commitments

Pursuant to the DOE Determination of Exceptional Circumstances (DEC) dated September 9, 2013, each applicant is required to submit a U.S. Manufacturing Plan as part of its application. The U.S. Manufacturing Plan represents the applicant's measurable commitment to support U.S. manufacturing as a result of its award.

Each U.S. Manufacturing Plan must include a commitment that any products embodying any subject invention or produced through the use of any subject invention will be manufactured substantially in the United States, unless the applicant can show to the satisfaction of DOE that it is not commercially feasible to do so (referred to hereinafter as "the U.S. Competitiveness Provision"). The applicant further agrees to make the U.S. Competitiveness Provision binding on any subawardee and any assignee or licensee or any entity otherwise acquiring rights to any subject invention, including subsequent assignees or licensees. A subject invention is any invention conceived of or first actually reduced to practice under an award.

Due to the lower technology readiness levels of this FOA, DOE does not expect the U.S. Manufacturing Plans to be tied to a specific product or technology. However, in lieu of the U.S. Competitiveness Provision, an applicant may propose a U.S. Manufacturing Plan with more specific commitments that would be beneficial to the U.S. economy and competitiveness. For example, an applicant may commit specific products to be manufactured in the U.S., commit to a specific investment in a new or existing U.S. manufacturing facility, keep certain activities based in the U.S. or support a certain number of jobs in the U.S. related to the technology. An applicant which is likely to license the technology to others, especially universities for which licensing may be the exclusive means of commercialization the technology, the U.S. Manufacturing Plan may indicate the applicant's plan and commitment to use a specific licensing strategy that would likely support U.S. manufacturing.

If DOE determines, at its sole discretion, that the more specific commitments would provide a sufficient benefit to the U.S. economy and industrial competitiveness, the specific commitments will be part of the terms and conditions of the award. For all other awards, the U.S. Competitiveness Provision shall be incorporated as part of the terms and conditions of the award as the U.S. Manufacturing Plan for that award.

The U.S. Competitiveness Provision is also a requirement for the Class Patent Waiver that applies to domestic large business under this FOA (see Section VIII.K. Title to Subject Inventions).

Save the U.S. Manufacturing Plan in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_USMP".

xiv. Data Management Plan (DMP)

Applicants under AOI 4, AOI 6, and AOI 10 are required to submit a DMP with their Full Application.

Applicants under AOI's 1-3, 5, and 7-9 whose full applications are selected for award negotiations will be required to submit a DMP during the award negotiations phase.

An applicant may select one of the template Data Management Plans (DMP) listed below. Alternatively, instead of selecting one of the template Data Management Plans below, an applicant may submit another DMP provided that the DMP, at a minimum, (1) describes how data sharing and preservation will enable validation of the results from the proposed work, how the results could be validated if data are not shared or preserved and (2) has a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publications. DOE Public Access Plan dated July 24, 2014 provides additional guidance and information on Data Management Plans.

Option 1 (when protected data is allowed): For the deliverables under the award, the recipient does not plan on making the underlying research data supporting the findings in the deliverables publicly-available for up to 5 years after the data were first produced because such data will be considered protected under the award. The results from the DOE deliverables can be validated by DOE who will have access, upon request, to the research data. Other than providing deliverables as specified in the award, the recipient does not intend to publish the results from the project. However, in an instance where a publication includes results of the project, the underlying research data will be made available according to the policies of the publishing media. Where no such policy exists, the recipient must indicate on the publication a means for requesting and digitally obtaining the underlying research data. This includes the research data necessary to validate any results, conclusions, charts, figures, images in the publications.

Option 2: For any publication that includes results of the project, the underlying research data will be made available according to the policies of the publishing media. Where no such policy exists, the recipient must indicate on the publication a means for requesting and digitally obtaining the underlying research data. This includes the research data necessary to validate any results, conclusions, charts, figures, images in the publications.

Save the DMP in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_DMP".

E. Content and Form of Replies to Reviewer Comments

EERE will provide applicants with reviewer comments following evaluation of all eligible Full Applications. Applicants will have a brief opportunity to review the comments and to prepare a short Reply to Reviewer Comments responding to comments however they desire or supplementing their Full Application. The Reply to Reviewer Comments is an optional submission; applicants are not required to submit a Reply to Reviewer Comments. EERE will post the Reviewer Comments in EERE Exchange. The expected submission deadline is on the cover page of the FOA; however, it is the applicant's responsibility to monitor EERE Exchange in the event that the expected date changes. The deadline will not be extended for applicants who are unable to timely submit their reply due to failure to check EERE Exchange or relying on the expected date alone. Applicants should anticipate having approximately three (3) business days to submit Replies to Reviewer Comments.

EERE will not review or consider ineligible Replies to Reviewer Comments (see Section III of the FOA). EERE will review and consider each eligible Full Application, even if no Reply is submitted or if the Reply is found to be ineligible.

Replies to Reviewer Comments must conform to the following content and form requirements, including maximum page lengths, described below. If a Reply to Reviewer Comments is more than three pages in length, EERE will review only the first three (3) pages and disregard any additional pages.

SECTION	PAGE LIMIT	DESCRIPTION
Text	2 pages max	Applicants may respond to one or more reviewer comments or supplement their Full Application.
Optional	1 page max	Applicants may use this page however they wish; text, graphs, charts, or other data to respond to reviewer comments or supplement their Full Application are acceptable.

F. Post Selection Information Requests

If selected for award, EERE reserves the right to request additional or clarifying information regarding the following (non-exhaustive list):

- Indirect cost information;
- Other budget information;
- Commitment Letters from Third Parties Contributing to Cost Share, if applicable;

- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5);
- Representation of Limited Rights Data and Restricted Software, if applicable;
- Environmental Questionnaire; and
- Data Management Plan (AOIs 1-3, 5, and 7-9).

G. Dun and Bradstreet Universal Numbering System (DUNS) Number and System for Award Management (SAM)

Each applicant (unless the applicant is an individual or federal awarding agency that is excepted from those requirements under 2 CFR §25.110(b) or (c), or has an exception approved by the federal awarding agency under 2 CFR §25.110(d)) is required to: (1) Be registered in the SAM at https://www.sam.gov before submitting its application (It takes up to two weeks to register with SAM, then 1 business day for updates made in SAM to be reflected in Grants.gov) ; (2) provide a valid DUNS number in its application; and (3) continue to maintain an active SAM registration with current information at all times during which it has an active federal award or an application or plan under consideration by a federal awarding agency. DOE may not make a federal award to an applicant until the applicant has complied with all applicable DUNS and SAM requirements and, if an applicant has not fully complied with the requirements by the time DOE is ready to make a federal award, the DOE will determine that the applicant is not qualified to receive a federal award and use that determination as a basis for making a federal award to another applicant.

H. Submission Dates and Times

Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted in EERE Exchange no later than 5 p.m. Eastern Time on the dates provided on the cover page of this FOA.

I. Intergovernmental Review

This FOA is not subject to Executive Order 12372 – Intergovernmental Review of Federal Programs.

J. Funding Restrictions

i. Allowable Costs

All expenditures must be allowable, allocable, and reasonable in accordance with the applicable federal cost principles.

Refer to the following applicable federal cost principles for more information:

- Federal Acquisition Regulation (FAR) Part 31 for For-Profit entities; and
- 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

ii. Pre-Award Costs

Selectees must request prior written approval to charge pre-award costs. Pre-award costs are those incurred prior to the effective date of the federal award directly pursuant to the negotiation and in anticipation of the federal award where such costs are necessary for efficient and timely performance of the scope of work. Such costs are allowable only to the extent that they would have been allowable if incurred after the date of the federal award and **only** with the written approval of the federal awarding agency, through the Contracting Officer assigned to the award.

Pre-award costs cannot be incurred prior to the Selection Official signing the Selection Statement and Analysis. Pre-award costs can only be incurred if such costs would be reimbursable under the agreement if incurred after award.

Pre-award expenditures are made at the Selectee's risk. EERE is not obligated to reimburse costs: (1) in the absence of appropriations; (2) if an award is not made; or (3) if an award is made for a lesser amount than the Selectee anticipated.

1. **Pre-Award Costs Related to National Environmental Policy Act (NEPA) Requirements**

   EERE's decision whether and how to distribute federal funds under this FOA is subject to NEPA. Applicants should carefully consider and should seek legal counsel or other expert advice before taking any action related to the proposed project that would have an adverse effect on the environment or limit the choice of reasonable alternatives prior to EERE completing the NEPA review process.

   EERE does not guarantee or assume any obligation to reimburse costs where the prime recipient incurred the costs prior to receiving written authorization from the Contracting Officer. If the applicant elects to undertake activities that may have an adverse effect on the environment or limit the choice of reasonable alternatives prior to receiving such written authorization from the Contracting Officer, the applicant is doing so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share. Likewise, if an application is selected for negotiation of award, and the prime recipient elects to undertake activities that are not authorized for federal funding by the Contracting Officer in advance of EERE completing a NEPA review, the prime recipient is doing so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share. Nothing contained in the pre-award cost reimbursement regulations or any pre-award costs approval letter from the Contracting Officer override these NEPA requirements to obtain the written authorization from the Contracting

Officer prior to taking any action that may have an adverse effect on the environment or limit the choice of reasonable alternatives.

iii. Performance of Work in the United States

1. **Requirement**
   All work performed under EERE awards must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment; however, the prime recipient should make every effort to purchase supplies and equipment within the United States. The prime recipient must flow down this requirement to its subrecipients.

2. **Failure to Comply**
   If the prime recipient fails to comply with the Performance of Work in the United States requirement, EERE may deny reimbursement for the work conducted outside the United States and such costs may not be recognized as allowable recipient cost share. The prime recipient is responsible should any work under this award be performed outside the United States, absent a waiver, regardless of if the work is performed by the prime recipient, subrecipients, contractors or other project partners.

3. **Waiver**
   There may be limited circumstances where it is in the interest of the Project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit a written waiver request to EERE. Appendix C lists the necessary information that must be included in a request to waive the Performance of Work in the United States requirement.

