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

FY20 Bioenergy Technologies Multi-Topic FOA

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FOA Issue Date:	1/23/2020
Submission Deadline for Concept Papers:	5:00pm ET on 03/05/2020
Submission Deadline for Full Applications:	5:00pm ET on 04/30/2020
Expected Submission Deadline for Replies to Reviewer Comments:	5:00pm ET on 06/11/2020
Expected Date for EERE Selection Notifications:	07/27/2020
Expected Timeframe for Award Negotiations:	September 2020

- 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 bioeconomy. The activities supported by BETO are authorized by Public Law 109–58, TITLE IX, § 932, which authorizes the Secretary of Energy to establish a program of research and development for bioenergy with the goal of price-competitive biofuels, bioproducts, and biopower made from biomass-based feedstocks – see section I.E for details. This Funding Opportunity Announcement (FOA) will support high-impact technology research and development (R&D) to enable growth and innovation to accelerate the bioeconomy by requesting applications across the entire scope of BETO's mission space.

The United States has the potential to produce more than one billion tons[1] of sustainable biomass, which can be used to produce renewable fuels for cars, trucks, and jets; renewable chemicals; and renewable power to supply the grid. Leveraging waste streams can further enhance this potential. The activities supported by BETO's funding for this opportunity will be a component of the comprehensive U.S. energy strategy to enhance energy supply, create domestic jobs, secure the nation's global leadership in bioenergy technologies, and increase U.S. energy resources. These efforts support the growth of the U.S. bioeconomy.

As part of DOE's Office of Energy Efficiency and Renewable Energy (EERE), BETO invests in high-impact, high-value technology development activities to produce bioenergy and products from terrestrial and algal biomass and other waste streams such as biogas, waste carbon dioxide, and waste plastics that industry would be unable to pursue independently due to the high level of risk and technological 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 (GGE) in the near-term.[2]

This FOA will provide funding to address BETO's highest priority R&D areas. It includes Topic Areas from five BETO programs: Feedstock Supply and Logistics; Advanced Algal Systems; Conversion Technologies; Advanced Development and Optimization; and Strategic Analysis

[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., https://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

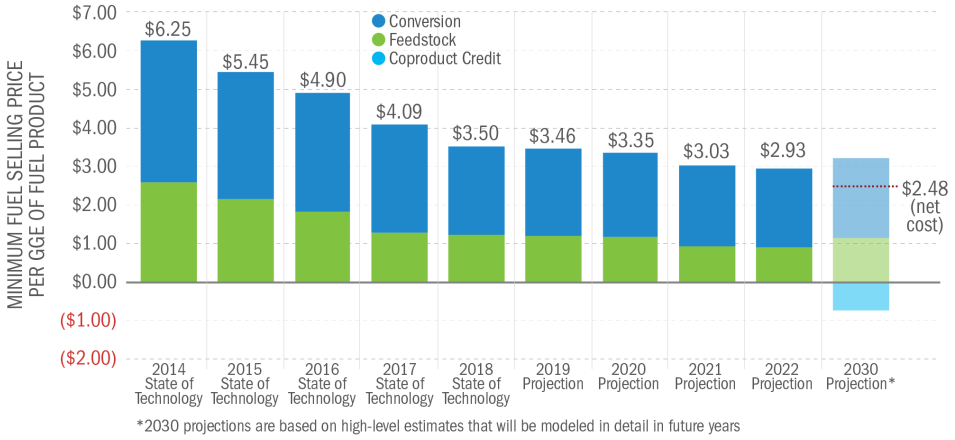
and Crosscutting Sustainability. Each Topic Area supports BETO's objectives to reduce the minimum selling price of drop-in biofuels, lower the cost of biopower, and enable high-value products from biomass or waste resources.

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.

Biofuels and bioproducts are produced via a variety of technology configurations that can be referred to as 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 technology pathways.

Illustrative biofuel pathway progress is assessed annually by BETO using techno-economic analyses (TEA), which translate technology development into GGE price improvements. These results, along with life cycle assessments (LCA) of energy and emissions and supply chain sustainability analyses, which estimate the environmental impact of improvements, are referred to by BETO as the state of technology (SOT). Figure 1 illustrates for one example technology pathway, (wood biomass via catalytic fast pyrolysis with upgrading to hydrocarbon fuel), the TEA impact of technology development progress representing a 42% reduction in the modeled Minimum Fuel Selling Price (MFSP) in 4 years and projections of future improvements.



*2030 projections are based on high-level estimates that will be modeled in detail in future years

Figure 1: Illustrative biofuel pathway progress toward $3/GGE (woody feedstocks via catalytic fast pyrolysis and upgrading pathway).[3]

There is significant R&D that is still required in order to reach the ultimate trajectory of a modeled mature biofuel MFSP of less than $2.50/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
- R&D on enhancing and valorizing the ecosystem services provided by biomass
- Development of integrated processes, tested and verified at engineering scale, to reduce technological uncertainties and enable industry deployment
- Crosscutting sustainability and strategic analysis of economic, social, and environmental effects to identify emerging opportunities

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

All work under EERE funding agreements, such as those awarded as a result of this FOA, 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. See section III.A.iii. for instructions on how to request a waiver of either of these requirements. An applicant must submit an explicit waiver request in the Full Application. Also see Section IV.C.xiv. and Appendix B.

B. Topic Areas

Topic Area	Topic Area
1	Scale Up of Bench Applications (SCUBA)
2	Waste to Energy Strategies for the Bioeconomy 2a: Municipal Solid Waste (MSW) 2b: Optimizing Community Scale Wet Organic Wastes 2c: Synergistic Wastewater Integration with Microalgae (SWIM)

[3] Adapted from "Ex Situ Catalytic Fast Pyrolysis of Lignocellulosic Biomass to Hydrocarbon Fuels: 2018 State of Technology and Future Research." National Renewable Energy Laboratory. NREL/TP-5100-1954, accessible at: https://www.nrel.gov/docs/fy19osti/71954.pdf. Projections are interpolations of unpublished data.

3	Algae Bioproducts and CO_2 Direct-Air-Capture Efficiency (ABCDE)
4	Bio-Restore: Biomass to Restore Natural Resources
5	Efficient Wood Heaters
6	Biopower and Products from Urban and Suburban Wastes: North American Multi-University Partnership for Research and Education 6a: Biopower from Organic Wastes 6b: Waste Plastics to Products
7	Scalable CO_2 Electrocatalysis

i. Topic Area 1: SCale Up of Bench Applications (SCUBA)

Scaling a new biorefinering process from small laboratory- and/or bench-scale components to integrated engineering scale unit operations is a key step in the commercialization of most processes. However, technical uncertainty and risk are typically assumed when scaling up and integrating entire processes at once, as some unit operations are far less defined than others in the scaled process and connections between unit operations are not fully understood. This, coupled with the inherent challenges associated with handling and processing of solids and recalcitrant biomass, makes designing, operating, and financing fully integrated biorefinery technology systems difficult.

This Topic Area aims to reduce the scale-up technology uncertainty and risk of integrating biorefinery technology pathways by focusing on engineering solutions for key process steps, specifically by working on the portion of a process that has the highest scale-up risk. This can include a single or multiple integrated unit operations. The goal of this Topic Area is to develop specialized engineering-scale equipment that will reduce technological uncertainty and risk of an eventual fully integrated engineering- or pilot-scale facility.

The proposed scale-up should go from a laboratory- or bench-scale process to the next logical process scale in order to enable the production of small volumes of intermediates or products, enable learning from the operational performance of the proposed technologies at the proposed scale, and facilitate optimization in an integrated or semi-integrated environment. The process may encompass both batch and continuous modes of operations. If the proposed project is operating within an integrated environment, some of the proposed unit operations could function in batch or semi-batch mode while the rest of unit operations could be under continuous mode. During the proposed project, the unit operations are not intended to comprise a fully integrated system, but rather to support future integration of the entire process. Similarly, applicants may propose engineering solutions, on a unit operation basis, to existing cellulosic biorefinery facilities.

Applicants may propose to address scale-up challenges associated with the production of an intermediate with the intent that the proposed intermediate would be further upgraded to fuels and products in a biorefinery or an existing petroleum refinery. As described in the "Topic Area 1 Specific Requirements" section below, such applications must address how at least 50% of the

biogenic carbon in the product(s) would be converted to a biofuel and how this would be measured. Additionally, applicants proposing coprocessing at an existing petroleum refinery are required to show how the renewable fraction would be distributed across the refinery's product suite, and continue to meet, or show a strategy to meet, all applicable regulatory requirements both during production and also through distribution and use. The applicant must also show how the coprocessing of an intermediate is economically viable. An acceptable feedstock (per Appendix C) must be used for the proposed process whether the proposed process focuses on utilizing an intermediate in a biorefinery or if the proposed process utilizes coprocessing of an intermediate in an existing petroleum refinery.

BETO has previously made substantial capital investments at numerous Federally Funded Research and Development Centers (FFRDCs). Industry and academia are highly encouraged to utilize these FFRDC capabilities. All Topic Area requirements and merit considerations apply equally to all applications irrespective of the utilization of FFRDC for the proposed project. Under this Topic Area, FFRDCs are not eligible as Prime Recipients and may not make up more than 50% of the project budget.

Topic Area 1 Specific Areas of Interest:

- Applications proposing the use of acceptable 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.

Topic Area 1 Specific Requirements:

The following requirements must be addressed in 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 Diagram and Supplemental Data template is included with the FOA (See Appendix D). 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 attachment will be deemed non-responsive per Section I.C. of this FOA and excluded from further review under this FOA**.
- The application must propose the use of an acceptable biomass feedstock (see Appendix C), an intermediate created from an acceptable biomass feedstock, or a nongaseous waste stream derived from processing an acceptable biomass feedstock.
- The application must describe a credible plan to run the proposed unit operations 500 cumulative hours on stream, with a minimum of 100 continuous hours.
- The primary biofuel stream(s) must be a liquid at standard temperature and pressure (STP).
- The primary biofuel stream(s) must contain at least 50% of the utilizable biogenic carbon.
- Bioproducts and biopower are acceptable as co-products.

