U.S. Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE)

FY24 Energy and Emissions Intensive Industries FOA
Funding Opportunity Announcement (FOA) Number: DE-FOA-0003219
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FOA Issue Date:	January 25, 2024
Submission Deadline for Concept Papers:	March 19, 2024 5:00 p.m. ET
Submission Deadline for Full Applications:	July 2, 2024 5:00 p.m. ET
Expected Submission Deadline for Replies to Reviewer Comments:	August 13, 2024 5:00 p.m. ET
Expected Date for EERE Selection Notifications:	November/December 2024
Expected Timeframe for Award Negotiations:	Winter 2024 - Spring2025

- Applicants must submit a Concept Paper by 5:00 p.m. ET on 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.

- **Unique Entity Identifier (UEI) and System for Award Management (SAM) -** Each applicant (unless the applicant is excepted from those requirements under 2 CFR 25.110) is required to: (1) register in the SAM at **https://www.sam.gov** before submitting an application; (2) provide a valid UEI number in the application; and (3) maintain an active SAM registration with current information when the applicant 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 UEI 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, 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.

NOTE: Due to the high number of UEI requests and SAM registrations, entity legal business name and address validations are taking longer than expected to process. Entities should start the UEI and SAM registration process as soon as possible. If entities have technical difficulties with the UEI validation or SAM registration process they should use the HELP feature on SAM.gov. SAM.gov will address service tickets in the order in which they are received and asks that entities not create multiple service tickets for the same request or technical issue. Additional entity validation resources can be found here: GSAFSD Tier 0 Knowledge Base - Validating your Entity.

Modifications

All modifications to the FOA are HIGHLIGHTED in the body of the FOA.

Mod. No.	Date	Description of Modification
0001	5/16/2024	Updated schedule with revised dates, see table above on the cover page.
0002	6/14/2024	1) Added State Point Data table application requirement to Topic Area 6, Areas of Interest 2 & 3. Please see FOA sections I.B, IV.D.i, and Appendix G. 2) Removed Locations of Work application requirement

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I. Funding Opportunity Description

A. Background and Context

i. Background and Purpose

This Funding Opportunity Announcement (FOA) is issued by the Industrial Efficiency and Decarbonization Office (IEDO). IEDO provides funding, management, and the strategic direction necessary for a balanced national program of research, development, and demonstration (RD&D), as well as technical assistance and workforce development, to drive improvements in energy, materials, and production efficiency and to accelerate decarbonization across the industrial sector. IEDO and its programs are critical to putting the nation on a pathway to achieve net-zero carbon emissions by 2050.[1]

The industrial sector is considered one of the most difficult to decarbonize because of the diversity and complexity of energy inputs, processes, and operations.[2] Achieving net-zero emissions across the U.S. economy by 2050 will require an aggressive, multidimensional approach to eliminate industrial emissions. This FOA will advance the Biden Administration's goals to "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050"[3] to the benefit of all Americans.

To attain these goals, IEDO's RD&D strategy focuses on two complementary approaches: tackling subsector-specific decarbonization challenges through the energy- and emissions-intensive industries and pursuing cross-sector challenges that are common across many industries. This FOA focuses on subsector-specific decarbonization approaches for the highest emitting and most challenging to address industrial subsectors.

The Energy- and Emissions- Intensive Industries (EEII) program within IEDO focuses on improving efficiency and decarbonizing industries with the largest energy use and GHG emissions (i.e., chemicals and refining, iron and steel, cement and concrete, forest and paper products, food and beverage, and other industries such as glass and aluminum). Together, these industries account for over 65% of the U.S. and global industrial manufacturing emissions, and products from these industries are inputs to other subsectors. Therefore, decarbonizing

[1] Section 6003 of the Energy Act of 2020, as codified at 42 U.S.C. § 17113 et seq.
[2] National Academies of Sciences, Engineering, and Medicine, *Accelerating Decarbonization in the United States Energy Sector*, February 2021, https://www.nap.edu/catalog/25932/accelerating-decarbonization-of-the-us-energy-system.
[3] Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021.

these industries will have both significant immediate impacts on manufacturing overall and far-reaching impacts on supply chains in many areas of the economy.

IEDO is committed to pushing the frontiers of science and engineering; catalyzing clean energy jobs through research, development, demonstration, and deployment (RDD&D); and ensuring environmental justice and inclusion of underserved communities. In addition to consuming significant amounts of energy, resulting in greenhouse gas (GHG) emissions, many processes used in industrial facilities produce air pollutants with harmful impacts on respiratory and cardiovascular health, including nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter (PM). In the United States, disadvantaged communities are disproportionately exposed to these types of emissions, resulting in social, economic, and health burdens beyond those of the general population. Addressing pollution from industrial energy use to remediate these burdens is an integral step toward achieving environmental justice.[4]

To accelerate the development of these emerging industrial decarbonization technologies, DOE created the Technologies for Industrial Emissions Reduction Development (TIEReD) Program. This program leverages resources across DOE applied research offices to invest in fundamental science, research, development, initial pilot-scale demonstrations projects, and technical assistance and workforce development. Rooted in the principles identified in the 2022 Industrial Decarbonization Roadmap, DOE is building an innovation pipeline to accelerate the development and adoption of industrial decarbonization technologies.[5] The TIEReD Program leverages resources, expertise, and investments from the Offices of Energy Efficiency and Renewable Energy (EERE), Fossil Energy and Carbon Management (FECM), Nuclear Energy (NE), Advanced Research Projects Agency–Energy (ARPA-E), and Science (SC) to achieve deep decarbonization across the U.S. industrial sector. The program complements the demonstration and large-scale deployment efforts led by the DOE Offices of Clean Energy Demonstrations (OCED) and Manufacturing and Energy Supply Chains (MESC) and the Loan Programs Office (LPO).

Additionally, to support the industrial decarbonization approaches, DOE launched several Energy Earthshots™, including two supported by this FOA: the Clean Fuels and Products Shot™ and the Industrial Heat Shot™. The Clean Fuels and Products Shot™ is an initiative to reduce emissions from the fuels and chemicals industry through alternative sources of carbon. This initiative aims to

[4] DOE Office of Economic Impact and Diversity. "How Energy Justice, Presidential Initiatives, and Executive Orders Shape Equity at DOE." January 3, 2022. https://www.energy.gov/diversity/articles/how-energy-justice-presidential-initiatives-and-executive-orders-shape-equity.

[5] DOE, Industrial Decarbonization Roadmap, 2022, https://doi.org/10.2172/1961393

lower GHG emissions at least 85% compared to fossil-based sources by 2035.[6] The Industrial Heat Shot™ is aimed at dramatically reducing the cost, energy use, and carbon emissions associated with industrial heat demand.[7] By reaching the targets of these Energy Earthshots™, the U.S. industrial sector will be on course to reduce its carbon-equivalent emissions by 650 million metric tons by 2050.

ii. Technology Space and Strategic Goals

The industrial sector presents very specific challenges spanning technology, market, economics, and supply chains. Reaching net-zero goals economically will require more than broad decarbonization tools (e.g., fuel switching, electrification, and carbon capture). Today, 60% of industrial emissions cannot be addressed with cost-effective solutions. To fully decarbonize the U.S. industrial sector in a way that is environmentally sustainable and maintains our competitive edge will require technology solutions that are not yet commercially available or economically viable.[8]

The EEII program takes an industry-specific approach to decarbonization while also leveraging knowledge and opportunities between industries. In addition, the program seeks to identify and develop emerging technologies with transformative potential for industrial decarbonization that are technically and economically advantageous. Technology development as part of this program involves powerful partnerships between industry, universities, national laboratories, and federal agencies. IEDO's vision is to support U.S. industries as leaders in competitive low-carbon manufacturing, thereby gaining a broader position of global leadership in manufacturing. To this end, the United States must advance and adopt innovative low-energy and low-emitting technologies that have cost, performance, and resource efficiency advantages over traditional manufacturing.

This FOA will focus on applied R&D and pilot demonstration for the highest GHG-emitting subsectors, specifically chemicals and fuels; iron and steel; food and beverage; cement and concrete, asphalt pavements, and glass; and forest products. Technology approaches include achieving cost and emissions savings through increased circularity and sustainability across manufacturing to reduce waste and decrease the need for resource extraction. The FOA will fund research, development, and prototype or pilot-scale technology validation and

[6] DOE, Energy Earthshots – Clean Fuels and Products Shot Fact Sheet, May 2023, https://www.energy.gov/sites/default/files/2023-05/EERE-Earthshots_CleanFuels-Products-Factsheet-508-v3.pdf.
[7] DOE, Energy Earthshots – Industrial Heat Shot Fact Sheet, September 2022, https://www.energy.gov/sites/default/files/2022-09/earth-shot-industrial-heat-fact-sheet.pdf.
[8] DOE. Pathway to Commercial Liftoff: Industrial Decarbonization, 2023, https://liftoff.energy.gov/wp-content/uploads/2023/10/LIFTOFF_DOE_Industrial-Decarbonization_v8.pdf

demonstration activities that will accelerate the development and adoption of sustainable technologies that increase efficiency and eliminate industrial GHG emissions for the most energy- and emissions- intensive industrial subsectors. These activities will contribute to a clean and equitable energy economy, bolster the technological and economic competitiveness of domestic manufacturing, and boost the viability and competitiveness of U.S. industrial technology exports.

Industrial decarbonization depends not just on the transformation of isolated industrial unit processes, but also on the development of integrated process and technology solutions that together achieve deep cuts in energy and emissions along with improved economics. Two of the most critical supporting technologies are carbon capture – to abate process emissions inherent to certain industrial products – and hydrogen – a key low-carbon fuel and chemical feedstock. To that end, IEDO is working in collaboration with the Office of Fossil Energy and Carbon Management (FECM) and the Hydrogen and Fuel Cell Technologies Office (HFTO) to accelerate adoption of technologies in hard-to-decarbonize industries. This FOA includes a joint topic soliciting pre-Front-End Engineering and Design (pre-FEED) studies for the integration of clean hydrogen and carbon capture in the industrial sector. This topic will allow industry to explore opportunities to integrate novel process technologies with carbon capture and hydrogen technologies, supporting the development of integrated, decarbonized industrial processes to enable net-zero industrial generation of products while understanding the impacts of these technologies on costs and emissions.

iii. Teaming Partner List

DOE is compiling a Teaming Partner List to facilitate the formation of project teams for this FOA. The Teaming Partner List allows organizations that may wish to participate on a project to express their interest to other applicants and to explore potential partnerships.

The Teaming Partner List will be available on EERE eXCHANGE and will be regularly updated to reflect new teaming partners who provide their organization's information.

SUBMISSION INSTRUCTIONS: View the Teaming Partner List by visiting the EERE eXCHANGE homepage and clicking on "Teaming Partners" within the left-hand navigation pane. This page allows users to view published Teaming Partner Lists. To join the Teaming Partner List, submit a request within eXCHANGE. Select the appropriate Teaming Partner List from the drop-down menu and fill in the following information: Investigator Name, Organization Name, Organization Type, Topic Area, Background and Capabilities, Website, Contact Address, Contact Email, and Contact Phone.

DISCLAIMER: By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of the above-referenced information. By facilitating the Teaming Partner List, DOE is not endorsing, sponsoring, or otherwise evaluating the qualifications of the individuals and organizations that are identifying themselves for placement on this Teaming Partner List. DOE will not pay for the provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

B. Topic Areas

IEDO intends to fund high-impact, applied research and development (R&D) and pilot-stage technology validation and demonstration activities through this funding opportunity announcement (FOA). Proposed requested funding levels and project durations should be commensurate with the work scope necessary to advance the technology to the proposed technology readiness level (TRL). See Appendix D for definitions of TRLs for this FOA. In general, efforts should primarily include work scopes between TRL 2 and TRL 7, which includes research, development, and validation of technology advancements to facilitate industrial decarbonization or pre-FEED projects to demonstrate economically and technically feasible at a site-specific location.

Awards will potentially be made using one of four project tiers. The table below indicates TRL level and period of performance for each project tier.

	Tier 0	**Tier 1**	**Tier 2**	**Pre-Feed Studies**
TRL	2 – 3	3 – 5	4 – 5 (optional) 6 – 7	6 – 7
Period of Performance	12 – 18 months	24 – 36 months	24 – 36 months	12 – 18 months

The table below indicates the project tier applicable to each topic and Area of Interest (AOI).

Topic Area	Tier 0 Area of Interest	Tier 1 Area of Interest	Tier 2 Area of Interest	Pre-Feed Studies
1. Decarbonizing Chemicals & Fuels	n/a	1, 2, 3	1, 2, 3	n/a
2. Decarbonizing Iron and Steel	1	1, 2, 3, 4	1, 2, 3, 4	n/a
3. Decarbonizing Food and Beverage Products	1, 2	3, 4, 5	3, 4, 5	n/a
4. Decarbonizing Building and Infrastructure Materials – Cement and Concrete, Asphalt, and Glass	3, 4	1, 2	1, 2	n/a
5. Decarbonizing Forest Products	1, 2	1, 2	1, 2	n/a
6. Innovative Industrial Pre-FEED Studies	n/a	n/a	n/a	1, 2, 3

Project Tier: The project tiers are defined below. Applicants should indicate the project tier they are applying for (i.e., Tier 0, Tier 1, Tier 2, or Pre-Feed) on the cover page of the Concept Paper and the Full Application.

A. **Tier 0 projects** are primarily focused on TRL 2 and TRL 3 R&D activities to validate technologies in a laboratory with the intent of seeding future projects at higher TRLs. The cost share for Tier 1 projects must be at least 20% of the total allowable costs.

B. **Tier 1 projects** are primarily focused on TRL 3 to TRL 5 R&D activities to validate technology components in a laboratory or relevant environment beyond proof-of-concept stage. The cost share for Tier 1 projects must be at least 20% of the total allowable costs.

C. **Tier 2 projects** can include TRL 4 and 5 R&D activities but must include TRL 6 and/or TRL 7 demonstration activities. Tier 2 projects must conduct system/subsystem prototype or pilot-scale technology validation in a

relevant or operational environment. The cost share for Tier 2 projects must be at least 50% of the total allowable costs.

D. **Preliminary Front-End Engineering Design (pre-FEED) projects** are focused on initial detailed design to ensure a project is economically and technically feasible at a site-specific location. The cost share for pre-FEED projects must be at least 20% of the total allowable costs.

Cost share: Total allowable costs represent the sum of the government share, including FFRDC costs if applicable, and the recipient share of allowable costs for the project. See Section III.B. and Appendix A for further discussion regarding cost-share.

Industry Partners: Tier 0 applications in all Topics are strongly encouraged to include an industry partner on the project team. Tier 1, Tier 2, and Pre-FEED applications in all topics are required to include an industry partner on the project team. The term "Industry Partner" includes non-profit and for-profit entities engaged in production, processing, or equipment manufacturing in an industry relevant to the topic area.

For all Topic Areas, letters of commitment from partner organizations—particularly in the case of existing collaborations and partners contributing cost share—are highly encouraged.

Metrics and Benchmarks: Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Applications should include energy and GHG intensity analyses, including a comparison of the current, commercially available state-of-the-art technology with the proposed advancement for both a unit level and national level if broadly implemented. These analyses should be expanded and validated as part of the proposed work via technoeconomic analysis (TEA) and lifecycle assessment (LCA). IEDO has developed resources to support assessment of the potential cost and environmental impacts of emerging technologies.[9] Applicants are not required to use these resources; however, these trainings, tools, and examples can help users understand impact drivers and quantify the impact potential of their technologies.

For all topics and subtopics, the applicant must identify key technical and market barriers to successful achievement of topic area goals. Applicants must identify key metrics and targets to address those barriers, consistent with technical and market analyses of their application space, and clearly indicate how the proposed innovations will satisfy those metrics. Applicants are expected to explicitly compare their proposed technology advancement to an existing state-of-the-art baseline, in

[9] IEDO, Life Cycle Assessment and Techno-Economic Analysis Training, https://www.energy.gov/eere/iedo/life-cycle-assessment-and-techno-economic-analysis-training.

terms of both cost and performance, with justification as to why that technology is the appropriate baseline. Successful applicants will be required to have periodic assessments of their metrics during the award to evaluate potential impacts, and applications should include project-specific experimental metrics that can be evaluated at interim and end-of-project milestones. Examples of potential metrics are provided in each topic description.

All work under EERE funding agreements must be performed in the United States. See Section IV.J.iii. and Appendix B.

Topic Area 1: Decarbonizing Chemicals & Fuels

Topic 1 Background and Opportunity: The chemicals industry is a critical element of the U.S. economy, contributing over 25% of the U.S. gross domestic product and exporting $179 billion of goods. It is responsible for converting raw materials into more than 70,000 diverse products, which are essential to several sectors of the U.S. economy, including agriculture, manufacturing, pharmaceuticals, and energy. As the industry transforms to achieve decarbonization, there is a unique opportunity to realize broader sustainability and efficiency improvements across the chemicals industry.

The manufacturing of chemicals involves energy and resource intensive processes. As a result, the chemicals industry is responsible for the greatest energy consumption and GHG emissions within the U.S. industrial sector, accounting for an estimated 8,169 trillion British thermal units (TBTU) of primary energy consumption in 2018 (including both feedstock and fuel use) and an associated 332 MMT of CO_2e GHG emissions (including both process and energy-related emissions). The scale of the industry and individual facilities present a significant opportunity for reduction of global GHG emissions and improvements in efficiency.

The breadth of the chemicals sector underscores the difficulty of decarbonizing an industry with complex value chains and deep sectoral interconnections. A sustainable and competitive U.S. chemicals industry will not be decarbonized without transformational innovation.

Reaching the nation's ambitious emissions goals requires recognition of the need to decarbonize the totality of the chemicals value chain and improve energy and material efficiency throughout. This transformation of industry provides the opportunity to simultaneously address decarbonization and establish a more efficient and sustainable chemicals industry that reduces the environmental footprint of the sector through reduction in land and water usage, hazardous emissions, and waste generation. Implementation of sustainable chemistry practices in chemicals manufacturing can positively influence communities near

manufacturing facilities by improving local air quality and reducing risk of exposure to harmful chemicals.[10]

Decarbonization of the chemicals sector must address both the emissions associated with the energy input into chemical processing, as well as the lifecycle emissions from the feedstocks needed to source the carbon atoms incorporated into much of the chemicals value chain. As emphasized by the Clean Fuels and Products Earthshot,™ a key pathway for chemicals sector decarbonization is to transform sustainable and waste carbon into fuels, materials, and products. This FOA intends to help achieve this goal through the development and scaling of process technologies to convert sustainable feedstocks, such as CO_2, recycled materials, industrial waste, forest residues, agricultural wastes, and municipal solid waste into chemical products.

Topic 1 Technology Focus: Topic 1 will focus on the development, validation, and demonstration needed to accelerate the commercial readiness of next generation technologies to produce chemicals and fuels. Technologies with potential for ambitious reductions (>50%) in greenhouse gas emissions that increase energy efficiency to produce chemicals and fuels are of interest.

This topic seeks both Tier 1 and Tier 2 applications. For Tier 1, applications should prove concepts in a relevant environment (e.g., temperature, pressure, pH use in operation) at TRL 3 – 5 at an appropriate scale to advance the technology towards commercialization – for example 1/100th of current commercial scale processes – and should achieve continuous operation by the end of the project. Applications must show potential for >50% reduction in greenhouse gas emissions and encouraged to include an energy intensity improvement compared the current state-of-the-art. Applications must discuss the potential to be cost competitive with commercially available state-of-the-art technology. During the award performance period, greenhouse gas emissions, energy intensity, and cost must be validated via LCA and TEA.

For Tier 2, applications should validate concepts in a relevant environment or operational environment at TRL 6 – 7 at an appropriate scale to advance the technology towards commercialization – for example scaling to 1/50th of current commercial scale processes for a continuous operation. Applications must show potential for >50% reduction in greenhouse gas emissions and encouraged to show potential for energy intensity reduction. Applications must establish the potential to be cost competitive with commercially available state-of-the-art technology. During

[10] DOE, *Sustainable Chemistry in RD&D to Transform the Chemicals Sector Roundtable*, 2023, energy.gov/sites/default/files/2023-12/2023-sustainable-chemistry-roundtable-report.pdf

the award performance period, greenhouse gas emissions, energy intensity, and cost must be validated via LCA and TEA.

Additionally, applications are encouraged to discuss the potential impact of their technologies as related to principles of sustainable chemistry practices within the scope of work and the Community Benefits Plan. New chemistries, manufacturing processes, and chemical products should consider environmental justice-related aspects across the full value chain and lifecycle of a product, including acute and cumulative impacts to workers, end product consumers, and neighboring communities. The benefits of connecting sustainable chemistry, decarbonization, and environmental justice should be felt in local communities in areas such as improved public health metrics, improved local air quality, environmental co-benefits, and reduced risk of exposure to harmful chemicals.

All applications must include an Industry Partner that is a non-profit or for-profit entity engaged in chemical production or a related industry.

Area of Interest 1 – Advanced Process Technologies to Convert Sustainable Feedstocks to Hydrocarbon Chemicals & Fuels: This area of interest seeks to advance scalable pathways to produce high-volume chemicals and fuels starting from non-fossil-based sources of carbon.

Applications should address the high volume, energy intensive, high greenhouse gas emitting chemicals including petrochemicals (NAICS 325110), basic organic chemicals (NAICS 325199), ethanol (NAICS 325193), and plastics materials and resins (NAICS 325211), and others. Applications must aim to address chemicals with a current U.S. production volume >0.5 MMT or justify the ability for the technology to have broader decarbonization potential within the chemicals sector.[11] Additional interests include chemicals (e.g., ethanol, methanol) that have value as a fuel or can be used as precursors for existing hard-to-electrify fuels like aviation, shipping, long-haul trucking.

Sustainable feedstocks include waste gases (CO_2, CO, CH_4), industrial waste products, biomass, recovered plastics, renewable natural gas, among others. Applications must consider heterogeneity and variability in feedstock quality through use of realistic feedstocks. Applications must justify that the proposed alternative feedstock can be scalable to meet demand of targeted chemical products.

[11]Example list of annual chemicals production values can be found in DOE, Bandwidth Study on Energy Use and Potential Energy Saving Opportunities in U.S. Chemical Manufacturing, 2015, https://www.energy.gov/sites/default/files/2015/08/f26/chemical_bandwidth_report.pdf

Area of Interest 2 – Advanced Processes for Production of Non-hydrocarbon Products: This area of interest seeks applications for innovative, low-carbon/low energy production of non-hydrocarbon chemical products including advanced technologies for production of inorganic chemicals (NAICS 325180), industrial gases (NAICS 325120), nitrogenous and phosphatic fertilizers (NAICS 325311), and others.

Area of Interest 3 – Chemicals Value Chain Decarbonization: This area of interest seeks integration of efficiency and decarbonization benefits across chemical value chains. Research under this subtopic will advance technology to reduce life-cycle greenhouse gas emissions and de-risk low-carbon fuel and product supply chains. Applications may target direct chemical replacements, low carbon processes, or alternative reaction pathways towards end products. For example (a) direct replacement pathway from biomass (or other alternative feedstocks) to functional replacements of thermoplastic products, (b) low carbon ethylene to polyethylene to thermoplastic products, (c) alternative chemical pathways like CO_2 to ethylene glycol to PET. Applications must consider emissions impact, techno-economics, scalability, and required material properties of the full chemical supply chain – from feedstock to chemical intermediates to end product.

A successful proposal is expected to address any significant barriers upstream or downstream of the proposed technology related to technical feasibility, emissions, and product quality. This AOI requires teams with industry partners at multiple stages of the chemicals supply chain that enables collaboration and information sharing.

AOIs 1, 2, 3 seek applications for innovative unit operations and/or processes that address challenges specific to the chemicals sector. Notably, process heating alone accounted for over 70 MMT CO_2e in the chemical industry in 2018. Improvements in process heating can lower emissions through more efficient heating or reduced energy requirements of next generation technologies. Chemicals-specific technologies include advanced separations, advanced reactors, and advanced catalysts which enable conversion of sustainable feedstocks and creation of low-carbon chemical value chains.

