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

Industrial Efficiency and Decarbonization FOA

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002804
FOA Type: Modification 0002
Assistance Listing Number: 81.086

FOA Issue Date:	09/07/2022
Submission Deadline for Concept Papers:	10/12/2022 5:00pm ET
Submission Deadline for Full Applications:	01/04/2023 5:00pm ET
Expected Submission Deadline for Replies to Reviewer Comments:	02/10/2023 5:00pm ET
Expected Date for EERE Selection Notifications:	April 2023
Expected Timeframe for Award Negotiations:	April 2023 – July 2023

- Applicants must submit a Concept Paper by 5:00pm 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) Be registered in the SAM at https://www.sam.gov before submitting its application; (2) provide a valid UEI number in its application; and (3) continue to maintain an active SAM registration with current information at all times during which it has an active federal award or an application or plan under consideration by a federal awarding agency. DOE may not make a federal award to an applicant until the applicant has complied with all applicable 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, the DOE will determine that the applicant is not qualified to receive a federal award and use that determination as a basis for making a federal award to another applicant.

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. Applicants should start the UEI and SAM registration process as soon as possible. If applicants have technical difficulties with the SAM registration or UEI validation process they should contact Customer Service on SAM.gov. SAM.gov Customer Service will work service tickets in the order in which they are received and asks that applicants not create multiple service tickets for the same request or technical issue.

Modifications

All modifications to the Funding Opportunity Announcement are [HIGHLIGHTED] in the body of the FOA.

Mod. No.	Date	Description of Modification
0001	09/22/2022	Changes in language related to: Applications Not of Interest for Topic Area 1 clarified in Section I.B. (page 17) and Section I.C. (page 40). Also, clarification of TRL levels permitted for Tier 1 projects on page 13. And on page 15, NAICS code reference revision to 325199 for all other organic chemicals.
0002	11/28/2022	Change Submission Deadline for Full Applications to 01/04/2023 5:00pm ET and Expected Submission Deadline for Replies to Reviewer Comments to 02/10/2023 5:00pm ET.

Table of Contents

Table of Contents **3**

I. Funding Opportunity Description **7**

A. Background and Context 7
i. Background and Purpose 7
ii. Technology Space and Strategic Goals 10
iii. Diversity, Equity, and Inclusion 11
B. Topic Areas 13
C. Applications Specifically Not of Interest 39
D. Authorizing Statutes 40

II. Award Information **40**

A. Award Overview 40
i. Estimated Funding 40
ii. Period of Performance 41
iii. New Applications Only 41
B. EERE Funding Agreements 41
i. Cooperative Agreements 41
ii. Funding Agreements with Federally Funded Research and Development Center (FFRDCs) 42

III. Eligibility Information **42**

A. Eligible Applicants 42
i. Domestic Entities 42
ii. Foreign Entities 43
iii. Incorporated Consortia 43
iv. Unincorporated Consortia 43
B. Cost Sharing 44
i. Legal Responsibility 44
ii. Cost Share Allocation 45
iii. Cost Share Types and Allowability 45
iv. Cost Share Contributions by FFRDCs 46
v. Cost Share Verification 46
vi. Cost Share Payment 46
C. Compliance Criteria 47
D. Responsiveness Criteria 48
E. Other Eligibility Requirements 48
i. Requirements for DOE/National Nuclear Security Agency (NNSA) Federally Funded Research and Development Centers (FFRDC) Listed as the applicant 48
ii. Requirements for DOE/NNSA and non-DOE/NNSA Federally Funded Research and Development Centers Included as a Subrecipient 48
F. Limitation on Number of Concept Papers and Full Applications Eligible for Review 50
G. Questions Regarding Eligibility 50

IV. Application and Submission Information **50**

A. Application Process 50
i. Additional Information on EERE eXCHANGE 51

B. Application Forms 51
C. Content and Form of the Concept Paper 51
i. Concept Paper Content Requirements 51
D. Content and Form of the Full Application 53
i. Full Application Content Requirements 53
ii. Technical Volume 54
iii. Resumes 59
iv. Letters of Commitment 60
v. Statement of Project Objectives (SOPO) 60
vi. SF-424: Application for Federal Assistance 60
vii. Budget Justification Workbook 61
viii. Summary/Abstract for Public Release 61
ix. Summary Slide 61
x. Subrecipient Budget Justification (if applicable) 62
xi. Budget for DOE/NNSA FFRDC (if applicable) 62
xii. Authorization for non-DOE/NNSA or DOE/NNSA FFRDCs (if applicable) 62
xiii. SF-LLL: Disclosure of Lobbying Activities (required) 62
xiv. Waiver Requests: Foreign Entity and Foreign Work (if applicable) 63
xv. Waiver of the Build America, Buy America Requirement for Infrastructure Projects 63
xvi. Diversity, Equity and Inclusion Plan 64
xvii. Current and Pending Support 65
E. Content and Form of Replies to Reviewer Comments 68
F. Post Selection Information Requests 68
G. Unique Entity Identifier (UEI) and System for Award Management (SAM) 69
H. Submission Dates and Times 69
I. Intergovernmental Review 69
J. Funding Restrictions 69
i. Allowable Costs 69
ii. Pre-Award Costs 70
iii. Performance of Work in the United States (Foreign Work Waiver) 71
iv. Construction 71
v. Foreign Travel 71
vi. Equipment and Supplies 72
vii. Buy America Requirements for Infrastructure Projects 72
viii. Lobbying 72
ix. Risk Assessment 73
x. Invoice Review and Approval 73
xi. Prohibition Related to Foreign Government-Sponsored Talent Recruitment Programs 74

V. Application Review Information 75

A. Technical Review Criteria 75
i. Concept Papers 75
ii. Full Applications 75
iii. Criteria for Replies to Reviewer Comments 77
B. Standards for Application Evaluation 77
C. Other Selection Factors 77
i. Program Policy Factors 77
D. Evaluation and Selection Process 78
i. Overview 78
ii. Pre-Selection Interviews 78
iii. Pre-Selection Clarification 79
iv. Recipient Integrity and Performance Matters 79

v. Selection 80
E. Anticipated Notice of Selection and Award Negotiation Dates 80

VI. Award Administration Information 80

A. Award Notices 80
i. Ineligible Submissions 80
ii. Concept Paper Notifications 80
iii. Full Application Notifications 81
iv. Successful Applicants 81
v. Alternate Selection Determinations 82
vi. Unsuccessful Applicants 82
B. Administrative and National Policy Requirements 82
i. Registration Requirements 82
ii. Award Administrative Requirements 83
iii. Foreign National Participation 83
iv. Subaward and Executive Reporting 84
v. National Policy Requirements 84
vi. Environmental Review in Accordance with National Environmental Policy Act (NEPA) 84
vii. Applicant Representations and Certifications 85
viii. Statement of Federal Stewardship 86
ix. Statement of Substantial Involvement 87
x. Interim Conflict of Interest Policy for Financial Assistance Policy 87
xi. Subject Invention Utilization Reporting 88
xii. Intellectual Property Provisions 88
xiii. Reporting 88
xiv. Go/No-Go Review 88
xv. Conference Spending 89
xvi. Uniform Commercial Code (UCC) Financing Statements 89
xvii. Implementation of Executive Order 13798, Promoting Free Speech and Religious Liberty 90
xviii. Participants and Collaborating Organizations 90
xix. Current and Pending Support 90
xx. U.S. Manufacturing Commitments 90
xxi. Data Management Plan (DMP) 91
xxii. Fraud, Waste and Abuse 92