   The applicant must demonstrate to the satisfaction of EERE that a waiver would further the purposes of the FOA and is in the economic interests of the United States. EERE may require additional information before considering a waiver request. Save the waiver request(s) in a single PDF file titled "ControlNumber_LeadOrganization_Waiver". The applicant does not have the right to appeal EERE's decision concerning a waiver request.

iv. Construction

Recipients are required to obtain written authorization from the Contracting Officer before incurring any major construction costs.

v. Foreign Travel

If international travel is proposed for your project, please note that your organization must comply with the International Air Transportation Fair Competitive Practices Act of 1974 (49 USC 40118), commonly referred to as the "Fly America Act," and implementing regulations at 41 CFR 301-10.131 through 301-10.143. The law and regulations require air transport of people or property to, from, between, or within a country other than the United States, the cost of which is supported under this award, to be performed by or under a cost-sharing arrangement with a U.S. flag carrier, if service is available. Foreign travel costs are allowable only with the written prior approval of the Contracting Officer assigned to the award.

vi. Equipment and Supplies

To the greatest extent practicable, all equipment and products purchased with funds made available under this FOA should be American-made. This requirement does not apply to used or leased equipment.

Property disposition will be required at the end of a project if the current fair market value of property exceeds $5,000. The rules for property disposition are set forth in 2 CFR 200.310 – 200.316 as amended by 2 CFR 910.360.

vii. Lobbying

Recipients and subrecipients may not use any federal funds to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters.

Recipients and subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-federal funds have not been paid and will not be paid to any person for influencing or attempting to influence any of the following in connection with the application:

- An officer or employee of any federal agency;
- A Member of Congress;
- An officer or employee of Congress; or
- An employee of a Member of Congress.

viii. Risk Assessment

Prior to making a federal award, the DOE is required by 31 U.S.C. 3321 and 41 U.S.C. 2313 to review information available through any Office of Management and Budget (OMB)-designated repositories of government-wide eligibility

qualification or financial integrity information, such as SAM Exclusions and "Do Not Pay."

In addition, DOE evaluates the risk(s) posed by applicants before they receive federal awards. This evaluation may consider: results of the evaluation of the applicant's eligibility; the quality of the application; financial stability; quality of management systems and ability to meet the management standards prescribed in this part; history of performance; reports and findings from audits; and the applicant's ability to effectively implement statutory, regulatory, or other requirements imposed on non-federal entities.
In addition to this review, DOE must comply with the guidelines on government-wide suspension and debarment in 2 CFR 180, and must require non-federal entities to comply with these provisions. These provisions restrict federal awards, subawards and contracts with certain parties that are debarred, suspended or otherwise excluded from or ineligible for participation in federal programs or activities.

ix. Invoice Review and Approval

DOE employs a risk-based approach to determine the level of supporting documentation required for approving invoice payments. Recipients may be required to provide some or all of the following items with their requests for reimbursement:

- Summary of costs by cost categories;
- Timesheets or personnel hours report;
- Invoices/receipts for all travel, equipment, supplies, contractual, and other costs;
- UCC filing proof for equipment acquired with project funds by for-profit recipients and subrecipients;
- Explanation of cost share for invoicing period;
- Analogous information for some subrecipients; and
- Other items as required by DOE.

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

Concept Papers are evaluated based on consideration the following factors. All sub-criteria are of equal weight.

Concept Paper Criterion: Overall FOA Responsiveness and Viability of the Project (Weight: 100%)

This criterion involves consideration of the following factors (all sub-criteria are of equal weight):

- The applicant clearly describes the proposed technology, describes how the technology is unique and innovative, and how the technology will advance the current state-of-the-art;
- The applicant has identified risks and challenges, including possible mitigation strategies, and has shown the impact that EERE funding and the proposed project would have on the relevant field and application;
- The applicant has the qualifications, experience, capabilities and other resources necessary to complete the proposed project; and
- The proposed work, if successfully accomplished, would clearly meet the objectives as stated in the FOA.

ii. Full Applications

Applications will be evaluated against the merit review criteria shown below. All sub-criteria are of equal weight.

Criterion 1: Technical Merit, Innovation, and Impact (50%)

This criterion involves consideration of the following factors (all factors are of equal weight):

Technical Merit and Innovation (each sub-criterion is of equal weight)

- Extent to which the proposed technology or process is innovative;
- Degree to which the current state of the technology and the proposed advancement are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state-of-the-art to the proposed advancement; and
- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work.

Impact of Technology Advancement (each sub-criterion is of equal weight)

- How the project supports the topic area objectives and target specifications and metrics; and
- The potential impact of the project on advancing the state-of-the-art.

Criterion 2: Project Research and Market Transformation Plan (30%)
This criterion involves consideration of the following factors (all factors are of equal weight):

Research Approach, Workplan and SOPO (each sub-criterion is of equal weight)

- Degree to which the approach and critical path have been clearly described and thoughtfully considered; and
- Degree to which the task descriptions are clear, detailed, timely, and reasonable, resulting in a high likelihood that the proposed Workplan and SOPO will succeed in meeting the project goals.

Identification of Technical Risks

- Discussion and demonstrated understanding of the key technical risk areas involved in the proposed work and the quality of the mitigation strategies to address them.

Baseline, Metrics, and Deliverables (each sub-criterion is of equal weight)

- The level of clarity in the definition of the baseline, metrics, and milestones; and
- Relative to a clearly defined experimental baseline, the strength of the quantifiable metrics, milestones, and a mid-point deliverables defined in the application, such that meaningful interim progress will be made.

Market Transformation Plan (each sub-criterion is of equal weight)

- Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including mitigation plan; and
- Comprehensiveness of market transformation plan including but not limited to product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, Data Management Plan, U.S. manufacturing plan, and product distribution.

Criterion 3: Team and Resources (20%)
This criterion involves consideration of the following factors (each sub-criterion is of equal weight):

- The capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. The qualifications, relevant expertise, and time commitment of the individuals on the team;
- The sufficiency of the facilities to support the work;

- The degree to which the proposed consortia/team demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies;
- The level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan; and
- The reasonableness of the budget and spend plan for the proposed project and objectives.

iii. Criteria for Replies to Reviewer Comments

EERE has not established separate criteria to evaluate Replies to Reviewer Comments. Instead, Replies to Reviewer Comments are attached to the original applications and evaluated as an extension of the Full Application.

B. Standards for Application Evaluation

Applications that are determined to be eligible will be evaluated in accordance with this FOA, by the standards set forth in EERE's Notice of Objective Merit Review Procedure (76 Fed. Reg. 17846, March 31, 2011) and the guidance provided in the "DOE Merit Review Guide for Financial Assistance," effective April 14, 2017, which is available at: https://energy.gov/management/downloads/merit-review-guide-financial-assistance-and-unsolicited-proposals-current.

C. Other Selection Factors

i. Program Policy Factors

In addition to the above criteria, the Selection Official may consider the following program policy factors in determining which Full Applications to select for award negotiations:

- The degree to which the proposed project exhibits technological diversity when compared to the existing DOE project portfolio and other projects selected from the subject FOA;
- The degree to which the proposed project, including proposed cost share, optimizes the use of available EERE funding to achieve programmatic objectives;
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers;
- The degree to which the proposed project is likely to lead to increased employment and manufacturing in the United States;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty;

- The degree to which the proposed project, or group of projects, represent a desired geographic distribution (considering past awards and current applications); and
- The degree to which the proposed project is likely to meet the BETO programmatic requirement to meet at least the Minimum Fuel Selling Price of $3.00/GGE while maximizing the reduction of GHG emissions.

D. Evaluation and Selection Process

i. Overview

The evaluation process consists of multiple phases; each includes an initial eligibility review and a thorough technical review. Rigorous technical reviews of eligible submissions are conducted by reviewers that are experts in the subject matter of the FOA. Ultimately, the Selection Official considers the recommendations of the reviewers, along with other considerations such as program policy factors, in determining which applications to select.

ii. Pre-Selection Interviews

As part of the evaluation and selection process, EERE may invite one or more applicants to participate in Pre-Selection Interviews. Pre-Selection Interviews are distinct from and more formal than pre-selection clarifications (See Section V.D.iii of the FOA). The invited applicant(s) will meet with EERE representatives to provide clarification on the contents of the Full Applications and to provide EERE an opportunity to ask questions regarding the proposed project. The information provided by applicants to EERE through Pre-Selection Interviews contributes to EERE's selection decisions.

EERE will arrange to meet with the invited applicants in person at EERE's offices or a mutually agreed upon location. EERE may also arrange site visits at certain applicants' facilities. In the alternative, EERE may invite certain applicants to participate in a one-on-one conference with EERE via webinar, videoconference, or conference call.

EERE will not reimburse applicants for travel and other expenses relating to the Pre-Selection Interviews, nor will these costs be eligible for reimbursement as pre-award costs.

EERE may obtain additional information through Pre-Selection Interviews that will be used to make a final selection determination. EERE may select applications for funding and make awards without Pre-Selection Interviews. Participation in Pre-Selection Interviews with EERE does not signify that applicants have been selected for award negotiations.

iii. Pre-Selection Clarification

EERE may determine that pre-selection clarifications are necessary from one or more applicants. Pre-selection clarifications are distinct from and less formal than pre-selection interviews. These pre-selection clarifications will solely be for the purposes of clarifying the application, and will be limited to information already provided in the application documentation. The pre-selection clarifications may occur before, during or after the merit review evaluation process. Information provided by an applicant that is not necessary to address the pre-selection clarification question will not be reviewed or considered. Typically, a pre-selection clarification will be carried out through either written responses to EERE's written clarification questions or video or conference calls with EERE representatives.

The information provided by applicants to EERE through pre-selection clarifications is incorporated in their applications and contributes to the merit review evaluation and EERE's selection decisions. If EERE contacts an applicant for pre-selection clarification purposes, it does not signify that the applicant has been selected for negotiation of award or that the applicant is among the top ranked applications.

EERE will not reimburse applicants for expenses relating to the pre-selection clarifications, nor will these costs be eligible for reimbursement as pre-award costs.

iv. Recipient Integrity and Performance Matters

DOE, prior to making a federal award with a total amount of federal share greater than the simplified acquisition threshold, is required to review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313).