Of particular interest are advanced separations capable of replacing thermal-based evaporators and distillation processes including, but not limited to, separations driven by non-equilibrium processes; membranes; or processes that are driven by electrochemical or other novel separation technologies. Separation technologies must be robust and durable in realistic operational environments including longevity and stability in corrosive or acidic environments of chemical manufacturing processes. Applications focused on hard-to-separate chemical products (e.g., olefins/paraffins, liquid-liquid extractions) are encouraged.

Advanced reactors capable of improving reaction performance while reducing greenhouse gas emissions through thermal catalytic, non-catalytic, electrochemical, non-contact energy transfer for precision heating, non-equilibrium reactors or other novel reactor technologies are also of interest. Applications must consider the optimization or design of the reactor system including heat transfer, material flow, and catalysts when applicable. Applications must improve the conversion, selectivity, and stability of the reactor system and components compared to current state-of-the-art.

In addition, applications focused on advanced catalysts, which include experimental and computational research on dynamic catalyst science to enable next generation catalytic reactors and processes in support of AOIs 1, 2, and 3 are of interest. Applications must consider engineered catalysts, and catalyst-reactor integration.

Not of interest: Applications focused on the production of alternative feedstocks, including projects exclusively focused on the capture of carbon dioxide; production of transportation fuels without a touchpoint to the chemicals value chain (e.g., sustainable aviation fuels); exclusive focus on hydrogen generation. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Topic 1 Metrics & Targets: Targets for technology developed and demonstrated under this topic must be specified in the application. Applications must show potential for more than 50% reduction in greenhouse gas emissions and are encouraged to show potential for energy intensity reduction. Greenhouse gas and energy intensity analyses must be included with a discussion of the current, commercially available state-of-the-art technology. Applications will be evaluated based on potential to reduce greenhouse gas emissions annually within the chemicals sector at the national level if broadly implemented and must discuss emissions reduction dependent on other decarbonization levers (e.g., decarbonized electric grid). Technologies must also establish the potential to be scalable in terms of material availability, manufacturability of components, and scaling operations to reach commercial production capacity.

Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Successful applicants will be required to have a periodic assessment of their metrics during the award to evaluate potential impacts. Applications must clearly explain how the proposed technology will meet the following metrics including defining appropriate benchmarks or baselines:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce greenhouse gas Intensity (production or life cycle)	% carbon intensity change as measured by ton CO_2e/kg product	>50%	>100%	*Applicant Defined*
Energy consumption (production or life cycle)	Btu/kg product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Additional metrics and critical criteria that will lead to successfully meeting GHG emissions and energy goals above should also be identified. Substantial improvements in environmental and economic co-benefits will be consider if they exceed 50% improvement. Examples of optional applicant identified metrics include the following:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce criteria air pollutant emissions	ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Reduce water consumption	kg water consumed/kg product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Reduce hazardous by-products or solvents	% reduction from current typical process	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Reduce cost	Unit (product mass or part basis) cost vs. state of the art	Cost parity	>50%	*Applicant Defined*
Increase component lifetime	Number of cycles or time before regeneration or replacement	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Process improvements	Increased yield/per physical unit input	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 2: Decarbonizing Iron and Steel

Topic 2 Background and Opportunity: Steel is a vital material for many economic sectors. It is used for automotive and other transportation applications, homes, commercial buildings, and industrial equipment, as well as many other applications

in everyday life. The U.S. steel industry produced about 81 million tonnes of crude steel in 2022, consuming 0.8 quads of energy. The U.S. steel industry is among the best globally in terms of GHG emissions per tonne of product [12] because of the high fraction of remelted scrap in steel production compared to other nations. To achieve even deeper decarbonization in the U.S., steel manufacturers will require new strategies to decarbonize ironmaking from virgin ore, to improve the ore quality cost-effectively, and to reverse the accumulation of copper contamination in steel scrap to improve steel recycling rates. Also, there is an opportunity to minimize carbon consumption in steelmaking, the last step of refining scrap and ore-based metallics into quality steel.

Topic 2 Technology Focus: This topic seeks to advance innovative, high-impact decarbonization opportunities in the iron and steel industry. The areas of interest in this topic fall into three categories: 1) high specific emissions intensity, such as ironmaking, 2) enabling technologies, such as tramp element removal from scrap and improved ore beneficiation to make existing alternative processes more commercially attractive, and 3) iterative improvement technologies, such as low carbon steelmaking to further improve the emissions intensity of the U.S.'s existing EAF fleet.

This topic seeks to fund four key areas of interest that are critical to decarbonization in this industrial sector. Applications should identify key technical challenges to be solved to advance the technology. Applications must review similar approaches and show how the proposed work is different, innovative, and overcomes barriers not addressed in competing concepts. During the award performance period, greenhouse gas emissions, energy intensity, and cost must be validated via LCA and TEA.

Area of Interest 1—Alternative Iron Making: The most intensive source of CO_2 emissions in the iron and steel industry is the ironmaking process in the blast furnace, where iron oxide is transformed to high carbon molten iron using metallurgical coke. To decarbonize this subsector, replacing blast furnace production with a process that uses a low carbon alternative reductant is needed. Examples include hydrogen (including plasma hydrogen), electrolysis, sodium, green ammonia, or other alternative elements or compounds that are available in relevant commercial quantities without a large carbon footprint. The application must provide supporting evidence that the process is rationally scalable to a production plant that could produce a minimum of 2 million tonnes of iron per year. The supporting evidence must show that the process is CAPEX-competitive: the production plant should have a pathway to cost less than $1.5B in capital equipment

[12] Hasanbeigi and Springer, "How Clean Is the U.S. Steel Industry." https://www.bluegreenalliance.org/wp-content/uploads/2021/04/HowCleanistheU.S.SteelIndustry.pdf

in order to produce >2 Mt/year of iron (to be competitive with the hydrogen Direct Reduced Iron (hydrogen DRI) process).

Another idea circulating in decarbonization circles is to reduce blast furnace grade ore with an alternative process,[13] and remove the excessive non-ferrous oxides by slagging off in a melting furnace before transferring to a basic oxygen furnace for steel refining. This approach leverages existing steelmaking infrastructure for reduced cost and risk. A demonstration system for pre-melting blast-furnace grade DRI for basic oxygen furnace (BOF) steelmaking would be considered within scope for this area of interest. The process should feasibly be able to achieve reduced energy and emissions intensity from melting and decarburizing in a BOF, when compared to EAF melting a similar quality of DRI and directly producing steel.

For Tier 2 applications, projects must demonstrate a system capable of producing more than 200 kg iron/day. The proposed process must have successfully and verifiably demonstrated a laboratory or bench scale production capacity greater than 1 kg/day at the time of proposal submission. The process may produce either solid state iron for arc furnace steelmaking, or molten iron for BOF or arc furnace steelmaking. Processes that can accommodate a wide range of ore quality are preferred, including blast furnace grade iron ore. The proposal must provide supporting technoeconomic estimates for the cost of the 200 kg/day target system to justify the funding level requested. Tier 0 and Tier 1 applications must provide evidence of successful laboratory proof of concept results showing reduction of commercial iron ore samples (not reagent grade chemicals) and degree of metallization achieved, along with details of how much reductant was used (electrical current or chemical reductant) per kg ore in excess of the theoretical minimum, and supporting information such as reduction over time curves demonstrating the terminal metallization of the product and reduction rates achieved during earlier stage development.

Not of interest: Applications focused on hydrogen DRI solid state processes with DRI grade iron ore; DRI produced using natural gas, even if integrated with carbon capture; the use of biomass to reduce iron oxide; carbon capture systems; hydrogen production systems. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Area of Interest 2 – **Ore improvement:** Direct reduced iron requires a higher quality of iron ore than is typically used in a blast furnace because DRI is primarily used in arc furnace melting where excessive gangue (non-ferrous mineral matter within the

[13] Nicholas and Basirat, "Solving Iron Ore Quality Issues for Low-Carbon Steel," IEEFA, August 2022. Solving iron ore quality issues for low-carbon steel | IEEFAs

material) reduces productivity and can result in operational challenges. This AOI seeks to enable broader applicability of DRI by developing innovative, cost-effective processes to improve ore quality, including the use of advanced separations enabled by low-energy crushing and grinding. Currently, approximately only 3% of global seaborne iron ore supply is of DR quality and an estimated additional 59 Mt of global DRI capacity is expected to be online by 2030[14]. Therefore, it is anticipated that DR grade iron ore supplies will continue to be greatly constrained. Applications with innovative approaches should explain why the proposed method is not currently being used now, and what key technical challenges must be overcome to put the improvements into practice. Blast furnace grade ore (<65% iron) must be cost-competitively processed to DRI grade ore (>67% iron), on a gangue removal basis. Applications must provide supporting documentation justifying that the estimated processing costs would provide sufficient value for the increased metallics concentration and include supportable estimates for reduction in GHG emissions and energy consumption.

This AOI seeks Tier 1 or Tier 2 proposals.

Area of Interest 3—Improving steel recyclability through reducing tramp metal contaminants: This AOI seeks to fund technologies that minimize or eliminate problematic tramp elements in steel scrap (primarily copper, but also tin and others) either in recycling stages or during steelmaking. Steel production from remelted scrap does not remove copper that is in solution in the metal, and it also accumulates additional copper that is co-mingled with steel scrap (for example, copper wire or bronze components). As a result, the average level of copper in steel scrap has increased steadily over the last 70 years.

Excessive copper and tin cause hot shortness during hot rolling, ruining the surface quality of the steel for the most demanding applications. Due to the quality issues caused in the steel product by increasing copper in the scrap supply, producers have been forced to purchase higher quality scrap and dilute residual elements using carbon intensive ore-based metallics. Though low in copper, ore-based iron production is more carbon intensive and energy intensive than scrap remelting. While ironmaking from ore will remain critical to meet future steel demands, managing residual accumulation in the scrap supply solely by dilution is unlikely to have long-term viability due to depletion of high-quality ore deposits.

[14] Institute for Energy Economics and Financial Analysis, "Iron Ore Quality a Potential Headwind to Green Steelmaking." 2022 https://ieefa.org/sites/default/files/2022-06/Iron%20Ore%20Quality%20a%20Potential%20Headwind%20to%20Green%20Steelmaking_June%202022.pdf

This AOI is broadly divided into two sub-areas with different performance metrics; (a) processes that preclude copper and other tramp elements from entering the steelmaking process through scrap sorting or pre-treatment with the iron in scrap remaining in the solid state, and (b) processes that serve to refine or eliminate copper and other tramp elements from liquid steel through a refining process.

For preclusion-based processes, separation technologies of interest include reactive gas evaporation, mechanical separation, preferential melting, solvent extraction, matte extraction, electrolytic extraction, leaching, density separations, and embrittlement, among others. Additional interests include processes that automate scrap sorting through use of artificial intelligence (AI) image analysis, remote chemical analysis, or other methods. Applications must support any assumptions on the nature of co-mingling of copper versus its presence within solid-state solution with data from commercial systems. Cost estimates should be included for any required pre-treatment process including hand-picking and additional shredding or downsizing. Proposals should demonstrate a tolerance for the variability present in merchant scrap and utilize representative commercially available material during experimental demonstration.

Separation technologies should produce an improved quality scrap product, via separation of tramp elements from a low-grade scrap (assume 0.3 wt.% Cu shredded steel scrap as a feed stock), that is suitable both chemically and physically for reintegration into steel recycling through an electric arc furnace (EAF) or BOF as a drop-in replacement for untreated scrap.

Proposed treatment processes should be capable of cost-effectively reducing the level of Cu in the incoming scrap to <0.1 wt.% Cu. Reasonable processing cost estimates must be provided in support of the application. The purchase price and processing costs of the separation process combined should be comparable to the purchase of prime scrap of equivalent quality to the product. For cost approximation purposes, processes that can recover copper as a separated metal may assume a recovered value of $7 per kg of copper. For processes that are proposing comprehensive elimination of Cu to levels below what is possible even with prime scrap, purchase and processing costs may be compared against a price estimation to produce H_2-DRI of $530/tonne to demonstrate cost effectiveness.

For liquid steel refining process proposals, tramp element refining processes would likely take the form of a secondary steelmaking process, i.e., treatment of liquid steel that has been tapped from a melting operation. Separations may be based on any extractive principle such as vacuum distillation, slag-metal interactions, ceramic filtration, and reactive gas treatments. The output of the process should be liquid steel with a copper content < 0.1 wt.%. Removal of Ni to <0.05 wt.% and Sn to <0.03 wt.% can be considered stretch targets for this AOI.

For both preclusion and refining processes, treatment cost estimates and supporting calculations should be provided. For partial elimination of copper, cost benefit may be calculated using the price of lower quality scrap to produce steel of <0.1 wt.% that is enabled by the process. For processes proposing complete removal of residuals below what is achievable using even the cleanest scrap, cost comparison may be made to dilution of residuals using H_2-DRI produced at $530/tonne on a maximized value in use basis.

Processes requiring re-carburization of liquid steel or decoupling of the melting process and decarburization process of steel in the EAF to perform refining are less preferable and must be robustly supported with cost approximation calculations to demonstrate viability, inclusive of additional processing requirements such as desulfurization. Processes that introduce additional S, P, N or other undesirable element into scrap or liquid steel must also estimate the additional post-processing costs.

Approximations of additional energy and material input should be provided, and liquid steel refining process proposals should target a process time of approximately 60 minutes to reach the objective residual levels. Proposed processes that exceed these metrics require reasonable justification with regards to additional energy losses and processing time to be deemed feasible.

This AOI seeks Tier 1 or Tier 2 proposals.

Not of interest: Applications focused on technologies that seek to manage copper by dilution using other metallics, or technologies that seek to mitigate hot shortness through alloy design or modifications to slab reheating or hot rolling processes. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Area of Interest 4—Low-carbon steelmaking: This topic would fund low carbon steelmaking technologies and practices to reduce GHG emissions in traditional arc furnace steelmaking, or reduce carbon emissions via alternative steelmaking processes. Arc furnace steelmaking currently relies on significant quantities of carbon (a) intrinsic to metallic charge (in pig iron and direct reduced iron, for example) and (b) otherwise injected. The additional energy that carbon supplies serves to melt the steel charge faster than with arc heating alone (carbon burning off as CO_2). Additionally, when carbon reacts with oxygen and becomes gas, this assists nitrogen removal while the resulting foaming forms a protective slag layer that shields the refractory furnace lining from the otherwise damaging high intensity electric arc. The elevated carbon levels in the bath are then adjusted (again, by

oxidizing the carbon to CO_2) to a target level before tapping, optional ladle refining, and casting.

The productivity of the steelmaking process has historically outweighed the need to minimize any excess carbon. A more precise and nuanced use of carbon throughout the arc-based steelmaking process could significantly reduce GHG emissions. This AOI seeks to advance technologies and practices that maintain existing furnace production rates and reduce the GHG emissions by 20% or more over that of current standard practice. As new sources of iron will come from decarbonized ironmaking, and as that iron will have intrinsically low or zero carbon content, these new technologies and practices become even more important.

While methods to minimize the need for carbon in arc furnace steelmaking are of primary interest, decarbonizing methods to pre-process the arc furnace charge may be considered. This could include rapidly pre-melting part of an arc furnace charge with submerged arc, electromagnetic induction, microwaves, plasmas, or lasers. Applications must make the business case as to why the proposed method is not currently being used and how the innovation overcomes existing obstacles. The application should identify the key technical challenge that is to be solved, show how the innovation is revolutionary, and justify how the innovation reduces GHG emissions by 20% or more over the applicant's current practice.

This AOI seeks Tier 1 or Tier 2 proposals.

Not of interest: Applications focused on transforming CO_2 to solid carbon or to carbon-metal compounds; carbon capture technologies; use of biomass or biochar; scrap preheating with hydrogen combustion; scrap preheating with waste heat streams; net zero (green) carbon electrodes; the addition to a steelmaking furnace of molten iron from a molten oxide electrolysis process or from hydrogen plasma direct reduction; high magnetic field processing; insulating or otherwise retaining the heat in ore-based metallics direct from their ironmaking process. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Topic 2 Metrics & Targets: Targets for technology developed and demonstrated under this topic must be specified in the application. Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Successful applicants will be required to have a periodic assessment of their metrics during the award to evaluate potential impacts. Applications must clearly explain how the proposed technology will meet the following metrics including defining appropriate benchmarks or baselines:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce Scope I CO_2e emissions of iron production (AOI 1)	CO_2e per tonne of iron product	*For liquid pig iron:* <735 kg CO_2e/mt	*For liquid pig iron:* <10 kg CO_2e/mt	*For alternative processes producing liquid pig iron (5 wt% C):* 2451 kg CO_2e /mt[15]
		For solid iron and iron + gangue: <360 kg CO_2e/mt	*For solid iron and iron + gangue:* <10 kg CO_2e/mt	*For alternative processes producing solid iron/ iron + gangue:* 1200 kg CO_2e/mt[16]
Increase Fe content of iron ore (AOI 2)	Wt. % Fe	> 67 wt.% Fe	> 69 wt.% Fe	*BF grade ore < 65 wt.% Fe*
Reduce Cu content in scrap/liquid steel (AOI 3)	Wt.% Cu in product	< 0.1 wt% Copper	< 0.06 wt% Copper	*0.3 wt. % Cu scrap/liquid steel*
Reduce scope I emissions of EAF steelmaking (AOI 4)	CO_2e per tonne of iron product	20%	100%	*Applicant defined based on practices from exemplar EAF*

Topic Area 3: Decarbonizing Food and Beverage Products

Topic 3 Background and Opportunity: The food and beverage (F&B) industry is a critical component of the U.S. economy. In 2021, the F&B manufacturing sector produced and shipped products with a value of nearly $1.1 trillion and employed approximately 1.7 million workers.[17] The sector accounted for an estimated 1,935

[15] Pardo N, Moya Rivera J, Vatopoulos K. Prospective Scenarios on Energy Efficiency and CO2 Emissions in the EU Iron and Steel Industry. EUR 25543. Luxembourg (Luxembourg): Publications Office of the European Union; 2012. JRC74811. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC74811/ld1a25543enn.pdf

[16] Kappes, Horst, Ingo Both, Energy Transition in the European Steel Industry – Reality not Exception. Midrex, 2021, https://www.midrex.com/tech-article/energy-transition-in-the-european-steel-industry-reality-not-exception/

[17] Annual Survey of Manufactures, 2018-2021 - Statistics for Industry Groups and Industries. U.S. Census Bureau. 2022, https://data.census.gov/table/ASMAREA2017.AM1831BASIC01?q=AM1831BASIC&n=311:312&nkd=YEAR~2021

TBtu of energy (10% of total energy use for U.S. manufacturing) and 96 MMT CO_2e of GHG emissions (10% of total energy-related GHG emissions for U.S. manufacturing) in 2018.[18] The F&B industry produces a wide spectrum of products that are both consumed domestically and exported to international markets. Key industry segments include grain and oilseed milling, animal slaughtering and processing, fruit and vegetable processing, dairy product operations, baking and snacks, sugar manufacturing, beverage manufacturing, and others.

Over 50,000 F&B establishments nationwide directly consumed over 1,262 TBtu of energy and accounted for an estimated 45 MMT of onsite GHG emissions in 2018, excluding off-site electricity and steam generation losses.[19] About two-thirds of end-use energy consumed by the F&B industry at manufacturing plants is used in manufacturing processes (the remainder is used for non-process uses or lost in onsite steam and electricity generation and distribution). Considerable opportunity remains for improving the energy efficiency of F&B processing operations, as indicated in the energy bandwidth report for the industry published in 2017.[20] The U.S. DOE Industrial Decarbonization Roadmap[21] highlights opportunities to decarbonize the sector by electrifying processes and utilizing low carbon fuels and energy sources. A Thermal Process Intensification workshop, organized by DOE's Advanced Manufacturing Office in 2022, identified alternative thermal processing approaches for reducing energy and emissions of the F&B industry.[22]

The F&B industry can leverage many cross-cutting, low-carbon technology solutions for decarbonization, including low-carbon steam generation, drying, and process heating and cooling. However, achieving net-zero emissions for the entire F&B industry in a way that is both economical and sustainable also requires sector-specific technology solutions that address sector-specific challenges. This topic seeks to advance sector-specific technology solutions in the F&B industry in order to address challenges that are unique to the industry and will have a large impact. The following AOIs that IEDO has identified for deep F&B decarbonization include:

- **Food packaging:** Food loss throughout the value chain (from farm through consumer) represents a significant opportunity for improvement and savings. In the United States, food waste is estimated to account for 40% of the food

[18] DOE, 2018 Manufacturing Energy and Carbon Footprints: Food and Beverage Sector, 2021, https://www.energy.gov/sites/default/files/2021-12/2018_mecs_food_beverage_energy_carbon_footprint.pdf
[19] Ibid.
[20] DOE, Bandwidth Study on Energy Use and Potential Energy Savings Opportunities in U.S. Food and Beverage Manufacturing, 2017, https://www.energy.gov/sites/default/files/2019/05/f62/Food_and_beverage_bandwidth_study_2017.pdf
[21] DOE, Industrial Decarbonization Roadmap, 2022, https://doi.org/10.2172/1961393
[22] DOE, Thermal Process Intensification: Transforming the Way Industry Uses Thermal Process Energy, 2022, https://www.energy.gov/sites/default/files/2022-05/TPI%20Workshop%20Report_AMO.pdf

supply. [23] Reducing food waste though improved packaging that reduces spoilage and extends shelf life can have a profound impact on emissions reductions (including emissions from land use, fertilizer and water use, harvesting, processing, and waste disposal). There is also an opportunity to replace traditional packaging materials with materials and systems that are more sustainable.

- **Foodservice:** Foodservice is a dominant segment of the hospitality industry that represents a significant proportion of the economy and consumes about 300 billion cubic feet of natural gas that accounts for over 16 MMT CO2 annually. 76% of foodservice establishments consume natural gas for cooking. Thus, there are many opportunities in this space to boost up the efficiency and carbon footprint reduction including but not limited to process intensification, equipment innovation, cost-effective switching to low-carbon fuels or to electricity.[24]
- **Alternative proteins:** Industrialized animal agriculture is responsible for 14.5% of global greenhouse gas emissions, according to U.N.'s Food and Agriculture Organization (FAO). Alternative proteins strongly outperform conventional meat for several environmental impact factors and have the potential for significant decarbonization of F&B industrial sector.[25] Innovations in alternative protein products and processing is needed to drive down emissions in this growing space.
- **Energy input redistribution:** More effective and efficient use of primary energy input within F&B manufacturing processes and facilities can significantly reduce total energy losses (primarily in the form of waste heat and pressure loss) and, therefore, significantly reduce energy consumption as well as carbon footprint of F&B operations. Innovative, highly efficient, and cost-effective technical solutions are needed in multiple segments across the F&B industry to achieve decarbonization.
- **Post-harvest technical activities:** There are many important processes and operations that occur between farms and food processing plants (washing, hauling, sorting, drying, pre-processing, etc.). Most of these are low-efficiency, emission intensive, and seasonal. Post-harvest technological innovations and

[23] EPA, Draft National Strategy for Reducing Food Loss and Waste and Recycling Organics, 2023, https://www.epa.gov/circulareconomy/draft-national-strategy-reducing-food-loss-and-waste-and-recycling-organics

[24] American Gas Association, Advancing America's Hospitality: The Value of Natural Gas to the U.S. Hospitality Sector, 2023, https://www.aga.org/wp-content/uploads/2023/09/AGA-Hospitality-Report.pdf

[25] DOE, Industrial Efficiency and Decarbonization Office Stakeholders' Workshop: Decarbonization Challenges and Priorities across the U.S. Food and Beverage Industry, 2023, https://www.energy.gov/eere/iedo/events/us-doe-industrial-efficiency-and-decarbonization-office-stakeholders-workshop

disruptive cost-effective solutions represent a significant opportunity for savings and have strong support from both producers and processors.