VII. Questions/Agency Contacts 92

VIII. Other Information 93

A. FOA Modifications 93
B. Government Right to Reject or Negotiate 93
C. Commitment of Public Funds 93
D. Treatment of Application Information 93
E. Evaluation and Administration by Non-Federal Personnel 95
F. Notice Regarding Eligible/Ineligible Activities 95
G. Notice of Right to Conduct a Review of Financial Capability 95
H. Requirement for Full and Complete Disclosure 95
I. Retention of Submissions 95
J. Title to Subject Inventions 96
K. Government Rights in Subject Inventions 96
L. Rights in Technical Data 97
M. Copyright 98
N. Export Control 98

O. Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment 98
P. Personally Identifiable Information (PII) 99
Q. Annual Independent Audits 99

Appendix A – Cost Share Information 100

Appendix B – Sample Cost Share Calculation for Blended Cost Share Percentage 105

Appendix C – Waiver Requests and Approval Processes: 1. Foreign Entity Participation as the Prime Recipient; and 2. Performance of Work in the United States (Foreign Work Waiver) 107

Appendix D -- Required Use of American Iron, Steel, Manufactured Products, and Construction Materials 110

Appendix E – Glossary 114

Appendix F – Definition of Technology Readiness Levels 116

Appendix G – List of Acronyms 117

I. Funding Opportunity Description

A. Background and Context

i. Background and Purpose

The Advanced Manufacturing Office (AMO) plays a leading role in increasing energy efficiency along with decarbonizing the industrial sector. AMO drives the innovation and deployment that can lead to a more resilient, robust, and competitive domestic clean energy manufacturing sector that provides economic opportunities across diverse communities. As part of its industrial efficiency and decarbonization efforts, AMO supports applied research, development, and demonstration (RD&D) targeting the reduction of greenhouse gas (GHG) emissions from high emitting industrial sectors and through cross-sector technologies relevant across multiple industrial sectors. Significant decarbonization of the industrial sector is essential to achieving the overall goal of economy-wide decarbonization by 2050 and creating good paying jobs; while ensuring that U.S. industry remains globally competitive and production is not transferred to locations with higher carbon emissions.

Building a clean and equitable energy economy and addressing the climate crisis is a top priority of the Biden Administration. This FOA will advance the Biden Administration's goals to achieve carbon pollution-free electricity by 2035 and 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"[1] to the benefit of all Americans. The Department of Energy 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. The projects selected under this FOA are expected to contribute to the Justice40 Initiative[2], which set a goal that 40% of the overall benefits of government's climate and clean energy investments will flow to disadvantaged communities.

The research, development, and demonstration (RD&D) activities to be funded under this FOA will support the government-wide approach to the climate crisis by driving the innovation that can lead to the deployment of clean energy technologies, which are critical for climate protection. Specifically, this FOA will

[1] Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021.

[2] The Justice40 Initiative was created by Executive Order 14008. For this FOA, each project is expected to contribute to achieving the 40% goal to some extent. However, it is not expected that 40% of benefits of each individual project will flow to disadvantaged communities. Recipients will be required to report on to what extent the anticipated project benefits will flow to disadvantaged communities. For additional information on the Justice40 Intiative, see https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf.

fund high-impact, applied research and development and prototype or pilot-scale technology validation and demonstration projects in order to expedite the adoption of transformational industrial technology necessary to increase energy efficiency across industry and in high GHG-emitting industrial subsectors, reducing both energy usage and GHG emissions. This includes cross-sector industrial decarbonization approaches via opportunities in energy efficiency; industrial electrification; low carbon fuels, feedstocks and energy sources; and industrial carbon capture and utilization. This FOA and its associated projects are separate from any forthcoming efforts to be funded under the Bipartisan Infrastructure Law, including activities related to Industrial Emissions Demonstration Projects.[3]

Significant portions of the industrial sector are considered "difficult-to-decarbonize" sectors of the energy economy,[4] due in part to the diversity of energy inputs into a wide array of heterogeneous industrial processes and operations that range from less than megawatt (MW) to hundreds of MWs for both continuous and batch processes. In 2020, the industrial sector accounted for about 33% of the nation's primary energy use[5] and around 30% of primary energy-related carbon dioxide (CO_2) emissions, with chemicals, iron and steel, cement, and food products among the top energy-consuming and carbon-emitting industrial sectors (see Figure 1. below).[6]

Industrial emissions are primarily attributable to processes that combust fossil fuels on-site for direct use or for steam (e.g., for process heating), the generation of electricity on-site or off-site (e.g. for motor-driven systems), the use of other fuels and feedstocks, as well as additional non-energy-related process emissions (e.g., CO_2 emissions from calcination in the production of cement).

[3] Section 41008 of the Bipartisan Infrastructure Law (officially known as the Infrastructure Investment and Jobs Act(Public Law 117-58), authorized appropriations for demonstration projects that test and validate industrial emissions reduction technologies. Associated activities will be led by the DOE Office of Clean Energy Demonstrations (https://www.energy.gov/office-clean-energy-demonstrations).

[4] National Academies of Sciences, Engineering, and Medicine, Accelerating Decarbonization in the United States Energy Sector, February 2021. Available at: https://www.nap.edu/catalog/25932/accelerating-decarbonization-of-the-us-energy-system.

[5] Including feedstocks – fossil inputs to material production (i.e., plastics, chemicals).

[6] EIA (Energy Information Administration), Annual Energy Outlook 2021 with Projections to 2050. 2021. https://www.eia.gov/outlooks/archive/aeo21/. Does not include non-energy related CO_2 or other GHG emissions.

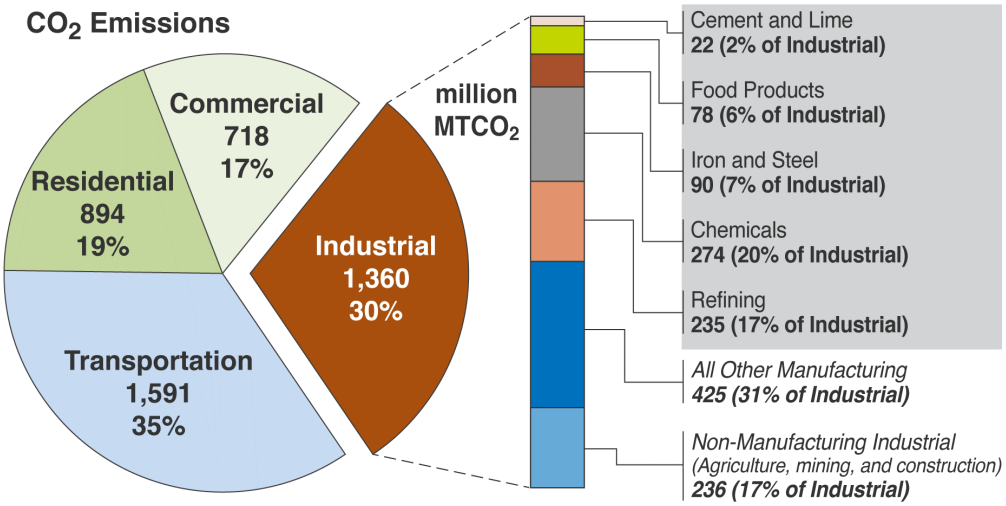

Figure 1. U.S. Energy-Related CO_2 Emissions in 2020.