The applicant, at its option, may review information in the designated integrity and performance systems accessible through SAM and comment on any information about itself that a federal awarding agency previously entered and is currently in the designated integrity and performance system accessible through SAM.

DOE will consider any written comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under federal awards when completing the review of risk posed by applicants as described in 2 C.F.R. § 200.205.

v. Selection

The Selection Official may consider the technical merit, the Federal Consensus Board's recommendations, program policy factors, and the amount of funds available in arriving at selections for this FOA.

E. Anticipated Notice of Selection and Award Negotiation Dates

EERE anticipates notifying applicants selected for negotiation of award and negotiating awards by the dates provided on the cover page of this FOA.

VI. Award Administration Information

A. Award Notices

i. Ineligible Submissions

Ineligible Concept Papers and Full Applications will not be further reviewed or considered for award. The Contracting Officer will send a notification letter by email to the technical and administrative points of contact designated by the applicant in EERE Exchange. The notification letter will state the basis upon which the Concept Paper or the Full Application is ineligible and not considered for further review.

ii. Concept Paper Notifications

EERE will notify applicants of its determination to encourage or discourage the submission of a Full Application. EERE will post these notifications to EERE Exchange.

Applicants may submit a Full Application even if they receive a notification discouraging them from doing so. By discouraging the submission of a Full Application, EERE intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. The purpose of the Concept Paper phase is to save applicants the considerable time and expense of preparing a Full Application that is unlikely to be selected for award negotiations.

A notification encouraging the submission of a Full Application does not authorize the applicant to commence performance of the project. Please refer to Section IV.J.ii. of the FOA for guidance on pre-award costs.

iii. Full Application Notifications

EERE will notify applicants of its determination via a notification letter by email to the technical and administrative points of contact designated by the applicant

in EERE Exchange. The notification letter will inform the applicant whether or not its Full Application was selected for award negotiations. Alternatively, EERE may notify one or more applicants that a final selection determination on particular Full Applications will be made at a later date, subject to the availability of funds or other factors.

iv. Successful Applicants

Receipt of a notification letter selecting a Full Application for award negotiations does not authorize the applicant to commence performance of the project. If an application is selected for award negotiations, it is not a commitment by EERE to issue an award. Applicants do not receive an award until award negotiations are complete and the Contracting Officer executes the funding agreement, accessible by the prime recipient in FedConnect.

The award negotiation process will take approximately 60 days. Applicants must designate a primary and a backup point-of-contact in EERE Exchange with whom EERE will communicate to conduct award negotiations. The applicant must be responsive during award negotiations (i.e., provide requested documentation) and meet the negotiation deadlines. If the applicant fails to do so or if award negotiations are otherwise unsuccessful, EERE will cancel the award negotiations and rescind the Selection. EERE reserves the right to terminate award negotiations at any time for any reason.

Please refer to Section IV.J.ii. of the FOA for guidance on pre-award costs.

v. Alternate Selection Determinations

In some instances, an applicant may receive a notification that its application was not selected for award and EERE designated the application to be an alternate. As an alternate, EERE may consider the Full Application for federal funding in the future. A notification letter stating the Full Application is designated as an alternate does not authorize the applicant to commence performance of the project. EERE may ultimately determine to select or not select the Full Application for award negotiations.

vi. Unsuccessful Applicants

EERE shall promptly notify in writing each applicant whose application has not been selected for award or whose application cannot be funded because of the unavailability of appropriated funds. EERE will post the merit reviewers' comments on the Exchange website, which are made available to all applicants during the replies to reviewers' comments period. Those comments provide details on the strengths and weaknesses of the application. DOE does not have

any additional comments to provide to applicants. EERE, therefore, will not be holding debriefings for this FOA.

B. Administrative and National Policy Requirements

i. Registration Requirements

There are several one-time actions before submitting an application in response to this FOA, and it is vital that applicants address these items as soon as possible. Some may take several weeks, and failure to complete them could interfere with an applicant's ability to apply to this FOA, or to meet the negotiation deadlines and receive an award if the application is selected. These requirements are as follows:

1. **EERE Exchange**
   Register and create an account on EERE Exchange at https://eere-Exchange.energy.gov.

   This account will then allow the user to register for any open EERE FOAs that are currently in EERE Exchange. It is recommended that each organization or business unit, whether acting as a team or a single entity, use only one account as the contact point for each submission. Applicants should also designate backup points of contact so they may be easily contacted if deemed necessary. **This step is required to apply to this FOA.**

   The EERE Exchange registration does not have a delay; however, **the remaining registration requirements below could take several weeks to process and are necessary for a potential applicant to receive an award under this FOA**.

2. **DUNS Number**
   Obtain a DUNS number (including the plus 4 extension, if applicable) at http://fedgov.dnb.com/webform.

3. **System for Award Management**
   Register with the SAM at https://www.sam.gov. Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called a Marketing Partner ID Number (MPIN) are important steps in SAM registration. Please update your SAM registration annually.

4. **FedConnect**
   Register in FedConnect at https://www.fedconnect.net. To create an organization account, your organization's SAM MPIN is required. For more

information about the SAM MPIN or other registration requirements, review the FedConnect Ready, Set, Go! Guide at https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf.

5. **Grants.gov**
   Register in Grants.gov (http://www.grants.gov) to receive automatic updates when Amendments to this FOA are posted. However, please note that Concept Papers and Full Applications will not be accepted through Grants.gov.

6. **Electronic Authorization of Applications and Award Documents**
   Submission of an application and supplemental information under this FOA through electronic systems used by the DOE, including EERE Exchange and FedConnect.net, constitutes the authorized representative's approval and electronic signature.

ii. Award Administrative Requirements

The administrative requirements for DOE grants and cooperative agreements are contained in 2 CFR Part 200 as amended by 2 CFR Part 910.

iii. Foreign National Access to DOE Sites

All applicants that ultimately enter into an award resulting from this FOA will be subject to the following requirement concerning foreign national involvement. Upon DOE's request, prime recipients must provide information to facilitate DOE's responsibilities associated with foreign national access to DOE sites, information, technologies, and equipment. A foreign national is defined as any person who was born outside the jurisdiction of the United States, is a citizen of a foreign government, and has not been naturalized under U.S. law. If the prime recipient or subrecipients, contractors or vendors under the award, anticipate utilizing a foreign national person in the performance of an award, the prime recipient is responsible for providing to the Contracting Officer specific information of the foreign national(s) to satisfy compliance with all of the requirements for access approval.

iv. Subaward and Executive Reporting

Additional administrative requirements necessary for DOE grants and cooperative agreements to comply with the Federal Funding and Transparency Act of 2006 (FFATA) are contained in 2 CFR Part 170. Prime recipients must register with the new FFATA Subaward Reporting System database and report the required data on their first tier subrecipients. Prime recipients must report

the executive compensation for their own executives as part of their registration profile in SAM.

v. National Policy Requirements

The National Policy Assurances that are incorporated as a term and condition of award are located at: http://www.nsf.gov/awards/managing/rtc.jsp.

vi. Environmental Review in Accordance with National Environmental Policy Act (NEPA)

EERE's decision whether and how to distribute federal funds under this FOA is subject to NEPA (42 USC 4321, *et seq.*). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website, at http://nepa.energy.gov/.

While NEPA compliance is a federal agency responsibility and the ultimate decisions remain with the federal agency, all recipients selected for an award will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their proposed project. If DOE determines certain records must be prepared to complete the NEPA review process (e.g., biological evaluations or environmental assessments), the costs to prepare the necessary records may be included as part of the project costs.

vii. Applicant Representations and Certifications

1. **Lobbying Restrictions**
   By accepting funds under this award, the prime recipient agrees that none of the funds obligated on the award shall be expended, directly or indirectly, to influence Congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. §1913. This restriction is in addition to those prescribed elsewhere in statute and regulation.

2. **Corporate Felony Conviction and Federal Tax Liability Representations**
   In submitting an application in response to this FOA, the applicant represents that:
   - **a.** It is **not** a corporation that has been convicted of a felony criminal violation under any federal law within the preceding 24 months, and
   - **b.** It is **not** a corporation that has any unpaid federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely

manner pursuant to an agreement with the authority responsible for collecting the tax liability.
For purposes of these representations the following definitions apply:

A Corporation includes any entity that has filed articles of incorporation in any of the 50 states, the District of Columbia, or the various territories of the United States [but not foreign corporations]. It includes both for-profit and non-profit organizations.

3. **Nondisclosure and Confidentiality Agreements Representations**
In submitting an application in response to this FOA the applicant represents that:
   a. It **does not and will not** require its employees or contractors to sign internal nondisclosure or confidentiality agreements or statements prohibiting or otherwise restricting its employees or contactors from lawfully reporting waste, fraud, or abuse to a designated investigative or law enforcement representative of a federal department or agency authorized to receive such information.

   b. It **does not and will not** use any federal funds to implement or enforce any nondisclosure and/or confidentiality policy, form, or agreement it uses unless it contains the following provisions:

      (1) *''These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this agreement and are controlling.''*

      (2) The limitation above shall not contravene requirements applicable to Standard Form 312 Classified Information Nondisclosure Agreement (https://fas.org/sgp/othergov/sf312.pdf), Form 4414 Sensitive Compartmented Information Disclosure Agreement (https://fas.org/sgp/othergov/intel/sf4414.pdf), or any other form issued by a federal department or agency governing the nondisclosure of classified information.

(3) Notwithstanding the provision listed in paragraph (a), a nondisclosure or confidentiality policy form or agreement that is to be executed by a person connected with the conduct of an intelligence or intelligence-related activity, other than an employee or officer of the United States Government, may contain provisions appropriate to the particular activity for which such document is to be used. Such form or agreement shall, at a minimum, require that the person will not disclose any classified information received in the course of such activity unless specifically authorized to do so by the United States Government. Such nondisclosure or confidentiality forms shall also make it clear that they do not bar disclosures to Congress, or to an authorized official of an executive agency or the Department of Justice, that are essential to reporting a substantial violation of law.

viii. Statement of Federal Stewardship

EERE will exercise normal federal stewardship in overseeing the project activities performed under EERE awards. Stewardship Activities include, but are not limited to, conducting site visits; reviewing performance and financial reports; providing assistance and/or temporary intervention in unusual circumstances to correct deficiencies that develop during the project; assuring compliance with terms and conditions; and reviewing technical performance after project completion to ensure that the project objectives have been accomplished.

ix. Statement of Substantial Involvement

EERE has substantial involvement in work performed under awards made as a result of this FOA. EERE does not limit its involvement to the administrative requirements of the award. Instead, EERE has substantial involvement in the direction and redirection of the technical aspects of the project as a whole. Substantial involvement includes, but is not limited to, the following:

1. EERE shares responsibility with the recipient for the management, control, direction, and performance of the project.

2. EERE may intervene in the conduct or performance of work under this award for programmatic reasons. Intervention includes the interruption or modification of the conduct or performance of project activities.