Topic 3 Technology Focus: This topic focuses on the development and demonstration of transformative, high impact decarbonization solutions for a wide variety of F&B operations across a full spectrum of applications, ranging from post-harvest activities, wholesale baking and ingredients manufacturing, to product fermentation and livestock processing and rendering. Applicants should propose novel technology concepts and disruptive advances in processes and/or equipment in these applications.

Topic 3 seeks Tier 0, Tier 1 and Tier 2 applications as identified in the AOI descriptions. Applications for Tier 1 and Tier 2 must include an Industry Partner on the team that includes non-profit or for-profit entities directly or indirectly engaged in food and beverage production or processing, or a closely related industry. In addition, applicants are encouraged to explicitly describe how they intend to bring their technology to market (i.e., commercialization strategy) and their potential commercialization partners in the Market Transformation Plan. The role of the commercialization partner, such as equipment providers, original equipment manufacturers, suppliers, and technology integration firms, should be discussed in the Market Transformation Plan.

Applications submitted under this topic must be F&B-specific and demonstrate a strong decarbonization potential by addressing the areas of interest (AOI) stated below. During the award performance period, greenhouse gas emissions, energy intensity, and cost must be validated via LCA and TEA.

Area of Interest 1 – Innovations in Food Packaging: This area of interest seeks innovative food packaging concepts across the spectrum of raw, processed, and/or prepared foods to reduce energy consumption and GHG emissions associated with packaging materials and manufacturing techniques across the entire cradle-to-grave supply chain while meeting the requirements to safely and sustainably preserve, protect, and contain the food product. Additional interests include packaging materials and systems that reduce food waste (including spoilage) and therefore the global warming potential (GWP) associated with food production (including agricultural activities), delivery, storage, and disposal. Potential packaging innovations can include, but are not limited to, novel packaging materials or approaches such as biopolymer films and active and smart packaging; improved systems and materials across or in certain areas of the full F&B value chain; reducing the amount of packaging material required while maintaining product quality and safety. Overall sustainability and circularity, of both packaging and food, should be considered. This AOI seeks Tier 0 proposals.

Area of Interest 2 – Innovations in Commercial Food Service: This area of interest seeks energy efficiency improvements and emissions reductions in energy- and emissions-intensive cooking equipment and commercial kitchen systems (e.g., grills, fryers, cookers, ovens, etc.) widely used across commercial and institutional food chains, restaurants, catering services, and other F&B establishments. Transformative and innovative concepts and solutions across the equipment value chain and processing technologies are of primary interest and may include, but are not limited to, a) solutions that use alternative sources of energy (other than fossil fuels) while retaining quality, appearance, texture, and taste of F&B products; b) modular equipment designs for widespread deployment at commercial kitchen facilities, and c) novel techniques/methods for food preparation. The application of existing technologies that do not require significant technical development to implement or incremental improvement beyond the state-of-the-art are not of interest to this AOI. This AOI seeks Tier 0 proposals.

Area of Interest 3 – Decarbonization of Alternative Protein Production: This area of interest seeks applications for innovative technologies that cost-effectively decarbonize manufacturing and processing of alternative F&B protein products (e.g., plant-based, precision fermented, cell cultivated) with focus on Scope 1 and 2[26] GHG emissions reductions. Examples of processes utilized within the industry include, but are not limited to, evaporation, pasteurization, extraction, drying and dehydration, fermentation, purification, extrusions, and others. Technology approaches could include but are not limited to advanced separations, low carbon fuels, and other innovations. However, all proposed innovations must be directly related to manufacturing and processing of alternative proteins and their respective ingredients. This AOI seeks Tier 1 and Tier 2 proposals.

Area of Interest 4 – Energy Input Redistribution in Food and Beverage Processing: This area of interest seeks applications for innovative technologies and advancements in technology integration that would achieve significant reduction in energy consumption and carbon intensity of F&B operations by redistribution of the energy across different parts of the processing line or production facility. For example, waste energy/energy losses at one step, system, or sub-system of the processing line may serve as a valid energy input to another step, system, or sub-system within the same facility. This may reduce overall energy consumption by de-rating or completely eliminating the ancillary energy-intensive equipment or component for F&B operations (e.g., boilers for water heating and steam generation, compressors and pumps, others). All applicants must clearly state future plans and approaches for integration and demonstration of the proposed concept

[26] United States Environmental Protection Agency, "Scope 1 and Scope 2 Inventory Guidance." 2023 https://www.epa.gov/climateleadership/scope-1-and-scope-2

within an actual F&B facility and should include an industrial partner. This AOI seeks Tier 1 and Tier 2 proposals.

Area of Interest 5 – Reduction of Energy Consumption and GHG Emissions during Post-Harvesting Activities: This area of interest seeks the cost-effective advancement of post-harvesting processes (washing, drying, sorting, pre-processing, etc.) and equipment to drastically reduce energy and water consumption and associated GHG emissions. The seasonal operation and low-margin economics should be considered for the proposed innovative concepts and technical solutions in assessing feasibility from an operation and cost standpoint. These may include, but are not limited to, novel treatments as well as innovative approaches to conventional post-harvesting processes such as those reliant on new equipment, process configurations, and/or advanced controls. The seasonal operation and low-margin economics should be taken into consideration for the proposed innovative concepts in assessing feasibility from an operation and cost standpoint. This AOI seeks Tier 1 and 2 proposals.

Not of interest: Applications focused on carbon capture, utilization, and storage (CCUS); stand-alone heat pumps and combined heat and power (CHP) systems; solutions based only on more efficient usage of fossil fuels; production of fuels, value chemicals from byproducts or wastes; and cross-cutting technologies not specifically related to F&B industry are not of interest for Topic 3. Because many electric alternatives for process heating, cooling, and refrigeration (e.g., heaters, chillers, boilers) are presently available off-the-shelf on the commercial market, they are not of primary interest for Topic 3 as well. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Topic 3 Metrics & Targets: Targets for processes developed and demonstrated under this topic must be specified in the application. Applicants are strongly encouraged to include preliminary carbon emissions, energy intensity, and cost assessments with their submission. Successful applicants will be required to have a periodic assessment of the preliminary estimates and the metrics during the award to evaluate potential impacts. Compared to state-of-the-art technology, competitive applications should have the potential to reduce CO_2-equivalent emissions by at least 0.5 MMT annually within the food and beverage sector at the national level if broadly implemented. Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Applicants must clearly explain how the proposed technology will meet the following metrics:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance

Reduce carbon Intensity	% carbon intensity change as measured by ton CO_2 equivalent (CO_2e)/kg product	50%	>85%	*Applicant defined*
Reduce energy intensity	Energy use per unit product	25%	>50%	*Applicant defined*

Additional metrics and critical criteria that will lead to successfully meeting the goal above should also be identified. Relevant benchmarks/baselines, minimum targets, and stretch targets should be included for each metric. These can also incorporate co-benefits, such as a reduction in criteria air pollutants, for example. Examples of applicant-identified metrics are provided in the table below.

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce air pollutant emissions (e.g., NO_X, PM, CH_4, etc.)	% pollutant change per ton of product	30%	*Applicant Defined*	*Applicant Defined*
Reduce operating costs (including maintenance)	USD/ton of product	30%	*Applicant Defined*	*Applicant Defined*
Increase production throughput	Ton of product per unit of time	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 4: Decarbonizing Building and Infrastructure Materials – Cement and Concrete, Asphalt, and Glass

Topic 4 Background and Opportunity: Cement, concrete, asphalt pavements, and glass are materials critical to society and modern life but are also energy-and emissions intensive. The production volume of these materials in the U.S. is high and is expected to grow into the future as the U.S. replaces aging infrastructure and transitions to renewable energy such as solar and wind. Achieving net-zero GHG

emissions for the industries that produce these materials is critical to achieving U.S. and global GHG emissions targets. At the same time, the transition to a decarbonized industrial sector also represents a unique opportunity to improve energy efficiency, circularity, and sustainability for these and other industries.

Concrete is strong, durable, and uses abundant raw materials which makes concrete the second most used substance in the world (water is first) with 400 million cubic yards of ready-mix concrete produced in the USA in 2022.[27] Demand is likely to continue to increase due to the expanding need for infrastructure construction (new and replacement). Cement is the binder in concrete and the component most responsible for concrete's structural performance. Cement is also responsible for nearly 90% of concrete's GHG emissions. To meet market demand, the U.S. produced approximately 95 MMT of cement in 2022.[28] The cement industry is considered a "hard-to-abate" sector that is responsible for 2% of U.S. GHG emissions and 1% of U.S. energy consumption.[29] Emissions from portland cement production stem mostly from the calcination of calcium carbonate raw materials (limestone) (~60%) with the remaining 40% resulting from fossil fuel combustion required to reach high kiln temperatures of 1450°C.

Asphalt pavement is used in nearly all paved roads in the U.S., making it an essential material in current and future U.S infrastructure. This energy intensive sector accounted for 0.3% of total GHG emissions in the U.S. (cradle to gate)[30] and with many public roadways in poor or mediocre condition the need for repairs is driving the growth of asphalt pavement. Process and materials innovations that improve pavement durability and reduce emissions will have an important impact on decarbonization of the U.S. industry and infrastructure.

The carbon footprint of asphalt pavement is process-dependent with emissions arising mainly from process heat needed to reach target mix temperatures during preparation and placement. There are three main asphalt mix types, designated by process temperature and differing in CO_2 emissions. The pavement with the highest process temperature range is Hot Mix Asphalt (HMA), with a carbon footprint of ~100 kg of CO_2e per mile of road. This is the most widely used type of asphalt due to its durability and ease of application. Cold Mix Asphalt (CMA) and Warm Mix Asphalt (WMA) have lower CO_2 emissions than HMA (~70% and ~10-15% reduction, respectively). However, their durability is typically lower, limiting their application.

[27] US geological survey data
[28] IEA, Cement: Net Zero Emissions Guide, 2023,: https://www.iea.org/reports/cement-3
[29] DOE, Industrial Decarbonization Roadmap, 2022, https://doi.org/10.2172/1961393
[30] Shacat, Joseph, J. Richard Willis, Ben Ciavola, GHG Emissions Inventory for Asphalt Mix Production in the Unites States: Current Industry Practices and Opportunities to Reduce Future Emissions, 2022, https://www.asphaltpavement.org/uploads/documents/Sustainability/SIP-106_GHG_Emissions_Inventory_for_Asphalt_Mix_Production_in_the_US_%E2%80%93_NAPA_June_2022.pdf

Innovation in materials and process that delivers more durable and less energy intensive materials is needed to advance the sector and limit carbon emissions. In addition, the current use of Reclaimed Asphalt Pavement (RAP) (approximately 23% of the U.S. asphalt production each year) reduces emissions and improves sustainability, but further innovation is required to increase recycled content and attain near-net-zero emissions.

Glass is a versatile material, playing an important role in the U.S. economy in applications such as automotive, architecture, consumer products, and communications. As of January 2023, the U.S. glass manufacturing industry reached a market value of $31 billion providing a total of more than 89,000 jobs.[31] In 2022, glass production in the U.S. accounted for 155.2 trillion Btu of energy consumption and 11 MMT of CO_2e emissions. Currently, glass accounts for about 4% of global material production emissions. However, the volume of glass produced in the U.S. and its contribution to CO_2 emissions has the potential to grow significantly in the coming years to meet the projected growth of solar PV.[32]

Topic 4 Technology Focus: This topic seeks innovative solutions with a high decarbonization impact across the full value chain of these materials. Tier 0, Tier 1, or Tier 2 are of interest as specified in each AOI. For all AOIs, applicants should demonstrate the novelty of their innovation compared to existing solutions and show that the challenges and barriers faced by those solutions can be overcome. During the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA for Tier 1 and Tier 2 applications. It is encouraged for applications at Tier 0.

Applications with cement and concrete should develop and demonstrate advances to accelerate the commercial readiness of emerging low-carbon or net-zero-carbon technologies for the cement and concrete industry, to provide energy savings, carbon emissions reduction, and other benefits, such as reduced complexity and improved process efficiency/optimization in the cement/concrete production sector. All applications for these sectors should include an Industry Partner on the team. The term "Industry Partner" includes non-profit and for-profit entities engaged in cement and concrete production or processing or a related industry.

Tier 1 and Tier 2 applications are of interest for AOIs related to cement and concrete. Tier 2 applications should validate concepts in a relevant environment or operational environment at TRL 5–7 at an appropriate scale to advance the technology toward commercialization—for example, scaling to 1/50th of the current

[31] M. Garside, "U.S. glass product manufacturing figures 2023," Statista.
[32] H. Wikoff, "Criticality of Glass in the Deployment of Solar for Decarbonization," presented at the 84th Conference on Glass Problems, Columbus, OH, Nov. 09, 2023. [Online]. Available: https://gmic.org/conference-schedule/

commercial scale process for a continuous operation. New cement/concrete formulations must be tested and shown to comply with all applicable performance specifications (e.g., strength, heat of hydration, durability/resistance to attack) for general and special use of hydraulic cement given in ASTM C1157[33] or blended hydraulic cement in ASTM C595.[34] Investigations should be made with respect to the effects of new formulations and materials on the microstructural features and physical properties of both plain and reinforced concretes, as appropriate.

Applications with Asphalt and Glass are expected to demonstrate transformative, early-stage technology innovations (Tier 0 at TRL 2-3) that address and accelerate decarbonization and sustainability for Asphalt and Glass. Investigations of the impact of the new formulation on the final product need to be assessed according to relevant standards when appropriate.

Area of Interest 1 – Novel cement formulations in combination with alternative Supplementary Cementitious Materials (SCMs): This area of interest seeks emerging low-carbon technologies that have the potential to produce scalable quantities of cost-competitive binders (new phases or blended) which do not include ordinary portland cement (OPC) type I/II and type I/L. Tier 1 and Tier 2 proposals should address challenges related to raw material/feedstock supply chains, scalability, non-GHG emissions, and cost. Alternative binders with an Alite/Belite ratio <1 (i.e., higher reactive belite phase compared to OPC) are of interest as they require less high-grade silica and can be produced at lower temperature.

To reach net-zero, it is encouraged that applicants combine the novel/hybrid cement binders with alternative sustainably sourced supplementary cementitious materials (SCMs) or waste valorization, including, but not limited to, concrete demolition waste and CO_2 mineralization from direct air capture, point source, or flue gas without the implementation of complex carbon capture technologies. In parallel, the alternative SCMs can be combined with traditional clinker. Both scenarios should guarantee comparable or improved concrete performance (e.g., strength at early and late stages, hardening profile, durability, and other performance properties) versus the baseline.

The addition of chemicals, minerals, or admixtures (e.g., viscosity modifiers, superplasticizers) may be necessary to achieve the desired finished concrete qualities, particularly with an acceptable rate of strength development, without compromising the cost of the solution. New admixture development should not be the focal point of proposals. Proposals may focus on advancing the development,

[33] ASTM, ASTM C1157-08a: Standard Performance Specifications for Hydraulic Cement, 2010, https://www.astm.org/c1157-08a.html

[34] ASTM, ASTM C595-08a, Standard Specification for Blended Hydraulic Cement, 2010, https://www.astm.org/standards/c595

durability, and adoption of new binders through the development of characterization of non-destructive tools, techniques, and methods (i.e., sensors, real-time in-situ methods, durability testing, and other accelerated measurements) that correlate structure-property relationships and/or other measured responses to predict long and short-term performance. It is encouraged to evaluate the impact of various parameters through modeling to forecast potential upgrades.

Not of interest: Applications focused on (i) developing admixtures to enhance binder performance, and (ii) using merchant market CO_2 feedstock as a commercial scale solution. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Area of Interest 2 – Novel Lime/Portland Cement Production Processes: This area of interest addresses scale-up challenges associated with novel low-carbon production routes for lime, modern portland cement, and similar formulations. This AOI seeks Tier 1 and Tier 2 projects with novel, net-low-carbon, carbon-neutral, zero-carbon, or carbon-negative production routes for (1) lime (CaO), a feedstock for OPC and other industries, or combined with other phases and water to directly produce calcium silicate hydrate (concrete); (2) modern OPC; or (3) a cement product that approximates the alite/belite ratio in OPC. The production routes may involve chemical-, electrochemical-, thermal-, biological-based processes, other routes, or combinations thereof. The valorization of side-products (other than CO_2 emissions) can be included as part of the proposed scope. The use of alternative feedstocks, including non-carbonate sources of calcium, waste materials, waste concrete, mine tailings, spoils, etc. is encouraged. Estimates of availability of alternative feedstock materials should be made and should include geographic distribution.

Not of interest: Applications focused on traditional portland cement production processes/equipment with carbon capture or electrification of heat retrofits. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Area of interest 3 – Low-Carbon Asphalt pavement: Asphalt concrete is a combination of two main ingredients: aggregates (90-95% of the mix) and asphalt binder (5-10%). Asphalt binder is typically derived from crude oil and includes fossil-based polymers. The binder characteristics and performance are critical and determine the nature of the application. To decarbonize this industry, innovations are needed in (i) the raw materials, (ii) the manufacturing process (temperature), and (iii) recycling. This AOI seeks Tier 0 proposals (TRL 2-3) that advance the development of asphalt materials through the development of mixes that can use low-carbon raw materials and remain durable at lower temperatures. Interest should be put into developing and evaluating novel low-carbon asphalt materials

including, but not limited to, RAP and refined residuum that leads to emissions reduction and improve long-term durability, especially at lower temperatures.

Areas of Interest 4 – Glass Decarbonization: Emissions from glass production can be reduced in all stages of manufacturing, including through raw material substitution. Traditional glass feedstocks often include carbonates (e.g., Na_2CO_3, $CaCO_3$) which can decompose during production and lead to ~9% of glass production[35] CO_2 emissions. The use of recycled glass (cullet) has been shown to reduce process-related emissions. However, the sensitivity of glass melts to contamination has limited post-consumer glass recycling to a handful of applications.

Raw material extraction and beneficiation can be emission-intensive processes. The use of alternative feedstocks in glass production has the potential to address one or more of these challenges. DOE is interested in glass feedstocks and formulations that reduce or avoid process CO_2 emissions (i.e., decomposition of carbonates) during glass production and/or reduce required processing temperatures. Additional interests include glass formulations and/or processing routes that are more tolerant of contaminants and/or enable innovative use of post-consumer recycled glass waste streams. This AOI seeks Tier 0 proposals (TRL 2-3).

Topic 4 Metrics and Targets: Compared to current technology, the novel technology proposed should have the potential to reduce CO_2 emissions by at least 50% within all sectors at the national level if broadly implemented. Applicants must clearly explain how the proposed technology will meet the following metrics:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce carbon Intensity	% carbon intensity change as measured by ton CO_2 equivalent (CO_2e)/kg product	50%	>80%	*Applicant defined*

Additional metrics and critical criteria that will lead to successfully meeting the goal above should also be identified. Examples of applicant-identified metrics are provided in the table below.

[35] DOE, Pathways to Commercial Liftoff: Industrial Decarbonization, 2023, https://liftoff.energy.gov/industrial-decarbonization/

Objective/Goal	Sector	Metric	Minimum	Stretch Target	Baseline Performance
Clinker content	Cement and concrete	Clinker-to-cement ratio	≤ 0.80	none	*ASTM C595 cement types: IL, IS, IP, and IT*
Technical performance (e.g., strength, heat of hydration, sulfate resistance, etc.)	Cement and concrete	Standard performance specifications for hydraulic and blended cements	As given in ASTM C595 or C1157	none	ASTM C595 and ASTM C1157
Economic impacts of decarbonized raw materials, products, or processes	Cement and concrete	Cost	Cost competitive /minimal green premium	Cost parity	Type I/L - centric baseline
Asphalt binder content	Asphalt pavement	Binder % in the mix	<10% w/w	<5% w/w	*Defined by Applicant*
Technical performance at lower temperature	Asphalt pavement	Standard performance specifications based on AASTHO	40°F reduction	100°F reduction	*Defined by Applicant*
Economic impact	Asphalt pavement	Cost	Cost parity	Cost advantage	*Defined by Applicant*
Health impact	Asphalt pavement	VOC emissions	Baseline	10% improvement vs baseline	*Defined by applicant*
Increase alternative feedstock content	Glass	kg/kg product	>10%	>50%	*Defined by applicant*
Objective/Goal	**Sector**	**Metric**	**Minimum**	**Stretch Target**	**Baseline Performance**
Economic impact	Glass	Unit (product mass or part	Cost parity	>50%	*Defined by applicant*

		basis) cost vs. state of the art			
Technical performance (e.g. optical, mechanical properties)	Glass	Applicant defined	Performance Parity	>10%	*Defined by applicant*

Topic Area 5: Decarbonizing Forest Products

Topic 5 Background and Opportunity: The forest products industry is a key component of the U.S. economy. It produces nearly $300 billion worth of essential products annually (including pulp, paper, packaging, plywood, lumber) and employs approximately 950,000 people nationwide.[36] The industry is the third-largest consumer of energy in the U.S. manufacturing sector, accounting for 2,883 TBtu of energy use (15% of total energy use for U.S. manufacturing).[37] Approximately 56% of energy demand is met from renewable energy sources through reuse of waste materials from the manufacturing process and includes bark, sawdust, and black liquor.[38] Pulp, paper, and many wood products are made mostly from recycled fiber or fiber from sustainably managed forests that are replanted to ensure a renewable supply, thereby reducing the environmental footprint of the industry. Yet despite producing more carbon-neutral bioenergy than any other industrial subsector, the forest products industry still consumes significant quantities of energy, including fossil fuel-based energy that results in approximately 80 MMT CO_2e of non-biogenic GHG emissions annually (8% of total energy-related emissions for U.S. manufacturing).[39]

As indicated in the DOE's energy bandwidth report for the industry published in 2015,[40] the major consumers of thermal energy within the forest products industry are liquor evaporation, pulping chemical preparation, wood cooking, bleaching, and drying. While production of recycled paper does not have the steps associated with the kraft pulping process, there is also a significant thermal energy use associated with recycling paper including heating the pulp slurry and drying paper.

[36] USDA Forest Service, Forest Products, https://www.fs.usda.gov/research/forestproducts

[37] DOE, 2018 Manufacturing Energy and Carbon Footprints: Forest Products, 2021, https://www.energy.gov/sites/default/files/2021-12/2018_mecs_forest_products_energy_carbon_footprint_0.pdf.

[38] Based on analysis of EPA Greenhouse Gas Reporting Program (GHGRP) data.

[39] DOE, 2018 Manufacturing Energy and Carbon Footprints: Forest Products Sector, 2021, https://www.energy.gov/sites/default/files/2021-12/2018_mecs_forest_products_energy_carbon_footprint_0.pdf.

[40] DOE, Bandwidth Study on Energy Use and Potential Energy Savings Opportunities in U.S. Pulp and Paper Manufacturing, 2015, https://www.energy.gov/sites/default/files/2015/08/f26/pulp_and_paper_bandwidth_report.pdf.

A Thermal Process Intensification workshop, organized by DOE's Advanced Manufacturing Office (AMO), highlighted thermal process intensification and alternative thermal processing approaches for the pulp and paper industry.[41]

Topic 5 Technology Focus: This topic will accelerate technology innovations in the areas of increasing energy efficiency, industrial electrification, and raw material substitution for the energy-intensive manufacturing processes used in producing pulp, paper, and forest products. Applicants should demonstrate advances in processes and equipment to accelerate the technology and adoption readiness of novel low-carbon or net-zero-carbon process technologies. Research, development, and deployment activities focused on reducing the cost of decarbonization technologies and on integrating those technologies within existing manufacturing systems and supply chains are also of interest. Within this topic, DOE seeks to address high impact decarbonization opportunities for the U.S. forest products industry including, but not limited to, novel dewatering or drying technologies and improved pulping and chemical recovery processes.