In addition to consuming significant amounts of energy, 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 (U.S.), racial and ethnic minority groups as well as lower-income groups are disproportionately exposed to elevated levels of air pollution and, consequently, experience higher rates of adverse health impacts compared to the general population.[7] Addressing pollution from industrial energy use is an integral step towards achieving environmental justice by remediating social, economic, and health burdens on those disproportionately harmed by industrial sector emissions.[8] Assessing community-level impacts and prioritizing energy justice help ensure the benefits of investments to decarbonize industry will flow to disadvantaged communities.[9] For additional insights, a broader look at environmental impact factors and associated lifecycle analysis is provided in the Quadrennial Technology Review 2015 technology assessment focused on sustainable manufacturing.[10]

[7] Liu, et al. "Disparities in Air Pollution Exposure in the United States by Race/Ethnicity and Income, 1990–2010." *Environmental Health Perspectives* (2021). https://doi.org/10.1289/EHP8584; Tessum, et al. "PM2.5 polluters disproportionately and systemically affect people of color in the United States." *Science Advances* (2021). https://doi.org/10.1126/sciadv.abf4491 .

[8] 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.

[9] Sec. 223 "Justice40 Initiative," Executive Order 14008 of Jan 27, 2021 "Tackling the Climate Crisis at Home and Abroad." https://www.federalregister.gov/d/2021-02177/p-163.

[10] See "Chapter 6: Innovating Clean Energy Technologies in Advanced Manufacturing | Sustainable Manufacturing - Flow of Materials through Industry Technology Assessment." DOE. Available at: https://www.energy.gov/sites/prod/files/2016/05/f31/QTR2015-6L-Sustainable-Manufacturing.pdf.

ii. Technology Space and Strategic Goals

In recent years there has been increasing recognition of the importance of industrial decarbonization. New approaches and technologies must be developed that will reduce absolute emissions from the industrial sector while allowing for growth and increasing productivity. The United States has the opportunity to take a leadership role in developing, demonstrating, and deploying technologies that will reduce U.S. GHG emissions, and in manufacturing clean energy technologies that can have a global impact. While some companies across different industrial subsectors have started making investments and setting decarbonization goals spurred by various drivers, more investment is needed to make significant carbon reductions across the industrial sector in the next few decades.

To address this topic, the Department of Energy has developed an industrial decarbonization roadmap which frames the emerging and transformative technology pathways needed to achieve net-zero GHG emissions in the industrial sector by 2050.[11] The analysis was scoping in nature and highlighted the key technology needs and opportunities, while also considering the necessity of maintaining and enhancing U.S. industrial competitiveness. This roadmap is intended to fulfill a technical and strategic need by laying out a cohesive technical approach for industrial sector decarbonization in the United States.

The roadmap identified four key "pillars" of decarbonization: energy efficiency; industrial electrification; low-carbon fuels, feedstocks, and energy sources (LCFFES); and carbon capture, utilization, and storage (CCUS). Each represents a high-level element of an industrial decarbonization action plan, and a cohesive strategy will require all four pillars to be pursued in parallel. Decarbonization opportunities were explored and quantified in the roadmap by studying subsector-specific and crosscutting technologies, processes, and practices for several of the most carbon-intensive manufacturing subsectors. For each pillar, the roadmap identified the primary barriers and opportunities, as well as key research, development, and demonstration (RD&D) needs. Scenario modeling was also undertaken to show the potential that application of these pillars have towards achieving net-zero CO_2 emissions for the industrial sector. Relevant activities that address the four pillars are funded within various offices in the Department of Energy. Some of these efforts are funded by the Bipartisan Infrastructure Law, including a provision for industrial emission reduction demonstration projects which is separate from this FOA.

AMO is issuing this FOA to fund high-impact, applied research, development, and pilot-scale technology validation and demonstration projects in order to advance

[11] Available at: https://www.energy.gov/eere/industrial-decarbonization.

transformational technology and innovation necessary to reduce energy usage and GHG emissions from high GHG-emitting industrial subsectors along with cross-sector industrial decarbonization approaches.

AMO's priorities include:

- Achieving a decarbonized industrial sector;
- Supporting domestic clean energy technology manufacturing;
- Ensuring secure and sustainable supply chains; and
- Developing a skilled and diverse manufacturing workforce.

AMO supports these goals through technical assistance partnerships and workforce development activities as well as investments in RD&D activities through a range of cost-shared funding models.

iii. Diversity, Equity, and Inclusion

To achieve the greatest impact for all Americans with the industrial decarbonization activities, it critical that the projects selected under this FOA not only contribute to the country's energy technology and climate goals, but also advances DOE's diversity, equity[12], and inclusion priorities. Advancing equity, civil rights, racial justice, and equal opportunity is a key priority of the Biden Administration.

As part of this whole of government approach, this FOA seeks to encourage the participation of underserved communities[13] and underrepresented groups. Applicants are highly encouraged to include individuals from groups historically

[12] Executive Order 13985, "Advancing Racial Equity and Support for Underserved Communities Through the Federal Government" (Jan. 20, 2021).

[13] The term "underserved communities" refers to populations sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified by the list of in the definition of "equity." E.O. 13985. For purposes of this FOA, as applicable to geographic communities, applicants can refer to economically distressed communities identified by the Internal Revenue Service as Qualified Opportunity Zones; communities identified as disadvantaged or underserved communities by their respective States; communities identified on the Index of Deep Disadvantage referenced at https://news.umich.edu/new-index-ranks-americas-100-most-disadvantaged-communities/, and communities that otherwise meet the definition of "underserved communities" stated above.

underrepresented[14,15] in STEM on their project teams. As part of the application, applicants are required to describe how diversity, equity, and inclusion objectives will be incorporated in the project. Specifically, applicants are required to submit a Diversity, Equity, and Inclusion Plan that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM, advance equity, and encourage the inclusion of individuals from these groups in the project; and the extent the project activities will be located in or benefit underserved communities (See Section IV.D.xv.). The plan should include at least one SMART (Specific, Measurable, Assignable, Realistic and Time-Related) milestone per budget period supported by metrics to measure the success of the proposed actions. This plan will be evaluated as part of the technical review process, and incorporated into the award if selected.

Further, Minority Serving Institutions[16], Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements (See Section III.) are encouraged to apply as the prime applicant or participate on an application as a proposed partner to the prime applicant. The Selection Official may consider the inclusion of these types of entities as part of the selection decision (See Section V.C.i.).

---

[14] According to the National Science Foundation's 2019 report titled, "Women, Minorities and Persons with Disabilities in Science and Engineering", women, persons with disabilities, and underrepresented minority groups—blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives—are vastly underrepresented in the STEM (science, technology, engineering and math) fields that drive the energy sector. That is, their representation in STEM education and STEM employment is smaller than their representation in the U.S. population. https://ncses.nsf.gov/pubs/nsf19304/digest/about-this-report For example, in the U.S., Hispanics, African Americans and American Indians or Alaska Natives make up 24 percent of the overall workforce, yet only account for 9 percent of the country's science and engineering workforce. DOE seeks to inspire underrepresented Americans to pursue careers in energy and support their advancement into leadership positions. https://www.energy.gov/articles/introducing-minorities-energy-initiative

[15] See also. Note that Congress recognized in section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329:

> (1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

[16] Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities/Other Minority Institutions as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

B. Topic Areas

AMO intends to fund high-impact, applied R&D and pilot-stage technology validation and demonstration activities through this FOA. All applications in Topics 1 through 6 are strongly encouraged to include an industry partner on the project team. 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 F for EERE's definitions of TRLs. In general, efforts should primarily include work scopes between TRL 4 and TRL 7 to develop and validate technology advancements to facilitate industrial decarbonization. Awards will be made at one of two funding levels, with maximum award amount by tier and topic indicated in the table below:

- **Tier 1 projects** are primarily focused on TRL 4 and TRL 5 R&D activities to validate technology components in a laboratory or relevant environment. For select areas of interest (all Areas of Interest in Topic 1, and Area of Interest 2 in Topic 6), efforts can begin in TRL 3. The cost share for Tier 1 projects must be at least 20% of the total allowable costs.
- **Tier 2 projects** can include activities in TRL 4 and 5, but must also include scope to include TRL 6 and/or TRL 7 to conduct system/subsystem prototype or pilot-scale technology validation in a relevant or operational environment. Tier 2 projects should be organized into distinct phases, and should include Phase 2 and/or Phase 3, below:
    - Phase 1: Research and development;
    - Phase 2: Design and testing; and
    - Phase 3: Installation and demonstration.