- Applications proposing coprocessing with an existing petroleum refinery must address how at least 50% of the biogenic carbon would be converted to a biofuel and how this would be measured. The application must also show how the renewable fraction would be distributed across the refinery's product suite, and continue to meet, or show a strategy to meet all applicable regulatory requirements both during production and also through distribution and use. Additionally, the application must show how the coprocessing of an intermediate is economically viable.
- American Society for Testing and Materials (ASTM) approved drop-in fuel pathways are eligible under this Topic Area. Applications that include pathways pending approval are eligible under this Topic Area, as long as the applicant can show during the project that the fuel has a reasonable chance of receiving ASTM approval (e.g., a task in the SOPO describing how the project will pursue ASTM approval).
- Primary products must qualify as biofuels with at least a 60% reduction in greenhouse gas (GHG) emissions over the petroleum derived equivalent. 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 envisioned biofuel product(s) must meet all applicable regulatory compliance for its (their) intended use. Gasoline and diesel must be acceptable for use on public roadways. Marine and jet fuels must be suitable for commercial use.
- Applicants must have completed a reasonable and verifiable amount of prior scale work on the proposed unit operation(s) 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 and Data Sheet Instructions in Appendix D.
- Applications must clearly describe the applicant's ability to access all physical and intellectual property necessary to complete the proposed scope.
- The application must clearly describe plans to utilize industrially relevant equipment and materials in the application (e.g., use of cellulosic derived materials, as opposed to model compounds).
- Applications cannot include greater than 10% of the total project budget for earlier stage R&D (<TRL 4), including expenses for equipment, salaries, and supplies.

Topic Area 1 Applications Specifically Not of Interest:

- Those identified in Section I.C. of the FOA.
- Applications that propose processes that will not be economical when scaled to industrially relevant capacity.
- 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 whose overall proposed process will only produce alcohols or other intermediates without conversion to finished drop-in biofuels (i.e., biofuels ready to sell into the commercial market without further upgrading or blending) or other products.
- Applications that propose to develop and/or utilize artificial lighting-based cultivation of algae.
- Applications proposing the use of traditional, commercial anaerobic digestion. However, alternative reactor designs such as anaerobic membrane bioreactors or other novel configurations that are not commercial, and otherwise meet the requirements, are acceptable.
- Applications only proposing to produce biogas without further processing into drop in liquid biofuels.

Topic Area 1 Metrics:
The application must propose to meet all the minimum targets in the table below by the end of the project.

Metric:	Minimum:	Stretch Target:
Fuel Selling Price	$3.00/GGE	$2.50/GGE
Cumulative time on stream	500 hours	1000 hours
Continuous time on stream	100 hours	250 hours
Throughput equivalent	0.5 Dry Tonnes Per Day (DTPD) equivalent; 12,500 gallons of intermediate per year for an algal process equivalent; or 8 million British Thermal Units (MMBTU)/day of biogas equivalent	1 DTPD equivalent; 25,00 gallons of intermediate per year for an algal process equivalent; or 16 MMBTU/day of biogas equivalent
Reduction in emissions relative to petroleum-derived fuels	60%	60%

Topic Area 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 Topic Area:

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

- A publicly releasable final technical report describing how the technology would contribute to the BETO 2030 goal of $2.50/GGE MFSP with at least 60% reduction in greenhouse gas emissions relative to petroleum derived fuels.

ii. Topic Area 2: Waste to Energy Strategies for the Bioeconomy

Projects selected under this Topic Area will advance the bioeconomy by diverting organic wastes from disposal for conversion to fuels, products, and energy. Selected projects will address several aspects of the waste-to-energy-and-products supply chain, including advanced preprocessing of feedstocks, conversion of wet wastes such as food waste to energy and products, and synergistic integration of algal biomass technologies with municipal wastewater treatment for greater energy efficiencies and lower costs. Applicants must identify which Subtopic they are applying to.

1. Subtopic 2a: Advanced Fractionation and Decontamination of Municipal Solid Waste for Improved Conversion Efficiency

Municipal Solid Waste (MSW) represents a source of potentially low-cost feedstocks for the production of biofuels, bioproducts, and biopower. Heterogeneity and variability in MSW constituents are significant barriers for MSW use as a bioenergy and bioproducts feedstock. MSW requires high-fidelity fractionation to produce homogeneous feedstock streams. In addition, physical and/or chemical preprocessing to reduce variability in feedstock and to remove harmful contaminants from MSW and other waste resources can help BETO meet its 2029 performance goal to identify key feedstock quality and variability factors necessary to produce conversion-ready feedstocks that meet a modeled delivered cost of $73/dry ton.

Subtopic 2a seeks applications to develop advanced and techno-economically viable sorting and preprocessing methods tailored to MSW to address its known heterogeneity and variability, and to produce high-purity value-added feedstocks and/or to focus on identifying and removing contaminants economically. Applicants have the option to address advanced fractionation of MSW, decontamination of MSW, or both, in their applications.

Subtopic 2a Areas of Interest:

- The design and testing of novel sorting/preprocessing technology to produce high-purity streams from non-recyclable MSW sources for specific end uses (See Appendix C for definitions). Applicants should describe the technologies needed to fractionate non-recyclable MSW sources, and define the fractions and their fidelity.
- Technologies need to reduce the variability in a high-fidelity fraction (preprocessing) and to meet the applicable feedstock specification(s). Applicants should describe the technology needed to reduce variability, and define the applicable feedstock specification(s).
- Technologies need to reduce contaminants in a high-fidelity fraction. Applicants should describe the technology needed to reduce contaminant(s), and define contaminant(s).

Applicants will compare an unprocessed baseline stream to a processed stream to determine percent removal of contaminants.

Subtopic 2a Specific Requirements:
The following requirements must be addressed in 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.):

- The application must propose projects that work on non-recyclable MSW sources only. For the purposes of this FOA, non-recyclable MSW is defined as the organic and plastic constituents of the MSW stream going to the landfill. See Appendix C for complete definition.
- The application must provide an internal baseline for the performance of the proposed system. In the context of this Subtopic, an internal baseline refers to experiments performed and data gathered directly by members of the project team. 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/waste type of interest at the location proposed.
- Applicants must propose to perform techno-economic analysis and life cycle assessment of the proposed process. Technologies that have no path to economic feasibility will not be considered.
- The application must discuss the specific end use for each stream produced. This includes methods to define the market and quantitatively characterize the valorization of this stream for that particular end use.
- The application must justify why the applicant believes its 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 F for TRL definitions.)
- Successful applications will propose to develop and run systems at a relevant scale appropriate for the technology. The proposed scale will be subject to DOE's verification procedures as described in Section I.D.
- Successful applications must define and justify both a credible starting baseline, and a clear R&D path toward achieving the required metrics as shown below. Both baseline claims and milestone objectives will be subject to DOE's verification procedures as described in Section I.D.

Subtopic 2a Applications Specifically Not of Interest:
- Those identified in Section I.C. of this FOA.
- Those that propose the use of feedstocks other than non-recyclable MSW sources (e.g., inorganic materials, recyclable paper, manures, and construction and demolition (C&D) waste).

- Those that propose to conduct field work, pilot- or demonstration-level development, or undertake construction or development of new facilities and/or equipment.

Subtopic 2a Metrics:
The application must propose to meet all the minimum targets in the table below by the end of the project.

Metric	Interest Area(s)	Unit	Minimum	Stretch Target
Purity of Stream Relative to the Proposed Baseline	Fractionation	Wt % (dry basis)	95	99
Reduction in variability of feedstock for an end use	Fractionation	%	50	80
Decontamination Efficiency Over Proposed Baseline	Decontamination	Wt % (dry basis)	80	95
Added Cost of Technology over Delivered Cost Goal of $86/ton, including collection, handling, preprocessing, and transportation costs	Fractionation and Decontamination	$/ton	30	20

2. Subtopic 2b: Optimizing Community-Scale Wet Organic Wastes

Wet organic waste streams represent valuable potential feedstocks for the bioeconomy. They include, but are not limited to, industrial, commercial, and residential food wastes, municipal sludges and biosolids, 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, but in many cases their ultimate fate is a landfill. While some of the available energy in these streams is currently being captured, a significant amount remains untapped.[4,5] These resources offer a potential opportunity for conversion into biofuels, bioproducts, and biopower.

States, Municipalities, and Indian tribal governments are increasingly responding to these issues by limiting or even prohibiting the disposal of organic wastes, particularly food

[4] 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.
[5] 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.

wastes, in landfills.[6] This creates a significant challenge for traditional anaerobic digestion (AD). AD is a proven technology for the conversion of heterogeneous and dynamic mixtures of food and other wet wastes to biogas. However, the required capital expense for traditional anaerobic digestion systems presents challenges at community scales (smaller than 5 dry tons/day).[7] These wastes are produced and managed locally, and transportation costs of wet materials are prohibitive, so processing systems for these materials need to operate at the sites where the wastes are gathered.

Subtopic 2b seeks solutions that address these challenges by developing processes for the conversion of food wastes, including blends with other relevant wet organic streams that substantially enhance overall carbon conversion efficiency and/or reduce disposal costs, and have the potential for economic viability at community scales. Organizations within states, localities, or tribes that have enacted organics diversion directives are particularly encouraged to partner with solution providers in applications to this Subtopic.

A primary challenge of processing food and other wet wastes as feedstock streams at community scales is one of costs. There are at least five 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. Improving processing system resilience to the inherent variability of blended food and other organic waste streams.
5. 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[8,9] in the context of current and changing energy and economic trends. Therefore, applicants must illustrate the potential technoeconomic benefit of their process with respect to incumbent technologies and waste management practices.

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[6] Badgett, A, Milbrandt, A. A summary of standards and practices for wet waste streams used in waste-to- energy technologies in the United States. Renewable & Sustainable Energy Reviews, 2020; 117: 109425. https://doi.org/10.1016/j.rser.2019.109425.

[7] WERF. Utilities of the Future Energy Findings, (Water Environment Research Foundation, Alexandria, VA, 2014), pp. 86.

[8] 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):5672-5681.

[9] 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.