Topic 5 seeks applications across Tiers 0 (TRL 2-3), 1 (TRL 3-5) and 2 (TRL 6-7) with the selection of the appropriate Tier left to the applicant based on the current TRL of the proposed technology. Applications for Tier 1 and Tier 2 must include an Industry Partner on the team that includes non-profit or for-profit entities directly or indirectly engaged in pulp, paper, or other forest products industry manufacturing. In addition, applicants are encouraged to explicitly describe how they intend to bring their technology to market (i.e., commercialization strategy) and their potential commercialization partners in the Market Transformation Plan. The role of commercialization partners, such as equipment providers, original equipment manufacturers, suppliers, and technology integration firms, should be discussed in the Market Transformation Plan.

Applications submitted under this topic must address one of the AOIs stated below. The results of LCA and TEA for carbon emissions, energy intensity, and cost, prepared based on prior proof of concept work, are encouraged in the application to validate the expected benefits and feasibility of the proposed technology (Tier 1 and 2 applications). During the award performance period, greenhouse gas emissions, energy intensity, and cost must be validated via LCA and TEA.

Applications should demonstrate technical feasibility and economic viability at small-scale (pilot or slip-stream), with commercially relevant materials and conditions.

[41] DOE, Thermal Process Intensification: Transforming the Way Industry Uses Thermal Process Energy, 2022, https://www.energy.gov/sites/default/files/2022-05/TPI%20Workshop%20Report_AMO.pdf.

Area of Interest 1 – Novel Dewatering and Drying Technologies: This AOI seeks applications for innovative technologies that decarbonize drying and dewatering processes within both paper and wood products manufacturing, as a considerable portion of energy use in the forest products industry is consumed in drying operations. Technology approaches could include, but are not limited to, novel dewatering or drying technologies, energy capture and reuse technologies, and other relevant innovations.

Proposals sought include those addressing challenges related to:

- More energy efficient pulp and paper drying and dewatering technologies.
- Alternative approaches to provide target levels of paper strength without increasing water retention and drying energy.
- Energy capture (including waste heat) from the drying process (wood or paper) with reuse of the recovered energy onsite.
- Cost-effective, energy efficient, renewable drying technologies tailored for the wood product industry that can operate efficiently along with waste biomass.
- Novel sensing technologies to improve drying control and reduce energy use.

Area of Interest 2 – Innovative Fiber Preparation, Pulping, and Chemical Recovery Processes: This AOI seeks applications for innovative pulping and chemical recovery technologies to improve energy efficiency and decarbonize operations associated with the preparation of pulp fibers. Technology approaches could include, but are not limited to, improvements to the kraft process, catalytic pulping, novel solvent-based pulping, refining improvements, and other innovations.

Proposals sought include those addressing challenges related to:

- Reducing energy use in pulping of wood and associated emissions.
- Novel, alternative approaches to reduce energy use and carbon emissions associated with recovery of pulping chemicals.
- Lower-energy mechanical refining or chemical approaches to fiber development.
- Reducing energy use during processing and improving quality of recycled fiber.

Not of interest: Applications focused on carbon capture, steam or electricity generation, or the production of fuels or chemicals from byproducts or wastes. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Topic 5 Metrics and Targets: Compared to current technology, competitive applications should have the potential to reduce CO_2e emissions by at least one

million metric ton annually within the paper and forest products sector at the national level, if broadly implemented.

Applicants must clearly explain how the proposed technology will meet the following metric:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce carbon Intensity	% carbon intensity change as measured by kg CO_2 equivalent (CO_2e)/kg product	50%	>85%	*Applicant defined*

Additional metrics and critical criteria that will lead to successfully meeting the goal above should also be identified. Relevant benchmarks/baselines, minimum targets, and stretch targets should be included for each metric; these can also include co-benefits, such as a reduction in criteria air pollutants. Examples of potential applicant-identified metrics are provided in the table below.

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce energy consumption	Btu/ton product	10%	30%	*Applicant Defined*
Increase throughput	Production rate per unit of time	10%	30%	*Applicant Defined*
Decrease operating cost	$/ton product	10%	30%	*Applicant Defined*
Reduce criteria air pollutant emissions	% pollutant change as measured by pound pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 6: Innovative Industrial Pre-FEED Studies

Topic 6 Background and Opportunity: Manufacturing contributed $2.3 trillion to the United States economy in 2021 while employing 11.4 million people. While critical

for the economy, industrial manufacturing is energy and emissions intensive. The U.S. industrial sector accounts for 33% of the nation's primary energy use and 30% of energy-related CO_2 emissions totaling 1,360 MMT CO_2 in 2020. Additionally, the industrial sector's energy demand is expected to grow 30% by 2050.[42] Net-zero carbon emissions by 2050 in the industrial sector will be achieved through implementing a variety of approaches including, but not limited to, improved energy efficiency, next generation reactors and separations, electrification, process heating innovations, and low carbon feedstocks. As industry transforms to meet the needs of decarbonization, clean hydrogen production and carbon capture technologies will play critical roles in minimizing environmental and climate impacts across the industrial sector—this aligns with the Industrial Decarbonization Roadmap's Low-carbon fuels and feedstocks and energy sources (LCFFES) and CCUS pillars.[43] To that end, IEDO is working in collaboration with the Office of Fossil Energy and Carbon Management (FECM) and the Hydrogen and Fuel Cell Technologies Office (HFTO) to accelerate adoption of technologies in hard-to-decarbonize industries.

Hydrogen can be produced from diverse domestic resources, including fossil resources (natural gas, oil, and coal), low carbon and renewable resources (such as biomass), or by splitting water with clean electricity sources. Currently, 10 MMT of hydrogen is produced annually in the U.S., and this production can be a significant source of emissions, particularly in the chemicals and refining subsectors. For example, approximately 90% of the GHG emissions associated with the production of ammonia are related to hydrogen generation. The U.S. Government and DOE are pursuing several initiatives to reduce emissions associated with hydrogen production and increase the applicability to broad economy-wide decarbonization strategies. The U.S. National Clean Hydrogen Strategy and Roadmap[44] plans for 50 MMT/yr of clean hydrogen production by 2050, the Regional Clean Hydrogen Hubs Program is forming the foundation of a national clean hydrogen network,[45] and the U.S. DOE Hydrogen Shot[46] sets a goal of $1 per 1 kg of clean hydrogen in 1 decade. With these goals, it is estimated that U.S. industry has potential for a 10% CO_2 emission reduction by 2050 while creating 100,000 jobs by 2030 – unlocking new markets, creating more clean energy jobs, reducing emissions, and positioning America to compete in clean energy markets on a global scale.

Similarly, the capture of CO_2 from industrial point sources is expected to play a critical role in the decarbonization of several industrial subsectors. The U.S. DOE's

[42] U.S. Energy Information Administration, "Annual Energy Outlook 2021 with Projections to 2050"
[43] DOE, Industrial Decarbonization Roadmap, 2022, https://doi.org/10.2172/1961393
[44] U.S. Department of Energy, "DOE National Clean Hydrogen Strategy and Roadmap", https://www.hydrogen.energy.gov/library/roadmaps-vision/clean-hydrogen-strategy-roadmap
[45] DOE, OCED Regional Clean Hydrogen Hubs, https://www.energy.gov/oced/regional-clean-hydrogen-hubs-0
[46] DOE, Hydrogen Shot, https://www.energy.gov/eere/fuelcells/hydrogen-shot

2022 Industrial Decarbonization Roadmap[47] predicts that CCUS pillar will be a source of long-term emission reductions across the U.S. industrial sector. Similarly, the International Energy Agency (IEA) 2020 World Energy Outlook suggests that CCUS could reduce approximately 15% of cumulative emissions world-wide and the Intergovernmental Panel on Climate Change (IPCC) AR6 Working Group III Report further confirms the need for the deployment of carbon dioxide removal to achieve global net zero goals. In 2022, 117 facilities reported capture of CO_2 at industrial sources (primarily ethanol, natural gas processing, and ammonia production facilities) to supply 18.1 MMT CO_2 into the economy.[48] While progress has been made, it remains critical to develop lower cost, highly efficient technologies for carbon capture at industrial point sources which pair and optimize technologies with specific industrial processes.

To decarbonize industry, it is critical to bridge the gap from research, development, and demonstration to rapid adoption in operational environments. Pre-FEED refers to a stage of project development – after basic feasibility study and conceptual design – which develops the initial concept into a detailed design basis and scope of work to ensure a project is economically and technically feasible as well as accurately estimated. Decarbonization technology projects at this stage must consider site-specific risks and impacts including integration with existing equipment and environmental justice-related impacts to local communities.

Given the scope and complexity of the U.S. industrial sector, this topic area is intended to support the development of industrial decarbonization projects which integrate clean hydrogen production or carbon capture with site-specific industrial processes. Specifically, there is opportunity to reduce barriers for accelerated industrial adoption by de-risking demonstrations within operational environments for innovative decarbonization technologies currently at TRL 6-7.

Topic 6 Technology Focus: Within this topic, IEDO, HFTO, and FECM are soliciting pre-FEED studies that support the development of decarbonized industrial processes. Successful projects will allow industry to explore opportunities which integrate clean hydrogen or carbon capture with industrial processes, improve understanding of the site-specific cost and emissions impacts, and educate the industrial sector on a technology's potential for carbon abatement. All applications should propose integration into existing industrial processes or greenfield facilities and target technologies that are ready for commercial deployment or large-scale demonstration.

[47] DOE, Industrial Decarbonization Roadmap, 2022, https://doi.org/10.2172/1961393

[48] U.S. Environmental Protection Agency, Greenhouse Gas Reporting Program. "Supply, Underground Injection, and Geologic Sequestration of Carbon Dioxide"

Applicants can evaluate various process design strategies which explore scenarios that qualify for federal and state incentives, including the 45V and 45Q tax credits,[49,50] and tradeoffs such as co-located hydrogen production with end-use, thermal integration, electrical integration with the grid or behind the meter connections, and hydrogen storage options.

Area of Interest 1 – Integration of Clean Hydrogen in the Industrial Sector: This area of interest is soliciting pre-FEED studies for the integration of clean hydrogen in the industrial sector. Hard-to-decarbonize industrial processes such as ammonia, methanol, iron reduction, and sustainable aviation fuels (SAF) all offer significant carbon abatement potential through integration of clean hydrogen. However, there are many unknowns related to the cost required to integrate clean hydrogen and design tradeoffs which can impact industrial adoption of clean hydrogen.

For **AOI 1**, clean hydrogen must be the sole decarbonization approach to be included in the pre-FEED study. Technologies of interest must include hydrogen as a feedstock, reductant, or process chemical. Of particular interest are systems that integrate production, storage, and use within the industrial site, accommodate clean hydrogen production from intermittent renewables through novel storage and/or end-use flexibility, thermal integration with high-temperature electrolysis, and innovative end-use process design. While all potential industrial end-uses of clean hydrogen are allowed, those with the highest decarbonization potential for the industrial sector will be prioritized. Projects should enable >85% emission reduction relative to the existing process baseline.

Not of interest: applications that include hydrogen production facilities only (without integration with industrial end-uses), hydrogen for industrial heat, hydrogen for oil refining, on-site integration of steam methane or autothermal reformers (these systems can apply under AOI 3), industrial end-use design unrelated to clean hydrogen integration, carbon capture equipment design, or power sector applications/use. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

Area of Interest 2 – Carbon Capture for the Industrial Sector: This area of interest is soliciting pre-FEED studies of transformational carbon capture systems that separate CO_2 from major process streams at existing, point source, domestic industrial

[49] DOE, Financial Incentives for Hydrogen and Fuel Cell Projects. https://www.energy.gov/eere/fuelcells/financial-incentives-hydrogen-and-fuel-cell-projects

[50] Building a Clean Energy Economy: A Guidebook to the Inflation Reduction Act's Investments in Clean Energy and Climate Action. https://www.whitehouse.gov/wp-content/uploads/2022/12/Inflation-Reduction-Act-Guidebook.pdf

facilities. Applications are encouraged to include facilities located near CarbonSAFE project locations, if carbon storage is considered as the off-take option.[51] For **AOI 2**, carbon capture must be the sole decarbonization approach to be included in the pre-FEED study. Proposed advanced carbon capture systems should have already attained TRL 6 or above based on previous developments for industrial application or power generation. Justification for the TRL designation should be included within the appropriate state point data table, as illustrated in Appendix G. State point data tables are required in the Topic Area 6 Area of Interest 2 full application submission and should be saved in a single PDF using the following convention for the title "controlNumber_LeadOrganization_State Point Data". These systems should separate more than 100,000 tonne/year net CO_2 with at least 95% capture efficiency.

The industrial sectors of interest for this AOI include aluminum, ammonia, cement, glass, iron-steel, lime, chemicals, forest products (e.g., pulp and paper), soda ash, and liquified natural gas (LNG). Applicants are required to identify and propose plausible options for CO_2 transportation, long duration carbon storage (i.e., geological storage or sub-surface mineralization) or CO_2 conversion/utilization into long-lasting products (e.g., synthetic aggregates, concrete, biochar, durable carbon products). CO_2 pressure and CO_2 quality and quantity at the carbon capture plant "gate" should meet the requirements of the intended transport and storage solutions. If proposed, advanced CO_2 conversion/utilization systems should have already attained TRL 6 or above. However, the pre-FEED study should not include work to design the systems for CO_2 transportation, long duration carbon storage, or CO_2 conversion/utilization systems.

Not of Interest: Areas considered to be outside the scope of **AOI 2** are listed below. Applications that propose work in these areas will be considered non-responsive and will not be evaluated.

- R&D to advance the maturation of post-combustion and pre-combustion carbon capture technologies, apart from the required design of a carbon capture system;
- R&D to advance the maturation of CO_2 conversion technologies;
- R&D on Direct Air Capture (DAC) approaches;
- R&D on CO_2 storage technologies, apart from engineering analysis to support the required design of a carbon capture system;
- R&D on advanced power cycles (e.g., supercritical CO_2 cycle, oxy-combustion and chemical looping configurations);
- R&D on technologies to increase CO_2 concentration in the flue gas (e.g., exhaust

[51] NETL, CarbonSAFE, https://netl.doe.gov/node/7677

gas recirculation), other than engineering analysis;

- R&D on CO_2 compression technologies, apart from engineering analysis to support the required design of a carbon capture system;
- Algae-based carbon capture technologies;
- Materials screening (computational or experimental) of novel sorbents, solvents, membrane or electrochemical materials;
- R&D to advance the maturation of carbon dioxide removal technologies such as direct air capture or biomass with carbon capture (BECCS) technologies or enhanced weathering; and
- Submissions that propose a host site that is not located in the United States.

Area of Interest 3 – Integrated Process Pre-FEED: This area of interest is soliciting pre-FEED studies that support the integration of multiple innovative technologies across an industrial process to achieve a combined emissions reduction > 95%. Projects may consider technologies including, but not limited to, carbon capture, clean hydrogen production and storage, energy efficiency, electrification, process feed substitutions, and process heating innovations (e.g., hydrogen). Applications are encouraged to include facilities located near DOE Hydrogen Hub[52], CarbonSAFE (if carbon storage is considered as the off-take option), or Industrial Decarbonization host sites. If applicable, the carbon capture component proposed in **AOI 3** should have already attained TRL 6 or above based on previous developments for industrial application or power generation. Justification for the TRL designation associated with carbon capture should be included within the appropriate state point data table, as illustrated in Appendix G. State point data tables are required in the Topic Area 6 Area of Interest 3 full application submission and should be saved in a single PDF using the following convention for the title "controlNumber_LeadOrganization_State Point Data". Industrial sectors of interest include: (i) chemical production excluding ethanol production, (ii) mineral production (e.g., cement and lime), (iii) iron and steel production, and (iv) forest products (e.g., pulp and paper).

Applications should demonstrate progress toward achieving a minimum 15% reduction in product cost or significantly improved carbon abatement compared to a single-technology decarbonization approach (e.g., a current state-of-the-art, retrofit, carbon capture approach, or purely hydrogen-focused approach). DOE is not interested in funding applications which are exclusively focused on either clean hydrogen or carbon capture technologies where no additional innovation or integration is present.

[52] DOE, OCED Regional Clean Hydrogen Hubs, https://www.energy.gov/oced/regional-clean-hydrogen-hubs-0

AOIs 1, 2, 3 seek Pre-FEED studies which are site-specific and target technologies starting at minimum TRL 6. The pre-FEED study will consist of process design and optimization, LCA, TEA, HAZOP (hazard operability) analysis (including hydrogen safety, if applicable), final design specifications, and other analyses, such as impacts of federal and state incentives (e.g., 45V and 45Q). To facilitate technology transfer, successful applications will be required to disseminate high-level findings, TEA, and LCA to the public in settings such as program specific annual review meetings.

The proposed project must be consistent with AACE (Association of the Advancement of Cost Engineering) Class 4 designs.[53] As such, process design, engineering, and optimization should have a project maturity level of 1-15% and cost estimate accuracy should be within -15% to -30% on the low side and +20% to +50% on the high side. Final design specifications should include the following:

- Process flow diagrams (PFD), process model scale-up, utility flow, piping and instrument (P&ID) diagrams, heat and mass balance, plot plan, final layout drawings, engineered process and utility equipment lists;
- Equipment sizing with kinetic, heat, and mass transfer data as well as justification for materials of construction;
- Vendor quotes, project execution plans, resourcing and workforce plans, constructability review;
- Balance of plant engineering -- utilities, waste treatment, energy sources, storage;
- Method / amount of energy storage or back-up power when renewable electricity is not available;
- Environment, health & safety analysis;
- HAZOP; and
- Storage field development plan, in cases of underground hydrogen storage.

LCA and pre-FEED should be site-specific leveraging existing tools such as GREET®[54] or analysis tools developed by FECM/NETL.[55] The LCA and pre-FEED should identify efficiency improvements compared to applicant-defined baseline and cost impacts compared to applicant defined competitor. Additional analysis can include the following:

- Identification of documentation that would eventually be required by regulatory agencies in order to secure permits
- Environmental information volume to support NEPA process
- Market analysis
- Workforce analysis

[53] Association of the Advancement of Cost Engineering, "Cost Estimate Classification System – As applied in Engineering Procurement and Construction for the Process Industries"
[54] ANL, Energy Systems and Infrastructure Analysis. https://greet.anl.gov/
[55] NETL, Strategic Systems Analysis and Engineering Strategic Systems Analysis and Engineering | netl.doe.gov

Within the Community Benefits Plan, applications are encouraged to discuss energy and environmental justice-related impacts of their technologies, if they were fully deployed following the pre-FEED study. Applicants should consider acute and cumulative impacts to workers and neighboring communities and are encouraged to develop plans that engage with the communities surrounding speculative siting locations. For example, applicants are encouraged to identify if a speculative site is located within a disadvantaged community, engage surrounding communities to inform members of technology design and potential benefits, and solicit community feedback and partnership. To support the goal of building a clean and equitable energy economy, the projects are expected to: support meaningful community and labor engagement; invest in America's workforce; advance diversity, equity, inclusion, and accessibility; and contribute to the President's Justice40 Initiative that 40% of the overall benefits of certain federal investments flow to disadvantaged communities.

Topic 6 Candidate Metrics & Targets: Technologies assessed under this topic must be clearly specified in the application and assessed at a specific location. Applications must show potential for more than 85% reduction in greenhouse gas emissions for AOI 1 and 95% for AOIs 2 and 3 relative to an unmitigated industrial process that generates the same quantity of product. Applications will be evaluated based on potential to reduce greenhouse gas emissions annually within industrial subsectors at the national level if broadly implemented.

Applications must clearly justify the TRLs assigned. Successful applicants will be required to have a periodic assessment of their progress during the award to evaluate potential impacts. Applications must clearly explain how the proposed technology will meet the following metrics including defining appropriate benchmarks or baselines:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce greenhouse gas Intensity (AOI 1)	% carbon intensity change as measured by ton CO_2e/kg product	>85%	>100%	*Applicant Defined*
Reduce greenhouse gas Intensity (AOI 2)	reduction in carbon emissions for a specific industrial process stream being treated	>95%	>100%	*Applicant Defined*
Reduce greenhouse gas Intensity (AOI 3)	% facility-wide carbon intensity change as measured by ton CO_2e/kg product	>95%	>100%	*Applicant Defined*
Energy consumption (AOI 1, 2, 3)	Btu/kg product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Additional metrics and critical criteria that will lead to successfully meeting the goals above should also be identified. Applications must identify and justify appropriate metrics for their technology and clearly indicate how the proposed innovation will satisfy them. Relevant benchmarks/baselines, minimum targets, and stretch targets should be included for each metric; these can also include co-benefits, for instance, a reduction in criteria air pollutants. Examples of applicant-identified metrics include the following:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce cost	Unit (product mass or part basis) cost vs. state of the art	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Reduce criteria air pollutant emissions	% pollutant change as measured by ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Reduce hazardous by-products or solvents	% reduction from current typical process	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

C. Applications Specifically Not of Interest

The following types of applications, in addition to those identified in each Topic, 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 Sections 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).
- See topic area descriptions for other specific areas not of interest.

D. R&D Community Benefits Plan

DOE is committed to investing in research and development (R&D) of innovations that deliver benefits to the American public and lead to commercialization of technologies and products that foster sustainable, resilient, and equitable access to clean energy. Further, DOE is committed to supporting the development of more diverse, equitable, inclusive, and accessible workplaces to help maintain the nation's leadership in science and technology.

To support the goal of building a clean and equitable energy economy, projects funded under this FOA are expected to (1) advance diversity, equity, inclusion, and accessibility (DEIA); (2) contribute to energy equity; and (3) invest in America's workforce. To ensure these objectives are met, applications must include a Research and Development Community Benefits Plan (R&D Community Benefits Plan) that addresses the three objectives stated above. See Section IV.D.xvi. and Appendix F for the more information on the R&D Community Benefits Plan content requirements.

E. Authorizing Statutes

The programmatic authorizing statute is §6003 of the Energy Act of 2020, as codified at 42 U.S.C. § 17113 et seq.

Awards made under this announcement will fall under the purview of 2 CFR Part 200 as supplemented by 2 CFR Part 910.

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make a total of approximately $83,100,000 of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 25 – 49 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $500,000 and $7,000,000.

EERE may issue awards in one, multiple, or none of the following topic areas:

Topic Area Number	Topic Area Title	Anticipated Number of Awards	Project Tier	Anticipated Period of Performance (months)	Anticipated Minimum Award Size for Any One Individual Award (Fed Share)	Anticipated Maximum Award Size for Any One Individual Award (Fed Share)	Approximate Total Federal Funding Available for All Awards
1	Decarbonizing Chemicals & Fuels	3 – 5	Tier 1	24 – 36	$1.1 M	$3 M	$71.1M
			Tier 2	24 – 36	$3.1 M	$7 M	
2	Decarbonizing Iron and Steel	4 – 7	Tier 0	12 – 18	$0.5 M	$1 M	
			Tier 1	24 – 36	$1.1 M	$3 M	
			Tier 2	24 – 36	$3.1 M	$7 M	
3	Decarbonizing Food and Beverage Products	3 – 8	Tier 0	12 – 18	$0.5 M	$1 M	
			Tier 1	24 – 36	$1.1 M	$3 M	
			Tier 2	24 – 36	$3.1 M	$7 M	
4	Decarbonizing Building and Infrastructure Materials – Cement and Concrete, Asphalt, and Glass	3 – 10	Tier 0	12 – 18	$0.5 M	$1 M	
			Tier 1	24 – 36	$1.1 M	$3 M	
			Tier 2	24 – 36	$3.1 M	$7 M	
5	Decarbonizing Forest Products	3 – 8	Tier 0	12 – 18	$0.5 M	$1 M	
			Tier 1	24 – 36	$1.1 M	$3 M	
			Tier 2	24 – 36	$3.1 M	$7 M	
6	Industrial Pre-FEED Studies	8 – 10	Pre-FEED	12 – 18	$0.5 M	$1.5 M	$12.0M

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

For Tier 0 and Pre-FEED project applications, EERE anticipates making awards that will run from 12 months up to 18 months, comprised of one budget period. Justification must be provided if the budget period exceeds 12 months.