  Tier 2 applications with technology demonstration integrated into industrial operations must include Phase 3. The cost share for Phase 1 and Phase 2 must be at least 20% of the total allowable costs. For Phase 3, the demonstration phase, the cost share must be at least 50% of total allowable costs.

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 Appendices A and B for further discussion regarding cost-sharing.

Topic Area	Tier 1 Maximum Funding Level	Tier 2 Maximum Funding Level
1. Decarbonizing Chemicals	$3 million	$10 million
2. Decarbonizing Iron and Steel	$4 million	$10 million
3. Decarbonizing Food and Beverage Products	$3 million	$6 million
4. Decarbonizing Cement and Concrete	$4 million	$10 million
5. Decarbonizing Paper and Forest Products	$3 million	$8 million
6. Cross-sector Decarbonization Technologies	$3 million	$5 million

All applicants are expected to identify a baseline technology to compare their advancement against and justify why that technology is the appropriate baseline. Applicants should also include associated energy and carbon impact analyses for domestic technology adoption. In addition, the applicant shall provide no less than three (3) leading factors that will impact successful achievement of efficiency and decarbonization goals. The applicant shall identify metrics or goals associated with those leading factors such that the achievement of those goals will result in the improvements claimed in the proposal. Examples of potential factors that apply to each Topic area are provided in the descriptions below. These metrics are provided as examples. Applicants should use their knowledge and judgement to identify key factors that apply to their specific technology.

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

Topic Area 1: Decarbonizing Chemicals

Topic 1 Background: There is a significant opportunity for the U.S. chemicals industry to decarbonize and impact global carbon emissions. The chemicals sector consumes the most energy and emits the most carbon in U.S. manufacturing, 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 million metric tons (MMT) of carbon dioxide equivalent (CO_2e) GHG emissions (including both process and energy-related emissions).[17]

Reducing carbon emissions and energy input are key aspects of sustainable chemistry goals to design and use chemicals with lower impacts on human and environmental health. Broadly, sustainable chemistry can be defined as the design, development, and use of chemicals and materials that have lower energy consumption and emissions; are less toxic to human health and the environment; have reduced natural resource impacts; and are designed for reduced waste and increased recycling capability across the product lifecycle. Decarbonization of the chemicals sector offers opportunities to incorporate aspects of sustainable chemistry throughout manufacturing operations with potential to contribute to the Biden Administration's Environmental and Energy Justice goals.

Additionally, the chemicals industry has significant impact on the U.S. economy supporting over 25% of the U.S. gross domestic product and exporting $125 billion of U.S. goods.[18] The chemicals industry converts raw materials into more than

[17] 2018 Manufacturing Energy and Carbon Footprints, Chemicals Sector. DOE AMO, 2021. Available at: https://www.energy.gov/sites/default/files/2021-12/2018_mecs_chemicals_energy_carbon_footprint_0.pdf
[18] American Chemistry Council, 2021, Data & Industry Statistics.

70,000 different products[19] which are used to make a wide variety of consumer goods that are essential inputs to other sectors of the U.S economy, including agriculture, manufacturing, pharmaceutical, and construction.

Topic 1 Opportunity: The breadth of the chemicals sector underscores the difficulty of decarbonizing an industry with an extensive value chain and deep sectoral interconnections. Large amounts of natural gas and petroleum derivatives are used by the chemicals sector to generate usable building block chemicals. For example, steam cracking processes use natural gas liquid feedstocks, such as ethane, to produce valuable olefins (e.g., ethylene, propylene, and butadiene). Olefins are critical building blocks for a variety of end products including plastics, detergents, and coatings; however, olefin production is energy and carbon intensive.

In manufacturing processes for chemicals there is a high demand for energy to drive reactions, evaporations, and distillation for purification and separation of chemical products. Process heating alone accounted for over 70 MMT CO_2e in the chemical industry in 2018.[20] Improvements in process heating can be achieved through more efficient heating or less heat requirements with advanced unit operations including advanced catalysts, advanced reactor concepts, and advanced separations.

Decarbonization of the chemicals sector will require dynamic and multi-faceted approaches for innovations in unit operations including advanced catalysts, reactor concepts, and separations that leverage energy efficiency improvements; electrification of processes; and low carbon fuels, feedstocks, and energy sources.

Topic 1 Technology Focus: Topic 1 will focus on the development, validation, and demonstration needed to accelerate the commercial readiness of emerging low carbon unit operations to decarbonize the full supply chain of the chemicals sector. Technologies with potential for significant reductions in carbon emissions that increase energy efficiency for manufacturing high-volume chemicals are of interest, as are technologies that consider sustainable chemistry practices as defined in Topic 1 Background.

Applications should address the production of high volume, energy intensive, high carbon emissions chemicals including petrochemicals (NAICS[21] 325110), all other basic organic chemicals (NAICS 325199), nitrogenous fertilizers (NAICS 325311), basic inorganics chemicals (NAICS 325180), and plastics materials and resins (NAICS

[19] Ibid.
[20] 2018 Manufacturing Energy and Carbon Footprints, Chemicals Sector. DOE AMO, 2021. Available at: https://www.energy.gov/sites/default/files/2021-12/2018_mecs_chemicals_energy_carbon_footprint_0.pdf.
[21] North American Industrial Classification System (NAICS). Used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. Details on specific codes and references available at: https://www.census.gov/naics/.

325211). Applications must aim to produce chemical product(s) with a current U.S. production volume >1 MMT and with a current combined (feedstock and fuel) carbon emission >3 MMT CO_2e.

Strongly encouraged are technologies that produce chemical(s) via alternative feedstocks including CO_2, carbon monoxide, biobased feedstocks, recovered plastics, or renewable natural gas. 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.

Applications submitted under this subtopic must address one or more of the areas of interest (AOI) stated below.

Area of Interest 1 – Advanced Separations: This area of interest seeks applications for innovative technologies focusing on advanced separations capable of replacing thermal-based evaporators and distillation processes including, but not limited to, reactions driven by non-equilibrium processes; membranes; or processes that are driven by electrochemical or other novel separation technologies. 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.

Area of Interest 2 – Advanced Reactions and Reactor Systems: This area of interest seeks applications focusing on advanced reactors capable of improving reaction performance while reducing carbon emissions and improving energy efficiency through thermal catalytic, non-catalytic oxidation, electrochemical, and non-contact energy transfer for precision heating (e.g., photonic, microwave, and plasma) reactor systems or other novel reactor technologies. Applications must consider the optimization or design of the reactor system including heat transfer 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.