Subtopic 2b Areas of Interest:

- Applications to eliminate AD entirely by diverting the primary and secondary sludge from normal wastewater treatment that would normally feed a digester to an alternative set of processes to produce biofuels and bioproducts of greater value than biogas or methane.
- Solutions, whether thermochemical, biochemical, electrochemical, or some combination thereof, capable of handling widely variable blends of food wastes and other organic feedstocks without significant operational disruption.
- Applications to alter the traditional AD process to produce more valuable products than biogas or methane, such as those directed toward volatile fatty acids as a bioproduct or biofuel precursor. Applications in this Subtopic should address the significant technical challenges that remain, particularly in separations.
- Systems that could dramatically reduce the capital costs relative to traditional AD via a radical redesign of the AD reactor system, particularly those that separate hydraulic and solids retention times in a convincing fashion, while minimizing both the volume/cost of residual disposal and the release of methane (dissolved or otherwise) to the environment.
- Some recent research indicates that there may be synergies available by introducing electricity into anaerobic systems to increase carbon efficiency. Applications in this area should explicitly address how they would meet the scale and continuous operation requirements described below.
- Alternatives with the potential to replace the entire existing wastewater treatment process. Such solutions would need to take raw wastewater and produce biofuels and/or bioproducts, clean water, and minimal disposal residues.

Subtopic 2b Specific Requirements:

The following requirements must be addressed in 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 food and other wet organic waste streams (including blends thereof) as the primary feedstock 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.

Subtopic 2b Applications Specifically Not of Interest:

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

This topic is specifically focused on food waste feedstocks likely to be targeted by existing state and/or local organics-diversion-from-MSW legislation or regulation.

- Applications that propose hydrogen, ethanol, methane, biogas, syngas, dimethyl ether, or methanol as end products. Note, that while these materials are not allowed as end products, they are acceptable as intermediates, if the application is clear how the intermediates will be incorporated into processes to produce biofuels or bioproduct precursors by project completion.

Subtopic 2b Metrics:
The application must propose to meet the minimum targets below by the end of the project:

- 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.

3. Subtopic 2c: Synergistic Wastewater Integration with Microalgae (SWIM)

Wastewater treatment reduces pollution in water discharged to natural water systems and for reuse in communities and industries. The Environmental Protection Agency reports that municipalities expend more than one-third of their energy use on water and wastewater facilities and that the U.S. would save $400 million and 5 billion kWh annually if these facilities improved energy efficiency by 10%.[10] Phosphorus in particular is a problematic constituent of wastewater effluent and removal of phosphorus to meet strict tertiary discharge limits can be both costly and energy intensive, with costs and energy use increasing dramatically to achieve effluent concentrations of less than 1 g/mL effective phosphorus concentration.[11] The U.S. Department of Energy Water-Energy Nexus: Challenges and Opportunities report identifies algae as a water treatment technology with the potential to enhance energy efficiency of wastewater systems while also enabling the safe and productive use of municipal wastewater for energy and non-energy applications.[12] Further, a recent resource assessment performed by Argonne National Laboratory found

[10] U.S. EPA. *ENERGY STAR for Wastewater Plants and Drinking Water Systems*. Available: https://www.energystar.gov/about/content/energy-star-tool-drinking-water-and-wastewater-facilities-0.

[11] Bashar, et al. Cost effectiveness of phosphorus removal processes in municipal wastewater treatment. Chemosphere, Volume 197, 2018, Pages 280-290, https://doi.org/10.1016/j.chemosphere.2017.12.169.

[12] U.S. DOE. *The Water-Energy Nexus: Challenges and Opportunities Overview and Summary*. Available: https://www.energy.gov/sites/prod/files/2014/07/f17/Water%20Energy%20Nexus%20Executive%20Summary%20July%202014.pdf. Accessed 10/21/19

significant potential for making biofuels on a national scale by integrating algae cultivation with wastewater treatment.[13]

The objective of Subtopic 2c is to seek applications that integrate algae biomass technologies with municipal wastewater treatment to increase the energy efficiency and lower the costs of treatment while also enabling consistent yields of algal biomass that meet conversion process specifications for bioenergy, biofuels, and/or bioproducts. Successful projects will deliver R&D to improve wastewater treatment systems through strategies like increased electricity efficiencies measured by kWh/kg of problematic pollutants removed (e.g., total nitrogen (N) and phosphorus (P)) and improved nutrient recovery measured by cost per ton of recovered N and/or P, all while modeling lowered costs of production of bioenergy and/or bioproducts from high productivity algae. Treating wastewaters in a municipal setting with microalgae cultivation has the potential to leverage environmental/ecosystem services to expand the domestic resource potential of the bioeconomy through creation of low cost of supply of algae biomass for products. This aligns with the BETO's mission to lower the cost of biofuels, and can help contribute to the Advanced Algal Systems goals for less than $2.50/GGE algae biofuels by 2030.

Projects will develop technologies and operational strategies that, if commercialized, can reduce the energy intensity of removing pollutants in wastewater treatment operations while also producing algal biomass that can be converted into bioenergy, biofuels, and/or bioproducts per the table below.

Subtopic 2c Areas of Interest:
Engineering and operational improvements, novel cultivation systems, and/or innovative strategies that:

- Reduce the cost of secondary and/or tertiary wastewater nutrient removal via algae technologies;
- Lower the energy intensity of wastewater treatment and provides consistently high algal biomass productivity; and
- Identify economical bioenergy and/or bioproduct applications from wastewater grown algal biomass based on compositional analysis.

Subtopic 2c Specific Requirements:
The following requirements must be addressed in 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.):

[13] Chiu, Y. W., & Wu, M. (2013). Considering water availability and wastewater resources in the development of algal bio-oil. Biofuels, Bioproducts and Biorefining, 7(4), 406-415.

- Applications must propose to work with algae. For purposes of this FOA, "algae" is defined as eukaryotic microalgae, macroalgae, and cyanobacteria.
- Applicants must provide letter(s) of commitment that describes partnership(s) with a wastewater treatment facility to develop reasonable internal cost and performance baselines to inform internal minimum and stretch performance metrics. Applicants may consider the Department of Energy's Advanced Manufacturing Office (AMO) "Energy Performance Indicator Tool" (EnPI)[14] to establish a normalized baseline of energy consumption and the "Better Plants Program"[15] to improve energy efficiency. Applicants are not required to use these tools.
- Applicants must propose techno-economic and lifecycle modeling of the system. The modeled system must address operating cost components such as those associated with the energy demand for aeration, mixing, and pumping. The envisioned sale of algal biomass/products must generate revenue, support cost-competitive wastewater treatment operations, and produce cost-competitive energy/fuels/products. In order to demonstrate improvements, techno-economic analysis of the system must show that kWh/kg of pollutant removed and cost per kg of pollutant removed (i.e., biological oxygen demand, total N, ammonia N, and total P) are comparable with or better than industry standards, while meeting relevant discharge permit standards for total concentrations within the effluent.
- Applicants must provide the inputs requested in the technical datasheet (See Appendix D) and a specific initial verification requirement is that either the data described in the baseline column of the technical datasheet will be recreated for observation by the verification team, or the methods and tools used to generate the data will be reviewed in depth by the verification team.

Subtopic 2c Applications Specifically Not of Interest:

- Those identified in Section I.C. of the FOA.
- Those that propose to undertake construction or groundbreaking for new research facilities (installation of new experimental equipment is allowable).

Subtopic 2c Metrics:

The application must propose to meet all the minimum targets in the table below by the end of the project.

Metrics	Unit	Minimum	Stretch

[14] U.S. DOE. Energy Performance Indicator Tool: https://www.energy.gov/eere/amo/articles/energy-performance-indicator-tool Accessed 10/21/19

[15] U.S. DOE. Better Plants program of the Better Buildings initiative: https://betterbuildingssolutioncenter.energy.gov/better-plants Accessed 10/21/19

Energy requirement per amount of pollutant removed	kWh/kg pollutant removed	20% improvement from internal baseline	50% improvement from internal baseline
Yield of algal feedstock	ton of algae/ million gallons-per day (MGD) of treated water	20% improvement from internal baseline	50% improvement from internal baseline
Effluent total phosphorus concentration after remediation	mg/L	0.3 mg/L	0.1 mg/L

Topic Area 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 Topic Area:

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

iii. Topic Area 3: Algae Bioproducts and CO_2 Direct-Air-Capture Efficiency (ABCDE)

Direct air capture (DAC) technologies, such as alkaline solutions used in algae cultivation to drive CO_2 into solution, can decouple algae cultivation from CO_2 sources and have the potential to increase the national resource potential of algal biomass. Therefore, BETO is seeking R&D on improving algal feedstock quality for algae grown using CO_2 captured from the air (i.e., DAC). Successful projects will capture CO_2 from the air, grow high quality algal biomass suitable for conversion to fuels and products, and develop fuels and/or products made from the algae biomass. Projects will, by the end of the research, deliver techno-economic analyses utilizing data generated from the R&D that show lower potential algal biomass costs and increased potential revenue from the incorporation of DAC with production of valuable algae products. This aligns with the BETO's mission to lower the price of biofuels and can help contribute to the Advanced Algae Systems program goals for less than $2.50/GGE algae biofuels by 2030.

Topic Area 3 Specific Areas of Interest:

- Utilizing and optimizing DAC technologies in conjunction with algae cultivation and pre-processing systems;
- Improving algal biomass quality for conversion to fuels and products;

- Developing algal fuels and co-products from algal biomass; and
- Although not required, partnering with a product(s) developer(s) is strongly encouraged.