For Tier 1 and Tier 2 project applications, EERE anticipates making awards that will run from 24 months up to 36 months, comprised of one or more budget periods.

For Tier 1 and Tier 2, project continuation will be contingent upon several elements, including satisfactory performance and Go/No-Go decision. For a complete list, see Section VI.B.xiii.

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 U.S. 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)[56]

In some 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. See Section III.E.

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.

A. Eligible Applicants

i. Domestic Entities

Domestic entities are eligible to apply as prime recipient and subrecipients. The following types of domestic entities are eligible to participate as a prime recipient or subrecipient of this FOA:

1. Institutions of higher education;
2. For-profit entities; and
3. Nonprofit entities

To qualify as a domestic entity, the entity must be organized, chartered, or incorporated (or otherwise formed) under the laws of a particular state or territory of the United States; have majority domestic ownership and control; and have a physical place of business in the United States.

State, local, and tribal government entities are eligible to participate as a subrecipient.

DOE/NNSA FFRDCs are eligible to apply for funding as a prime recipient or subrecipient.

Non-DOE/NNSA FFRDCs are eligible to participate as a subrecipient but are not eligible to apply as a prime recipient.

[56] FFRDCs are public-private partnerships that conduct research for the U.S. government. A listing of FFRDCs can be found at http://www.nsf.gov/statistics/ffrdclist/.

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

Entities banned from doing business with the U.S. government such as entities debarred, suspended, or otherwise excluded from or ineligible for participating in federal programs are not eligible.

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.

ii. Foreign Entities

In limited circumstances, EERE may approve a waiver to allow a foreign entity to participate as a prime recipient or subrecipient. A foreign entity may submit a Full Application to this FOA, but the Full Application must be accompanied by an explicit written waiver request. Likewise, if the applicant seeks to include a foreign entity as a subrecipient, the applicant must submit a separate explicit written waiver request in the Full Application for each proposed foreign subrecipient.

Appendix B lists the information that must be included in a foreign entity waiver request. The applicant does not have the right to appeal EERE's decision concerning a waiver request.

B. Cost Sharing

Applicants are bound by the cost share proposed in their Full Applications if selected for award negotiations.

For Tier 0, Tier 1, and Pre-FEED project applications, the cost share must be at least 20% of the total project costs. The Tier 2 project applications must be at least 50% of the total project costs. [57]

To help applicants calculate proper cost share amounts, EERE has included a cost share information sheet and sample cost share calculation as Appendix A to this FOA.

i. Legal Responsibility

Although the cost share requirement applies to the entire project, 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

[57] Energy Policy Act of 2005, Pub. L. 109-58, sec. 988. Also see 2 CFR 200.306 and 2 CFR 910.130 for additional cost sharing requirements

funding agreement is terminated prior to the end of the project period, the prime recipient is required to contribute at least the cost share percentage of total expenditures incurred through the date of termination.

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

ii. Cost Share Allocation

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

iii. Cost Share Types and Allowability

Every cost share contribution must be allowable under the applicable federal cost principles, as described in Section IV.J.i. of the FOA. In addition, cost share must be verifiable upon submission of the Full Application. Cost share may be provided in the form of cash or cash equivalents, or in-kind contributions. Cost share must come from non-federal sources (unless otherwise allowed by law), such as project participants, state or local governments, or other third-party financing. Federal financing, such as DOE Loan Guarantee, cannot be leveraged by applicants to provide the required cost share or otherwise support the same scope that is proposed under a project.

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 federal government did not provide the funding to the state or local government.

The recipient may not use the following sources to meet its cost share obligations:

- 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 supplemented by 2 CFR 910.130 for additional cost sharing requirements

iv. Cost Share Contributions by FFRDCs

Because FFRDCs are funded by the federal government, costs incurred by FFRDCs generally may not be used to meet the cost share requirement. FFRDCs may contribute cost share only if the contributions are paid directly from the contractor's Management Fee or another non-federal source.

v. Cost Share Verification

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

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

vi. Cost Share Payment

DOE 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).

In limited circumstances, and where it is in the government's interest, the 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

All applicant submissions must:

- Comply with the applicable content and form requirements listed in Section IV. of the FOA;
- Include all required documents;
- Be uploaded and submitted to EERE eXCHANGE https://eere-eXCHANGE.energy.gov; and
- Be submitted by the deadline stated in the FOA.

EERE will not review or consider submissions submitted through means other than EERE eXCHANGE, submissions submitted after the applicable deadline, or incomplete submissions.

Applicants are strongly encouraged to submit their Concept Papers, Full Applications, and Replies to Reviewer Comments at least 48 hours in advance of the submission deadline. Under normal conditions (i.e., at least 48 hours before the submission deadline), applicants should allow at least one 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 will not extend the submission deadline for

applicants that fail to submit required information by the applicable deadline due to server/connection congestion.

D. Responsiveness Criteria

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

E. Other Eligibility Requirements

i. Requirements for DOE/NNSA FFRDCs Listed as the Applicant

A DOE/NNSA FFRDC is eligible to apply for funding under this FOA if its cognizant Contracting Officer provides written authorization and this authorization is submitted with the application.

The following wording is acceptable for the 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.

If a DOE/NNSA FFRDC is selected for award negotiation, the proposed work will be authorized under the DOE work authorization process and performed under the laboratory's Management and Operating (M&O) contract.

ii. Requirements for DOE/NNSA and Non-DOE/NNSA FFRDCs 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:

a. 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.

b. 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.

c. Funding, Cost Share, and Subaward with FFRDCs
DOE will not fund DOE/NNSA FFRDCs participating as a subrecipient through the DOE field work authorization process. DOE will not fund non-DOE/NNSA FFRDCs through an interagency agreement with the sponsoring agency. Therefore, the prime recipient and FFRDC are responsible for entering into an appropriate subaward that will govern, among other things, the funding of the FFRDC portion of the work from the prime recipient under its DOE award. Such an agreement must be entered into before any project work begins.

The applicant should prepare the budgets using rates appropriate for funding the FFRDCs through subawards. 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.

d. 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.

e. Limit on FFRDC Effort
The scope of work to be performed by the FFRDC should not be more significant than the scope of work to be performed by the applicant.

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 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 apply in response to this FOA lies solely with the applicant.

IV. Application and Submission Information

A. Application Process

The application process will include two submission phases: Concept Paper, and Full Application. **Only applicants who have submitted an eligible Concept Paper will be eligible to submit a Full Application**.

All submissions must conform to the form and content requirements described below, including maximum page lengths.

- 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" paper with margins not less than one inch on every side. Use Calibri 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;
- A **control number** will be issued when an applicant begins the EERE eXCHANGE application process. The control number must be included with all application documents. Specifically, the control number must be prominently displayed on the upper right corner of the header of every page and included in the file name (i.e., *Control Number_Applicant Name_Full Application*);
- 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.

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.

Applicants who experience technical difficulties with submission PRIOR to the FOA deadline should contact the EERE eXCHANGE helpdesk for assistance (EERE-eXCHANGESupport@hq.doe.gov).

B. Application Forms

The application forms and instructions are available at EERE Funding Application and Management Forms and on EERE eXCHANGE. To access these materials on EERE eXCHANGE, 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 50MB. Files larger than 50MB cannot be uploaded and hence cannot be submitted for review. If a file is larger than 50MB 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:
TechnicalVolume_Part_1
TechnicalVolume_Part_2

DOE will not accept late submissions that resulted from technical difficulties due to uploading files that exceed 50MB.

C. Content and Form of the Concept Paper

Each Concept Paper must be limited to a single concept or technology. The Concept Paper must conform to the requirements listed below, including the stated page limits.

Section	Page Limit	Description
Cover Page	1 page maximum	The cover page should include the project title, the specific announcement Topic Area being addressed (if applicable), the project tier applying for (e.g., Tier 0, Tier 1, Tier 2, or Pre-FEED), both the technical and business points of contact, names of all team member organizations, the project location(s), and any statements regarding confidentiality.
Technology Description	4 pages maximum	Applicants are required to succinctly describe: • 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; • How the proposed location of the proposed project will support technology development and long-term success; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project.
Addendum	1 pages maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed project team, including: • Whether the Principal Investigator (PI) and project team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has 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; and • 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. See Section VI.A.

D. Content and Form of the Full Application

Applicants must complete the following application forms found at EERE Funding Application and Management Forms and on the EERE eXCHANGE website at https://eere-eXCHANGE.energy.gov/.

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.

i. Full Application Content Requirements

Each Full Application must be limited to a single concept. Full Applications must conform to the following requirements and must not exceed the stated page limits.

Component	File Format	Page Limit	File Name
SF-424: Application for Federal Assistance	PDF	n/a	ControlNumber_LeadOrganization_App424
Technical Volume	PDF	20	ControlNumber_LeadOrganization_TechnicalVolume
Technical Volume – CONFIDENTIAL *(Optional)*	PDF	20	ControlNumber_LeadOrganization_TechnicalVolume_CONFIDENTIAL
Resumes	PDF	3 pages each	ControlNumber_LeadOrganization_Resumes
Letters of Commitment	PDF	1 page each	ControlNumber_LeadOrganization_LOCs
Statement of Project Objectives	MS Word	10	ControlNumber_LeadOrganization_SOPO
Statement of Project Objectives – CONFIDENTIAL *(Optional)*	MS Word	10	ControlNumber_LeadOrganization_SOPO_CONFIDENTIAL
Community Benefits Plan	PDF	3	ControlNumber_LeadOrganization_CBP
Budget Justification Workbook	MS Excel	n/a	ControlNumber_LeadOrganization_Budget_Justification
Summary/Abstract for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary
Summary Slide	MS PowerPoint	1	ControlNumber_LeadOrganization_Slide
Subrecipient Budget Justification	MS Excel	n/a	ControlNumber_LeadOrganization_Subrecipient_Budget_Justification
DOE Work Proposal for FFRDC, (see DOE O 412.1A, Attachment 2)	PDF	n/a	ControlNumber_LeadOrganization_WP
Authorization from cognizant Contracting Officer for FFRDC	PDF	n/a	ControlNumber_LeadOrganization_FFRDCAuth
SF-LLL Disclosure of Lobbying Activities	PDF	n/a	ControlNumber_LeadOrganization_SF-LLL
Waiver Requests	PDF	n/a	ControlNumber_LeadOrganization_Waiver

Open-source Software Distribution Plan (if applicable)	PDF	n/a	ControlNumber_LeadOrganization_OSSDP
Current and Pending Support	PDF	n/a	ControlNumber_LeadOrganization_CPS
Transparency of Foreign Connections	PDF	n/a	ControlNumber_LeadOrganization_TFC
Potentially Duplicative Funding Notice	PDF	n/a	ControlNumber_LeadOrganization_PDFN
State Point Data Table. Required for Topic Area 6, Areas of Interest 2 & 3 **ONLY**	PDF	n/a	ControlNumber_LeadOrganization_State Point Data

Note: The maximum file size that can be uploaded to the EERE eXCHANGE website is 50MB. See Section IV.B.

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

ii. SF-424: Application for Federal Assistance

Applicants must complete the SF-424 Application for Federal Assistance, which is available on EERE Funding Application and Management Forms.

Effective January 1, 2020, the System for Award Management (SAM) is the central repository for common government-wide certifications and representations required of Federal grants recipients. As registration in SAM is required for eligibility for a federal award and registration must be updated annually, Federal agencies use SAM information to comply with award requirements and avoid increased burden and costs of separate requests for such information, unless the recipient fails to meet a federal award requirement, or there is a need to make updates to their SAM registration for other purposes.

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_424".

iii. Technical Volume

The Technical Volume must conform to the following content and form requirements. This volume must address the technical review criteria as discussed in Section V. of the FOA.

Save the Technical Volume in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_TechnicalVolume".

If submitting an additional confidential version of the Technical Volume, save the confidential Technical Volume in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_TechnicalVolume_CONFIDENTIAL"

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 20 pages, including the cover page, table of contents, and all citations, charts, graphs, maps, photos, or other graphics, and must include all information in the table below. The applicant should consider the weighting of each of the technical review 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.

Technical Volume Content Requirements

SECTION/PAGE LIMIT	DESCRIPTION
Cover Page	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), the project tier applying for (e.g., Tier 0, Tier 1, Tier 2, or Pre-FEED), both the technical and business points of contact, names of all team member organizations, names of the PI, Senior/Key Personnel and their organizations, the project location(s), and any statements regarding confidentiality.

Project Overview (Approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: The applicant should discuss the background of its organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact (Approximately 45% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state-of-the-art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state-of-the-art/technical baseline if the project is successful.
Workplan and Market Transformation Plan (Approximately 25% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Tasks, Go/No-Go Decision Points, and Project Schedule. A detailed SOPO is separately requested and should include detailed descriptions of the work breakdown structure (WBS), tasks, subtasks, milestones, and Go/No-Go decision points. The Workplan should serve as a high-level complement to the SOPO; it is not intended to be duplicative of the SOPO. 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.
	• Task and Milestone 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 around budget periods and provide a narrative description of how the tasks to be performed contribute to achievement of the final project goal(s). The Workplan shall contain a concise summary of the activities to be conducted over the life of the project and should summarize major SMART (Specific, Measurable, Achievable, Relevant, and Timely) milestones that demonstrate success over the course of the project. The summary provided should be consistent with the SOPO. The SOPO will contain the complete, detailed description of the WBS and tasks.
	• Go/No-Go Decision Points (See Section VI.B.xiii. for more information on the Go/No-Go Review): The applicant should provide a summary of project-wide Go/No-Go decision points at appropriate points in the Workplan. 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.xiii. 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.
	• Buy America Requirements for Infrastructure Projects: Within the first two pages of the Workplan, include a short statement on whether the project will involve the construction, alteration, and/or repair of infrastructure in the United States. See Appendix C for applicable definitions and other information to inform this statement.
	• Project Management: The applicant should discuss the team's proposed management plan, including the following:
	  ○ The overall approach to and organization for managing the work
	  ○ The roles of each project team member

	○ Any critical handoffs/interdependencies among project team members ○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices ○ The approach to project risk management ○ A description of how project changes will be handled ○ If applicable, the approach to Quality Assurance/Control ○ How communications will be maintained among project team members • Market Transformation Plan: The applicant should provide a market transformation plan, including the following: ○ Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan ○ Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, and product distribution.
Technical Qualifications and Resources (Approximately 20% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • A description of the project team's unique qualifications and expertise, including those of key subrecipients; • A description of the project team's existing equipment and facilities, or equipment or facilities already in place on the proposed project site, 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; • Relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives; • The time commitment of the key team members to support the project; • A description of the technical services to be provided by DOE/NNSA FFRDCs, if applicable; • The skills, certifications, or other credentials of the construction and ongoing operations workforce; • For multi-organizational projects, describe succinctly:

	○ The roles and the work to be performed by the PI and Senior/Key Personnel at the prime and sub levels; ○ Business agreements between the applicant and sub; ○ How the various efforts will be integrated and managed; ○ Process for making decisions on technical direction; ○ Publication arrangements; ○ Intellectual property issues; and ○ Communication plans

iv. Resumes

A resume provides information reviewers can use to evaluate an individual's skills, experience, and potential for leadership within the scientific community. Applicants must submit a resume (limited to three pages) for each Principal Investigator and Senior/Key Personnel that includes the following:

1. Contact information;
2. Education and training: Provide name of institution, major/area, degree, and year for undergraduate, graduate, and postdoctoral training;
3. Research and professional experience: Beginning with the current position, list professional/academic positions in chronological order with a brief description. List all current academic, professional, or institutional appointments, foreign or domestic, at the applicant institution or elsewhere, whether or not remuneration is received, and, whether full-time, part-time, or voluntary;
4. Awards and honors;
5. A list of up to 10 publications most closely related to the proposed project. For each publication, identify the names of all authors (in the same sequence in which they appear in the publication), the article title, book or journal title, volume number, page numbers, year of publication, and website address if available electronically. Patents, copyrights, and software systems developed may be provided in addition to or substituted for publications. An abbreviated style such as the Physical Review Letters (PRL) convention for citations (list only the first author) may be used for publications with more than 10 authors;
6. Synergistic activities: List up to five professional and scholarly activities related to the proposed effort; and
7. There should be no lapses in time over the past 10 years or since age 18, whichever period is shorter.

As an alternative to a resume, it is acceptable to use the biographical sketch format approved by the National Science Foundation (NSF). The biographical

sketch format may be generated by the Science Experts Network Curriculum Vita (SciENcv), a cooperative venture maintained at https://www.ncbi.nlm.nih.gov/sciencv/, also available at https://www.nsf.gov/bfa/dias/policy/researchprotection/commonform_biographicalsketch.pdf. The use of a format required by another agency is intended to reduce the administrative burden to researchers by promoting the use of common formats.

Save the resumes in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Resumes".

v. Letters of Commitment

Submit letters of commitment from all subrecipient and third-party cost share providers. If applicable, the letter must state that the third party is committed to providing a specific minimum dollar amount or value of in-kind contributions allocated to cost sharing. The following information for each third party contributing to cost sharing should be identified: (1) the name of the organization; (2) the proposed dollar amount to be provided; and (3) the proposed cost sharing type (cash or in-kind contributions). Each letter must not exceed one page.

Save the letters of commitment in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_LOCs".

Letters of support or endorsement for the project from entities that do not have a substantive role in the project will not be accepted.

vi. Statement of Project Objectives (SOPO)

Applicants must complete a SOPO. The SOPO should include detailed descriptions of the WBS, tasks, subtasks, milestones, and Go/No-Go decision points. Descriptions in the SOPO 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.

A SOPO template is available on EERE Funding Application and Management Forms and on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/. The SOPO, including the Milestone Table, must 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 (except in figures or tables, which may be 10-point font).

Save the SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_SOPO".

If submitting an additional confidential version of the SOPO, save the confidential SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_SOPO_CONFIDENTIAL"

vii. Community Benefits Plan

The Community Benefits Plan must set forth the applicant's approach to ensuring the Federal investments advance the following three objectives: (1) DEIA; (2) energy equity; and (3) investing in America's workforce. The below sections set forth the content requirements for the Community Benefits Plan, which addresses each of these objectives. Applicants must address all three sections.

The applicant's Community Benefits Plan must include at least one Specific, Measurable, Attainable, Realistic, and Timely (SMART) milestone per budget period to measure progress on the proposed actions. The Community Benefits Plan will be evaluated as part of the technical review process. If a project is selected, EERE will incorporate the Community Benefits Plan into the award and the recipient must implement its Community Benefits Plan when carrying out its project. EERE will evaluate the recipient's progress throughout the life of the award, including as part of the Go/No-Go review process.

The plan should be specific to the proposed project and not a restatement of an organization's policies. Applicants should describe the future implications or a milestone-based plan for identifying future implications of their research on energy equity, including, but not limited to, benefits for the U.S. workforce. These impacts may be uncertain, occur over a long period of time, and/or have many factors within and outside the specific proposed research. Applicants are encouraged to describe the influencing factors and the most likely workforce and energy equity implications of the proposed research if the research is successful. While some guidance and example activities are provided in Appendix F, applicants are encouraged to leverage promising practices and develop a plan tailored to their project.

The Community Benefits Plan must not exceed three pages. It must be submitted in PDF format using the following convention name for the title: "ControlNumber_LeadOrganization_CBP." This Plan must address the technical review criterion titled, "Community Benefits Plan." See Section V. of the FOA.

The Community Benefits Plan should reflect the technology maturity and proportional to the project scope (e.g., more extensive plans should be proposed

for a Tier 2 application than a Tier 0 application). Community Benefit plans must address the following three sections:

1) **Diversity, Equity, Inclusion, and Accessibility:**
   To building a clean and equitable energy economy, it is important that there are opportunities for people of all racial, ethnic, socioeconomic and geographic backgrounds, sexual orientation, gender identity, persons with disabilities, and those re-entering the workforce from incarceration. This section of the plan must demonstrate how DEIA is incorporated in the technical project objectives. The plan must identify the specific action the applicant would take that integrates into the research goals and project teams. Submitting an institutional DEIA plan without specific integration into the project will be deemed insufficient.

2) **Energy Equity:**
   This section must articulate the applicant's consideration of long-term equity implications of the research. It must identify how the specific project integrates equity considerations into the project design to support equitable outcomes if the innovation is successful. Like cost reductions and commercialization plans, the Community Benefits Plan requires description of the equity implications of the innovation.

3) **Workforce Implications:**
   This section must articulate the applicant's consideration of long-term workforce impacts and opportunities of the research. It must identify how the project is designed and executed to include an understanding of the future workforce needs if the innovation is successful.

See Appendix F for more guidance.

viii. Budget Justification Workbook

Applicants must complete the Budget Justification Workbook, which is available on EERE Funding Application and Management Forms and on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/. Applicants must complete each tab of the Budget Justification Workbook for the project, including all work to be performed by the prime recipient and its subrecipients and contractors. Applicants should include costs associated with required annual audits and incurred cost proposals in their proposed budget documents. The "Instructions and Summary" included with the Budget Justification Workbook will auto-populate as the applicant enters information into the Workbook. Applicants

must carefully read the "Instructions and Summary" tab provided within the Budget Justification Workbook.

Save the Budget Justification Workbook in a single Microsoft Excel file using the following convention for the title "ControlNumber_LeadOrganization_Budget_Justification".

ix. Summary for Public Release

Applicants must submit a one-page summary of their project that is 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).) and the project's commitments and goals described in the Community Benefits Plan. This document must not include any proprietary or business-sensitive information as DOE may make it available to the public after selections are made. The summary must not exceed one page when printed using standard 8.5" x 11" paper with 1" margins (top, bottom, left, and right) with font not smaller than 12-point.

Save the Summary for Public Release in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Summary".

x. Summary Slide

Applicants must provide a single slide summarizing the proposed project. The Summary Slide template is available on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/ and must include 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;
- Topline community benefits;
- Project title, prime recipient, PI, and Senior/Key Personnel information; and
- Requested EERE funds and proposed applicant cost share.

Save the Summary Slide in a single Microsoft PowerPoint file using the following convention for the title "ControlNumber_LeadOrganization_Slide".

xi. 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% of the total work effort, whichever is less. The budget justification must include the same justification information described in the "Budget Justification" section above.

Save each subrecipient budget justification in a Microsoft Excel file using the following convention for the title: "ControlNumber_LeadOrganization_Subrecipient_Budget_Justification".

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

If a DOE/NNSA FFRDC is to perform a portion of the work, the applicant must provide a DOE work proposal (WP) in accordance with the requirements in DOE Order 412.1A, Work Authorization System, Attachment 2, available at: https://www.directives.doe.gov/directives-documents/400-series/0412.1-BOrder-a-chg1-AdmChg.

Save the WP in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_WP".

xiii. Authorization for Non-DOE/NNSA or DOE/NNSA FFRDCs (if applicable)

The federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The use of a FFRDC must be consistent with the contractor's authority under its award.

Save the Authorization in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_FFRDCAuth".

xiv. SF-LLL: Disclosure of Lobbying Activities

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(s) in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_SF-LLL".

xv. Waiver Requests (if applicable)

Foreign Entity Participation
For projects selected under this FOA, all recipients and subrecipients must qualify as domestic entities. See Section III.A. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. Appendix B lists the information that must be included in a waiver request.

Performance of Work in the United States (Foreign Work Waiver Request)
As set forth in Section IV.J.iii., all work for projects selected under this FOA must be performed in 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 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_Waiver".

xvi. Current and Pending Support

Current and pending support is intended to allow the identification of potential duplication, overcommitment, potential conflicts of interest or commitment, and all other sources of support. As part of the application, the principal investigator and Senior/Key Personnel at the applicant and subrecipient level must provide a list of all sponsored activities, awards, and appointments, whether paid or unpaid; provided as a gift with terms or conditions or provided as a gift without terms or conditions; full-time, part-time, or voluntary; faculty, visiting, adjunct, or honorary; cash or in-kind; foreign or domestic; governmental or private-sector; directly supporting the individual's research or indirectly supporting the individual by supporting students, research staff, space, equipment, or other research expenses. All connections with foreign government-sponsored talent recruitment programs must be identified in current and pending support.