Applications on electrochemical processes should focus on production of molecules with multiple carbon-carbon bonds (e.g., C2+, ethylene) and ammonia. Applications focused on dynamic catalyst science must apply data analytics and modeling with transient characterization techniques for realistic industrial reactions with advanced operando spectroscopic methods that have time-resolution on the scale of 10^{-3} seconds. Applications must inform industrial catalyst formulation, process conditions, or catalyst performance through structural characterization, microkinetic data, or transport phenomena. Applications that reduce platinum group metal (PGM) loadings or utilize non-PGM based catalysts are encouraged.

Area of Interest 3 – Alternative Production and Process Heating Technologies: This area of interest seeks applications for alternative production methods (e.g., electrification of direct-fire reactors) and novel energy transfers for process heating (e.g., capture and reuse of process heat, electrification and low carbon fuels for process heating, and renewable steam generation).

For AOI 1, AOI 2, and AOI 3, this topic seeks both Tier 1 and Tier 2 applications. For Tier 1, applications should prove concepts in a relevant environment at TRL 3-5 at an appropriate scale to advance the technology towards commercialization – for example 1/100th of current commercial scale process – and achieving a continuous operation by the end of the project. Applications must show potential for >50% reduction in carbon emissions of the unit operation and energy intensity reduction of >30%. Applications must establish the potential to be cost competitive with commercially available state-of-the-art technology. During the award performance period, carbon emissions, energy intensity, and cost must be validated via lifecycle analysis (LCA) and technoeconomic analysis (TEA).

For 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 towards commercialization – for example scaling to 1/50 of current commercial scale process for a continuous operation. Applications must show potential for >50% reduction in carbon emissions of the unit operation and energy intensity reduction of >30%. Applications must establish the potential to be cost competitive with commercially available state-of-the-art technology. During the award performance period, carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

Additionally, implementation of sustainable chemistry processes in chemicals manufacturing can positively influence communities near chemicals production facilities by improving local air quality and reducing risk of exposure to harmful chemicals. Applications are encouraged to discuss impact of their technologies as related to principles of sustainable chemistry processes within the scope of work and the Diversity, Equity, and Inclusion Plan.

All applications should include an Industry Partner. The term "Industry Partner" includes non-profit and for-profit entities engaged in chemical production or a related industry.

Not of interest in Topic 1: DOE is not interested in funding applications in this topic focused on the production of alternative feedstocks, including the capture of carbon dioxide, or focused on production of fuels from byproducts or wastes. See Section I.C. of the FOA.

Topic 1 Candidate 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 carbon emissions of the unit operation and energy intensity reduction of more than 30%. Carbon and energy intensity analyses must be included with a comparison of the current, commercially available state-of-the-art technology if broadly implemented at the national level. Applications will be evaluated based on potential to reduce carbon emissions annually within the chemicals sector at the national level if broadly implemented. Technologies must also establish the potential to be scalable in terms of material availability and scaling operations to reach 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 carbon intensity	% carbon intensity change as measured by ton CO_2e/kg product	50%	>70%	*Applicant Defined*
Reduce energy consumption	Btu/kg product	30%	>70%	*Applicant Defined*

Additional metrics and critical criteria that will lead to successfully meeting the goal 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
Process improvements	Increased yield/per physical unit input	30%	>70%	*Applicant Defined*
Reduce cost	Unit (product mass or part basis) cost vs. state of the art	Cost parity	>50%	*Applicant Defined*
Increase component lifetime (e.g., catalyst stability)	Number of cycles or time before regeneration or replacement	30%	>50%	*Applicant Defined*
Reaction selectivity	Desired product formed / undesired product formed	30%	>50%	*Applicant Defined*
Reduce criteria air pollutant emissions	% Pollutant change as measured by ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 2: Decarbonizing Iron and Steel

Topic 2 Background: Steel is a vital material for many economic sectors, with uses in transportation, homes, commercial buildings, and industrial equipment, as well as many other applications used in everyday life. Total U.S. steel mill shipments were around 95 million net tons of steel in 2018, with an import market share of finished steel estimated at 23% of total consumption.[22] To produce these products, the U.S. steel industry consumed over a quad of energy and accounted for an estimated 71 million metric tons of GHG emissions in the same year, excluding off-site electricity and steam generation losses.[23] While significant, the high proportion of electric arc furnace (EAF) based domestic steel production results in lower GHG emissions per ton of steel compared to other leading steel-producing countries. Key industry operations include integrated steelmaking, EAF steelmaking, direct reduced iron production, and downstream steel mill operations.

Topic 2 Opportunity: Steelmaking remains a relatively energy-intensive process with considerable GHG emissions. There is no single solution for the decarbonization of the steel industry. Possible pathways to a decarbonized steel industry include approaches such as alternate iron and steelmaking, hydrogen injection into the blast furnace, utilizing clean electricity sources, increased use of scrap, and integrating

[22] "AISI Releases 2018 Annual Statistical Report." https://www.steel.org/2019/07/aisi-releases-2018-annual-statistical-report-2/. Accessed March 28, 2022.
[23] 2018 Manufacturing Energy and Carbon Footprints, Iron and Steel Sector. DOE AMO. December 2021. Available at: https://www.energy.gov/sites/default/files/2021-12/2018_mecs_iron_steel_energy_carbon_footprint.pdf.

hydrogen use into existing processes. Technology development is underway outside of this topic area to provide an infrastructure capable of supplying clean hydrogen and renewable electricity to help enable the industry decarbonize its operations.

Topic 2 Technology Focus: This topic will initiate or accelerate novel technology innovations for iron and steel industry operations; applicants should develop and achieve advances in technologies leading to commercial readiness of low carbon or net-zero carbon process technologies for the iron and steel industry. All applications should include an Industry Partner on the team. The term "Industry Partner" includes non-profit and for-profit entities engaged in iron and steel production or processing, or a related industry. Applications submitted under this topic must address at least one of the areas of interest stated below.

Area of Interest 1 – Enabling Decarbonization: This area of interest seeks applications for innovative technologies that enable decarbonization in ore-based or scrap-based iron and steelmaking operations. Innovative technologies may include, but are not limited to, the following: new ironmaking or steelmaking technologies (up to 400 kg/day scale); feedstock flexibility such as blast furnace (BF) alternative injection processes, coke substitution, EAF variable metallic feedstock processing, or hydrogen integration; increased scrap use; and heat recovery. This AOI includes both ore-based production—beneficiation, reduction, BF, basic oxygen furnace (BOF), and refining; and scrap-based production—scrap and metallics use, EAF, and refining operations.

Area of Interest 2 – Electrification and Clean Fuels: This area of interest seeks applications outside of AOI 1 for technologies that convert other existing iron and steelmaking thermal processes up to production scale in order to utilize clean fuels, including the integration of hydrogen or electricity. Possible applications include reheat and annealing furnaces, finishing operations, combustion applications, vessel preheaters, etc.

For both AOI 1 and AOI 2, Topic 2 seeks both Tier 1 and Tier 2 applications. During the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

Not of interest in Topic 2: DOE is not interested in funding applications in this topic focused on CCUS, on-site electricity generation, production of fuels/chemicals from byproducts or wastes, or carbon reduction in product end-use or solely from purchased electricity. See Section I.C. of the FOA.

Topic 2 Candidate Metrics & Targets: Targets for processes developed and demonstrated under this topic must be specified in the application. Energy and carbon intensity analyses should be included, 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. Compared to current technology, the novel technology proposed should have the potential to significantly reduce CO_2 emissions within the iron and steel 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. Successful applicants will be required to have a periodic assessment of their metrics during the award to evaluate potential impacts.