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

- Applications must propose to work with algae. For purposes of this Topic Area, "algae" is defined as macroalgae, eukaryotic microalgae, and cyanobacteria.
- Applications must propose utilization of DAC and delivery of CO_2 within the algae cultivation and pre-processing system AND work on algae biomass quality towards their specific product regime.
- Applications must describe and test a DAC technology for the delivery and utilization of CO_2 within an algae cultivation and preprocessing system. Applicants must provide:
  - The DAC baseline percentage of CO_2 delivery to the algae cultivation system.
  - A research and development plan to increase the delivery and utilization by a minimum of 20% over their baseline.
- Applications must describe:
  - the algal strain(s) and product(s) of interest;
  - the quality specifications of the algal biomass and pre-processed intermediate required to realize the product(s) specifications;
  - the variability in algal biomass supply with respect to required product specifications; and
  - the research and development plan related to strain, cultivation, and/or process development to cultivate and process the algal biomass to meet the product(s) specifications.
- Applications must describe a research plan that shows the ability to reliably cultivate biomass grown outdoors to generate sufficient product intermediate for quality testing by the product(s) developer(s).
- The research plan must describe how energy and carbon balance analyses of the system will be developed and delivered.
- As part of the research plan, the applicant must conduct technoeconomic and life cycle analyses that both inform the ongoing R&D, allowing R&D to be focused on the most promising areas, and integrate the R&D results into the final deliverables showing lower potential algal biomass costs and increased potential revenue from the incorporation of direct air capture with production of valuable algae fuels and products.
- Applicants must provide the inputs requested in the technical datasheet (See Appendix D).
- All projects must undergo external verifications: initially after selection; at interim points separating budget periods; and at the end of the project. Applications must account for these verifications in the project scope, schedule, and budget (See Section I.D. for a description of the verification requirements). A specific initial verification requirement is that either the data described in the baseline column of the technical

datasheet will be recreated for observation by the verification team or the methods and tools used to generate the data will be reviewed in depth by the verification team.

Topic Area 3 Applications Specifically Not of Interest:

- Those identified in Section I.C. of the FOA.
- Those that propose to undertake construction or groundbreaking for new research facilities (installation of new experimental equipment is allowable).

Topic Area 3 Metrics:

The application must propose to meet all the minimum targets in the table below by the end of the project.

Metrics	Unit	Minimum	Stretch
Algal biomass revenue potential	$ per ton harvested algae biomass	25% increase from applicant's baseline*	50% increase
Algal biomass quality for downstream testing	% meeting fuel and product(s) specifications	<10% out of specification	<5% out of specification
Algae areal productivity	$g/m^2/d$	Increase productivity 10% over applicant's baseline with CO_2 from DAC	Increase productivity >10% over applicant's baseline with CO_2 from DAC
DAC CO_2 delivered and utilized by algal system	% of DAC CO_2 delivered and utilized by algal system	20% increase over applicant's baseline	>20% increase over applicant's baseline
Cost** of CO_2 delivered to algal system	$ per volume of CO_2 delivered to the algae system from DAC versus non-DAC	10% decrease in the cost of CO_2 delivered via DAC versus non-DAC CO_2 delivery	>10% decrease in cost of CO_2 delivered via DAC versus non-DAC CO_2 delivery

*Applicant's baseline must include valorization pertinent characteristics such as moisture content; ash content; lipid, protein, carbohydrate content; cultivation media; nutrients; others

**Cost must be presented without incentives or tax credits.

Topic Area 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 Topic Area:

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

iv. Topic Area 4: Bio-Restore: Biomass to Restore Natural Resources

Earth's natural systems provide services that are critical to our economy and quality of life, such as pure water, clean air, and raw materials. While bioenergy production has received negative press around potential adverse impacts on these systems, there is growing scientific research showing that producing and/or harvesting biomass has the potential to enhance natural systems through erosion control, reduction of nutrient and chemical loading, carbon storage, flood control, and wildlife habitat enhancement (e.g., bird or pollinator habitat).

Opportunities are emerging to assign economic value to these benefits—also referred to as "ecosystem services"—in a manner that increases the availability and affordability of bioenergy and bioproducts. These economic opportunities could include (but are not limited to) nutrient and water quality trading, markets for soil carbon storage, or institutions financially supporting ecosystem services to meet their sustainability goals (e.g., corporate social responsibility initiatives). Furthermore, biomass production can improve farm economics and productivity by enhancing soil organic carbon, reducing soil erosion, and enabling more efficient use of nutrients and chemicals.

This Topic Area is intended to advance capabilities for: 1) targeting the appropriate places to produce or harvest biomass to deliver ecosystem services, 2) measuring, verifying, and valuing those ecosystem services in a scientifically rigorous manner, and 3) reducing uncertainty in modeled estimates of ecosystem services. Ultimately, these advancements can enable the quantification and valuation of ecosystem services to support BETO's goal of $2.50/GGE. Specifically, BETO's goal is to verify biomass production systems that provide ecosystem services that equate to at least a 10% reduction in MFSP relative to $3/GGE.

Topic Area 4 Specific Areas of Interest:
- Field research to quantify the ecosystem services associated with biomass production and/or harvesting. While the ecosystem service(s) will vary by context, all projects should assess biomass productivity, soil quality, water quantity and quality, greenhouse gas (GHG) emissions, and implications for wildlife and/or biodiversity. This assessment should be done annually for at least three (3) years.
- Developing protocols or methods for verifying ecosystem services associated with the biomass types eligible for this FOA. See Appendix C for a description of acceptable

biomass types. Methods should pertain to defining the baseline and measuring and verifying environmental benefits.

- Applying robust, low-cost sensors applicable to monitoring environmental effects (e.g., soil carbon, soil erosion, water quality, N_2O or other emissions) from which producers can derive data to inform management decisions while enabling participation in economic opportunities (e.g., sale of ecosystem service credits). Activities could include (but are not limited to) development or modification of existing sensor technologies as well as ground-truthing or calibrating these technologies.
- Improving information-management platforms so they are applicable to the biomass types eligible for this FOA. Activities could include (but are not limited to) ground-truthing or calibrating these platforms.

Topic Area 4 Specific Requirements:

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

- The biomass type and production and/or harvesting methods must show environmental benefits. At a minimum, projects must verify ecosystem services that pertain to improved water quality and/or increased soil carbon relative to business as usual. See Appendix C for a description of acceptable biomass types.
- In addition to verifying ecosystem services, projects must measure the following suite of environmental effects to understand complementarities and tradeoffs: yield/productivity, soil quality, water quantity and quality, GHG emissions, and implications for wildlife (see the Sustainability Technical Datasheet for additional guidance).
- Projects must conduct an economic analysis that estimates the monetary value of the ecosystem service(s). Projects must complete a baseline TEA to estimate biomass production cost (on a $/dry ton basis) and an enhanced TEA that includes ecosystem services.
- Data collection and/or technology development must be aligned with at least one ecosystem valuation system or certification system to ensure that the data or technology is directly applicable to that system.
- Projects must explain the current state of technology, how the project will improve the state of technology, and how this improvement is applicable to the biomass types eligible for this FOA. Projects must also explain how broadly the technology could be implemented across the United States.
- Projects must describe a plan to meet the Topic Area 4 Metrics described below.
- Initial, intermediate, and final verifications must be performed in conditions representative of actual agricultural systems.
- Projects must use a multi-stakeholder approach that includes landowners, industry, non-profit organizations, and/or other relevant stakeholders. This includes establishing a multi-stakeholder advisory panel early in the project to provide guidance on the

project's approach. The panel should include landowners who are potential early adopters, non-profit organizations, and other regional stakeholders.

- Projects must deliver representative replicate (at least two) biomass samples gathered from each experimental plot annually at the normal harvest time to be archived and characterized in the Bioenergy Feedstock Library (https://bioenergylibrary.inl.gov/Home/Home.aspx) located at the Idaho National Laboratory to enable broad access to physical samples and a database containing information about their chemical and physical properties, as available. Additionally, all data resulting from physical sample characterization must be catalogued in the Bioenergy Feedstock Library. This will help researchers and industry understand and overcome challenges posed by the variability of the physical and chemical properties of biomass while providing all stakeholders with accessible data about the physical and chemical properties of a wide variety of feedstock materials.
- Projects must upload publications and data stemming from funded projects to the Bioenergy Knowledge Discovery Framework (https://www.bioenergykdf.net/) administered at Oak Ridge National Laboratory to facilitate dissemination to other researchers and industry.
- Projects must identify the mechanism(s) by which datasets will be made available publicly, such as uploading relevant datasets to the USDA National Agricultural Library Data Commons (https://data.nal.usda.gov/), the USDA Life Cycle Assessment Commons (https://www.lcacommons.gov), or another appropriate publicly accessible site.

Optional:

- Applicants are strongly encouraged to incorporate other ecosystem services, such as enhanced wildlife habitat, decreased GHG emissions, and/or air quality benefits.
- Applicants are strongly encouraged to leverage existing field sites with established biomass production. Sites can be in a research, pre-commercial, or commercial setting.

Topic Area 4 Applications Specifically Not of Interest:

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

Topic Area 4 Metrics:

The application must propose to meet **at least one** of the following metrics for improvement compared to business as usual, which should be defined by the applicant. The business-as-usual baseline will be approved during the initial verification process. Applicants must also establish **at least one** additional success metric pertaining to improving natural capital, sensors, or information management platforms.

Metric	Unit	Minimum	Stretch Target
Reduce nutrient or sediment loading	kg km^{-2} y^{-1}	20% reduction	60% reduction

relative to business as usual			
Increase soil carbon relative to business as usual	Mg km^{-2}	20% increase	60% increase

Topic Area 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 Topic Area:

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

v. Topic Area 5: Efficient Wood Heaters

Wood is an abundant and renewable source of fuel for residential heat in the United States. Residential wood heaters 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. Design and automation improvements of wood heaters can significantly reduce emissions and increase efficiency.

The objective of this Topic Area is to support the development and testing of low-emission, high efficiency residential wood heaters. 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 stoves, fireplace insert wood heaters, and built-in wood heaters. Room 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.

Topic Area 5 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, achieve complete combustion of wood, 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
  - Integrated robust sensing technologies
  - System control strategies to enable efficient wood heater control over a wide range of operating conditions (startup to shutdown)
  - Secure remote control and real-time performance monitoring
  - Performance data acquisition
- 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

Topic Area 5 Specific Requirements:

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

- Applications must propose to utilize wood chips, cord wood, or wood pellets. No other biomass feedstocks are acceptable.
- Applications must include the **"Baseline Wood Heater Technology and Performance"** as indicated in Appendix D. This data establishes the baseline/as-is performance of the proposed wood heater technology that will be developed during proposed project.
- A detailed description of the technical approach and plan to reduce wood heater emissions by 25-50% relative to the EPA 2020 emission limits and a 5-15% improvement in weighted average efficiency. 2020 emission limits and test methods for room heaters and central heaters are defined in the 2015 Environmental Protection Agency (EPA) standards of performance for residential wood heater particulate matter emissions and subsequent updates[16] (2015 Standard):

Residential Wood Heater	Particulate Matter Emissions Limit
Room Heater	2.0 g/hr, or 2.5 g/hr (cord wood alternative)
Hydronic	0.1 lb/MMBTU heat output, or 0.15 lb/ MMBTU (cord wood alternative)
Forced-Air	0.15 lb/ MMBTU heat output

- Final performance testing of integrated residential wood heater designs in prototype form must be incorporated into the project plan. At a minimum, the testing must:

[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

- Evaluate reductions in PM, reductions in CO, and efficiency improvement.
- Be in accordance with relevant criteria (specific to the wood heater type) established in the 2015 Rule to quantify emissions reduction and efficiency improvements (testing in a certified test facility is optional).
- 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.