For every activity, list the following items:

- The sponsor of the activity or the source of funding;
- The award or other identifying number;
- The title of the award or activity. If the title of the award or activity is not descriptive, add a brief description of the research being performed that would identify any overlaps or synergies with the proposed research;
- The total cost or value of the award or activity, including direct and indirect costs and cost share. For pending proposals, provide the total amount of requested funding;
- The award period (start date through end date); and
- The person-months of effort per year dedicated to the award or activity.

To identify overlap, duplication of effort, or synergistic efforts, append a description of the other award or activity to the current and pending support.

Details of any obligations, contractual or otherwise, to any program, entity, or organization sponsored by a foreign government must be provided on request to either the applicant institution or DOE. Supporting documents of any identified source of support must be provided to DOE on request, including certified translations of any document.

PIs and Senior/Key Personnel must provide a separate disclosure statement listing the required information above regarding current and pending support. Each individual must sign and date their respective disclosure statement and include the following certification statement:

> I, [Full Name and Title], certify to the best of my knowledge and belief that the information contained in this Current and Pending Support Disclosure Statement is true, complete, and accurate. I understand that any false, fictitious, or fraudulent information, misrepresentations, half-truths, or omissions of any material fact, may subject me to criminal, civil, or administrative penalties for fraud, false statements, false claims or otherwise. (18 U.S.C. §§ 1001 and 287, and 31 U.S.C. 3729-3733 and 3801-3812). I further understand and agree that (1) the statements and representations made herein are material to DOE's funding decision, and (2) I have a responsibility to update the disclosures during the period of performance of the award should circumstances change which impact the responses provided above.

The information may be provided in the approved common disclosure format available at Common Form for Current and Pending (Other) Support (nsf.gov).

Save the Current and Pending Support in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_CPS".

Definitions:

Current and pending support – (a) All resources made available, or expected to be made available, to an individual in support of the individual's RD&D efforts, regardless of (i) whether the source is foreign or domestic; (ii) whether the resource is made available through the entity applying for an award or directly to the individual; or (iii) whether the resource has monetary value; and (b) includes in-kind contributions requiring a commitment of time and directly supporting the individual's RD&D efforts, such as the provision of office or laboratory space, equipment, supplies, employees, or students. This term has the same meaning as the term Other Support as applied to researchers in NSPM-33: For researchers, Other Support includes all resources made available to a researcher in support of and/or related to all of their professional RD&D efforts, including resources provided directly to the individual or through the organization, and regardless of whether or not they have monetary value (e.g., even if the support received is only in-kind, such as office/laboratory space, equipment, supplies, or employees). This includes resource and/or financial support from all foreign and domestic entities, including but not limited to gifts provided with terms or conditions, financial support for laboratory personnel, and participation of student and visiting researchers supported by other sources of funding.

Foreign Government-Sponsored Talent Recruitment Program – An effort directly or indirectly organized, managed, or funded by a foreign government, or a foreign government instrumentality or entity, to recruit science and technology professionals or students (regardless of citizenship or national origin, or whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to incentivize the targeted individual to physically relocate to the foreign state for the above purpose. Some programs allow for or encourage continued employment at United States research facilities or receipt of federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to United States entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement

opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

Senior/Key Personnel – An individual who contributes in a substantive, meaningful way to the scientific development or execution of a research, development, and demonstration (RD&D) project proposed to be carried out with a DOE award.[58]

xvii. Transparency of Foreign Connections

Applicants must provide the following as it relates to the proposed recipient and subrecipients. Include a separate disclosure for the applicant and each proposed subrecipient. U.S. National Laboratories, domestic government entities, and institutions of higher education are only required to respond to items 1, 2 and 9, and if applying as to serve as the prime recipient, must provide complete responses for project team members that are not U.S. National Laboratories, domestic government entities, or institutions of higher education.

1. Entity name, website address, and mailing address;
2. The identity of all owners, principal investigators, project managers, and Senior/Key Personnel who are a party to any *Foreign Government-Sponsored Talent Recruitment Program* of a foreign country of risk (i.e., China, Iran, North Korea, and Russia);
3. The existence of any joint venture or subsidiary that is based in, funded by, or has a foreign affiliation with any foreign country of risk;
4. Any current or pending contractual or financial obligation or other agreement specific to a business arrangement, or joint venture-like arrangement with an enterprise owned by a foreign state or any foreign entity;
5. Percentage, if any, that the proposed recipient or subrecipient has foreign ownership or control;
6. Percentage, if any, that the proposed recipient or subrecipient is wholly or partially owned by an entity in a foreign country of risk;
7. Percentage, if any, of venture capital or institutional investment by an entity that has a general partner or individual holding a leadership role in such entity who has a foreign affiliation with any foreign country of risk;
8. Any technology licensing or intellectual property sales to a foreign country of risk, during the 5-year period preceding submission of the proposal;

[58] Typically, these individuals have doctoral or other professional degrees, although individuals at the masters or baccalaureate level may be considered Senior/Key Personnel if their involvement meets this definition. Consultants, graduate students, and those with a postdoctoral role also may be considered Senior/Key Personnel if they meet this definition.

9. Any foreign business entity, offshore entity, or entity outside the United States related to the proposed recipient or subrecipient;
10. Complete list of all directors (and board observers), including their full name, citizenship and shareholder affiliation, date of appointment, duration of term, as well as a description of observer rights as applicable;
11. Complete capitalization table for your entity, including all equity interests (including LLC and partnership interests, as well as derivative securities). Include both the number of shares issued to each equity holder, as well as the percentage of that series and all equity on a fully diluted basis. Identify the principal place of incorporation (or organization) for each equity holder. If the equity holder is a natural person, identify the citizenship(s). If the recipient or subrecipient is a publicly traded company, provide the above information for shareholders with an interest greater than 5%;
12. A summary table identifying all rounds of financing, the purchase dates, the investors for each round, and all the associated governance and information rights obtained by investors during each round of financing; and
13. An organization chart to illustrate the relationship between your entity and the immediate parent, ultimate parent, and any intermediate parent, as well as any subsidiary or affiliates. Identify where each entity is incorporated.

DOE reserves the right to request additional or clarifying information based on the information submitted.

Save the Transparency of Foreign Connections information in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_TFC."

xviii. Potentially Duplicative Funding Notice

If the applicant or project team member has other active awards of federal funds, the applicant must determine whether the activities of those awards potentially overlap with the activities set forth in its application to this FOA. If there is a potential overlap, the applicant must notify DOE in writing of the potential overlap and state how it will ensure any project funds (i.e., recipient cost share and federal funds) will not be used for identical cost items under multiple awards. Likewise, for projects that receive funding under this FOA, if a recipient or project team member receives any other award of federal funds for activities that potentially overlap with the activities funded under the DOE award, the recipient must promptly notify DOE in writing of the potential overlap and state whether project funds from any of those other federal awards have been, are being, or are to be used (in whole or in part) for one or more of the

identical cost items under the DOE award. If there are identical cost items, the recipient must promptly notify the Contracting Officer in writing of the potential duplication and eliminate any inappropriate duplication of funding.

Save the Potentially Duplicative Funding Notice in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_PDFN."

E. Content and Form of Replies to Reviewer Comments (Optional)

EERE will provide applicants with reviewer comments following the evaluation of all eligible Full Applications. Applicants will have a brief opportunity to prepare a short Reply to Reviewer Comments (Reply). The Reply must not exceed three pages. If a Reply is more than three pages in length, EERE will review only the first three pages and disregard additional pages. Applicants may use the Reply to respond to one or more comments or to supplement their Full Application. The Reply may include text, graphs, charts, or data.

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 if 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 a Reply.

Applicants are not required to submit a Reply to Reviewer Comments. EERE will review and consider each eligible Full Application, even if no Reply is submitted or if the Reply is found to be ineligible.

F. Post Selection Information Requests

If selected for award negotiations, EERE reserves the right to require that selected applicants provide additional or clarifying information regarding the application submissions, the project, the project team, the award requirements, and any other matters related to anticipated award. The following is a list of examples of information that may be required:

- Personnel proposed to work on the project and collaborating organizations (See Section VI.B.xviii. Participants and Collaborating Organizations);
- Current and Pending Support (See Sections IV.D.xvi. and VI.B.xix. Current and Pending Support);
- A Data Management Plan (if applicable) describing how all research data displayed in publications resulting from the proposed work will be digitally accessible at the time of publications, in accordance with Section VI.B.xxii.;
- Indirect cost information;

- Other budget information;
- Letters of Commitment 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);
- Information for the DOE Office of Civil Rights to process assurance reviews under 10 CFR 1040;
- Representation of Limited Rights Data and Restricted Software, if applicable; and
- Environmental Questionnaire.

G. Unique Entity Identifier (UEI) 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) register in the SAM at https://www.sam.gov before submitting an application; (2) provide a valid UEI in the application; and (3) 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 UEI and SAM requirements. If an applicant has not fully complied with the requirements by the time DOE is ready to make a federal award, 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.

NOTE: Due to the high demand of UEI requests and SAM registrations, entity legal business name and address validations are taking longer than expected to process. Entities should start the UEI and SAM registration process as soon as possible. If entities have technical difficulties with the UEI validation or SAM registration process they should use the HELP feature on SAM.gov. SAM.gov will work entity service tickets in the order in which they are received and asks that entities not create multiple service tickets for the same request or technical issue. Additional entity validation resources can be found here: GSAFSD Tier 0 Knowledge Base - Validating your Entity.

H. Submission Dates and Times

All required submissions must be submitted in EERE eXCHANGE no later than 5 p.m. ET on the dates provided on the cover page of this FOA.

I. Intergovernmental Review

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

J. Funding Restrictions

i. Allowable Costs

All expenditures must be allowable, allocable, and reasonable in accordance with the applicable federal cost principles. Pursuant to 2 CFR 910.352, the cost principles in the Federal Acquisition Regulations (48 CFR 31.2) apply to for-profit entities. The cost principles contained in 2 CFR Part 200, Subpart E apply to all entities other than for-profits.

ii. Pre-Award Costs

Applicants selected for award negotiations (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.

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 overrides the requirement 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. 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

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

Save the waiver request(s) in a single PDF file. 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 United States 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.

vii. Build America Buy America Requirements for Infrastructure Projects

Pursuant to the Build America Buy America Act, subtitle IX of BIL (Buy America, or BABA), federally assisted projects that involve infrastructure work, undertaken by applicable recipient types, require that:

- All iron, steel, and manufactured products used in the infrastructure work are produced in the United States; and
- All construction materials used in the infrastructure work are manufactured in the United States.

Whether a given project must apply this requirement is project-specific and dependent on several factors, such as the recipient's entity type, whether the work involves "infrastructure," as defined in Section 70914 of the BIL, and whether the infrastructure in question is publicly owned or serves a public function.

Applicants are strongly encouraged to consult Appendix C of this FOA to determine whether their project may have to apply this requirement, both to make an early determination as to the need of a waiver, as well as to determine what impact, if any, this requirement may have on the proposed project's budget.

Please note that, based on implementation guidance from the Office of Management and Budget issued on April 18, 2022, the Buy America

requirements of the BIL do not apply to DOE projects in which the prime recipient is a for-profit entity; the requirements only apply to projects whose prime recipient is a "non-Federal entity," e.g., a State, local government, Indian Tribe, Institution of Higher Education, or nonprofit organization. Subawards should conform to the terms of the prime award from which they flow; in other words, for-profit prime recipients are not required to flow down these Buy America requirements to subrecipients, even if those subrecipients are non-Federal entities as defined above. Conversely, prime recipients which are non-Federal entities must flow the Buy America requirements down to all subrecipients, even if those subrecipients are for-profit entities. Finally, for all applicants—both non-Federal entities and for-profit entities—DOE is including a Program Policy Factor that the Selection Official may consider in determining which Full Applications to select for award negotiations that considers whether the applicant has made a commitment to procure U.S. iron, steel, manufactured products, and construction materials in its project.

The DOE financial assistance agreement will require each recipient to: (1) fulfill the commitments made in its application regarding the procurement of U.S.-produced products and (2) fulfill the commitments made in its application regarding the procurement of other key component metals and domestically manufactured products that are deemed available in sufficient and reasonably available quantities or of a satisfactory quality at the time of award negotiation. Applicants may seek waivers of these requirements in very limited circumstances and for good cause shown. Further details on requesting a waiver can be found in Appendix C and the terms and conditions of an award.

Applicants are strongly encouraged to consult Appendix C for more information.

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

Pursuant to 2 CFR 200.206, DOE will conduct an additional review of the risk posed by applications submitted under this FOA. Such risk assessment will consider:

1. Financial stability;
2. Quality of management systems and ability to meet the management standards prescribed in 2 CFR 200 as supplemented and adopted by 2 CFR 910;
3. History of performance;
4. Audit reports and findings; and
5. The applicant's ability to effectively implement statutory, regulatory, or other requirements imposed on non-federal entities.

DOE may make use of other publicly available information and the history of an applicant's performance under DOE or other federal agency awards.

Depending on the severity of the findings and whether the findings were resolved, DOE may elect not to fund the applicant.

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.

Further, as DOE invests in critical infrastructure and funds critical and emerging technology areas, DOE also considers possible threats to United States research, technology, and economic security from undue foreign government influence when evaluating risk. If high risks are identified and cannot be sufficiently mitigated, DOE may elect to not fund the applicant. As part of the research, technology, and economic security risk review, DOE may contact the applicant and/or proposed project team members for additional information to inform the review.

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.

xi. Prohibition Related to Foreign Government-Sponsored Talent Recruitment Programs

a. Prohibition

Persons participating in a *Foreign Government-Sponsored Talent Recruitment Program of a Foreign Country of Risk* are prohibited from participating in projects selected for federal funding under this FOA. Should an award result from this FOA, the recipient must exercise ongoing due diligence to reasonably ensure that no individuals participating on the DOE-funded project are participating in a *Foreign Government-Sponsored Talent Recruitment Program of a Foreign Country of Risk*. Consequences for violations of this prohibition will be determined according to applicable law, regulations, and policy. Further, the recipient must notify DOE within five (5) business days upon learning that an individual on the project team is or is believed to be participating in a foreign government talent recruitment program of a foreign country of risk. DOE may modify and add requirements related to this prohibition to the extent required by law.

b. Definitions

1. **Foreign Government-Sponsored Talent Recruitment Program.** An effort directly or indirectly organized, managed, or funded by a foreign government, or a foreign government instrumentality or entity, to recruit science and technology professionals or students (regardless of citizenship or national origin, or whether having a full-time or part-time position). Some foreign government-sponsored talent recruitment programs operate with the intent to import or otherwise acquire from abroad, sometimes through illicit means, proprietary technology or software, unpublished data and methods, and intellectual property to further the military modernization goals and/or economic goals of a foreign government. Many, but not all, programs aim to incentivize the targeted individual to relocate physically to the foreign state for the above purpose. Some programs allow for or encourage continued

employment at United States research facilities or receipt of federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

2. **Foreign Country of Risk.** DOE has designated the following countries as foreign countries of risk: Iran, North Korea, Russia, and China. This list is subject to change.

xii. Affirmative Action and Pay Transparency Requirements

All applicants must comply with all applicable federal labor and employment laws, including but not limited to Title VII of the Civil Rights Act of 1964, the Fair Labor Standards Act, the Occupational Safety and Health Act, and the National Labor Relations Act, which protects employees' right to bargain collectively and engage in concerted activities for the purpose of workers' mutual aid or protection.

All federally assisted construction contracts exceeding $10,000 annually will be subject to the requirements of Executive Order 11246:

(1) Recipients, subrecipients, contractors, and subcontractors are prohibited from discriminating in employment decisions on the basis of race, color, religion, sex, sexual orientation, gender identity, or national origin.

(2) Recipients and contractors are required to take affirmative action to ensure that equal opportunity is provided in all aspects of their employment. This includes flowing down the appropriate language to all subrecipients, contractors, and subcontractors.

(3) Recipients, subrecipients, contractors, and subcontractors are prohibited from taking adverse employment actions against applicants and employees for asking about, discussing, or sharing information about their pay or, under certain circumstances, the pay of their co-workers.

DOL's Office of Federal Contractor Compliance Programs (OFCCP) uses a neutral process to schedule compliance evaluations. Consult OFCCP's Technical

Assistance Guide[59] to gain an understanding of the requirements and possible actions the recipients, subrecipients, contractors, and subcontractors must take. Additional guidance may also be found in the National Policy Assurances, produced by DOE.

xiii. Foreign Collaboration Considerations

a. Consideration of new collaborations with foreign entities, organizations, and governments. The recipient will be required to provide DOE with advanced written notification of any potential collaboration with foreign entities, organizations, or governments in connection with its DOE-funded award scope. The recipient will then be required to await further guidance from DOE prior to contacting the proposed foreign entity, organization, or government regarding the potential collaboration or negotiating the terms of any potential agreement.

b. Existing collaborations with foreign entities, organizations, and governments. The recipient will be required to provide DOE with a written list of all existing foreign collaborations in which has entered in connection with its DOE-funded award scope.

c. Description of collaborations that should be reported. In general, a collaboration will involve some provision of a thing of value to, or from, the recipient. A thing of value includes but may not be limited to all resources made available to, or from, the recipient in support of and/or related to the DOE award, regardless of whether or not they have monetary value. Things of value also may include in-kind contributions (such as office/laboratory space, data, equipment, supplies, employees, students). In-kind contributions not intended for direct use on the DOE award but resulting in provision of a thing of value from or to the DOE award must also be reported. Collaborations do not include routine workshops, conferences, use of the recipient's services and facilities by foreign investigators resulting from its standard published process for evaluating requests for access, or the routine use of foreign facilities by awardee staff in accordance with the recipient's standard policies and procedures.

V. Application Review Information

[59] See OFCCP's Technical Assistance Guide at: https://www.dol.gov/sites/dolgov/files/ofccp/Construction/files/ConstructionTAG.pdf?msclkid=9e397d68c4b111ec9d8e6fecb6c710ec Also see the National Policy Assurances http://www.nsf.gov/awards/managing/rtc.jsp

A. Technical Review Criteria

i. Concept Papers

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

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

- This criterion involves consideration of the following factors. The applicant clearly describes the proposed technology, 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 of the technology, regulatory and financial aspects of the proposal 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 technical review criteria shown below. All sub-criteria are of equal weight.

Criterion 1: Technical Merit, Innovation, and Impact (45%)
This criterion involves consideration of the following factors:

Technical Merit and Innovation

- Extent to which the proposed technology, process, or project is innovative or replicable;
- 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, with analyses that support the viability of the proposed work;
- Extent to which project has buy-in from needed stakeholders to ensure success;

- Degree to which key manufacturing and supply chain challenges are considered, as applicable, for viable scale-up in this and future demonstrations;
- Degree to which siting and environmental constraints are considered for deployment;
- Extent to which project has the potential to reduce emissions and provide clean energy acceleration benefits for a community or region; and
- Sufficiency of existing infrastructure to support addition of proposed demonstration.

Impact of Technology Advancement

- Ability of the project to advance industry adoption;
- Extent to which the project supports the topic area objectives and target specifications and metrics;
- Potential impact of the project on advancing the state-of-the-art;
- Potential impact of the project on achieving GHG emissions reductions, industrial efficiency improvements, and co-benefits in industrial subsectors.
- Extent to which demonstration/deployment is replicable and may lead to future demonstrations; and
- Extent to which the project facilitates stakeholder relationships across new or existing stakeholders to gain technical buy-in and increase potential for future deployments.

Project Management

- Adequacy of proposed project management systems including the ability to track scope, cost, and schedule progress and changes;
- Reasonableness of budget and spend plan as detailed in the budget justification workbook for proposed project and objectives;
- Adequacy of contingency funding based on quality of cost estimate and identified risks;
- Adequacy, reasonableness, and soundness of the project schedule, as well as annual Go/No-Go decisions prior to a budget period continuation application, interim milestones, and metrics to track process;
- Adequacy of the identification of risks, including labor and community opposition or disputes, and “timely” and appropriate strategies for mitigation and resolution; and
- Soundness of a plan to expeditiously address environmental, siting, and other regulatory requirements for the project, including evaluation of resilience to climate change.

Criterion 2: Project Research and Market Transformation Plan (25%)
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

- Level of clarity in the definition of the baseline, metrics, and milestones; and
- Relative to a clearly defined project baseline, the strength of the quantifiable metrics, milestones, and 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, Open-source Software Distribution Plan, etc., and product distribution.

Industry Adoption Plan

- Identification of the interest and extent of industry adoption of the technology/process.

Criterion 3: Team and Resources (15%)

This criterion involves consideration of the following factors:

- 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;
- Diversity of expertise and perspectives of the team and the inclusion of industry partners that will amplify impact;

- Sufficiency of the facilities to support the work;
- Degree to which the proposed consortia/team demonstrates the ability to facilitate and expedite further demonstration, development and commercial deployment of the proposed technologies;
- Level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan; and
- Reasonableness of the budget and spend plan for the proposed project and objectives.

Criterion 4: Community Benefits Plan (15%)
This criterion involves consideration of the following factors:

- Diversity, Equity, Inclusion and Accessibility (DEIA)
  - Clear articulation of the project's goals related to diversity, equity, inclusion, and accessibility;
  - Quality of the project's DEIA goals, as measured by the goals' depth, breadth, likelihood of success, inclusion of appropriate and relevant SMART milestones, and overall project integration;
  - Degree of commitment and ability to track progress toward meeting each of the DEIA goals; and
  - Extent of engagement of organizations that represent disadvantaged communities as a core element of their mission, including Minority Serving Institutions (MSIs), Minority Business Entities, and nonprofit or community-based organizations.

- Energy Equity
  - Clear workplan tasks, staffing, research, and timeline for engaging energy equity stakeholders and/or evaluating the possible near and long-term implications of the project for the benefit of the American public, including, but not limited to public health and public prosperity benefits;
  - Approach, methodology, and expertise articulated in the plan for addressing energy equity and justice issues associated with the technology innovation; and
  - Likelihood that the plan will result in improved understanding of distributional public benefits and costs related to the innovation if successful.

- Workforce Implications
  - Clear and comprehensive workplan tasks, staffing, research, and timeline for engaging workforce stakeholders and/or evaluating the possible near- and long-term implications of the project for the U.S. workforce;

- Approach to document the knowledge, skills, and abilities of the workforce required for successful commercial deployment of innovations resulting from this research; and
- Likelihood that the plan will result in improved understanding of the workforce implications related to the innovation if successful.

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 September 2020, 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 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);

- The degree to which the proposed project incorporates applicant or team members from Minority Serving Institutions (e.g., Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs)); and partnerships with Minority Business Enterprises, minority-owned businesses, woman-owned businesses, veteran-owned businesses, or Indian tribes;
- The degree to which the proposed project, when compared to the existing DOE project portfolio and other projects to be selected from the subject FOA, contributes to the total portfolio meeting the goals reflected in the Community Benefits Plan criteria;
- The degree to which the proposed project will employ procurement of U.S. iron, steel, manufactured products, and construction materials.
- The degree to which the proposed project contributes to the diversity of organizations and organization types and sizes selected from the subject FOA when compared to the existing DOE project portfolio.
- The degree to which the proposed project avoids duplication/overlap with other publicly or privately funded work.
- The degree to which the proposed project supports complementary efforts or projects, which, when taken together, will best achieve the research goals and objectives.
- The degree to which the project promotes increased coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer.

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 and risk review, in determining which applications to select.

ii. Pre-Selection Interviews

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

information provided by applicants to EERE through pre-selection interviews contributes to EERE's selection decisions.

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

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

EERE may obtain additional information through pre-selection interviews that will be used to make a final selection determination. EERE may select applications for funding and make awards without pre-selection interviews.

Participation in pre-selection interviews with EERE does not signify that applicants have been selected for award negotiations.

iii. Pre-Selection Clarification

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

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

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

iv. Recipient Responsibility and Qualifications

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 responsibility and qualification information about the applicant that is in the entity information domain in SAM.gov (see 41 U.S.C. 2313).