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

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce carbon Intensity of iron & steel industry manufacturing	% carbon intensity change as measured by ton CO_2e/kg product (product must be identified such as hot metal, crude steel, finished steel, etc.)	40%	100%	*Applicant Defined (see note)*

Note: The U.S. BF-BOF route has CO_2 emissions of approximately 1.88 tons CO_2 per ton of crude steel. The scrap-based U.S. EAF route has CO_2 emissions of approximately 0.56 ton CO_2 per ton of crude steel using 2019 electricity emissions intensity of 0.381 kg CO_2/kilowatt-hour (kWh). The use of CO_2-free electricity would reduce the baseline steel scrap EAF route emissions to approximately 0.28 ton CO_2 per ton of crude steel.[24]

Additional metrics and critical criteria that will lead to successfully meeting the goal above should also be identified. Applicants must identify and justify appropriate metrics for their technology and clearly indicate how the proposed technology 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:

[24] Hasanbeigi, A. 2022. Steel Climate Impact - An International Benchmarking of Energy and CO_2 Intensities. Global Efficiency Intelligence. Florida, United States. Available at: https://www.globalefficiencyintel.com.

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Reduce energy consumption	Btu/ton product	15%	30%	*Applicant Defined*
Increase throughput	Production rate per unit of time	15%	30%	*Applicant Defined*
Decrease operating cost	$/ton product	Cost parity	30%	*Applicant Defined*
Reduce criteria air pollutant emissions	% Pollutant change as measured by ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 3: Decarbonizing Food and Beverage Products

Topic 3 Background: The food and beverage manufacturing industry is a critical component of the U.S. economy. In 2018, the food and beverage industry produced and shipped nearly $900 billion of products and employed approximately 1.7 million workers.[25] The industry produces a large number of diverse products that are both consumed domestically and exported to international markets. Key markets include grain and oilseed milling, animal slaughtering and processing, fruit and vegetable processing, dairy product operations, sugar manufacturing, beverage manufacturing, and bakery operations.

Topic 3 Opportunity: The food and beverage industry directly consumed over 1.2 quads of energy and accounted for an estimated 45 MMT of energy-related GHG emissions in 2018, excluding off-site electricity and steam generation losses.[26] About two-thirds of end-use energy consumed by the food and beverage 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 food and beverage processing operations, as indicated in the energy bandwidth report for the industry published in 2017.[27] The DOE Industrial Decarbonization Roadmap also highlights opportunities to decarbonize the sector by electrifying processes and

[25] Annual Survey of Manufactures. 2018-2020 - Statistics for Industry Groups and Industries. U.S. Census Bureau. December 2021. Available at: https://www.census.gov/data/tables/time-series/econ/asm/2018-2020-asm.html.
[26] 2018 Manufacturing Energy and Carbon Footprints, Food and Beverage Sector. DOE AMO. December 2021. Available at: https://www.energy.gov/sites/default/files/2021-12/2018_mecs_food_beverage_energy_carbon_footprint.pdf.
[27] Bandwidth Study on Energy Use and Potential Energy Savings Opportunities in U.S. Food and Beverage Manufacturing. DOE AMO. September 2017. Available at: https://www.energy.gov/sites/default/files/2019/05/f62/Food_and_beverage_bandwidth_study_2017.pdf.

utilizing low carbon fuels and energy sources. Furthermore, a separate AMO report identifies alternative thermal processing approaches for the food and beverage industry.[28]

Topic 3 Technology Focus: This topic will accelerate novel technology innovations for food and beverage operations; applicants should develop and demonstrate new advances in processes to accelerate the commercial readiness of emerging, low carbon or net-zero carbon process technologies for the food and beverage industry. All applications should include an Industry Partner on the team. The term "Industry Partner" includes non-profit and for-profit entities engaged in food and beverage production or processing, or a related industry. Applications submitted under this topic must address the area of interest stated below.

Area of Interest 1 – Low Carbon Process Heating Solutions: This area of interest seeks applications for innovative technologies that decarbonize existing thermal operations within the food and beverage sector. Process heating accounts for over 55% of onsite process energy use in the industry; technology advancements that decarbonize process heating operations in food and beverage processes are encouraged. Example thermal processes utilized within the industry include evaporation, pasteurization, drying and dehydration, baking, cooking, and frying. Technology approaches could include but are not limited to advanced separations, electric heating and low carbon fuels, and other innovations.

Topic 3 seeks both Tier 1 and Tier 2 applications. During the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

Not of interest in Topic 3: DOE is not interested in funding applications in this topic focused on CCUS, on-site electricity generation, or the production of fuels/chemicals from byproducts or wastes. See Section I.C. of the FOA.

Topic 3 Candidate Metrics & Targets: Targets for processes developed and demonstrated under this topic must be specified in the application. Energy and carbon intensity analyses should be included, 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. Compared to current technology, competitive applications should have the potential to reduce CO_2-equivalent emissions by at least 500 thousand metric tons annually within the food and beverage sector at the national level if broadly implemented. Applications must

[28] See Section 5.6. Thermal Process Intensification: Transforming the Way Industry Uses Thermal Process Energy. AMO. May 2022. Available at: https://www.energy.gov/sites/default/files/2022-05/TPI%20Workshop%20Report_AMO.pdf.

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.

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 ton 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. Applicants 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 energy consumption	Btu/kg product	10%	30%	*Applicant Defined*
Increase throughput	Production rate per unit of time	10%	30%	*Applicant Defined*
Decrease operating cost	$/kg product	10%	30%	*Applicant Defined*
Reduce criteria air pollutant emissions	% Pollutant change as measured by ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 4: Decarbonizing Cement and Concrete

Topic 4 Background: Cement and concrete are vital components of the nation's infrastructure (e.g., roads, runways, bridges, buildings, waterways) as well as industrial, commercial, and residential buildings that serve citizens and the economy. These resilient materials provide a strong foundation to withstand the

severe weather events that are predicted due to changes in climate. As demand for cement and concrete continues to rise, the industry has recognized the importance of decarbonizing and has developed its own Roadmap for Carbon Neutrality.[29] The production of modern Ordinary Portland Cement (OPC) involves pyroprocessing, namely, the high-temperature calcination and sintering, of a blended mixture comprised predominantly of calcareous (containing calcium carbonate) raw materials (e.g., limestone, marl, chalk) and clay raw materials (e.g., shale, slate, clay) together with small amounts of other oxides (e.g., those of iron and magnesium). The pyroprocessing converts the mixture to clinker (chiefly, various calcium silicates and calcium aluminate), which is ground and combined with other ingredients (e.g., gypsum) to make Portland cement. Portland cement clinker typically contains a relatively high (65-70%) lime content. When cement is combined with aggregate (sand and gravel), air, and water, and allowed to set, a strong composite material forms known as concrete, which further cures with time to its full strength.

Topic 4 Opportunity: To meet market demands, over 86 million metric tons of cement was produced in 2018 in the United States for use as a necessary component of concrete.[30] The cement industry accounted for 296 trillion Btu of onsite energy use in 2018, with an estimated 61 million metric tons of onsite GHG emissions – of which just over 20 million metric tons were from energy use and just under 40 million metric tons were from process CO_2 emissions.[31] Most importantly, the pyroprocessing step in the production of lime-rich Portland cement is responsible for the vast majority of CO_2 emissions from the cement industry. Therefore, the most impactful area to target for emissions and energy reductions is the pyroprocessing step.