- Applications proposing novel residential wood heater component development (e.g., novel/improved catalyst, improved sensors, and retrofit devices) must propose quantifiable performance metrics and test methods for baseline and final performance testing.

Topic Area 5 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 pellets 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.

Topic Area 5 Metrics:

The application must propose to meet all the minimum targets below by the end of the project:

- 25 – 50% reduction in emissions relative to the 2020 residential wood heater emission limits; and

- 5 – 15% improvement in the weighted average delivered efficiency for residential wood heaters relative to their current baseline residential wood heater design.

Topic Area 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 Topic Area:

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

vi. Topic Area 6: Biopower and Products from Urban and Suburban Wastes: North American Multi-University Partnership for Research and Education (Only U.S. Universities Eligible as Prime Applicants)

Urban and suburban waste streams represent valuable potential feedstocks for the bioeconomy. They include, but are not limited to, non-recycled paper, industrial, commercial, and residential food wastes, textiles, yard trimmings, wood, rubber, leather, construction and demolition waste, municipal sludges and biosolids, manure and manure slurries, and other components of municipal solid waste streams whose ultimate fate is generally a landfill. Waste plastics are an important waste stream originating mainly from urban and suburban areas. Combined, these wastes represent a clear and present disposal problem for municipalities across North America. These feedstock streams offer a potential opportunity for conversion into biopower, including intermediates that could be utilized for subsequent production of electricity using established technologies, and products.

This Topic Area seeks applications from U. S. universities to establish multi-university partnerships to conduct R&D and enhance educational programs for developing novel technologies and processes to produce biopower and products from relevant urban and suburban waste feedstocks. **The prime applicant to this Topic Area must be a university located in the United States and the applicant must partner with at least one other university in the United States. Please see the Topic Area 6 Specific Requirements below. Applications must also propose collaboration with at least one university in both Canada and Mexico to leverage capacity and capitalize on North American resources.** National laboratory and/or private sector partnerships as part of the proposed projects are also strongly encouraged.

Topic Area 6 is comprised of two separate Subtopics – 6a: Biopower from Organic Wastes; and 6b: Waste Plastics to products. If an entity or consortium of entities chooses to apply to both Subtopics, separate applications are required for each. All applications must meet all multi-university and Canadian and Mexican educational institution participation specifications. In addition to the R&D objectives, the Topic Area incorporates educational and outreach objectives and requirements, as described below.

Educational and Outreach Objectives (applicable to both Subtopics):

- Applications under this Topic Area must propose an educational and outreach effort that directly supports the quantitative R&D elements and research objectives.
- The educational and outreach aspect of the application will be a significant component of the application's evaluation. Overall, the integration of proposed educational activities with the research objectives stated in the application will be a key criterion of project evaluation throughout the project duration.
- The educational and outreach portion of the application should comprise approximately 10-20% of the proposed budget, with approximately 80-90% of the proposed budget supporting the R&D portion.
- Directly funded graduate and post-doctoral candidate research is expected to be an important component of the University involvement in the proposed projects. However, research conducted by graduate and post-doctoral candidates alone will not be deemed sufficient to meet the educational and outreach objectives of this Topic Area.
- Possibilities for educational and outreach efforts related to the production of biopower and/or products with an emphasis on recycled plastics from urban and suburban wastes include, but are not limited to:
  - Internship/co-op programs for undergraduates involving hands-on scientific experiences. These could include waste processing facilities, private sector conversion technology providers/consultants, relevant non-governmental organizations (NGOs), and National Laboratories.
  - 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.

Topic Area 6 Specific Requirements:

The following requirements apply to both Subtopics. They must be addressed in 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..):

- The prime applicant must be a U.S. university.
- The applicant must partner with at least one other U.S. university. Applications that do not explicitly include at least two U.S. universities will be deemed non-responsive.
- Applicants must partner with at least one university in both Canada and Mexico. As part of the application (not counting towards the page limit), applicants must include letters of support from those institutions detailing their contributions to the project. Letters of support must include:
  - Details describing the expertise each foreign University brings

  - How the foreign University's contributions would add value to the work proposed by the U. S. members of the partnership
  - How these entities would specifically contribute to the overall project research and educational objectives.
- Applicants proposing DOE funding for or cost share from foreign entities must submit a foreign waiver request as described in Section III.A.iii.
- Applications that include work outside of the U.S. must submit a waiver request as described in Section III.A.iii.
- Applications must include details on the management plan for the proposed partnership. This must include, but not be limited to, outlining the roles of the project partners, plans to facilitate communication, and transfer of materials and data.
- Applications must include a quantitative baseline of the proposed technology/technologies. This quantitative baseline must include relevant technical metrics such as product yield, time-on-stream, waste conversion efficiency, energy efficiency, and product purity.
- Applications must include a TEA (at the envisioned commercial scale) that includes, at a minimum:
  - Total capital costs of the proposed process.
  - Annual operating costs of the proposed process.
  - Minimum fuel selling price and/or cost-of-goods produced of the proposed process.
- Applications must propose work on educational and outreach activities related to these waste streams (see Topic Area 6 Education and Outreach Objectives section above).
- Applications must utilize real waste feedstocks, not model materials, throughout the proposed project. This Topic Area focuses on solutions to the problems of handling existing urban/suburban waste streams. Therefore, the utilization of actual waste feedstocks is paramount. Model compounds are allowable for proof-of-concept R&D but real wastes must be used for all milestone completion and Go/No-Go decision points.
- Applications must propose to have developed and implemented a minimum of three (3) unique educational or extension programs on urban and suburban wastes relevant to the R&D being proposed in the application by the end of the project. As applicable, the application should attempt to quantify a minimum number of participants involved in the particular program (e.g., 10 internship positions will be created/funded). Examples of possibilities to fulfill this requirement are described above in the "Educational and Outreach Objectives" section of this Topic Area.

1. Subtopic 6a: Biopower from Organic Wastes

Urban and suburban waste streams (as defined in Appendix C) constitute a large fraction of municipal solid waste and represent an opportunity feedstock for conversion to biopower. In many municipalities, these waste streams are commingled (i.e., food waste is in the same stream as yard waste), which presents challenges to converting them. This Subtopic specifically seeks to overcome the conversion challenges associated with handling

mixed waste streams. As an output, this Subtopic is seeking novel and innovative conversion technologies for the production of biopower and/or intermediates that could be used in biopower applications.

Subtopic 6a Specific Areas of Interest:

- Technologies that can produce intermediates that can be used for the production of biopower in distributed applications (including but not limited to renewable diesel fuel for remote, backup, or portable generators for disaster recovery, or renewable natural gas suitable for the subsequent generation of electricity). Applications do not need to include the actual conversion of intermediates to electricity, as these technologies are fully commercialized. However, they do need to demonstrate full readiness for utilization in such applications, including all necessary cleanup steps to meet relevant requirements.
- Processes that convert mixed or aggregated urban and suburban waste feedstocks to biopower. Note that because dairies and concentrated animal feeding operations (CAFOs) can be located in suburban areas, wastes from such facilities are considered acceptable feedstocks regardless of source location. Any combination of thermochemical, biochemical, and electrochemical processes could be eligible, as long as it meets appropriate techno-economic criteria.

Subtopic 6a Specific Requirements:

- The applicant must propose to use urban and suburban wastes feedstocks as defined in Appendix C.

Subtopic 6a Metrics:

- Levelized Cost of Energy Production (LCOE) – Applications to this Subtopic must develop technologies that reduce the net LCOE by at least 25% and provide a justified benchmark for the state-of-the-art. Applicants should note that net LCOE includes potential reductions in ultimate disposal costs.
- Although applications are not required to include scope on developing and/or testing the technologies needed to convert intermediates into electricity in the application, as these are well commercialized, they must include the entire process in the TEA and LCA analyses.

2. Subtopic 6b: Waste Plastics to Products

Plastic waste constitutes a significant opportunity feedstock towards realizing a robust domestic bioeconomy. In the United States, approximately 8 quadrillion BTU of energy is used to manufacture plastics, resins, and synthetic rubber and plastics use is expected to grow at greater than 3% per year. At the end of life, however, recycling rates are very low, with the majority of this plastic waste being sent to landfills or to material recovery facilities where it is not economical to be recycled. In the waste recovery hierarchy, disposal in the landfill represents the least desirable outcome.

This Subtopic seeks to develop novel technologies to deconstruct and convert plastic waste into products, thereby keeping these resources higher in the waste recovery hierarchy. These benefits include reduction of plastic waste ending up in landfills and the environment and reductions in energy use in the future into the manufacture of new plastics from virgin materials, amongst others. Applicants to Subtopic 6b must propose technologies for deconstruction of plastic waste and subsequent conversion to products, or propose direct conversion strategies. It is acceptable for the end product to be comprised of the same material as the original waste stream, reconstituted into a new physical form, and other products are also acceptable. For example, plastic bottles made of polyethylene terephalate (PET) could be converted back into new PET structures, polyethylene films with a terephalic acid byproduct, or many other options. The aim is for waste plastics to be transformed into materials that would otherwise have been made from virgin fossil resources. Conversion of plastic waste to any form of energy is not allowable for this Subtopic.

Subtopic 6b Specific Areas of Interest:

- Processes for the conversion of plastic waste streams derived from urban and suburban waste streams to products with the potential to supplant additional fossil feedstocks in plastic production processes.
- Potential solutions with the capacity to convert mixed plastics streams into useful products, including exogenous contaminants, are particularly encouraged.