The applicant, at its option, may review information in the entity information domain in SAM.gov and comment on any information about itself that a federal awarding agency previously entered and is currently in the entity information domain in SAM.gov.

DOE will consider any written comments by the applicant, in addition to the other information in the entity information domain in SAM.gov, 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 CFR 200.206.

v. Selection

The Selection Official may consider the technical merit, the Federal Consensus Board's recommendations, program policy factors, risk reviews, 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. EERE may include general comments on an applicant's Concept Paper in the encourage/discourage notifications.

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.

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. Applicants Selected for Award Negotiations

Successful applicants will receive written notification that they have been selected for award negotiations. 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 nor is it a guarantee of federal government funding. Applicants do not receive an award unless and until award negotiations are complete and the Contracting Officer executes the funding agreement, accessible by the prime recipient in FedConnect.

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

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

v. Alternate Selection Determinations

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

vi. Unsuccessful Applicants

EERE shall promptly notify in writing each applicant whose application has not been selected for award or whose application cannot be funded because of the unavailability of appropriated funds.

B. Administrative and National Policy Requirements

i. Registration Requirements

There are several one-time actions applicants must take before applying to this FOA. Some of these may take several weeks, so it is vital applicants build in enough time to complete them. Failure to complete these actions could interfere with application or negotiation deadlines or the ability to receive an award if selected. These requirements are as follows:

1. **EERE Funding Opportunity Exchange (eXCHANGE)**
   Register and create an account on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov. This account will allow the user to apply to any open EERE FOAs that are currently in EERE eXCHANGE.

   To access EERE eXCHANGE, potential applicants must have a Login.gov account. As part of the eXCHANGE registration process, new users will be directed to create an account in Login.gov. Please note that the email address associated with Login.gov must match the email address associated with the eXCHANGE account. For more information, refer to the eXCHANGE Multi-Factor Authentication (MFA) Quick Guide in the Manuals section of eXCHANGE.

   Each organization or business unit, whether acting as a team or a single entity, should use only one account as the contact point for each submission. Applicants should also designate backup points of contact. **This step is required to apply to this FOA.** The 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. **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.

3. **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.

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

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 supplemented by 2 CFR Part 910.

iii. Foreign National Participation

All applicants selected for an award under this FOA and project participants (including subrecipients and contractors) who anticipate involving foreign nationals in the performance of an award, may be required to provide DOE with specific information about each foreign national to satisfy requirements for foreign national participation. A "foreign national" is defined as any person who is not a United States citizen by birth or naturalization. The volume and type of information collected may depend on various factors associated with the

award. DOE concurrence may be required before a foreign national can participate in the performance of any work under an award.

DOE may elect to deny a foreign national's participation in the award. Likewise, DOE may elect to deny a foreign national's access to a DOE site, information, technologies, equipment, programs, or personnel.

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 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, a corporation is any for-profit or nonprofit 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].

3. **Nondisclosure and Confidentiality Agreements Representations**
In submitting an application 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. 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. Subject Invention Utilization Reporting

To ensure that prime recipients, subrecipients, and contractors 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.

xi. 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.

xii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement.

xiii. 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. A Go/No-Go Review 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 beginning the execution of future phases. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule

adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. 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;[60] 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.

xiv. 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 U.S. government would otherwise exceed $20,000, thereby circumventing the required notification by

[60] A continuation application is 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 its continuation application, which includes the following information:

i. A progress report on the project objectives, including 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 SOPO and/or Milestone Summary Table.

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.

xv. 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 million 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.

xvi. Real Property and Equipment

Real property and equipment purchased with project funds (federal share and recipient cost share) are subject to the requirements at 2 CFR 200.310, 200.311, 200.313, and 200.316 (non-federal entities, except for-profit entities) and 2 CFR 910.360 (for-profit entities).

For projects selected for awards under this FOA, the recipients may (1) take disposition action on the real property and equipment; or (2) continue to use the real property and equipment after the conclusion of the award period of performance with Contracting Officer approval. The recipient's written request for Continued Use must identify the property and include: a summary of how the property will be used (must align with the authorized project purposes); a proposed use period, (e.g., perpetuity, until fully depreciated, or a calendar date when the recipient expects to submit disposition instructions); acknowledgement that the recipient shall not sell or encumber the property or permit any encumbrance without prior written DOE approval; current fair

market value of the property; and an estimated useful life or depreciation schedule for equipment.

When the property is no longer needed for authorized project purposes, the recipient must request disposition instructions from DOE. For-profit entity disposition requirements are set forth in 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 200.310 – 200.316.

xvii. Implementation of Executive Order 13798, Promoting Free Speech and Religious Liberty

States, local governments, and other public entities may not condition subawards in a manner that would discriminate against or otherwise disadvantage subrecipients based on their religious character.

xviii. Participants and Collaborating Organizations

If selected for award negotiations, the selected applicant must submit a list of personnel who are proposed to work on the project, both at the recipient and subrecipient level and a list of collaborating organizations prior to award. Recipients will have an ongoing responsibility to notify DOE of changes to the personnel and collaborating organizations and submit updated information during the life of the award.

xix. Current and Pending Support

If selected for award negotiations, within 30 days of the selection notice, the selectee must submit 1) current and pending support disclosures and resumes for any new PIs or Senior/Key Personnel and 2) updated disclosures if there have been any changes to the current and pending support submitted with the application. Throughout the life of the award, the Recipient has an ongoing responsibility to submit 1) current and pending support disclosure statements and resumes for any new PI and Senior/Key Personnel and 2) updated disclosures if there are changes to the current and pending support previously submitted to DOE. Also see Section IV.D.xvi.

xx. U.S. Manufacturing Commitments

A primary objective of DOE's multi-billion-dollar research, development and demonstration investments is to cultivate new research and development ecosystems, manufacturing capabilities, and supply chains for and by United States industry and labor. Therefore, in exchange for receiving taxpayer dollars to support an applicant's project, the applicant and any subrecipient and contractor must agree to a U.S. Competitiveness provision requiring 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 recipient can show to the satisfaction of DOE that it is not commercially feasible. Award terms, including the specific U.S. Competitiveness Provision applicable to the various types of recipients and projects, are available at: https://www.energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards.

Please note that a subject invention is any invention conceived or first actually reduced in performance of work under an award. An invention is any invention or discovery which is or may be patentable. The recipient includes any awardee, recipient, sub-awardee, or sub-recipient.

As noted in the U.S. Competitiveness Provision, if an entity cannot meet the requirements of the U.S. Competitiveness Provision, the entity may request a modification or waiver of the U.S. Competitiveness Provision. For example, the entity may propose modifying the language of the U.S. Competitiveness Provision in order to change the scope of the requirements or to provide more specifics on the application of the requirements for a particular technology. As another example, the entity may request that the U.S. Competitiveness Provision be waived in lieu of a net benefits statement or United States manufacturing plan. The statement or plan would contain specific and enforceable commitments that would be beneficial to the United States economy and competitiveness. Examples of such commitments could include manufacturing specific products in the United States, making a specific investment in a new or existing United States manufacturing facility, keeping certain activities based in the United States or supporting a certain number of jobs in the United States related to the technology. DOE may, in its sole discretion, determine that the proposed modification or waiver promotes commercialization and provides substantial United States economic benefits, and grant the request. If granted, DOE will modify the award terms and conditions for the requesting entity accordingly.

More information and guidance on the waiver and modification request process can be found in the DOE Financial Assistance Letter on this topic, available at https://www.energy.gov/management/pf-2022-09-fal-2022-01-implementation-doe-determination-exceptional-circumstances-under. Additional information on DOE's Commitment to Domestic Manufacturing for DOE-funded R&D is available at https://www.energy.gov/gc/us-manufacturing.

The U.S. Competitiveness Provision is implemented by DOE pursuant to a Determination of Exceptional Circumstances (DEC) under the Bayh-Dole Act and DOE Patent Waivers. See Section VIII.J. Title to Subject Inventions of this FOA for more information on the DEC and DOE Patent Waivers.

xxi. Interim Conflict of Interest Policy for Financial Assistance

The DOE interim Conflict of Interest Policy for Financial Assistance (COI Policy)[61] is applicable to all non-Federal entities applying for, or that receive, DOE funding by means of a financial assistance award (e.g., a grant, cooperative agreement, or technology investment agreement) and, through the implementation of this policy by the entity, to each Investigator who is planning to participate in, or is participating in, the project funded wholly or in part under the DOE financial assistance award. The term "Investigator" means the PI and any other person, regardless of title or position, who is responsible for the purpose, design, conduct, or reporting of a project funded by DOE or proposed for funding by DOE. Recipients must flow down the requirements of the interim COI Policy to any subrecipient non-federal entities. Further, for DOE funded projects, the recipient must include all financial conflicts of interest (FCOI) (i.e., managed and unmanaged/ unmanageable) in its initial and ongoing FCOI reports.

It is understood that non-federal entities and individuals receiving DOE financial assistance awards will need sufficient time to come into full compliance with DOE's interim COI Policy. To provide some flexibility, DOE allows for a staggered implementation. Specifically, prior to award, applicants selected for award negotiations must: ensure all Investigators complete their significant financial disclosures; review the disclosures; determine whether a FCOI exists; develop and implement a management plan for FCOIs; and provide DOE with an initial FCOI report that includes all FCOIs (i.e., managed and unmanaged/ unmanageable). Recipients will have 180 days from the date of the award to come into full compliance with the other requirements set forth in DOE's interim COI Policy. Prior to award, the applicant must certify that it is, or will be within 180 days of the award, compliant with all requirements in the COI Policy.

xxii. Data Management Plan

Each applicant whose Full Application is selected for award negotiations will be required to submit a Data Management Plan (DMP) during the award negotiations phase. A DMP explains how, when appropriate, data generated in the course of the work performed under an EERE award will be shared and preserved to validate the results of the proposed work or how the results could be validated if the data is not shared or preserved. The DMP must provide a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publications. Recipients may satisfy this requirement to submit a DMP by making an appropriate selection from standard EERE DMP options during negotiations of the award contract.

[61] DOE's interim COI Policy can be found at PF 2022-17 FAL 2022-02 Department of Energy Interim Conflict of Interest Policy Requirements for Financial Assistance.

xxiii. Fraud, Waste, and Abuse

The mission of the DOE Office of Inspector General (OIG) is to strengthen the integrity, economy, and efficiency of the Department's programs and operations including deterring and detecting fraud, waste, abuse, and mismanagement. The OIG accomplishes this mission primarily through investigations, audits, and inspections of DOE activities to include grants, cooperative agreements, loans, and contracts.

The OIG maintains a hotline for reporting allegations of fraud, waste, abuse, or mismanagement. To report such allegations, please visit https://www.energy.gov/ig/ig-hotline.

Additionally, recipients of DOE awards must be cognizant of the requirements of 2 CFR 200.113 Mandatory disclosures, which states:

> The non-Federal entity or applicant for a federal award must disclose, in a timely manner, in writing to the Federal awarding agency or pass-through entity all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting the Federal award. Non-Federal entities that have received a federal award including the term and condition outlined in appendix XII of 2 CFR Part 200 are required to report certain civil, criminal, or administrative proceedings to SAM.gov. Failure to make required disclosures can result in any of the remedies described in 2 CFR 200.339. (See also 2 CFR part 180, 31 U.S.C. § 3321, and 41 U.S.C. § 2313.) [85 FR 49539, Aug. 13, 2020]

Applicants and subrecipients (if applicable) are encouraged to allocate sufficient costs in the project budget to cover the costs associated for personnel and data infrastructure needs to support performance management and program evaluation needs, including but not limited to independent program and project audits to mitigate risks for fraud, waste, and abuse.

xxiv. Human Subjects Research

Research involving human subjects, biospecimens, or identifiable private information conducted with DOE funding is subject to the requirements of DOE Order 443.1C, Protection of Human Research Subjects, 45 CFR Part 46, Protection of Human Subjects (subpart A which is referred to as the "Common Rule"), and 10 CFR Part 745, Protection of Human Subjects. Additional information on the DOE Human Subjects Research Program can be found at:

HUMAN SUBJECTS Human Subjects Pr... | U.S. DOE Office of Science (SC) (osti.gov).

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 described below. Questions regarding this FOA must be submitted to FY24EEIIFOA@ee.doe.gov no 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. **You must first select the FOA Number 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 EERE eXCHANGE 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 business-sensitive, proprietary, or otherwise confidential information 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 business-sensitive, proprietary, or otherwise confidential information, it is furnished to the federal 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 federal government's right to use the information if it is obtained from another source.

If an applicant chooses to submit trade secrets or business-sensitive, proprietary, or otherwise confidential information, the applicant must provide **two copies** of the submission (e.g., Concept Paper, Full Application). The first copy should be marked "non-confidential," with the information believed to be confidential deleted. The

second copy should be marked "confidential" and must clearly and conspicuously identify the trade secrets or business-sensitive, proprietary, or otherwise confidential information and 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 federal government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose as authorized by law.

The cover sheet of the Full Application, and other applicant submission must be marked as follows and identify the specific pages containing trade secrets or business-sensitive, proprietary, or otherwise confidential information:

> **Notice of Restriction on Disclosure and Use of Data:**
> Pages [list applicable pages] of this document may contain trade secrets or business-sensitive, proprietary, or otherwise confidential 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 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]

In addition, (1) the header and footer of every page that contains trade secrets or business-sensitive, proprietary, or otherwise confidential information must be marked as follows: "Contains Trade Secrets or Business-Sensitive, Proprietary, or Otherwise Confidential Information Exempt from Public Disclosure," and (2) every line or paragraph containing such information must be clearly marked with double brackets or highlighting. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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 Full Applications 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);
- Class Patent Waiver: DOE has issued a class waiver that applies to this FOA. Under this class waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. 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.

- Advance and Identified Waivers: Applicants not covered by a Class Patent Waiver or the Bayh-Dole Act 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.
  - DEC: On June 07, 2021, DOE approved a Determination of Exceptional Circumstances (DEC) under the Bayh-Dole Act to further promote domestic manufacture of DOE science and energy technologies. In accordance with this DEC, all awards, including sub-awards, under this FOA shall include the U.S. Competitiveness Provision in accordance with Section VI.B.xx. U.S. Manufacturing Commitments of this FOA. A copy of the DEC can be found at https://www.energy.gov/gc/determination-exceptional-circumstances-decs. Pursuant to 37 CFR § 401.4, any nonprofit organization or small business firm as defined by 35 U.S.C. 201 affected by any DEC has the right to appeal it by providing written notice to DOE within 30 working days from the time it receives a copy of the determination.
  - DOE may issue and publish further DECs on the website above prior to the issuance of awards under this FOA. DOE may require additional submissions or requirements as authorized by any applicable DEC.

K. Government Rights in Subject Inventions

Where prime recipients, subrecipients, and contractors 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 government contractors.

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 United States 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 under this FOA 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 award's 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 United States government regulates the transfer of information, commodities, technology, and software considered to be strategically important to the United States 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." All recipients and subrecipients are responsible for ensuring compliance with all applicable United States Export Control laws and regulations relating to any work performed under a resulting award.

The recipient must immediately report to DOE any export control violations related to the project funded under the DOE award, at the recipient or subrecipient level, and provide the corrective action(s) to prevent future violations.

O. Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment

As set forth in 2 CFR 200.216, recipients and subrecipients are prohibited from obligating or expending project funds (federal funds and recipient cost share) to procure or obtain; extend or renew a contract to procure or obtain; or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that use *covered telecommunications equipment or services* as a substantial or essential component of any system, or as critical technology as part of any system. As described in Section 889 of Public Law 115-232, *covered telecommunications equipment* is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

See Public Law 115-232, Section 889, 2 CFR 200.216, and 2 CFR 200.471 for additional information.

P. 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-17-12 dated January 3, 2017)

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).

Q. 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 CFR 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, a Single or Program-Specific Audit is required. For additional information, please refer to 2 CFR 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 terms in the titles specific to regulations applicable to cost sharing. EERE almost always uses "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 two 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, it is allowable as cost share. Conversely, if the cost is not allowable under the cost principles and not eligible for reimbursement, 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 above regulations, other factors may also come into play such as timing of donations and length of the project period. For example, the value of 10 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 cost of the item or service is reimbursed, 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, and 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. Consult your DOE contact if you have questions before filling out the In-Kind cost share section of the Budget Justification.

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

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

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

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

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

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

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

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

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

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

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

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

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

(B) Valuing and documenting contributions

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

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

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

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

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

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

(4) Valuing property donated by third parties.

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

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

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

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

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

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

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

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

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

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

APPENDIX B – WAIVER REQUESTS FOR: 1. FOREIGN ENTITY PARTICIPATION; AND 2. FOREIGN WORK

1. Waiver for Foreign Entity Participation

Many of the technology areas DOE funds fall in the category of critical and emerging technologies (CETs). CETs are a subset of advanced technologies that are potentially significant to United States national and economic security.[62] For projects selected under this FOA, all recipients and subrecipients must be organized, chartered, or incorporated (or otherwise formed) under the laws of a state or territory of the United States; have majority domestic ownership and control; 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.

Waiver Criteria

Foreign entities seeking to participate in a project funded under this FOA must demonstrate to the satisfaction of DOE that:

a. Its participation is in the best interest of the United States industry and United States economic development;
b. The project team has appropriate measures in place to control sensitive information and protect against unauthorized transfer of scientific and technical information;
c. Adequate protocols exist between the United States subsidiary and its foreign parent organization to comply with export control laws and any obligations to protect proprietary information from the foreign parent organization;
d. The work is conducted within the United States and the entity acknowledges and demonstrates that it has the intent and ability to comply with the United States Competitiveness Provision (see Section VI.B.xx); and
e. The foreign entity will satisfy other conditions that may be deemed necessary by DOE to protect United States government interests.

Content for Waiver Request

A Foreign Entity waiver request must include the following:

a. Information about the entity: name, point of contact, and proposed type of involvement in the project;
b. Country of incorporation, the extent of the ownership/level control by foreign entities, whether the entity is state owned or controlled, a summary of the ownership breakdown of the foreign entity, and the percentage of

[62] See Critical and Emerging Technologies List Update (whitehouse.gov).

ownership/control by foreign entities, foreign shareholders, foreign state or foreign individuals;

c. The rationale for proposing a foreign entity participate (must address criteria above);
d. A description of the project's anticipated contributions to the United States economy;
    - How the project will benefit the United States, including manufacturing, contributions to employment in the United States and growth in new markets and jobs in the United States;
    - How the project will promote manufacturing of products and/or services in the United States;
e. A description of how the foreign entity's participation is essential to the project;
f. A description of the likelihood of Intellectual Property (IP) being created from the work and the treatment of any such IP; and
g. Countries where the work will be performed (Note: if any work is proposed to be conducted outside the United States, the applicant must also complete a separate request foreign work waiver.)

DOE may also require:

- A risk assessment with respect to IP and data protection protocols that includes the export control risk based on the data protection protocols, the technology being developed, and the foreign entity and country. These submissions could be prepared by the project lead (if not the prime recipient), but the prime recipient must make a representation to DOE as to whether it believes the data protection protocols are adequate and make a representation of the risk assessment – high, medium, or low risk of data leakage to a foreign entity.
- Additional language be added to any agreement or subagreement to protect IP, mitigate risk, or other related purposes.

DOE may require additional information before considering the waiver request.

DOE's decision concerning a waiver request is not appealable.

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

As set forth in Section IV.J.iii., all work funded under this FOA must be performed in 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 DOE 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 for a foreign work waiver must include the following:

1. The rationale for performing the work outside the United States ("foreign work");
2. A description of the work proposed to be performed outside the United States;
3. An explanation as to how the foreign work is essential to the project;
4. A description of the anticipated benefits to be realized by the proposed foreign work and the anticipated contributions to the U.S. economy;
5. The associated benefits to be realized and the contribution to the project from the foreign work;
6. How the foreign work will benefit the United States, including manufacturing, contributions to employment in the United States and growth in new markets and jobs in the United States;
7. How the foreign work will promote manufacturing of products and/or services in the United States;
8. A description of the likelihood of IP being created from the foreign work and the treatment of any such IP;
9. The total estimated cost (DOE and recipient cost share) of the proposed foreign work;
10. The countries in which the foreign work is proposed to be performed; and
11. The name of the entity that would perform the foreign work.

DOE may require additional information before considering the waiver request.

DOE's decision concerning a waiver request is not appealable.

APPENDIX C – REQUIRED USE OF AMERICAN IRON, STEEL, MANUFACTURED PRODUCTS, AND CONSTRUCTION MATERIALS BUY AMERICA REQUIREMENTS FOR INFRASTRUCTURE PROJECTS

A. Definitions

For purposes of the Buy America requirements, based both on the statute and OMB Guidance Document dated April 18, 2022, the following definitions apply:

Construction materials includes an article, material, or supply—other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives[63] —that is or consists primarily of:

- Non-ferrous metals;
- Plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables);
- Glass (including optic glass);
- Lumber; or
- Drywall.

Infrastructure includes, at a minimum, the structures, facilities, and equipment for, in the United States, roads, highways, and bridges; public transportation; dams, ports, harbors, and other maritime facilities; intercity passenger and freight railroads; freight and intermodal facilities; airports; water systems, including drinking water and wastewater systems; electrical transmission facilities and systems; utilities; broadband infrastructure; and buildings and real property. Infrastructure includes facilities that generate, transport, and distribute energy.

Moreover, according to the OMB guidance document:

> When determining if a program has infrastructure expenditures, Federal agencies should interpret the term "infrastructure" broadly and consider the definition provided above as illustrative and not exhaustive. When determining if a particular construction project of a type not listed in the definition above constitutes "infrastructure," agencies should consider whether the project will serve a public function, including whether the project is publicly owned and operated, privately operated on behalf of the public, or is a place of public accommodation, as opposed to a project that is privately owned and not open to the public. Projects with the former qualities have greater indicia of infrastructure, while projects with the latter quality have fewer. Projects consisting solely of the

[63] BIL, § 70917(c)(1).

purchase, construction, or improvement of a private home for personal use, for example, would not constitute an infrastructure project.

The Agency, not the applicant, will have the final say as to whether a given project includes infrastructure, as defined herein. Accordingly, in cases where the "public" nature of the infrastructure is unclear but the other relevant criteria are met, DOE strongly recommends that applicants complete their full application with the assumption that Buy America requirements will apply to the proposed project.

Project means the construction, alteration, maintenance, or repair of infrastructure in the United States.

B. Buy America Requirements for Infrastructure Projects ("Buy America" requirements)
In accordance with Section 70914 of the BIL, none of the project funds (includes federal share and recipient cost share) may be used for a project for infrastructure unless:

(1) all iron and steel used in the project are produced in the United States--this means all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States;

(2) all manufactured products used in the project are produced in the United States—this means the manufactured product was manufactured in the United States; and the cost of the components of the manufactured product that are mined, produced, or manufactured in the United States is greater than 55 percent of the total cost of all components of the manufactured product, unless another standard for determining the minimum amount of domestic content of the manufactured product has been established under applicable law or regulation; and

(3) all construction materials[64] are produced in the United States—this means that all manufacturing processes for the construction material occurred in the United States.

The Buy America requirements only apply to articles, materials, and supplies that are consumed in, incorporated into, or affixed to an infrastructure project. As such, it does not apply to tools, equipment, and supplies, such as temporary scaffolding, brought to the construction site and removed at or before the completion of the infrastructure project. Nor does the Buy America requirements apply to equipment and furnishings, such as movable chairs, desks, and portable computer equipment, that are used at or within the finished infrastructure project, but are not an integral part of the structure or permanently affixed to the infrastructure project.

[64] Excludes cement and cementitious materials, aggregates such as stone, sand, or gravel, or aggregate binding agents or additives.