3. EERE may redirect or discontinue funding the project based on the outcome of EERE's evaluation of the project at the Go/No-Go decision point(s).

4. EERE participates in major project decision-making processes.

x. Intellectual Property Management Plan (IPMP)

For Area of Interest 6 and for awards in other AOIs with complex team arrangements, if requested by the Contracting Officer: as a quarter 1 milestone if selected for award, applicants must submit an executed IPMP between the members of the consortia or team.

The award will set forth the treatment of and obligations related to intellectual property rights between EERE and the individual members. The IPMP should describe how the members will handle intellectual property rights and issues between themselves while ensuring compliance with federal intellectual property laws, regulations, and policies (see Sections VIII.K.-VIII.N. of this FOA for more details on applicable federal intellectual property laws and regulations). Guidance regarding the contents of IPMP is available from EERE upon request.

The following is a non-exhaustive list of examples of items that the IPMP may cover:

- The treatment of confidential information between members (e.g., the use of NDAs);
- The treatment of background intellectual property (e.g., any requirements for identifying it or making it available);
- The treatment of inventions made under the award (e.g., any requirements for disclosing to the other members on an application, filing patent applications, paying for patent prosecution, and cross-licensing or other licensing arrangements between the members);
- The treatment of data produced, including software, under the award (e.g., any publication process or other dissemination strategies, copyrighting strategy or arrangement between members);
- Any technology transfer and commercialization requirements or arrangements between the members;
- The treatment of any intellectual property issues that may arise due to a change in membership of the consortia or team; and
- The handling of disputes related to intellectual property between the members.

xi. Subject Invention Utilization Reporting

In order to ensure that prime recipients and subrecipients holding title to subject inventions are taking the appropriate steps to commercialize subject inventions, EERE may require that each prime recipient holding title to a subject invention submit annual reports for 10 years from the date the subject invention was disclosed to EERE on the utilization of the subject invention and efforts made by prime recipient or their licensees or assignees to stimulate such utilization. The reports must include information regarding the status of development, date of

first commercial sale or use, gross royalties received by the prime recipient, and such other data and information as EERE may specify.

xii. Intellectual Property Provisions

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at http://energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards.

xiii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement. This helpful EERE checklist can be accessed at https://www.energy.gov/eere/funding/eere-funding-application-and-management-forms. See Attachment 2 Federal Assistance Reporting Checklist, after clicking on "Model Cooperative Agreement" under the Award Package section. In addition, BETO requires the following reporting:

BETO Reporting Requirements

Attendance at the BETO Biennial Peer Review is required so that external subject matter experts can review project accomplishments and provide feedback to ensure optimal use of BETO funds.

All applications must include a letter of commitment from the lead entity, agreeing to furnish DOE BETO with brief status updates regarding the increasing maturity and readiness of the technology for a period of five (5) years after the close of the project. These status updates must occur no more frequently than annually and consist of no more than 500 words. This information could include but is not limited to whether the lead entity has been granted a patent, whether additional funding has been subsequently awarded, whether new partnerships have been formed, whether there have been sales from new bioenergy products or technologies, whether new jobs were created in the prior year, whether new manufacturing facilities have been financed or established, and/or whether the technology has been acquired by another company.

xiv. Go/No-Go Review

Each project selected under this FOA will be subject to a periodic project evaluation referred to as a Go/No-Go Review. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the EERE program goals and objectives. Federal funding beyond the Go/No-Go decision point (continuation funding) is contingent upon (1) availability of federal funds appropriated by Congress for the purpose of this program; (2) the availability of future-year budget authority; (3) recipient's

technical progress compared to the Milestone Summary Table stated in Attachment 1 of the award; (4) recipient's submittal of required reports; (5) recipient's compliance with the terms and conditions of the award; (6) EERE's Go/No-Go decision; (7) the recipient's submission of a continuation application; and (8) written approval of the continuation application by the Contracting Officer.

As a result of the Go/No-Go Review, DOE may, at its discretion, authorize the following actions: (1) continue to fund the project, contingent upon the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority; (2) recommend redirection of work under the project; (3) place a hold on federal funding for the project, pending further supporting data or funding; or (4) discontinue funding the project because of insufficient progress, change in strategic direction, or lack of funding.

The Go/No-Go decision is distinct from a non-compliance determination. In the event a recipient fails to comply with the requirements of an award, EERE may take appropriate action, including but not limited to, redirecting, suspending or terminating the award.

xv. Conference Spending

The recipient shall not expend any funds on a conference not directly and programmatically related to the purpose for which the grant or cooperative agreement was awarded that would defray the cost to the United States Government of a conference held by any Executive branch department, agency, board, commission, or office for which the cost to the United States Government would otherwise exceed $20,000, thereby circumventing the required notification by the head of any such Executive Branch department, agency, board, commission, or office to the Inspector General (or senior ethics official for any entity without an Inspector General), of the date, location, and number of employees attending such conference.

xvi. Uniform Commercial Code (UCC) Financing Statements

Per 2 CFR 910.360 (Real Property and Equipment) when a piece of equipment is purchased by a for-profit recipient or subrecipient with federal funds, and when the federal share of the financial assistance agreement is more than $1,000,000, the recipient or subrecipient must:

Properly record, and consent to the Department's ability to properly record if the recipient fails to do so, UCC financing statement(s) for all equipment in excess of $5,000 purchased with project funds. These financing statement(s) must be

approved in writing by the Contracting Officer prior to the recording, and they shall provide notice that the recipient's title to all equipment (not real property) purchased with federal funds under the financial assistance agreement is conditional pursuant to the terms of this section, and that the Government retains an undivided reversionary interest in the equipment. The UCC financing statement(s) must be filed before the Contracting Officer may reimburse the recipient for the federal share of the equipment unless otherwise provided for in the relevant financial assistance agreement. The recipient shall further make any amendments to the financing statements or additional recordings, including appropriate continuation statements, as necessary or as the Contracting Officer may direct.

VII. Questions/Agency Contacts

Upon the issuance of a FOA, EERE personnel are prohibited from communicating (in writing or otherwise) with applicants regarding the FOA except through the established question and answer process as described below. Specifically, questions regarding the content of this FOA must be submitted to: FY19BETOMultiTopicFOA@ee.doe.gov. Questions must be submitted not later than 3 business days prior to the application due date and time. Please note, feedback on individual concepts will not be provided through Q&A.

All questions and answers related to this FOA will be posted on EERE Exchange at: https://eere-exchange.energy.gov. **Please note that you must first select this specific FOA Number in order to view the questions and answers specific to this FOA**. EERE will attempt to respond to a question within 3 business days, unless a similar question and answer has already been posted on the website.

Questions related to the registration process and use of the EERE Exchange website should be submitted to: EERE-ExchangeSupport@hq.doe.gov.

VIII. Other Information

A. FOA Modifications

Amendments to this FOA will be posted on the EERE Exchange website and the Grants.gov system. However, you will only receive an email when an amendment or a FOA is posted on these sites if you register for email notifications for this FOA in Grants.gov. EERE recommends that you register as soon after the release of the FOA as possible to ensure you receive timely notice of any amendments or other FOAs.

B. Government Right to Reject or Negotiate

EERE reserves the right, without qualification, to reject any or all applications received in response to this FOA and to select any application, in whole or in part, as a basis for negotiation and/or award.

C. Commitment of Public Funds

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by anyone other than the Contracting Officer, either express or implied, is invalid.

D. Treatment of Application Information

In general, EERE will only use data and other information contained in applications for evaluation purposes, unless such information is generally available to the public or is already the property of the Government.

Applicants should not include trade secrets or commercial or financial information that is privileged or confidential in their application unless such information is necessary to convey an understanding of the proposed project or to comply with a requirement in the FOA.

The use of protective markings such as "Do Not Publicly Release – Trade Secret" or "Do Not Publicly Release – Confidential Business Information" is encouraged. However, applicants should be aware that the use of protective markings is not dispositive as to whether information will be publicly released pursuant to the Freedom of Information Act, 5 U.S.C. §552, et. seq., as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175. (See Section I of this document, "Notice of Potential Disclosure Under the Freedom of Information Act (FOIA)" for additional information regarding the public release of information under the FOIA.

Applicants are encouraged to employ protective markings in the following manner:

The cover sheet of the application must be marked as follows and identify the specific pages containing trade secrets or commercial or financial information that is privileged or confidential:

Notice of Restriction on Disclosure and Use of Data:
Pages [list applicable pages] of this document may contain trade secrets or commercial or financial information that is privileged or confidential, and is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes or in accordance with a financial assistance or loan agreement between the submitter and the Government. The Government may use or disclose any information that is not appropriately

marked or otherwise restricted, regardless of source. [End of Notice]

The header and footer of every page that contains trade secrets or commercial or financial information that is privileged must be marked as follows: "May contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure."

In addition, each line or paragraph containing trade secrets or commercial or financial information that is privileged or confidential must be enclosed in brackets.

E. Evaluation and Administration by Non-Federal Personnel

In conducting the merit review evaluation, the Go/No-Go Review and Peer Review, the Government may seek the advice of qualified non-federal personnel as reviewers. The Government may also use non-federal personnel to conduct routine, nondiscretionary administrative activities, including EERE contractors. The applicant, by submitting its application, consents to the use of non-federal reviewers/administrators. Non-federal reviewers must sign conflict of interest (COI) and non-disclosure acknowledgements (NDA) prior to reviewing an application. Non-federal personnel conducting administrative activities must sign an NDA.