Subtopic 6b Specific Requirements:

- The applicant must propose to use waste plastics/polymers as a feedstock.
- Applications must include full product life cycles within the model boundary of their TEA and LCA analyses, including any prior separation processes assumed in the delivery of plastic feedstocks to their process boundaries.
- Applications must include a full conversion pathway from waste plastics to a final product or product precursor. Applications that only address deconstruction of waste plastics/polymers will not be considered for further review.

Subtopic 6b Metrics:

Metric	Unit	Minimum	Stretch Target
Chemically recyclable, as measured by % recovered monomers or intermediate chemicals	% recovered monomers or intermediate chemicals	10%	30%
Increased rate of degradation over state of technology	Mass/time	20% improvement	100% improvement
Ability to degrade mixed plastic streams simultaneously	Mass of each plastic stream	50% remaining	20% remaining

or sequentially (for applications proposing mixed plastic waste)	at the end of 7 days		

Topic Area 6 Applications Specifically Not of Interest:

- Those identified in Section I.C. of the FOA.
- Applications that do not use an acceptable feedstock as defined in Appendix C.
- Applications that propose any of the following end products:
  - Hydrogen (except as a component of syngas), 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 products with an emphasis on waste plastics as a feedstock (for Subtopic 6b), or biopower (including appropriate intermediates) (for Subtopic 6a) by project completion.
- Applications submitted by any entity other than a U.S. university.
- Applications that do not contain at least one other U.S. university partner.
- Applications that do not propose collaboration with at least one university in both Canada and Mexico.
- Applications that do not propose an educational and outreach component.
- Applications that propose to convert waste plastic to any form of energy.

Topic Area 6 Special Deliverables:

In addition to the deliverables required in the Federal Assistance Reporting Checklist, the following deliverables are required for awards made under Topic Area 6a and 6b:

- Applications submitted under this Topic Area are required to participate in a verification as described in Section I.D.

vii. Topic Area 7: Scalable CO_2 Electrocatalysis

For every molecule of ethanol produced via fermentation, an equivalent of carbon dioxide (CO_2) is also evolved, generating one of the most concentrated industrial sources of CO_2. In the U.S., this totals 45 million tons per year of high purity biogenic CO_2 from over 200 point sources across the country, and the use of this CO_2 as a feedstock has received notable attention as an opportunity to leverage renewable electricity for the production of fuels and products. Though this represents a large supply of potential feedstock, the major barrier to its utilization is the low energy content of CO_2.

The challenge associated with making fuels and products from CO_2 lies in the high energy requirement for CO_2 reduction. Often, this is done a) biologically via photosynthesis, or b) though catalytic routes that often require high temperature, high pressure, and massive scales to be technically and economically feasible. An attractive alternative route to CO_2 reduction lies in electrocatalysis, which can be done at low pressure, lower temperature, and be modular in scale, using electricity to power the chemical reduction of CO_2 and

making it an appealing route for a first step in CO_2 conversion to intermediates such as formic acid, methanol, and carbon monoxide. Such single-carbon (C1) compounds can act as platform molecules for further upgrading technologies, such as biological conversion.

While CO_2 electrocatalysis has seen exciting results in recent years, there are still knowledge and capability gaps around operating such technologies for commercial relevance. Research has consistently shown that current density, faradaic efficiency, and cell overpotential are the main metrics that need to advance. To move the field toward commercially-relevant capabilities, this Topic Area will provide funding for applications that develop lower temperature and pressure CO_2 electrocatalysis units for generating reduced C1 or C2 building blocks at relevant conversion rates and concentrations. Applicants must clearly describe their proposed CO_2 electrocatalytic conversion state-of-technology as well as their end-of-project target(s). The scalability and robustness of any proposed system will be evaluated, as well as the techno-economic and lifecycle assessment implications of the technology.

BETO supports R&D efforts to address critical challenges and barriers for biofuel production. To assist with that goal, *applications will specifically be evaluated as to the likelihood that such a technology could eventually scale to provide a CO_2-derived intermediate stream to a biological system to generate a fuel or product at relevant scale.* Thus, applicants must specify both the end-of-project production rate and concentration targets for their C1 or C2 building block as well as the biocompatibility of the outlet stream.

Topic Area 7 Areas of Interest:

- Applications targeting C1 or C2 carbon intermediates generated via electrocatalysis from CO_2, which may include (but are not limited to): formic acid, methanol, carbon monoxide and methane;
- Applications that will lead to a unit that generates a C1 or C2 intermediate at high rate, concentration, and selectivity.
- Applications that develop electrocatalysis units that maximize reaction surface area, current density, Faradaic efficiency, and can operate as a single unit or stacked in multiple cells.
- Applications that will lead to the on-site testing of a CO_2 electrocatalysis unit using CO_2 from an existing commercial fermentation process by the end of the project are encouraged.
- Applications that consider the cost and the carbon lifecycle implications of operating the proposed technology.

Topic Area 7 Specific Requirements:

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

- Applications must address issues of system scalability and robustness;
- Applicants must clearly state their current capabilities and state-of-technology regarding reaction surface area, current density, and Faradaic efficiency.
- Applicants must specify the end-of-project production rate, concentration, and single-pass conversion targets for their C1 or C2 building block(s).
- CO_2 feedstock streams used for this work can be synthetically derived (i.e. not from point sources), but applications that propose to use real waste gas from a fermentation point source of CO_2 by the end of the project are encouraged.
- Applications must describe how the proposed technology would change the lifecycle assessment and techno-economic analysis of the C1 or C2 intermediate in comparison to the current commercial process with particular attention to the C, H, O balance, conversion efficiencies, and energy balance. Recipients will be required to produce a detailed TEA and LCA by the end of the project; this must include a sensitivity analysis regarding the price and carbon intensity of the electricity used from citable sources.

Topic Area 7 Applications Specifically Not of Interest:

- Those identified in Section I.C of the FOA.
- Technologies that use any *in vivo* biological or photosynthetic processes.
- Any carbon feedstock other than CO_2.
- Any process that proposes to reduce CO_2 via a route other than direct electroreduction.
- Processes that rely on high temperature (>100°C) to achieve the project goals

Topic Area 7 Metrics:

By the end of the performance period, projects should achieve the following:

- Current density: >200 mA/cm2
- Faradaic Efficiency: >90%
- Active surface area: >750 cm2 per cell
- Demonstrated lifetime: >1000 hours

C. Applications Specifically Not of Interest

In addition to the Applications Specifically Not of Interest previously described in Section I.B above for Topic Areas 1-7, the following types of applications will be deemed nonresponsive and will not be reviewed or considered (See Section III.D. of the FOA):

- Applications that fall outside the technical parameters specified in Section I.A. and I.B. of the FOA.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Applications that fail to include the required data and information specified in the Topic Area.

- Applications that do not use an acceptable feedstock for the specific Topic Area as defined in Appendix C.
- 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 C) are used to achieve project metrics and goals.

D. Verification

All applications selected for award negotiations under this FOA are required to participate in a verification process led by DOE's identified external third-party non-conflicted verification team. This team may be led by the National Renewable Energy Laboratory's Systems Integration team, DOE BETO's independent engineering contractor, or another non-conflicted BETO contractor. Personnel involved in verifications sign project specific Non-Disclosure Agreements and conflict of interest statements. This verification process provides technical assistance to both the DOE BETO and the project by providing an in-depth analysis of key technical and economic metrics to ensure transparency and increase the likelihood of project success.

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 so that the milestones and Go/No-Go decision points separating budget periods may be tracked and evaluated.
- Update or provide data in the Technical datasheets and/or Block Flow Diagrams (see Appendix D).
- Establish benchmark, baseline, and associated target values.
- Identify potential major showstoppers and discuss risk mitigation strategies.
- Align project goals with BETO's expectations.

There are three types of verification periods throughout the lifetime of the project: the "Initial Verification," conducted at the beginning of the project (months 0-3); the "Intermediate Verification(s)," conducted as a part of Go/No Go decisions separating budget periods; 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 initially verify the data included in the application or Technical Table and/or Block Flow Diagram attached to this FOA and subsequently in conjunction with site visits to monitor progress.

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 project baseline against which future performance and cost improvements will be evaluated. During the initial verification, the verification team will work closely with the project team to discuss the project effort in detail; initiate the review of application 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 verification 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 project baseline will be set in this period, either through revision of the application data or by submission of additional/new data. The verification results are used by DOE in its sole discretion, among other factors, in making the Go/No-Go decision to proceed with Budget Period 2 (BP2). See Section II.A.ii. for information on period of performance and Go/No-Go decisions.
- An intermediate verification will be conducted toward the end of BP2. The intermediate verification assesses progress towards the project's BP2 Go/No-Go decision point and any targets established in the application, the initial verification, the achievement of the Statement of Project Objectives (SOPO) milestones in support of the Go/No-Go decision point, and any other factors contributing to progress toward the project objectives. The verification results are used by DOE in its sole discretion, among other factors, in making the Go/No-Go decision to proceed with BP3. In projects with more than 3 budget periods, additional interim verifications may be conducted.
- The final verification will be held prior to the end of the project. 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 Datasheets and Block Flow Diagrams:

The Technical Tables and Block Flow Diagram included with the FOA (Appendix D), 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 Topic Area 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 project (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 Renewable Energy 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 Diagram 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 verify and/or replicate benchmark/baseline data provided in the application and Technical datasheet or Block Flow diagram. 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 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 (i.e., BP1), 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 – is 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 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 § 932, as codified at 42 U.S.C § 16232, which states in part:

§ 16232. Bioenergy program
… (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.

…

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 a total of approximately $97 million of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 27-49 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $1 and $10 million, depending on the Topic Area as listed in **Table II-1**.