These requirements must flow down to all sub-awards, all contracts, subcontracts, and purchase orders for work performed under the proposed project, except where the prime recipient is a for-profit entity. Based on guidance from the Office of Management and Budget (OMB), the Buy America requirements of the BIL do not apply to DOE projects in which the prime recipient is a for-profit entity; the requirements only apply to projects whose prime recipient is a State, local government, Indian Tribe, Institution of Higher Education, or non-profit organization.

For additional information related to the application and implementation of these Buy America requirements, please see OMB Memorandum M-22-11, issued April 18, 2022:

Note that for all applicants—both non-Federal entities and for-profit entities—DOE is including a Program Policy Factor that the Selection Official may consider in determining which Full Applications to select for award negotiations that considers whether the applicant has made a commitment to procure U.S. iron, steel, manufactured products, and construction materials in its project.

C. Waivers

The DOE financial assistance agreement will require each recipient: (1) to fulfill the commitments made in its application regarding the procurement of U.S.-produced products and (2) to fulfill the commitments made in its application regarding the procurement of other key component metals and domestically manufactured products that are deemed available in sufficient and reasonably available quantities or of a satisfactory quality at the time of award negotiation.

In limited circumstances, DOE may waive the application of the Buy America requirements where DOE determines that:

(1) Applying the Buy America requirements would be inconsistent with the public interest;

(2) The types of iron, steel, manufactured products, or construction materials are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality; or

(3) The inclusion of iron, steel, manufactured products, or construction materials produced in the United States will increase the cost of the overall project by more than 25%.

If an applicant or recipient is seeking a waiver of the Buy America requirements, it may submit a waiver request after it has been notified of its selection for award negotiations. A waiver request must include:

- A detailed justification for the use of "non-domestic" iron, steel, manufactured products, or construction materials to include an explanation as to how the non-domestic item(s) is essential to the project;
- A certification that the applicant or recipient made a good faith effort to solicit bids for domestic products supported by terms included in requests for proposals, contracts, and nonproprietary communications with potential suppliers;
- Applicant/Recipient name and Unique Entity Identifier (UEI)
- Total estimated project cost, DOE and cost-share amounts;
- Project description and location (to the extent known);
- List and description of iron or steel item(s), manufactured goods, and construction material(s) the applicant or recipient seeks to waive from Domestic Content Procurement Preference requirement, including name, cost, country(ies) of origin (if known), and relevant PSC and NAICS code for each;
- Waiver justification including due diligence performed (e.g., market research, industry outreach) by the applicant or recipient; and
- Anticipated impact if no waiver is issued

DOE may require additional information before considering the waiver request.

Waiver requests are subject to public comment periods of no less than 15 days and must be reviewed by the Made in America Office. There may be instances where an award qualifies, in whole or in part, for an existing waiver described at DOE Buy America Requirement Waiver Requests.

DOE's decision concerning a waiver request is not appealable.

APPENDIX D – 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 E – LIST OF ACRONYMS

AACE	Association of the Advancement of Cost Engineering
AASTHO	American Association of State Highway and Transportation Officials
AI	Artificial intelligence
AOI	Area of interest
ARPA-E	Advanced Research Projects Agency - Energy
BECCS	Biomass with carbon capture
BOF	Basic oxygen furnace
CAPEX	Capital expenditure
CBP	Community Benefits Plan
CCUS	Carbon capture, utilization, and storage
CFR	Code of Federal Regulations
CHP	Combined heat and power
CMA	Cold mix asphalt
CO	Carbon monoxide
CO_2e	Carbon dioxide equivalent
COI	Conflict of interest
CRADA	Cooperative Research and Development Agreement
DAC	Direct air capture
DEC	Determination of Exceptional Circumstances
DEIA	Diversity, equity, inclusion, and accessibility
DMP	Data Management Plan
DOE	Department of Energy
DOI	Digital object identifier
DRI	Direct reduce iron
EEII	Energy- and Emissions-Intensive Industries
EERE	Energy Efficiency and Renewable Energy
FAR	Federal Acquisition Regulation
FCOI	Financial conflicts of interest
FECM	Office of Fossil Energy and Carbon Management
FEED	Front-end engineering design
FFATA	Federal Funding and Transparency Act of 2006
FFRDC	Federally Funded Research and Development Center
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
GAAP	Generally accepted accounting principles
GHG	Greenhouse gas

GREET	Greenhouse gas, Regulated Emissions, and Energy Use in Transportation
GWP	Global warming potential
HAZOP	Hazard and operability analysis
HFTO	Hydrogen and Fuel Cell Technologies Office
HMA	Hot mix asphalt
IEDO	Industrial Efficiency and Decarbonization Office
IPCC	Intergovernmental Panel on Climate Change
IPMP	Intellectual Property Management Plan
IRB	Institutional Review Board
LCA	Lifecycle assessment
LCFFES	Low-carbon fuels and feedstocks and energy sources
LNG	Liquified natural gas
LPO	Loan Programs Office
M&O	Management and operating
MESC	Manufacturing and Energy Supply Chains
MFA	Multi-factor authentication
MMT	Million metric ton
mt	metric ton
MPIN	Marketing partner ID number
MSI	Minority-serving institution
MYPP	Multi-year program plan
NAICS	North American Industry Classification System
NDA	Non-disclosure acknowledgement
NE	Office of Nuclear Energy
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Agency
Nox	Nitrogen oxides
NSF	National Science Foundation
OCED	Office of Clean Energy Demonstrations
OIG	Office of Inspector General
OMB	Office of Management and Budget
OPC	Ordinary portland cement
OSTI	Office of Scientific and Technical Information
OTA	Other Transactions Authority
P&ID	Piping and instrument diagrams
PFD	Process flow diagram
PII	Personal identifiable information
PM	Particulate matter
RAP	Reclaimed asphalt pavement
R&D	Research and development

RD&D	Research, development, and demonstration
RDD&D	Research, development, demonstration, and deployment
RFI	Request for Information
RFP	Request for Proposal
SAF	Sustainable aviation fuel
SAM	System for Award Management
SC	Office of Science
SciENcv	Science Experts Network Curriculum Vita
SCM	Supplementary cementitious material
SMART	Specific, measurable, attainable, realistic, and timely
SOPO	Statement of Project Objectives
SPOC	Single Point of Contact
STEM	Science, Technology, Engineering, and Mathematics
TAA	Technical Assistance Agreement
TBtu	Trillion British thermal unit
TEA	Techno-economic analysis
TIA	Technology investment agreement
TIEReD	Technologies for Industrial Emissions Reduction Development
TRL	Technology readiness level
UCC	Uniform commercial code
UEI	Unique entity identifier
VOC	Volatile organic compound
WBS	Work breakdown structure
WMA	Warm mix asphalt
WP	Work proposal

APPENDIX F – COMMUNITY BENEFITS PLAN GUIDANCE

DOE is committed to pushing the frontiers of science and engineering; catalyzing high- quality domestic clean energy jobs through research, development, demonstration, and deployment; and ensuring energy equity and energy justice[65] for disadvantaged communities. Therefore, and in accordance with the Administration's priority to empower workers and harness opportunities to create good union jobs as stated in EO 14008 (Executive Order on Tackling the Climate Crisis at Home and Abroad),[66] it is important to consider the impacts of the successful commercial deployment of any innovations resulting from this FOA on the current and future workforce.

The goal of the Community Benefits Plan is to allow the application to illustrate engagement in critical thought about implications of how the proposed work will benefit the American people and lead to broadly shared prosperity, including for workers and disadvantaged communities.[67] The three sections of the Community Benefits Plans are considered together because there may be significant overlap among audiences considered in workforce and disadvantaged communities.

Example DEIA, Energy Equity, and Workforce Plan Elements

Outlined below are examples of activities that applicants might consider when developing their Community Benefits Plan. Applicants are not required to implement any of these specific examples and should propose activities that best fit their research goals, institutional environment, team composition, and other factors. Creativity is encouraged.

DEIA

DOE strongly encourages applicants to involve individuals and entities from disadvantaged communities. Tapping all the available talent requires intentional approaches and yields broad benefits.

Equity extends beyond diversity to equitable treatment. Equitable access to opportunity for members of the project team is paramount. This includes ensuring all members of the team, including students, are paid a living wage,

provided appropriate working conditions, and provided appropriate benefits. In the execution of their project plan, applicants are asked to describe efforts in diversity, equity, inclusion, and accessibility. In this context, efforts toward DEIA are defined as:[68]

1) The practice of including the many communities, identities, races, ethnicities, backgrounds, abilities, cultures, and beliefs of the American people;
2) The consistent and systematic fair, just, and impartial treatment of all individuals, including protecting workers rights and adhering to Equal Employment Opportunity laws;
3) The recognition, appreciation, and use of the talents and skills of employees of all backgrounds; and
4) The provision of accommodations so that all people, including people with disabilities, can fully and independently access facilities, information and communication technology, programs, and services.

Successful plans will not only describe how the project team seeks to increase DEIA but also will describe the overall approaches to retention, engagement, professional development, and career advancement. Specifically, they will demonstrate clear approaches to ensure all team members' strengths are meaningfully leveraged, and all members are provided opportunities and paths for career development, especially including paths for interns and trainees to secure permanent positions. Diversity should be considered at all levels of the project team, not just leveraging early career individuals to meet diversity goals.

DOE strongly encourages applicants to consider partnerships to promote DEIA, justice, and workforce participation. Minority Serving Institutions, Minority Business Enterprises, minority-owned businesses, disability-owned businesses, women-owned businesses, Native American-owned businesses, veteran-owned businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to lead these partnerships as the prime applicant or participate on an application as a proposed partner to the prime applicant.

When crafting the DEIA section of the Plan, applicants should describe how they will act to promote each of the four DEIA efforts above into their investigation. It is important to note that diversity, equity, inclusion, and

accessibility are four different but related concepts that should not be conflated. For instance, you can achieve diversity without equity; all four must be addressed. Applicants could discuss how the proposed investigation could contribute to training and developing a diverse scientific workforce. Applicants could describe the efforts they plan to take, or will continue to take, to create an inclusive workplace, free from retaliation, harassment, and discrimination. Applicants could outline any barriers to creating an equitable and inclusive workplace and address the ways in which the team will work to overcome these barriers within the bounds of the specific research project. The plan could detail specific efforts to inform project team members in any capacity of their labor rights and rights under Equal Employment Opportunity laws and their free and fair chance to join a union. Note that this inclusion of informing project team members is also incorporated into awards through the National Policy Assurances.

Equal treatment of workers, including students, is necessary but overcoming institutional bias requires intentionally reducing sometimes hidden barriers to equal opportunity. Applicants could consider measures like childcare, flexible schedules, paid parental leave, pay transparency, and other supports to ensure that societal barriers do not hinder realization of DEIA intentions. Some of these considerations may result in common approaches in different sections of the plan, and that is acceptable as long as the submission is not a singular approach to all sections.

EERE especially encourages applicants to form partnerships with diverse and often underrepresented institutions, such as MSIs, labor unions, and community colleges that otherwise meet the eligibility requirements. Underrepresented institutions that meet the eligibility requirements are encouraged to lead these partnerships as the prime applicant. The DEIA section of the Plan could include engagement with underrepresented institutions to broaden the participation of disadvantaged communities and/or with local stakeholders, such as residents and businesses, entities that carry out workforce development programs, labor unions, local government, and community-based organizations that represent, support, or work with disadvantaged communities. Applicants should ensure there is transparency, accountability, and follow-through when engaging with community members and stakeholders.

Specific examples include:

- Building collaborations and partnerships with researchers and staff at MSIs;
- Addressing barriers identified in climate surveys to remove

inequities;
- Providing anti-bias training and education in the project design and implementation teams;
- Offering training, mentorship, education, and other support to students and early/mid-career professionals from disadvantaged communities;
- Providing efforts toward improving a workplace culture of inclusion;
- Developing technology and technology integration innovations to meet the needs of disadvantaged communities;
- Creating partnerships with local communities, especially under-resourced and disadvantaged communities;
- Voluntary recognition of a union and informing employees of their rights, regardless of their classification;
- Making research products and engagement materials accessible in a greater variety of formats to increase accessibility of research outputs;
- Implementing training or distributing materials to reduce stigma towards individuals with disabilities;
- Designing technologies that strategically fit within the existing workforce for installation and maintenance of the potential innovation.

Energy Equity

The Energy Equity section should articulate how project proposals will drive equitable access to, participation in, and distribution of the benefits produced from successful technology innovations to disadvantaged communities and groups. Intentional inclusion of energy equity requires evaluating the anticipated long-term costs and benefits that will accrue to disadvantaged groups as a result of the project, and how research questions and project plans are designed for and support historically disadvantaged communities' engagement in clean energy decisions. Similar to potential cost reductions or groundbreaking research findings resulting from the research, energy equity and justice benefits may be uncertain, occur over a long period of time, and have many factors within and outside the specific proposed research influencing them.

Applicants should describe the influencing factors and the most likely energy equity implications of the proposed research. Applicants should describe any long-term constraints the proposed technology may pose to communities' access to natural resources and Tribal cultural resources. There may be

existing equity research available to use and cite in this description, or the applicant could describe milestone-based efforts toward developing that understanding through this innovation. These near- and long-term outcomes may include but are not limited to: a decrease in the percent of income a household spends on energy costs (energy burden);[69] an increase in access to low-cost capital; a decrease in environmental exposure and burdens; increases in clean energy enterprise creation and contracting (e.g., women or minority-owned business enterprises); increased parity in clean energy technology access and adoption; increases in energy democracy, including community ownership; and an increase in energy resilience.

Specific examples include:

- Describing how a successful innovation will support economic development in diverse geographic or demographic communities;
- Creating a plan to engage equity and justice stakeholders in evaluating the broader impacts of the innovation or in the development of the research methodology;
- Describing how the proposed research strategy and methodology was informed by input from a wide variety of stakeholders;
- Creating a literature review of the equity and justice implications of the outcomes of the specific research if the innovation is successful or a plan with dedicated budget and expertise (staffing or subawardee) to evaluate the potential equity implications of successful innovation outcomes.

Workforce

The Workforce section of the Community Benefits Plan should articulate the future workforce implications of the innovation or a milestone-driven plan for understanding those implications. This includes documenting the skills, knowledge, and abilities that would be required of workers installing, maintaining, and operating the technology that may be derivative of the applicant's research, as well as the training pathways and its accessibility for workers to acquire the necessary skills. There may be field-specific or relevant existing research that could be cited in this section. In addition, applicants could detail the process they will use to evaluate long-term impacts on jobs, including job growth or job loss, a change in job quality, disruptions to existing industry and resulting changes to relationships between employers and employees and improvements or reductions in the

ability of workers to organize for collective representation, and anything else that could result in changes to regional or national labor markets.

For additional support with developing the Workforce section of a Community Benefits Plan, please refer to the DOE's Community Benefits Plan Frequently Asked Questions (FAQs) webpage (https://www.energy.gov/bil/community-benefits-plan-frequently-asked-questions-faqs). This new resource, though created primarily for BIL-funded demonstration and deployment projects, may be useful for R&D projects.

Applicants will find section 2 of the FAQ ("Investing in America's Workforce") particularly helpful for understanding key federal policies, terms and concepts, as well as workforce development strategies relevant to examination of the workforce implications of applicants' proposed research.

Specific examples include:

- Outlining the challenges and opportunities for commercializing the technology in the United States;
- Creating a literature review of the workforce implications of the outcomes of the specific research if the innovation is successful, or a plan with dedicated budget and expertise (staffing or subawardee) to evaluate the potential equity implications of successful innovation outcomes;
- Creating a plan and milestones for assessing how a successful innovation will have implications for job savings or loss, either at the macroeconomic level or within specific industries;
- Describing how the project will support workforce training to address needs for successful innovation;
- Voluntary recognition of a union and informing employees of their rights, regardless of its classification;
- Creating a plan to evaluate how a successful innovation will result in potential workforce shifts between industries or geographies.

Inclusion of SMART milestones

EERE requires that the applicant's Community Benefits Plan include one Specific, Measurable, Attainable, Realistic and Timely (SMART) milestone for each budget period. An exemplary SMART milestone clearly answers the following questions:

- What needs to be accomplished?
- What measures and deliverables will be used to track progress toward accomplishment?
- What evidence suggests that the accomplishment is achievable?

- Why choose this milestone?
- When will the milestone be reached?

APPENDIX G – STATE- POINT DATA TABLES

***Instructions for completing data tables*:** For Topic 6, AOI 2 and AOI 3 which include carbon capture, the tables that follow shall be populated with data provided by the applicant and included as part of an application that includes carbon capture. Applicants proposing projects shall complete the appropriate combinations of Tables 1, 2 and 3 that relate to their proposed process concept. Save the State Point Data Table(s) in a single PDF using the following convention for the title "ControlNumber_LeadOrganization_State Point Data".

For **Topic 6, AOI 2** and **AOI 3**, applicants are required to provide the demonstrated performance data for their solvent, sorbent, or membrane material if relevant. Applicants shall prepare the State Point Data Table for flue gas conditions similar to the ones in the selected industrial applications. Applicants should substantiate performance of the proposed technology by providing bench-scale validation (i.e., total system or multi-component system) with simulated or real flue gas having similar conditions as to the ones in the selected industrial application.

Key data or estimates provided in the table(s) shall be supported with short narratives in bullet form. These bullets shall describe the sources for the individual data provided. This may be measurements made directly by the applicant and shall identify the apparatus and methodology used in the measurement(s). Other acceptable sources of data are the open literature (with citation and description), or estimated or extrapolated data (with description of method/model used for the estimate, or the procedure used for extrapolation).

Table 1. State-Point Data for Solvent Based Systems

	Units	Measured/ Estimated Performance	Projected Performance
Pure Solvent			
Molecular Weight	mol^{-1}		
Normal Boiling Point	°C		
Normal Freezing Point	°C		
Vapor Pressure @ 15°C	bar		
Working Solution			
Concentration	kg/kg		
Specific Gravity (15 °C/15 °C)	-		
Specific Heat Capacity @ STP	kJ/kg·K		
Viscosity @ STP	cP		
Surface Tension @ STP	dyn/cm		
CO_2 Mass Transfer Rate [K_L]	m/s		
CO_2 Reaction Rate	-		

Thermal Conductivity	W/(m·K)		
Absorption			
Pressure	bar		
Temperature	°C		
Equilibrium CO_2 Loading	gmol CO_2/kg		
Heat of Absorption	kJ/kg CO_2		
Solution Viscosity	cP		
Desorption			
Pressure	bar		
Temperature	°C		
Equilibrium CO_2 Loading	gmol CO_2/kg		
Heat of Desorption	kJ/kg CO_2		

***Definitions for Table 1*:**

STP – Standard Temperature and Pressure (15 °C, 1 atm)

Pure Solvent – Agent(s), working alone or as a component of a working solution, responsible for enhanced CO_2 absorption. For example: the amine monoethanolamine (MEA) in an aqueous solution.

Working Solution – The solute-free (*i.e.* CO_2-free) liquid solution used as the working solvent in the absorption/desorption process. For example: the liquid mixture of MEA and water.

Absorption – The conditions of interest for absorption are those that prevail at maximum solvent loading, which typically occurs at the bottom of the absorption column. Measured data are preferable to estimated data.

Desorption – The conditions of interest for desorption are those that prevail at minimum solvent loading, which typically occurs at the bottom of the desorption column. Operating pressure and temperature for the desorber/stripper are process dependent. Measured data are preferable to estimated data.

Pressure – The pressure of CO_2 in equilibrium with the solution. If the vapor phase is pure CO_2, this is the total pressure, and if it is a mixture of gases, this is the partial pressure of CO_2.

Concentration – Mass fraction of pure solvent in working solution.

Loading – The basis for CO_2 loading is moles of pure solvent.

Mass Transfer Rate – Overall liquid phase mass transfer coefficient.

CO_2 Reaction Rate – A characterization of the CO_2 absorption trend with respect to time, as complete in the range of time as possible.

Table 2. State-Point Data for Sorbent Based Systems

	Units	Measured Performance (Powder form)	Projected or Measured Performance (structured material system)
Sorbent			
True Density @ STP	kg/m^3		
Bulk Density	kg/m^3		
Average Particle Diameter	mm		
Particle Void Fraction	m^3/m^3		
Packing Density	m^2/m^3		
Solid Heat Capacity @ STP	kJ/kg·K		
Crush Strength	kg_f		
Attrition Index	-		
Thermal Conductivity	W/(m·K)		
Adsorption			
Pressure	bar		
Temperature	°C		
Equilibrium Loading	gmol CO_2/kg		
Heat of Adsorption	kJ/gmol CO_2		
CO_2 Adsorption Kinetics	gmol/time		
Desorption			
Pressure	bar		
Temperature	°C		
Equilibrium Loading	gmol CO_2/kg		
Heat of Desorption	kJ/gmol CO_2		
CO_2 Desorption Kinetics	gmol/time		
Overall Performance			
Space Velocity	hr^{-1}		
Volumetric Productivity	gmol $_{CO2}$ / (hr $l_{absorber\ bed}$)		
Carbon Capture Efficiency (single pass)	%		
Pressure Drop	Pa		

Degradation	(% Capacity fade/cycle)		

***Definitions for Table 2*:**

STP – Standard Temperature and Pressure (15 °C, 1 atm)

Sorbent – Adsorbate-free (*i.e.* CO_2-free) and dry material as used in adsorption/desorption cycle.

Adsorption – The conditions of interest for adsorption are those that prevail at maximum sorbent loading. Measured data are preferable to estimated data.

Desorption – The conditions of interest for desorption are those that prevail at minimum sorbent loading. Operating pressure and temperature for the desorber/stripper are process dependent. Measured data are preferable to estimated data.

Pressure – The pressure of CO_2 in equilibrium with the sorbent. If the vapor phase is pure CO_2, this is the total pressure, and if it is a mixture of gases, this is the partial pressure of CO_2.

Packing Density – Ratio of the active sorbent area to the bulk sorbent volume.

Loading – The basis for CO_2 loading is mass of dry sorbent.

Kinetics – A characterization of the CO_2 adsorption/desorption trend with respect to time, as complete in the range of time as possible.

Table 3. State-Point Data for Membrane Based Systems

	Units	Measured/ Estimated Performance	Projected Performance
Materials Properties			
Materials of Fabrication for Selective Layer			
Materials of Fabrication for Support Layer (if applicable)			
Nominal Thickness of Selective Layer (μm)			
Membrane Geometry			
Max Trans-Membrane Pressure	bar		
Hours tested without significant degradation			
Membrane Performance			
Temperature	°C		
Pressure Normalized Flux for Permeate (CO_2)	GPU or equivalent		
CO_2/H_2O Selectivity	-		
CO_2/N_2 Selectivity	-		
Type of Measurement (Ideal or mixed gas)	-		
Proposed Module Design			
Flow Arrangement	-		
Packing Density	m^2/m^3		
Shell-Side Fluid	-		

***Definitions for Table 3*:**

Membrane Geometry – Flat discs or sheets, hollow fibers, tubes, etc.

Pressure Normalized Flux – For materials that display a linear dependence of flux on partial pressure differential, this is equivalent to the membrane's permeance.

GPU – Gas Permeation Unit, which is equivalent to 10^{-6} $cm^3/(cm^2 \cdot s \cdot cmHg)$ at 1 atm and 0 °C. For non-linear materials, the dimensional units reported shall be based on flux measured in $cm^3/(cm^2 \cdot s)$ (at 1 atm and 0 °C) with pressures measured in cm Hg. Note: 1 GPU = 3.3464×10^{-6} $kgmol/(m^2 \cdot s \cdot kPa)$ [SI units]

Type of Measurement – Either mixed or pure gas measurements; projected permeance and selectivities shall be for mixture of gases found in de-sulfurized flue gas.

Flow Arrangement – Typical gas-separation module designs include spiral-wound sheets, hollow-fiber bundles, shell-and-tube, and plate-and-frame, which result in either co-current, counter-current, cross-flow arrangements, or some complex combination of these.

Packing Density – Ratio of the active surface area of the membrane to the volume of the module.

Shell-Side Fluid – Either the permeate or retentate stream