Pyroprocessing emissions can be divided into two categories, process (direct) emissions and energy (indirect) emissions. For the direct emissions, as a by-product of the high-temperature calcination chemical reaction, every ton of lime-rich Portland cement clinker produced is accompanied by around one-half ton of CO_2, accounting for over 60% of pyroprocessing CO_2 emissions. The second pyroprocessing emissions category, energy emissions, originates from the on-site combustion of fuel (currently, fuel mixes are about 60% petroleum coke or coal on average) for providing the heat required by the pyroprocessing, and accounts for about one-third of the total CO_2 emissions by the cement industry. Thus, so long as technical performance requirements of the product are met there is a potential for significant energy savings as well as for direct and indirect pyroprocessing emissions

[29] "Roadmap to Carbon Neutrality." Portland Cement Association. https://www.cement.org/sustainability/roadmap-to-carbon-neutrality. Accessed March 28, 2022.
[30] Mineral Commodity Summaries: Cement. U.S. Geological Survey. January 2020. Available at: https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-cement.pdf.
[31] 2018 Manufacturing Energy and Carbon Footprints, Cement Sector. DOE AMO. December 2021. Available at: https://www.energy.gov/sites/default/files/2021-12/2018_mecs_cement_energy_carbon_footprint_0.pdf.

reductions through innovations that lower the clinker content of concrete, lower the carbonated content of the clinker feedstock or the lime content of the clinker (lower lime contents reduce clinker process CO_2 emissions and allow for lower clinker pyroprocessing temperatures, translating to reduced fuel consumption) or, alternatively, those that increase the carbonated content of finished cement or concrete, as well as through increased use of low carbon/alternative fuels, and through carbon capture and utilization.

Topic 4 Technology Focus: This topic will accelerate technology innovations for cement and concrete operations. Applicants should develop and demonstrate advances to accelerate the commercial readiness of emerging, low carbon or net-zero carbon process technologies for the cement and concrete industry, in order 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. Decarbonization pathways of interest include energy efficiency, LCFFES, and carbon capture and utilization technologies. All applications 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. Applications submitted under this topic must address at least one of the areas of interest stated below.

Area of Interest 1 – Next Generation Cement/Concrete Formulations and Production Routes: This area of interest seeks applications for mid TRL R&D, including up to system/subsystem prototype or pilot-scale technology validation in a relevant or operational environment, of technologies that will enable or facilitate: 1) novel cement or concrete formulations; novel scalable production methods (thermal, chemical, biological, electrochemical), including process heat electrification; or energy efficiency improvements/process optimizations for current practices, which can significantly reduce emissions from Portland cement production; or 2) clinker feedstock substitutions (including lower lime containing or less carbonated raw materials) or the use at the concrete (precast or ready-mix) making stage of blended cements containing higher limestone or carbonated contents, additional supplementary cementitious materials (SCMs) such as steel slag, fly ash, waste glass, silica fume, and natural or synthetic pozzolans, with or without chemical admixtures (e.g., superplasticizers), and/or increased filler (non-SCM) contents. The projects should target minimizing detrimental effects to the performance of concrete products made from these substitutions. Therefore, the application must include in the scope of work experimental measurements of the performance of plain (non-reinforced) and/or reinforced concrete products made with the cement using standard manufacturing conditions. The concrete must be tested and compared to any applicable performance specifications (e.g., strength, heat of hydration, durability/resistance to attack) for general and special use of

hydraulic cements given in ASTM C1157[32] and/or blended hydraulic cements in ASTM C595. The effects of the substitutions on the microstructural features and physical properties of plain and reinforced concretes should also be investigated.

Area of Interest 2 – Low Carbon Fuels: This area of interest seeks applications for mid TRL R&D of technologies, including up to system/subsystem prototype or pilot-scale technology validation in a relevant or operational environment, which can support or enable process control/optimization and the minimization of deleterious effects from the firing of low carbon or carbon neutral fuels (e.g., clean hydrogen, biomass/biofuels, waste/refuse-derived fuels) on: cement pyroprocessing conditions (e.g., heat transfer/exchange, energy balance), process efficiency (e.g., varying moisture and caloric value of fuel, fuel feed rate, solid refuse fuel particle size), process pollutants (e.g., increased NO_x, fine particulates), operational health and safety considerations (e.g., fires from heat generation of fermentation, dust explosions), clinker product quality, and the detrimental impacts on process equipment, including refractory linings of preheating and calcination towers, rotary kilns, and cooling sections.

Area of Interest 3 – Carbon Capture Technologies: This area of interest seeks applications for mid TRL R&D or pilot scale validation of innovative technologies that enable 1) further lowering of the capital and operational costs, the complexity, and/or the energy consumption for separation of CO_2 from cement kiln flue gas, or 2) creation of value from captured CO_2 by either a) converting it to marketable by-products on-site, or b) establishment of commercially viable pathways for captured CO_2 direct sales to other industries/markets that can utilize it as an industrial commodity. Both a) and b) must be in a way that permanently sequesters the CO_2 emissions, and which does not simply postpone its release to the atmosphere, examples being CO_2's use in concrete curing/mixing and other CO_2-derived materials, chemicals, products, or services that support climate goals. A lifecycle assessment must be performed that includes: the CO_2 impact of capturing, transporting, and utilizing the CO_2 emissions; and the CO_2 emissions from compensating for the energy penalty of CO_2 capture to validate the net CO_2 benefits of the proposed strategy. Approaches which may be considered for 1) could include a testbed at an operating cement plant for technology developers to test a range of suitable CO_2 capture technologies under relevant industrial conditions with actual cement flue gas.

For AOI 1, AOI 2, and AOI 3, this topic seeks both Tier 1 and Tier 2 applications. For Topic 4, during the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

[32] Standard Performance Specifications for Hydraulic and Blended Cement, American Society for Testing and Materials (ASTM). Available at: https://www.astm.org/standards/c1157 or https://www.astm.org/standards/c595.

Not of interest in Topic 4: DOE is not interested in funding applications in this topic focused on geologic carbon sequestration or on-site electricity generation. See Section I.C. of the FOA.

Topic 4 Candidate Metrics & Targets: Targets for processes developed and demonstrated under this topic must be specified in the application. Energy and carbon intensity analyses should be included, 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. Compared to current technology, competitive applications should have the potential to reduce CO_2 emissions by at least 2 million metric tons annually within the cement and concrete 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. Successful applicants will be required to have a periodic assessment of their metrics during the award to evaluate potential impacts.

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 ton CO_2e/kg product	50%	>90%	*Applicant Defined*

Additional metrics and critical criteria that will lead to successfully meeting the goal above should also be identified. Applicants 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
Clinker content	Clinker-to-cement-ratio	≤ 0.80 by 2050	none	*Applicant Defined*
Technical performance (e.g., strength, heat of hydration, sulfate resistance, etc.)	Standard performance specification for hydraulic and blended cement	As given in ASTM C1157/ C595	none	*Applicant Defined*
CO_2 capture cost	$/ton CO_2 captured	≤ 50	≤ 30	*Applicant Defined*
CO_2 capture pilot demonstration scale	MT CO_2/year	25,000	100,000	*Applicant Defined*
CO_2 capture testbed scale	MT CO_2/day	1	15	*Applicant Defined*
Reduce criteria air pollutant emissions	% Pollutant change as measured by ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 5: Decarbonizing Paper and Forest Products

Topic 5 Background: The paper and forest products industry is a key component of the U.S. economy. The paper industry produces nearly 80 million tons of paper and paperboard annually, while wood products are used in a variety of residential and commercial applications. The industry produces a large number of diverse products including copy paper and newsprint, tissues and paper towels, food packaging, and plywood and lumber.