EERE may issue awards in one, multiple, or none of the following Topic Areas listed in **Table II-1**:

Table II-1. Estimated Funding Per Topic Area

#	Topic Area Name	# of Awards *estimated*	Federal $ per award *minimum – maximum*	Total Federal Funding *estimated*
1	Scale Up of Bench Applications (SCUBA)	6-9	$3-4 million	$28 million
2	Waste to Energy Strategies for the Bioeconomy: 2a: Municipal Solid Waste (MSW) 2b: Optimizing Community Scale Wet Organic Wastes 2c: Synergistic Wastewater Integration with Microalgae (SWIM)	7-15	2a: $1-2.5 million 2b: $1-2.5 million 2c: $1-2 million	$18.5 million
3	Algae Bioproducts and CO_2 Direct-Air-Capture Efficiency (ABCDE)	5-8	$1-2 million	$14 million
4	Bio-Restore: Biomass to Restore Natural Resources	2-4	$2-4 million	$8 million
5	Efficient Wood Heaters	2-5	$1-2.5 million	$5 million

6	Biopower and Products from Urban and Suburban Wastes: North American Multi-University Partnership for Research and Education 6a: Biopower from Organic Wastes 6b: Waste Plastics to Products	6a: 1 6b: 1	6a: $5 million 6b: $10 million	$15 million
7	Scalable CO_2 Electrocatalysis	4-6	$1.5-2.5 million	$8 million

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.

ii. Period of Performance

EERE anticipates making awards that will run up to 24 – 60 months in length, comprised of one or more budget periods (see Table II-2 below for the Period of Performance per Topic Area). Project continuation will be contingent upon several elements, including satisfactory performance and Go/No-Go decision review. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule adherence, the extent milestone objectives are met, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, EERE 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.

Table II-2. Period of Performance per Topic Area

#	Topic Area Name	Anticipated Period of Performance
1	Scale Up of Bench Applications (SCUBA)	36-60 months
2	Waste to Energy Strategies for the Bioeconomy	24-36 months
3	Algae Bioproducts and CO_2 Direct-Air-Capture Efficiency (ABCDE)	24-36 months
4	Bio-Restore: Biomass to Restore Natural Resources	36-60 months
5	Efficient Wood Heaters	24-36 months
6	Biopower and Products from Urban and Suburban Wastes: North American Multi-University Partnership for Research and Education	36-60 months
7	Scalable CO_2 Electrocatalysis	24-36 months

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

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.

NOTE: The eligibility requirements for Topic Area 6, "Biopower and Products from Urban and Suburban Wastes" are different from those of Topic Areas 1-5 and 7, which are subject to the eligibility criteria set forth below. Eligible applicants under Topic Area 6 are limited to U.S. Institutions of Higher Education (as defined in 20 U.S.C. § 1001, and in accordance with 2 C.F.R. §200.55). Individuals, domestic entities, foreign entities, DOE

FFRDCs, and non-DOE FFRDCs are eligible to participate as Subrecipients under Topic Area 6, subject to the restriction that greater than 50% of the budget must be based at the U.S. Institutions of Higher Education.

A. Eligible Applicants

i. Individuals

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

DOE/NNSA FFRDCs and Non-DOE/NNSA FFRDCs are eligible to participate as a subrecipient, but are not eligible to apply as a prime recipient in Topic Areas 1-7. 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 Topic Areas 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 B 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. Note: if any work is proposed to be conducted outside the U.S., the applicant must complete a request for waiver of the Performance of Work in the United States requirement. See Appendix B for waiver request information. The waiver must then be approved by DOE before work may be conducted outside the U.S.

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 for all Topic Areas 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.)
To assist applicants in calculating proper cost share amounts, EERE has included a cost share information sheet and sample cost share calculation as Appendix A to this FOA.

vi. 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.

vii. 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.

viii. Cost Share Types and Allowability

Every cost share contribution must be allowable under the applicable federal cost principles, as described in Section IV.I.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 cost sharing requirements.

ix. 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.

x. 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.

xi. 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 by the applicable deadline 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.B. 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.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 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.D. 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 the given Topic Area section "Applications Specifically Not of Interest" as well as 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 50% 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

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.

A. 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

B. 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 Topic Area 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 page 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.

C. 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_Topic_TechnicalVolume
	Resumes (PDF format. 1 page maximum per person)	ControlNumber_LeadOrganization_Topic_Resumes
	Letters of Commitment, if applicable (PDF format. 1 page maximum per letter)	ControlNumber_LeadOrganization_Topic_LOCs
	Statement of Project Objectives (SOPO) (Microsoft Word format. 10 page limit)	ControlNumber_LeadOrganization_Topic_SOPO
	SF-424 Application for Federal Assistance (PDF format)	ControlNumber_LeadOrganization_Topic_App424
	Budget Justification (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Topic_Budget_Justification
	Summary for Public Release (PDF format. 1 page limit)	ControlNumber_LeadOrganization_Topic_Summary
	Summary Slide (Microsoft PowerPoint format. 1 page limit)	ControlNumber_LeadOrganization_Topic_Slide
	Subrecipient Budget Justification, if applicable (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Topic_Subrecipient_Budget_Justification
	DOE WP for FFRDC, if applicable (PDF format. See DOE O 412.1A, Attachment 3)	ControlNumber_LeadOrganization_Topic_WP
	Authorization from cognizant Contracting Officer for FFRDC, if applicable (PDF format)	ControlNumber_LeadOrganization_Topic_FFRDCAuth
	SF-LLL Disclosure of Lobbying Activities (PDF format)	ControlNumber_LeadOrganization_Topic_SF-LLL
	Foreign Entity and Foreign Work waiver requests, if applicable (PDF format)	ControlNumber_LeadOrganization_Topic_Waiver

	U.S. Manufacturing Plan (PDF format)	ControlNumber_LeadOrganization_Topic_ USMP
	TOPIC AREA 2c & 3 ONLY: Technical Data Sheet Techdatasheet.xls (see Appendix D, Microsoft Excel format)	ControlNumber_LeadOrganization_Topic_ Techdatasheet
	TOPICA AREA 1 ONLY: Block Flow Diagram (see Appendix D, PDF Format)	ControlNumber_LeadOrganization_Topic_B FD
	TOPIC AREA 6 ONLY: Letters of collaboration with universities from Canada and Mexico	ControlNumber_LeadOrganization_Topic_ NA-Partnership

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_Topic_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, charts, graphs, maps, photos, or other graphics, and must include all of the information in the table below (applicants to Topic Area 6 may submit a Technical Volume of no more than 40 pages). Citations and references may be included as an appendix that does not count against the Technical Volume page limit. 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 must include the specific FOA Topic Area being addressed and should include the project title, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality. The cover page may include the table of contents.
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. • Responsiveness to FOA and specific topic requirements: The applicant should describe how the application meets all the FOA and the specific Topic Area Requirements, and is responsive to the Topic Area objectives and areas of interest.
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 specified in the FOA and given Topic Area. 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(s) of the proposed technology (ies), the advantages of proposed technology (ies) 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 Specific, Measurable, Achievable, Relevant, and Timely, 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, at a minimum, 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. See Section VI.B.xiv. The applicant should also provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. 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). At a minimum, 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: o The overall approach to and organization for managing the work o The roles of each project team member o Any critical handoffs/interdependencies among project team members o The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices o The approach to project risk management o A description of how project changes will be handled o If applicable, the approach to Quality Assurance/Control o 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. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. • 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 ○ Communication plans

iii. Resumes

Applicants are required to submit one-page resumes for key participating team members. Multi-page resumes are not allowed. Save the resumes in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Topic_Resumes".

iv. Letters of Commitment

Submit letters of commitment from all subrecipient and third party cost share providers. If applicable, also include any letters of commitment from partners/end users (1 page

maximum per letter). Save the letters of commitment in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Topic_LOCs".

v. 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, including the Milestone Table, should not exceed 10 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. Save the SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_Topic_SOPO".

vi. 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".

vii. 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_Topic_Budget_Justification".

viii. 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_Topic_Summary".

ix. 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_Topic_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.

x. 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_Topic_Subrecipient_Budget_Justification".

xi. 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_Topic_WP".

xii. 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_Topic_FFRDCAuth".

xiii. 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_Topic_SF-LLL".

xiv. Waiver Requests: Foreign Entities and Foreign Work (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 B lists the necessary information that must be included in a request to waive this requirement.

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

As set forth in Section IV.I.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 B lists the necessary information that must be included in a foreign work waiver request.

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

xv. 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_Topic_USMP".

xvi. Data Management Plan (DMP)

Applicants 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 DPMs 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 DMPs.

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 five (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_Topic_DMP".

D. Content and Form of Replies to Reviewer Comments

EERE will provide applicants with reviewer comments following the 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 the 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 (3) 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.

E. 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.

F. 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; (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.

G. 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.

H. Intergovernmental Review

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

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

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 pre-award costs incurred prior to receiving written authorization from the Contracting Officer. If the applicant elects to undertake activities that DOE determines 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 for their project 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. 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.

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

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 whether 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 foreign work waiver, the applicant must submit a written waiver request to EERE. Appendix B lists the necessary information that must be included in a request for a foreign work waiver.

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. For-profit entity disposition requirements are set forth at 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 200.310 – 200.316.

vii. Domestic Preference – Infrastructure Projects

As appropriate and to the extent consistent with law, Applicants shall ensure that, to the greatest extent practicable, iron and aluminum as well as steel, cement, and other manufactured products (items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber) used in the proposed project shall be produced in the United States. This requirement shall flow down to all sub-awards including all contracts, subcontracts and purchase orders for work performed under the proposed project.

viii. 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.

ix. 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.

x. 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 sub-criteria:

- 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 sub-criteria:

Technical Merit and Innovation

- 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;
- 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; and
- Degree to which the application is responsive to the objectives and specific requirements listed in the given Topic Area description.

Impact of Technology Advancement

- How the project supports the Topic Area objectives, 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:

Research Approach, Workplan and SOPO

- 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

- 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

- 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, U.S. manufacturing plan, and product distribution.

Criterion 3: Team and Resources (20%)

This criterion involves consideration of the following factors:

- 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 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
- Whether the proposed project with occur in a Qualified Opportunity Zone or otherwise advance the goals of Qualified Opportunity Zones.[17] The goals include spurring economic development and job creation in distressed communities throughout the United States.

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.

[17] Opportunity zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

ii. 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.

iii. 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.

iv. 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.I.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.I.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 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 Under DOE Order 142.3A, "Unclassified Foreign Visits and Assignments Program"

All applicants selected for an award under this FOA may be required to provide information to DOE in order to satisfy requirements for foreign nationals' access to DOE sites, information, technologies, equipment, programs or personnel. A foreign national is defined as any person who is not a U.S. citizen by birth or naturalization. If a selected applicant (including any of its subrecipients, contractors or vendors) anticipates involving foreign nationals in the performance of its award, the selected applicant may be required to provide DOE with specific information about each foreign national to ensure compliance with the requirements for access approval. National laboratory personnel already cleared for site access may be excluded. Access approval for foreign nationals from countries identified on the U.S. Department of State's list of State Sponsors of Terrorism must receive final approval authority from the Secretary of Energy or the Secretary's assignee before they commence any work under the award.