F. Notice Regarding Eligible/Ineligible Activities

Eligible activities under this FOA include those which describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not those which encourage or support political activities such as the collection and dissemination of information related to potential, planned or pending legislation.

G. Notice of Right to Conduct a Review of Financial Capability

EERE reserves the right to conduct an independent third party review of financial capability for applicants that are selected for negotiation of award (including personal credit information of principal(s) of a small business if there is insufficient information to determine financial capability of the organization).

H. Notice of Potential Disclosure Under Freedom of Information Act (FOIA)

Under the FOIA, 5 U.S.C. §552, et. seq., as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175, any information received from the applicant is considered to be an agency record, and as such, subject to public release under FOIA. The purpose of the FOIA is to afford the public the right to request and receive agency records unless those agency records are protected from disclosure under one or more of the nine FOIA exemptions. Decisions to disclose or withhold information received from the applicant are based upon the applicability of one or more of the

nine FOIA exemptions, not on the existence or nonexistence of protective markings or designations. Only the agency's designated FOIA Officer may determine if information received from the applicant may be withheld pursuant to one of the nine FOIA exemptions. All FOIA requests received by DOE are processed in accordance with 10 C.F.R. Part 1004.

I. Requirement for Full and Complete Disclosure

Applicants are required to make a full and complete disclosure of all information requested. Any failure to make a full and complete disclosure of the requested information may result in:

- The termination of award negotiations;
- The modification, suspension, and/or termination of a funding agreement;
- The initiation of debarment proceedings, debarment, and/or a declaration of ineligibility for receipt of federal contracts, subcontracts, and financial assistance and benefits; and
- Civil and/or criminal penalties.

J. Retention of Submissions

EERE expects to retain copies of all Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions. No submissions will be returned. By applying to EERE for funding, applicants consent to EERE's retention of their submissions.

K. Title to Subject Inventions

Ownership of subject inventions is governed pursuant to the authorities listed below:

- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions;
- All other parties: The federal Non-Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (see below);
- Class Patent Waiver:

DOE has issued a class waiver that applies to this FOA. Under this class waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class waiver, a domestic large business must agree that any products embodying or produced through the use of a subject invention first created or reduced to practice under this program will be

substantially manufactured in the United States, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan are sufficient.

- Advance and Identified Waivers: Applicants may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784; and

- Determination of Exceptional Circumstances (DEC): Each applicant is required to submit a U.S. Manufacturing Plan as part of its application. If selected, the U.S. Manufacturing Plan shall be incorporated into the award terms and conditions for domestic small businesses and nonprofit organizations. DOE has determined that exceptional circumstances exist that warrants the modification of the standard patent rights clause for small businesses and non-profit awardees under Bayh-Dole to the extent necessary to implement and enforce the U.S. Manufacturing Plan. Any Bayh-Dole entity (domestic small business or nonprofit organization) affected by this DEC has the right to appeal it.

L. Government Rights in Subject Inventions

Where prime recipients and subrecipients retain title to subject inventions, the U.S. Government retains certain rights.

1. Government Use License

The U.S. Government retains a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any subject invention throughout the world. This license extends to contractors doing work on behalf of the Government.

2. March-In Rights

The U.S. Government retains march-in rights with respect to all subject inventions. Through "march-in rights," the Government may require a prime recipient or subrecipient who has elected to retain title to a subject invention (or their assignees or exclusive licensees), to grant a license for use of the invention to a third party. In addition, the Government may grant licenses for use of the subject invention when a prime recipient, subrecipient, or their assignees and exclusive licensees refuse to do so.

DOE may exercise its march-in rights only if it determines that such action is necessary under any of the four following conditions:

- The owner or licensee has not taken or is not expected to take effective steps to achieve practical application of the invention within a reasonable time;
- The owner or licensee has not taken action to alleviate health or safety needs in a reasonably satisfied manner;
- The owner has not met public use requirements specified by federal statutes in a reasonably satisfied manner; or
- The U.S. Manufacturing requirement has not been met.

Any determination that march-in rights are warranted must follow a fact-finding process in which the recipient has certain rights to present evidence and witnesses, confront witnesses and appear with counsel and appeal any adverse decision. To date, DOE has never exercised its march-in rights to any subject inventions.

M. Rights in Technical Data

Data rights differ based on whether data is first produced under an award or instead was developed at private expense outside the award.

"Limited Rights Data": The U.S. Government will not normally require delivery of confidential or trade secret-type technical data developed solely at private expense prior to issuance of an award, except as necessary to monitor technical progress and evaluate the potential of proposed technologies to reach specific technical and cost metrics.

Government Rights in Technical Data Produced Under Awards: The U.S. Government normally retains unlimited rights in technical data produced under Government financial assistance awards, including the right to distribute to the public. However, pursuant to special statutory authority, certain categories of data generated under EERE awards may be protected from public disclosure for up to five years after the data is generated ("Protected Data"). For awards permitting Protected Data, the protected data must be marked as set forth in the awards intellectual property terms and conditions and a listing of unlimited rights data (i.e., non-protected data) must be inserted into the data clause in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

N. Copyright

The prime recipient and subrecipients may assert copyright in copyrightable works, such as software, first produced under the award without EERE approval. When copyright is asserted, the Government retains a paid-up nonexclusive, irrevocable

worldwide license to reproduce, prepare derivative works, distribute copies to the public, and to perform publicly and display publicly the copyrighted work. This license extends to contractors and others doing work on behalf of the Government.

O. Personally Identifiable Information (PII)

All information provided by the applicant must to the greatest extent possible exclude PII. The term "PII" refers to information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother's maiden name. (See OMB Memorandum M-07-16 dated May 22, 2007, found at: https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2007/m07-16.pdf

By way of example, applicants must screen resumes to ensure that they do not contain PII such as personal addresses, personal landline/cell phone numbers, and personal emails. **Under no circumstances should Social Security Numbers (SSNs) be included in the application**. Federal Agencies are prohibited from the collecting, using, and displaying unnecessary SSNs. (See, the Federal Information Security Modernization Act of 2014 (Pub. L. No. 113-283, Dec 18, 2014; 44 U.S.C. §3551).

P. Annual Independent Audits

If a for-profit entity is a prime recipient and has expended $750,000 or more of DOE awards during the entity's fiscal year, an annual compliance audit performed by an independent auditor is required. For additional information, please refer to 2 C.F.R. § 910.501 and Subpart F.

If an educational institution, non-profit organization, or state/local government is a prime recipient or subrecipient and has expended $750,000 or more of federal awards during the non-federal entity's fiscal year, then a Single or Program-Specific Audit is required. For additional information, please refer to 2 C.F.R. § 200.501 and Subpart F.

Applicants and subrecipients (if applicable) should propose sufficient costs in the project budget to cover the costs associated with the audit. EERE will share in the cost of the audit at its applicable cost share ratio.

APPENDIX A – COST SHARE INFORMATION

Cost Sharing or Cost Matching

The terms "cost sharing" and "cost matching" are often used synonymously. Even the DOE Financial Assistance Regulations, 2 CFR 200.306, use both of the terms in the titles specific to regulations applicable to cost sharing. EERE almost always uses the term "cost sharing," as it conveys the concept that non-federal share is calculated as a percentage of the Total Project Cost. An exception is the State Energy Program Regulation, 10 CFR 420.12, State Matching Contribution. Here "cost matching" for the non-federal share is calculated as a percentage of the federal funds only, rather than the Total Project Cost.

How Cost Sharing Is Calculated

As stated above, cost sharing is calculated as a percentage of the Total Project Cost. FFRDC costs must be included in Total Project Costs. The following is an example of how to calculate cost sharing amounts for a project with $1,000,000 in federal funds with a minimum 20% non-federal cost sharing requirement:

- Formula: Federal share ($) divided by federal share (%) = Total Project Cost
  Example: $1,000,000 divided by 80% = $1,250,000

- Formula: Total Project Cost ($) minus federal share ($) = Non-federal share ($)
  Example: $1,250,000 minus $1,000,000 = $250,000

- Formula: Non-federal share ($) divided by Total Project Cost ($) = Non-federal share (%)
  Example: $250,000 divided by $1,250,000 = 20%

What Qualifies For Cost Sharing

While it is not possible to explain what specifically qualifies for cost sharing in one or even a couple of sentences, in general, if a cost is allowable under the cost principles applicable to the organization incurring the cost and is eligible for reimbursement under an EERE grant or cooperative agreement, then it is allowable as cost share. Conversely, if the cost is not allowable under the cost principles and not eligible for reimbursement, then it is not allowable as cost share. In addition, costs may not be counted as cost share if they are paid by the federal Government under another award unless authorized by federal statute to be used for cost sharing.

The rules associated with what is allowable as cost share are specific to the type of organization that is receiving funds under the grant or cooperative agreement, though are generally the same for all types of entities. The specific rules applicable to:

- FAR Part 31 for For-Profit entities, (48 CFR Part 31); and
- 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

In addition to the regulations referenced above, other factors may also come into play such as timing of donations and length of the project period. For example, the value of ten years of donated maintenance on a project that has a project period of five years would not be fully allowable as cost share. Only the value for the five years of donated maintenance that corresponds to the project period is allowable and may be counted as cost share.

Additionally, EERE generally does not allow pre-award costs for either cost share or reimbursement when these costs precede the signing of the appropriation bill that funds the award. In the case of a competitive award, EERE generally does not allow pre-award costs prior to the signing of the Selection Statement by the EERE Selection Official.

General Cost Sharing Rules on a DOE Award

1. Cash Cost Share - encompasses all contributions to the project made by the recipient or subrecipeint(s), for costs incurred and paid for during the project. This includes when an organization pays for personnel, supplies, equipment for their own company with organizational resources. If the item or service is reimbursed for, it is cash cost share. All cost share items must be necessary to the performance of the project.

2. In-Kind Cost Share - encompasses all contributions to the project made by the recipient or subrecipient(s) that do not involve a payment or reimbursement and represent donated items or services. In-Kind cost share items include volunteer personnel hours, donated existing equipment, donated existing supplies. The cash value and calculations thereof for all In-Kind cost share items must be justified and explained in the Cost Share section of the project Budget Justification. All cost share items must be necessary to the performance of the project. If questions exist, consult your DOE contact before filling out the In-Kind cost share section of the Budget Justification.