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 U.S.C. 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 https://www.energy.gov/nepa.

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 recipient may be required to prepare the records and 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 consortia, an IP Management Plan may be required after selection and during negotiation per the discretion of the Contracting Officer. If required

during negotiation, it will be due within 30 days of selection. If required after initial award and during the project verification period, it will be due 30 days after award.

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 ten (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.

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.

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: FY20BETOMultiTopicFOA@ee.doe.gov. Questions must be submitted not later than three (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 three (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

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. Applicants are advised to not include any critically sensitive proprietary detail

If an application includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, EERE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for merit review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

The cover sheet of the Concept Paper, Full Application, Reply to Reviewer Comments, or other submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

> **Notice of Restriction on Disclosure and Use of Data:**
> Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that 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 confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure."

In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

E. Evaluation and Administration by Non-Federal Personnel

In conducting the merit review evaluation, the Go/No-Go Reviews and Peer Reviews, 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. 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.

I. 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.

J. 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);

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.

K. 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.

L. 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.

M. 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.

N. Export Control

The U.S. government regulates the transfer of information, commodities, technology, and software considered to be strategically important to the U.S. to protect national security, foreign policy, and economic interests without imposing undue regulatory burdens on legitimate international trade. There is a network of federal agencies and regulations that govern exports that are collectively referred to as "Export Controls". To ensure compliance with Export Controls, it is the prime recipient's responsibility to determine when its project activities trigger Export Controls and to ensure compliance.

Export Controls may apply to individual projects, depending on the nature of the tasks. When Export Controls apply, the recipient must take the appropriate steps to

obtain any required governmental licenses, monitor and control access to restricted information, and safeguard all controlled materials. Under no circumstances may foreign entities (organizations, companies or persons) receive access to export controlled information unless proper export procedures have been satisfied and such access is authorized pursuant to law or regulation.

Applicants are advised that some of the results of the research conducted under this FOA are expected to be restricted for proprietary reasons and not published or shared broadly within the scientific community.

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 subrecipient(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.

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.

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 – 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 and the extent, if any, the entity is state owned or controlled;
- 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.I.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 C – ACCEPTABLE FEEDSTOCKS

The Bioenergy Technologies Office works with biomass-based feedstocks, per the authorizing language in EPAct 2005 (see below). Each Topic Area and Subtopic has specific feedstock requirements and those are summarized here for reference.

Topic Area	Biomass (general definition)	Specific subsets of Biomass for purpose of FOA						Other Feedstocks	
		Energy Crops	Algae	Wood	Non-recyclable MSW	Wet Waste	Urban and Suburban Waste	Waste Carbon Dioxide	Waste Plastics
1: SCUBA	Yes	Yes						No	No
2: Waste to Energy	No	No	2a. No 2b. No 2c. Yes	No	2a. Yes 2b. Yes 2c. No	2a. Yes 2b. Yes 2c. Yes	No	2a. No 2b. No 2c. Yes	2a. No 2b. No 2c. No
3: ABCDE	No	No	Yes	No	No	No	No	No	No
4: Bio-Restore (*see further details below)	No	Yes	No	No	No	No	No	No	No
5: Wood Heaters	No	No	No	Yes	No	No	No	No	No
6: U/S Wastes	No	No	No	No	6a: Yes 6b: No	6a: Yes 6b: No	6a: Yes 6b: No	No	6a: No 6b: Yes
7: CO_2E	No	No						Yes	No

***Topic Area 4:**

- Eligible biomass types include energy crops (see definition below) or biomass that, when produced/harvested, provides environmental benefits (other than excluded biomass types below).
- Biomass types **not** eligible for this Topic Area 4:
  - Agricultural and forestry residues (e.g., corn stover, wheat straw, rice straw, sugarcane bagasse, guayule bagasse, forest thinnings, etc.), algae, animal wastes, urban wastes, industrial wastes, and municipal solid wastes (MSW) are not acceptable biomass for purposes of this Topic Area 4.
  - **No plant based material that is generally intended for use as food or animal feed may be employed as a feedstock,** including but not limited to corn grain, sugarcane, sweet sorghum, sugar beets, and oil crops.
  - Projects may not cultivate any crop species that is recognized by the governing state or federal agency as invasive or noxious, or species or varieties of plants that are determined potentially invasive by peer-reviewed or published risk assessment tools or other credible sources.

"**Biomass"** is defined generally in the authorizing language of EPAct 2005, §932 (reproduced below). More specifically for the purposes of this FOA, biomass includes agricultural residues, forest resources, perennial grasses, woody energy crops, algae, wet waste (e.g., biosolids), sorted municipal solid waste, urban wood waste, food waste, and biogas.

"Energy Crops" are defined as fast-growing, highly productive cellulosic crops that are cultivated to produce biofuels, bioproducts, and biopower from all or part of the lignocellulosic portions of the plant. Energy crops are primarily perennial species, including herbaceous grasses (e.g., switchgrass, energycane, miscanthus, mixed grasses) and short rotation woody crops (e.g., willows, hybrid poplars). However, non-food sorghum varieties, which are grown as annual crops, are also considered to be acceptable energy crops for purposes of this FOA.

"Algae" for the purpose of this FOA, is defined as eukaryotic microalgae, macroalgae (seaweed), and cyanobacteria.

"**Wood"** for the purpose of this FOA, is defined as wood chips, cord wood, or wood pellets. Unacceptable feedstocks include 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.

"Non-recyclable MSW" for the purposes of this FOA, is defined as the organic and plastic constituents of the MSW stream going to the landfill (typically known as municipal garbage). See chapter 2 in the Resource Conservation and Recovery Act Orientation Manual 2014 - https://www.epa.gov/sites/production/files/2015-07/documents/rom.pdf

"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.

"Urban/Suburban Waste" for the purpose of this FOA, includes non-recycled paper, industrial, commercial, and residential food wastes, municipal sludges and biosolids, manure and manure slurries, and other components of municipal solid waste streams whose ultimate fate is generally a landfill. This may include Non-recyclable MSW and wet waste, as defined above. Biogas is also a type of Urban/Suburban Waste for the purposes of this FOA. Waste plastics are an acceptable feedstock for Subtopic 6b only.

"Waste Carbon Dioxide" 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. For Topic Area 2, CO_2 must be captured from the air, i.e., direct air capture (DAC).

"Waste 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 and that is sourced from a plastic stream provided through a partnership with a waste management or other industry partner.

EPAct 2005, §932, codified at 42 U.S.C. § 16232. 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 D – TECHNICAL DATASHEETS, BLOCK FLOW DIAGRAMS, AND BASELINE TECHNOLOGY AND PERFORMANCE DATA

Refer to Topic Area Requirements to determine whether (1) a technical datasheet is required at the time of application submission or (2) if the technical datasheet will be developed upon selection for award negotiation during the initial verification.

Topic Area 1 SCUBA: A block flow diagram is required with the application. Please See **Block Flow Diagram Instructions in section ii.** below.

Topic Area 2 Waste to Energy: A technical datasheet is required after selection for Subtopics 2a and 2b, and with the application for Subtopic 2c. Please see **Technical Datasheet Instructions in section i.** below.

Topic Area 3 ABCDE: A technical datasheet is required with the application. Please see **Technical Datasheet Instructions in section i.** below.

Topic Area 4 Bio-Restore: A technical datasheet is required with the application. Please see **Technical Datasheet Instructions in section i.** below.

Topic Area 5 Wood Heaters: Please see the **Baseline Technology and Performance Data in Section iii.** below. The data described in that section is required within the narrative of the application.

Topic Area 6 Urban and Suburban Wastes: The requested data is required within the narrative of the application.

Topic Area 7: A technical datasheet is required after selection.

i. Technical Datasheets Instructions:

For Topic Areas 2c, 3, and 4 please refer to the Excel spreadsheet available for download from EERE Exchange for instructions per Topic Area. For other topics, the format of the datasheet will be discussed after selection.

ii. Block Flow Diagram Instructions and Overview:

Topic Area 1 will utilize a Block Flow Diagram and Supplemental Data template (BFD & SD). The purpose of the BFD & SD 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 refer to the PDF titled, "BFD & SD Template" available for download from EERE Exchange for the Block Flow Diagram and Supplemental Data instructions, overview, and recommended templates. Use of the template is not required, however equivalent data must be submitted with Topic Area 1 applications.

iii. Baseline Technology and Performance Data Instructions:

Applicants to Topic Area 5 are required to provide the baseline wood heater or wood heater technology performance data indicated in the following table **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.C.ii.)

Baseline Wood Heater Technology and Performance

Residential Wood Heater Type	Room, central hydronic, or forced air
Catalyst	Catalytic or Non-Catalytic
Power Generation (if applicable)	Thermoelectric device description and output
Integrated Sensors	Type and Location
Other Technology	Brief description of wood heater technology for emissions reduction or efficiency improvement
Wood used for testing	Species, moisture content, type (e.g., crib, cord, pellet)
Applicable test methods	For example 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/hr
Average Stack Gas CO	%
Average Stack Gas CO_2	%

APPENDIX E – 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 F – 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 G – LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
BETO	Bioenergy Technologies Office
BFD	Block Flow Diagram
CJF	Conventional Jet Fuel
CO	Carbon Monoxide
COI	Conflict of Interest
CRADA	Cooperative Research and Development Agreement
DAC	Direct Air Capture
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
EPAct	Energy Policy Act
FAR	Federal Acquisition Regulation
FFATA	Federal Funding and Transparency Act of 2006
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
FFRDC	Federally Funded Research and Development Center
GAAP	Generally Accepted Accounting Principles
GGE	Gallon of Gasoline Equivalent
GHG	Greenhouse Gas
IPMP	Intellectual Property Management Plan
LCA	Life Cycle Assessment
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
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
VOC	Volatile Organic Compound
WBS	Work Breakdown Structure
WP	Work Proposal