3. Funds from other federal sources MAY NOT be counted as cost share. This prohibition includes FFRDC subrecipients. Non-federal sources include any source not originally derived from federal funds. Cost sharing commitment letters from subrecipients must be provided with the original application.

4. Fee or profit, including foregone fee or profit, are not allowable as project costs (including cost share) under any resulting award. The project may only incur those costs that are allowable and allocable to the project (including cost share) as determined in accordance with the applicable cost principles prescribed in FAR Part 31 for For-Profit entities and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

DOE Financial Assistance Rules 2 CFR Part 200 as amended by 2 CFR Part 910

As stated above, the rules associated with what is allowable cost share are generally the same for all types of organizations. Following are the rules found to be common, but again, the specifics are contained in the regulations and cost principles specific to the type of entity:

(A) Acceptable contributions. All contributions, including cash contributions and third party in-kind contributions, must be accepted as part of the prime recipient's cost sharing if such contributions meet all of the following criteria:

(1) They are verifiable from the recipient's records.

(2) They are not included as contributions for any other federally-assisted project or program.

(3) They are necessary and reasonable for the proper and efficient accomplishment of project or program objectives.

(4) They are allowable under the cost principles applicable to the type of entity incurring the cost as follows:

a. For-profit organizations. Allowability of costs incurred by for-profit organizations and those nonprofit organizations listed in Attachment C to OMB Circular A–122 is determined in accordance with the for-profit cost principles in 48 CFR Part 31 in the FAR, except that patent prosecution costs are not allowable unless specifically authorized in the award document. (v) Commercial Organizations. FAR Subpart 31.2—Contracts with Commercial Organizations; and

b. Other types of organizations. For all other non-federal entities, allowability of costs is determined in accordance with 2 CFR Part 200 Subpart E.

(5) They are not paid by the federal government under another award unless authorized by federal statute to be used for cost sharing or matching.

(6) They are provided for in the approved budget.

(B) Valuing and documenting contributions

(1) Valuing recipient's property or services of recipient's employees. Values are established in accordance with the applicable cost principles, which mean that amounts chargeable to the project are determined on the basis of costs incurred. For real property or equipment used on the project, the cost principles authorize depreciation or use charges. The full value of the item may be applied when the item will be consumed in the performance of the award or fully depreciated by the end of

the award. In cases where the full value of a donated capital asset is to be applied as cost sharing or matching, that full value must be the lesser or the following:

a. The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation; or

b. The current fair market value. If there is sufficient justification, the Contracting Officer may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project. The Contracting Officer may accept the use of any reasonable basis for determining the fair market value of the property.

(2) Valuing services of others' employees. If an employer other than the recipient furnishes the services of an employee, those services are valued at the employee's regular rate of pay, provided these services are for the same skill level for which the employee is normally paid.

(3) Valuing volunteer services. Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services must be consistent with those paid for similar work in the recipient's organization. In those markets in which the required skills are not found in the recipient organization, rates must be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, allowable, and allocable may be included in the valuation.

(4) Valuing property donated by third parties.

a. Donated supplies may include such items as office supplies or laboratory supplies. Value assessed to donated supplies included in the cost sharing or matching share must be reasonable and must not exceed the fair market value of the property at the time of the donation.

b. Normally only depreciation or use charges for equipment and buildings may be applied. However, the fair rental charges for land and the full value of equipment or other capital assets may be allowed, when they will be consumed in the performance of the award or fully depreciated by the end of the award, provided that the Contracting Officer has approved the charges. When use charges are applied, values must be determined in accordance with the usual accounting policies of the recipient, with the following qualifications:

i. The value of donated space must not exceed the fair rental value of comparable space as established by an independent appraisal of

comparable space and facilities in a privately-owned building in the same locality.

ii. The value of loaned equipment must not exceed its fair rental value.

(5) Documentation. The following requirements pertain to the recipient's supporting records for in-kind contributions from third parties:

a. Volunteer services must be documented and, to the extent feasible, supported by the same methods used by the recipient for its own employees.

b. The basis for determining the valuation for personal services and property must be documented.

APPENDIX B – SAMPLE COST SHARE CALCULATION FOR BLENDED COST SHARE PERCENTAGE

The following example shows the math for calculating required cost share for a project with $2,000,000 in federal funds with four tasks requiring different non-federal cost share percentages:

Task	Proposed Federal Share	Federal Share %	Recipient Share %
Task 1 (R&D)	$1,000,000	80%	20%
Task 2 (R&D)	$500,000	80%	20%
Task 3 (Demonstration)	$400,000	50%	50%
Task 4 (Outreach)	$100,000	100%	0%

Federal share ($) divided by federal share (%) = Task Cost

Each task must be calculated individually as follows:

Task 1
$1,000,000 divided by 80% = $1,250,000 (Task 1 Cost)
Task 1 Cost minus federal share = Non-federal share
$1,250,000 - $1,000,000 = $250,000 (Non-federal share)

Task 2
$500,000 divided 80% = $625,000 (Task 2 Cost)
Task 2 Cost minus federal share = Non-federal share
$625,000 - $500,000 = $125,000 (Non-federal share)

Task 3
$400,000 / 50% = $800,000 (Task 3 Cost)
Task 3 Cost minus federal share = Non-federal share
$800,000 - $400,000 = $400,000 (Non-federal share)

Task 4
Federal share = $100,000
Non-federal cost share is not mandated for outreach = $0 (Non-federal share)

The calculation may then be completed as follows:

Tasks	$ Federal Share	% Federal Share	$ Non-Federal Share	% Non-Federal Share	Total Project Cost
Task 1	$1,000,000	80%	$250,000	20%	$1,250,000
Task 2	$500,000	80%	$125,000	20%	$625,000
Task 3	$400,000	50%	$400,000	50%	$800,000
Task 4	$100,000	100%	$0	0%	$100,000
Totals	$2,000,000		$775,000		$2,775,000

Blended Cost Share %
Non-federal share ($775,000) divided by Total Project Cost ($2,775,000) = 27.9% (non-federal)
Federal share ($2,000,000) divided by Total Project Cost ($2,775,000) = 72.1% (federal)

APPENDIX C – WAIVER REQUESTS AND APPROVAL PROCESSES: 1. FOREIGN ENTITY PARTICIPATION AS THE PRIME RECIPIENT; AND 2. PERFORMANCE OF WORK IN THE UNITED STATES (FOREIGN WORK WAIVER)

1. Waiver for Foreign Entity Participation as the Prime Recipient

As set forth in Section III.A.iii., all prime recipients receiving funding under this FOA 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. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

Overall, the applicant must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to have a foreign entity serve as the prime recipient. A request to waive the *Foreign Entity Participation as the prime recipient* requirement must include the following:

- Entity name;
- The rationale for proposing a foreign entity to serve as the prime recipient;
- Country of incorporation;
- A description of the project's anticipated contributions to the US economy;
- How the project will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
- How the project will promote domestic American manufacturing of products and/or services;
- A description of how the foreign entity's participation as the prime recipient is essential to the project;
- A description of the likelihood of Intellectual Property (IP) being created from the work and the treatment of any such IP; and
- Countries where the work will be performed (Note: if any work is proposed to be conducted outside the U.S., the applicant must also complete a separate request for waiver of the Performance of Work in the United States requirement).

EERE may require additional information before considering the waiver request.

The applicant does not have the right to appeal EERE's decision concerning a waiver request.

2. Waiver for Performance of Work in the United States (Foreign Work Waiver)

As set forth in Section IV.J.iii., all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the prime recipient should make every effort to purchase supplies and equipment within the United States. There may be limited circumstances where it is in the interest of the project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit an explicit waiver request in the Full Application. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

Overall, a waiver request must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to perform work outside of the United States. A request to waive the *Performance of Work in the United States* requirement must include the following:

- The rationale for performing the work outside the U.S. ("foreign work");
- A description of the work proposed to be performed outside the U.S.;
- An explanation as to how the foreign work is essential to the project;
- A description of the anticipated benefits to be realized by the proposed foreign work and the anticipated contributions to the US economy;
- The associated benefits to be realized and the contribution to the project from the foreign work;
- How the foreign work will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
- How the foreign work will promote domestic American manufacturing of products and/or services;
- A description of the likelihood of Intellectual Property (IP) being created from the foreign work and the treatment of any such IP;
- The total estimated cost (DOE and recipient cost share) of the proposed foreign work;
- The countries in which the foreign work is proposed to be performed; and
- The name of the entity that would perform the foreign work.

EERE may require additional information before considering the waiver request.

The applicant does not have the right to appeal EERE's decision concerning a waiver request.

APPENDIX D – ACCEPTABLE FEEDSTOCKS

	Biomass Feedstocks or Biomass Intermediates	Biogas	Algae	Carbon Dioxide/Flue Gas	Post-sorted MSW	Wet Waste	Plastics
AOI 1: Cultivation Intensification Processes for Algae	Not Applicable (N/A)	N/A	N/A	Yes	N/A	N/A	N/A
AOI 2: Biomass Component Variability and Feedstock Conversion Interface	Southern pine forest residues and corn stover only	N/A	N/A	N/A	N/A	N/A	N/A
AOI 3: Efficient Wood Heaters	Crib wood, Cord wood, Wood Chips, and Wood Pellets	No	No	N/A	No	No	No
AOI 4: Systems Research of Hydrocarbon Biofuel Technologies	Yes	Yes	Yes	Yes	Yes	Yes	N/A
AOI 5: Optimization of Bio-Derived Jet Fuel Blends	Yes	Yes	Yes	Yes	Yes	Yes	N/A
AOI 6: Renewable Energy from Urban and Suburban Wastes	No	Yes	No	Yes	Yes	Yes	No

AOI 7: Advanced Bioprocessing and Agile BioFoundry	Yes	Yes	No	Yes	No	No	
AOI 8: Plastics in the Circular Carbon Economy	8a Yes; 8b No	8a Yes; 8b No	8a Yes; 8b No	8a Yes; 8b No	8a Yes; 8b No	8a Yes; 8b No	8a No; 8b Yes
AOI 9: Rethinking Anaerobic Digestion	No	No	No	No	Yes	Yes	N/A
AOI 10: Reducing Water, Energy, and Emissions in Bioenergy	Yes	Yes	Yes	Yes	Yes	Yes	N/A

"Biodiesel" or other diesel-equivalent fuel derived from trans-esterification of renewable biomass, including vegetable oil and animal fat, is specifically excluded.

"**Biomass intermediates**" for the purposes of this FOA, 'biomass intermediates' are biologically derived materials such as mixed, dilute sugars, oligomeric sugars, acids, alcohols, biogases, biosolids, and lignin (additional information provided below). Further conversion of these intermediates leads to liquid transportation fuels or other bioproducts.

"Biomass feedstocks"
Both lignocellulosic and algal feedstocks are of interest. Applicants must identify their target, high-impact feedstock, which is defined as a feedstock that could be sustainably produced at a rate of at least 50 million dry tons of biomass per year. Alternatively, the proposed technology must be shown to have the ability to convert a variety of biomass feedstocks that together represent a total sustainable potential of at least 50 million dry tons of biomass per year. The lignocellulosic biomass sources include agricultural residues such as corn stover, other grain straws, bagasse, soybean matter and wood residues as defined in EPAct 2005 Section 932(a)(1)&(2) and cited below. No plant based material that is generally intended for use as food may be used as a feedstock under this FOA. Hence, sugars derived from sugarcane, sweet sorghum, or beets and oils derived from soy, canola, sunflower, peanut, and other such food sources normally recovered using conventional food processing methods are not eligible as feedstocks under this FOA. Model compounds may not be used to meet technical milestones; real biomass-derived feedstocks are required. To be clear, applications proposing to process

fiber from wet and dry-grind corn refineries, distillers dried grains and solubles, or other food related biomass will be considered non-responsive and will NOT be considered for funding under this FOA.

Algal biomass includes micro- and macro-algae, as well as cyanobacteria. Algal biofuel and bioproduct intermediates include extracted lipids, products derived from sugars or proteins (alcohol or hydrocarbon fuels), secreted metabolites (alcohols or others), or bio-crude resulting from hydrothermal liquefaction. If experimental plans rely on genetically modified organism (GMO) technology, a discussion of the U.S. regulatory landscape – e.g., Toxic Substance Control Act (TSCA), the Animal and Plant Health Inspection Service (APHIS) – and the impacts of regulations on the project objectives, scope, and schedule are required. Biology and cultivation experimental plans must consider scaling explicitly in experimental design and objectives as shown by but not limited to: primary use of robust production organisms (instead of model organisms, e.g., Chlamydomonas reinhardtii); diurnal cycles, solar-strength irradiance, and fluctuating temperatures for growth experiments; and outdoor culture performance verification.

"**Biogas**" (including landfill gas and sewage waste treatment gas) for the purposes of this FOA, is produced through the conversion of organic matter from renewable biomass. This DOES NOT include syngas from the gasification of biomass. Pure methane and mixtures of gases resembling biogas are specifically excluded.

"Carbon dioxide/flue gas" for the purpose of this FOA, refers to any waste carbon dioxide (CO_2) produced as a byproduct from fermentation or the combustion of biomass or other biopower processes. Applicants can propose to use synthetic gas mixtures that reasonably mimic actual waste CO_2 streams during their work.

"Lignin" for the purpose of this FOA, refers to a lignin-containing stream resulting from the deconstruction of lignocellulosic biomass. Model compounds may not be used to meet milestones or metrics. To meet the metric of >50% conversion of lignin, only carbon actually derived from the lignin polymer will be accepted. Therefore, appropriate methods must be in place to determine the extent of lignin conversion and to characterize lignin deconstruction products.

"Plastics" for the purpose of this FOA, refers to any synthetic material made from a wide range of organic polymers including but not limited to derivatives of polyethylene, polypropylene, polystyrene, polyurethane, nylon, polyamide, and polylactam.

"Post-sorted MSW" for the purposes of this FOA, biomass as defined in EPAct 2005 (Public Law 109-58) Section 932(a)(1-2) that is segregated from the MSW as a separate stream, could be employed as a feedstock with appropriate considerations for the costs of such segregation, collection, processing, and transportation. Hence, post-sorted MSW, where all recyclables and non-biomass components have been removed, would qualify, but only the remaining organic

material that meets the above requirements would qualify as a feedstock for purposes of this FOA. Unsorted MSW is specifically excluded.

"Wet waste" for the purpose of this FOA, "wet waste" refers to the following: Primary, secondary, tertiary, and post-anaerobic digestion sludge (i.e., biosolids) from municipal wastewater treatment systems; food wastes from industrial, commercial, and residential sources; Organic-rich wastewaters from industrial and commercial operations; Manure slurries from animal husbandry operations

Sec. 932. BIOENERGY PROGRAM.

(a) DEFINITIONS:—In this section:

(1) BIOMASS.—The term "biomass" means—

(A) any organic material grown for the purpose of being converted to energy;

(B) any organic byproduct of agriculture (including wastes from food production and processing) that can be converted into energy; or

(C) any waste material that can be converted to energy, is segregated from other waste materials, and is derived from—

(i) any of the following forest-related resources: mill residues, precommercial thinnings, slash, brush, or otherwise non-merchantable material; or

(ii) wood waste materials, including waste pallets, crates, dunnage, manufacturing and construction wood wastes (other than pressure-treated, chemically-treated, or painted wood wastes), and landscape or right-of-way tree trimmings, but not including municipal solid waste, gas derived from the biodegradation of municipal solid waste or paper that is commonly recycled.

(2) LIGNOCELLULOSIC FEEDSTOCK.—The term "lignocellulosic feedstock" means any portion of a plant or coproduct from conversion, including crops, trees, forest residues, and agricultural residues *not specifically grown for food*, [emphasis added] including from barley grain, grape seed, rice bran, rice hulls, rice straw, soybean matter, and sugarcane bagasse.

(b) PROGRAM.—The Secretary shall conduct a program of research, development, demonstration, and commercial application for bioenergy, including—

(1) biopower energy systems;

(2) biofuels;

(3) bioproducts;

(4) integrated biorefineries that may produce biopower, biofuels, and bioproducts;

(5) cross-cutting research and development in feedstocks; and

(6) economic analysis

(c) BIOFUELS AND BIOPRODUCTS.—The goals of the biofuels and bioproducts programs shall be to develop, in partnership with industry and institutions of higher education—

(1) advanced biochemical and thermochemical conversion technologies capable of making fuels from lignocellulosic feedstocks that are price-competitive with gasoline or diesel in either internal combustion engines or fuel cell-powered vehicles;

(2) advanced biotechnology processes capable of making biofuels and bioproducts with emphasis on development of biorefinery technologies using enzyme-based processing systems;
(3) advanced biotechnology processes capable of increasing energy production from lignocellulosic feedstocks, with emphasis on reducing the dependence of industry on fossil fuels in manufacturing facilities; and
(4) other advanced processes that will enable the development of cost-effective bioproducts, including biofuels.

APPENDIX E –AOI 1 TECHNICAL DATA TABLE

This Technical Data Table was designed to guide applicants in providing information to assess the technical and financial status of the technology being developed within the selected project. The spreadsheet form is available on EERE Exchange at https://eere-Exchange.energy.gov/ . Specific instructions on how to fill out these tables are provided in the attached AOI_1 Techdatasheet.xls. Examples regarding the adaptation of these parameters will be included with the tables. Applicants are required to submit the information in the tables at the time of application, as it will be reviewed during the merit review. **Applications submitted without the appropriate technical data will be deemed non-responsive and excluded from further review under this FOA**. In addition, the data provided will be used as the basis for review and discussion during the initial verification and will be considered the project's baseline. As such, it is expected the project will be able to reproduce this data when/if the verification team travels to the site to perform the verification. It is also expected the data will have been experimentally produced by the applicant in the applicant's facilities. However, if literature data needs to be used for parts of the process, those metrics based on literature data should be marked appropriately. Please refer to the Excel template for more detailed instructions on how to complete the Table.

AOI 1_Techdatasheet.xls

APPENDIX F –AOI 3 TECHNICAL TABLES

Applicants to AOI 3 are required to provide the baseline wood heater or wood heater technology performance data indicated in the following tables **in the Technical Volume of the full application**. This data should be included in the Technical Description, Innovation and Impact section of the Technical Volume (see IV.D.ii.)

Required Wood Heater Data

Type	e.g., room heater, central forced air, central hydronic, or retrofit device
Firebox	Dimensions and materials of construction
Air Introduction Systems:	cross sectional area of restrictive air inlets and outlets, location and method of control
Baffles	Dimensions and locations
Refractory / insulation	Dimensions, locations and materials of construction
Door	Solid or ceramic window
Catalyst	Dimensions, locations and type (composition, support)
Catalyst bypass mechanism & gap tolerances	Dimensions, cross-sectional area, and location
Flue gas exit	Dimensions and locations
Door and catalyst bypass gaskets	Dimensions and material of construction
Outer thermal shielding and thermal coverings	Dimensions, locations and materials of construction
Fuel feed system	Where applicable a system description with feed rate, motor design and power rating, angle of auger to firebox
Forced air combustion system	If equipped the location and horsepower of blower motors
Sensors	Type and location

Baseline Wood Heater Performance Data

Wood used for testing	Species, moisture content, type (e.g., crib, cord, pellet)
Applicable test methods	e.g., EPA Method 28
Particulate emissions concentration	mg/m^3
Emissions Rate	g/hr
Emissions factor	g/kg and lb/MMbtu
Weighted Delivered Efficiency	%
Max heat output	Btu
Average burn rate	kg/hr (dry)

Average Stack Gas CO	%
Average Stack Gas CO_2	%
Average Stack Gas O_2	%
Average CO emissions	g/Kg
Test Fuel	Lbs or kg
Test Fuel Burn Time	minutes

APPENDIX G – BLOCK FLOW DATA

NOTE: This Block Flow Data (BFD) template is provided as a convenient method of documenting the information required to assess the projects proposed in response to this FOA. The use of the Block Flow Data template is not required, but the data elements within the Block Flow Data template are required.

Instructions and Overview:

The purpose of this section is to assess the merits of the selected technology and the status of the process technology in order to gain an understanding of project risks and the potential viability of the proposed project. Please answers all questions as thoroughly as possible based on current knowledge.

It is expected that applicants have collected data from some **(a) existing facility** that is used to design the **(b) proposed facility** which in turn will be used to gain process information to build a **(c) commercial facility** in the future. Please pay particular attention to the proposed pilot or demonstration scale facility when reading and answering the questions. The attached BFD should relate to the proposed project.

Unit Operation Step: Unit operation steps are defined as the areas in the plant where a change occurs, such as reactions, physical changes to materials including materials handling, or chemical conversions. (A physical step physically alters material, and a chemical conversion step involves changes in the molecular form of a material.) Some examples of items to be included as unit operation steps appear below.

Examples of block steps:

Reactors	Shredder
Distillation	Mixers
Drying	Aerators
Separations	Filters
Ion exchange	Gas absorption

Use a unique number for each unit operation in the BFD. Show recycle loops and waste streams as well. The characteristics of each output should directly tie to input of the respective unit operation in the process. If additional processing is required before the output of one unit can be used as the input to another, an additional unit operation should be included to describe how the stream is altered. It is particularly important to focus on the heat and material balance of each block step. The description of the process should begin with the first manipulation of the feedstock in its as-received condition, such as de-stringing of baled corn stover or any initial sizing/moisture reduction of wood chips. Applicants are encouraged to summarize the process using ten blocks or fewer for an estimated level of detail.

Provide the following information for the process shown in the BFD

1. How and why was the proposed process chosen? Discuss technical and business risks, benefits and opportunities associated with the process.

2. Describe the history of research and development performed by the applicant for the proposed process including scale, duration of runs, type of data collected, etc.

Answer the following questions for each Unit Operation shown in the BFD

Unit Operation # – {title}

1. Name or title (as shown in the BFD).

2. Description of the unit operation.

    1) Capacity and throughput.

    2) Provide the heat and material balance (H&MB). Specifically including, but not limited to, energy and carbon balance information.

    3) Provide the processing conditions for the unit operation, including temperature, pressure, and residence time.

    4) Provide designed and actual yield, conversion and efficiency data for each unit operation detailing the products, byproducts, and waste streams.

    5) Provide the materials of construction and the basis for their selection for each critical piece of equipment.

    6) Provide the expected service life including expected maintenance cycles.

    7) Describe any known causes and the effects and impacts thereof for system upset and contaminants (including the source(s) of the contaminants).

8) Provide a description, including physical and chemical composition, phase, temperature and pressure of all input and output streams.

9) Describe the mode of operation, i.e., batch, plug or continuous flow.

10) For all waste streams leaving the process describe the physical and chemical composition, phase, temperature and pressure, and the proposed method of treatment, storage and/or disposal.

11) Provide the estimated capital cost of each unit operation and the basis for those costs.

12) Describe the instrumentation and controls that will be incorporated into this unit. This should complement the instrumentation and controls discussion in the Project Narrative.

3. Describe the state of technology for the unit operation.

1) If the technology is commercially available, is the proposed design and use within the manufacturer's normal operating parameters?

2) At what scale(s) has the technology been designed and tested? What is the scale-up factor for the proposed unit operation or integration step? (Scale up = proposed facility unit capacity divided by previous scale capacity.) That is, provide specific explanation and justification for the basis of assumed success in achieving the designed scale up.

3) How many runs were made at the stated scale, and for how many continuous hours/days? When (approximately) was the most recent test run?

4) If R&D is the basis for the state of technology, describe the original goals and objectives of the R&D. If not discussed in #3, above, summarize the results of the R&D and discuss how the original goals and objectives were met or not met. Describe the quality and replicability of the results. (If data quality objectives were used to set minimum data quality standards, briefly describe them.)

Is further R&D is needed? Describe the goal and summarize the work needed to obtain the needed information. In lieu of including the information here, if the work is planned to be conducted as part of the project within the scope of this application, reference the activity (preferably by task or WBS number(s)).

5) Calculate the following sustainability metrics for each unit operation commenting on both the values observed to date as well as targets for the envisioned commercial-scale facility:

- GHGs (g CO_2-e/MJ fuel) – (emissions)
- Fossil Energy Consumption (MJ fossil energy/MJ fuel product)
- Total Fuel Yield (gal/dry ton wood; GGE/dry ton wood)
- Carbon-to-Fuel Efficiency (C in fuel/C in biomass)
- Water Consumption (m^3/day; gal/GGE)
- Wastewater Generation (m^3/day; gal/GGE)

6) Discuss the current state of any offtake agreements and regulatory approval for any products intended to be sold. Include a discussion of any remaining regulatory approval requirements and how the proposed facility will contribute to advancing the market acceptance of the products.

APPENDIX H – GLOSSARY

Applicant – The lead organization submitting an application under the FOA.

Continuation application – A non-competitive application for an additional budget period within a previously approved project period. At least ninety (90) days before the end of each budget period, the Recipient must submit to EERE its continuation application, which includes the following information:

i. A report on the Recipient's progress towards meeting the objectives of the project, including any significant findings, conclusions, or developments, and an estimate of any unobligated balances remaining at the end of the budget period. If the remaining unobligated balance is estimated to exceed 20 percent of the funds available for the budget period, explain why the excess funds have not been obligated and how they will be used in the next budget period.

ii. A detailed budget and supporting justification if there are changes to the negotiated budget, or a budget for the upcoming budget period was not approved at the time of award.

iii. A description of any planned changes from the negotiated Statement of Project Objectives and/or Milestone Summary Table.

Cooperative Research and Development Agreement (CRADA) – a contractual agreement between a national laboratory contractor and a private company or university to work together on research and development. For more information, see https://www.energy.gov/gc/downloads/doe-cooperative-research-and-development-agreements

Federally Funded Research and Development Centers (FFRDC) - FFRDCs are public-private partnerships which conduct research for the United States Government. A listing of FFRDCs can be found at http://www.nsf.gov/statistics/ffrdclist/.

Go/No-Go Decision Points: – A decision point at the end of a budget period that defines the overall objectives, milestones and deliverables to be achieved by the recipient in that budget period. As of a result of EERE's review, EERE may take one of the following actions: 1) authorize federal funding for the next budget period; 2) recommend redirection of work; 3) discontinue providing federal funding beyond the current budget period; or 4) place a hold on federal funding pending further supporting data.

Project – The entire scope of the cooperative agreement which is contained in the recipient's Statement of Project Objectives.

Recipient or "Prime Recipient"– A non-Federal entity that receives a Federal award directly from a Federal awarding agency to carry out an activity under a Federal program. The term recipient does not include subrecipients.

Subrecipient – A non-Federal entity that receives a subaward from a pass-through entity to carry out part of a Federal program; but does not include an individual that is a beneficiary of such program. A subrecipient may also be a recipient of other Federal awards directly from a Federal awarding agency. Also, a DOE/NNSA and non-DOE/NNSA FFRDC may be proposed as a subrecipient on another entity's application. See section III.E.ii.

APPENDIX I – DEFINITION OF TECHNOLOGY READINESS LEVELS

TRL 1:	Basic principles observed and reported
TRL 2:	Technology concept and/or application formulated
TRL 3:	Analytical and experimental critical function and/or characteristic proof of concept
TRL 4:	Component and/or breadboard validation in a laboratory environment
TRL 5:	Component and/or breadboard validation in a relevant environment
TRL 6:	System/subsystem model or prototype demonstration in a relevant environment
TRL 7:	System prototype demonstration in an operational environment
TRL 8:	Actual system completed and qualified through test and demonstrated
TRL 9:	Actual system proven through successful mission operations

APPENDIX J – LIST OF ACRONYMS

Insert other acronyms applicable to this FOA (e.g., technology office name, technical terms or metrics)

AAS	Advanced Algal Systems
ADO	Advanced Development and Optimization
ARPA-E	Advanced Research Projects Agency-Energy
ASTM	American Society for Testing and Materials
BETO	Bioenergy Technologies Office
BFD	Block Flow Data
CIPA	Cultivation Intensification Processes for Algae
CJF	Conventional Jet Fuel
CO	Carbon Monoxide
COI	Conflict of Interest
CRADA	Cooperative Research and Development Agreement
DBTL	Design Build Test Learn
DEC	Determination of Exceptional Circumstances
DMP	Data Management Plan
DOE	Department of Energy
DOI	Digital Object Identifier
EERE	Energy Efficiency and Renewable Energy
EPA	Environmental Protection Agency
FAR	Federal Acquisition Regulation
FCIC	Feedstock Conversion Interface Consortium
FFATA	Federal Funding and Transparency Act of 2006
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
FFRDC	Federally Funded Research and Development Center
FSL	Feedstocks and Logistics
GAAP	Generally Accepted Accounting Principles
GGE	Gallon of Gasoline Equivalent
GHG	Greenhouse Gas
INL	Idaho National Laboratory
IPMP	Intellectual Property Management Plan
LBNL	Lawrence Berkeley National Laboratory
LCA	Lifecycle Assessment
LCOD	Levelized Cost of Disposal
LCOE	Levelized Cost of Energy production
M&O	Management and Operating
MFSP	Minimum Fuel Selling Price
MPIN	Marketing Partner ID Number
MYPP	Multi-Year Program Plan
NDA	Non-Disclosure Acknowledgement
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Agency

NREL	National Renewable Energy Laboratory
OMB	Office of Management and Budget
OSTI	Office of Scientific and Technical Information
PII	Personal Identifiable Information
PM	Particulate Matter
PNNL	Pacific Northwest National Laboratory
R&D	Research and Development
RFI	Request for Information
RFP	Request for Proposal
SAM	System for Award Management
SOPO	Statement of Project Objectives
SPOC	Single Point of Contact
STP	Standard Temperature and Pressure
TEA	Techno-economic Analysis
TIA	Technology Investment Agreement
TRL	Technology Readiness Level
UCC	Uniform Commercial Code
USDA	United States Department of Agriculture
VOC	Volatile Organic Compound
WBS	Work Breakdown Structure
WP	Work Proposal