Topic 5 Opportunity: The paper and forest products industry directly consumed over 2.4 quads of energy and accounted for an estimated 44 MMT of energy-related GHG emissions in 2018, excluding off-site electricity and steam generation losses.[33] Process heating accounts for just over 55% of end use onsite energy in the forest products industry, with over three-quarters of process heating energy supplied by steam which is predominantly produced onsite. Considerable opportunity remains for improving the energy efficiency of pulp and paper industry operations, as indicated in the energy bandwidth report for the industry published in 2015.[34] Major

[33] 2018 Manufacturing Energy and Carbon Footprints, Forest Products Sector. DOE AMO. December 2021. Available at: https://www.energy.gov/sites/default/files/2021-12/2018_mecs_forest_products_energy_carbon_footprint_0.pdf.

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

consumers of thermal energy within the pulp and paper industry are liquor evaporation, pulping chemical preparation, wood cooking and bleaching in pulp manufacturing, and paper drying and paper machine wet end in paper manufacturing. While recycled papermaking does not have the typical steps associated with Kraft pulping process, there is significant thermal energy use associated with heating the pulp slurry and dry paper. A separate AMO report highlights thermal process intensification and alternative thermal processing approaches for the pulp and paper industry.[35] In wood products, production processes include sawing, planing, shaping, laminating, and assembling of wood products starting from logs that are cut into bolts, or lumber that then may be further cut or shaped. Drying is an important process in many wood products as drying reduces shrinkage, increases strength, reduces weight, allows wood to be treated and adhesives to be applied, and improves overall manufacturing quality.

Topic 5 Technology Focus: This topic will accelerate novel technology innovations for paper and forest products industry operations; applicants should develop and demonstrate new advances in processes to accelerate the commercial readiness of emerging, low carbon or net-zero carbon process technologies for the paper and forest products industry. All applications should include an Industry Partner on the team. The term "Industry Partner" includes non-profit and for-profit entities engaged in paper and forest products production or processing, or a related industry. Applications submitted under this topic must address at least one of the areas of interest stated below.

Area of Interest 1 – Novel Paper and Wood Drying Technologies: This area of interest seeks applications for innovative technologies that decarbonize existing thermal drying processes within the paper and wood products industries, as a considerable portion of energy use in the paper and forest products industry is consumed in drying operations. Technology approaches could include but are not limited to the utilization of electric heating and low carbon fuels, increasing the dryness of paper webs entering the paper machine dryer section, and other innovations.

Area of Interest 2 – Innovative Pulping and Paper Forming Technologies: This area of interest seeks applications for innovative pulping and paper forming technologies, in order to improve energy efficiency and decarbonize existing operations in the pulp and paper industry. Technology approaches could include but are not limited to novel solvent-based pulping, foam forming, and other innovations.

[35] See Section 5.6. Thermal Process Intensification: Transforming the Way Industry Uses Thermal Process Energy. AMO. May 2022. Available at: https://www.energy.gov/sites/default/files/2022-05/TPI%20Workshop%20Report_AMO.pdf.

Topic 5 seeks both Tier 1 and Tier 2 applications. During the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

Not of interest in Topic 5: DOE is not interested in funding applications in this topic focused on CCUS, on-site electricity generation, or the production of fuels/chemicals from byproducts or wastes. See Section I.C. of the FOA.

Topic 5 Candidate Metrics & Targets: Targets for processes developed and demonstrated under this topic must be specified in the application. Energy and carbon intensity analyses should be included, 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. Compared to current technology, competitive applications should have the potential to reduce CO_2-equivalent emissions by at least 1 million metric tons annually within the paper and forest products 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. Successful applicants will be required to have a periodic assessment of their metrics during the award to evaluate potential impacts.

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 ton 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. Applicants 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 energy consumption	Btu/kg product	10%	30%	*Applicant Defined*
Increase throughput	Production rate per unit of time	10%	30%	*Applicant Defined*
Decrease operating cost	$/kg product	10%	30%	*Applicant Defined*
Reduce criteria air pollutant emissions	% Pollutant change as measured by ton pollutant/ton product	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*

Topic Area 6: Cross-sector Decarbonization Technologies

In addition to the industry-specific opportunities discussed in the preceding Topic Areas, which require process-specific solutions, there remains a wide range of more generic opportunities to minimize the carbon footprint of the manufacturing sector. One major category of opportunities is thermal energy utilization, recovery and management. Thermal energy encompasses all forms of process heating and steam generation. Process heating operations supply thermal energy needed to transform materials into a wide variety of commodities and end-use consumer products. Approximately 7.5 quads of manufacturing energy use and nearly 300 MMT of onsite CO_2 emissions are related to process heating annually, with approximately one-third, or around 2.5 quads, of that energy lost as waste heat.[36] In addition, onsite steam generation consumes over 5 quads of energy, with over one-fifth of that being lost as waste heat.[37]

The three Areas of Interest below address important aspects of thermal energy utilization. AOI 1 focuses on technologies for thermal energy storage, AOI 2 focuses on recovering waste heat and converting it to electric power and AOI 3 addresses the development and application of heat pumps in the industrial sector.

Area of Interest 1 – High Operating Temperature Thermal Energy Storage
Area of Interest 1 Background: As previously indicated, around 2.5 quads of energy is lost annually as waste heat from manufacturing process heating operations. Waste heat is generated from a variety of industrial systems distributed throughout a manufacturing plant. The largest sources of waste heat for most industries are

[36] 2018 Manufacturing Energy and Carbon Footprints, All Manufacturing Sector. DOE AMO. December 2021. Available at: https://www.energy.gov/sites/default/files/2022-01/2018_mecs_all_manufacturing_energy_carbon_footprint.pdf.
[37] Ibid.

exhaust and flue gases and heated air from heating systems such as high-temperature gases from burners in process heating. The implementation of thermal energy storage (TES) systems applied to harvesting and utilizing the wasted industrial thermal energy from processing is an excellent opportunity to decrease the nation's reliance on traditional fuels and decarbonize the manufacturing sector. Thermal energy storage (TES) methods and materials have been shown to be reliable, cost-competitive, and easily scalable, and can provide high energy intensity and capacity. The successful demonstration and deployment of TES in industrial settings may eventually lead to more wide-spread deployment of TES in other applications such as commercial buildings.

Area of Interest 1 Opportunity: A close look at the specific thermal energy consumption of industry reveals that the most intensive applications include chemicals, refining, pulp and paper, food and beverage, and iron and steel production with a wide distribution of temperature ranges in these industries – from less than 80°C to over 1,100°C.[38] Since TES contains energy in the same form (thermal), it is an ideal candidate to replace carbon-intensive energy sources for implementation in industrial process heating.

Area of Interest 1 Technology Focus: This AOI focuses on developing and using enabling technologies to demonstrate novel high operating temperature storage (HOTS) thermal systems to harvest, store, and utilize waste heat generated from industrial manufacturing processes. The long-term goal of this focus area is to aid in decarbonizing the industrial manufacturing sector. Waste heat generated and exhausted from medium and high-temperature industrial processes (such as blast furnaces used in iron and steel production) are target applications. The thermal storage mediums may be solid, liquid, phase-change, granular, or thermo-chemical. The heat should be stored at relatively high temperatures (400°C and above) for use over the span of 10 or more hours. The stored thermal energy must be used in an industrial application, such as petrochemicals manufacturing, iron and steel production, food and beverage processing, or used to generate a flexible and transportable energy source, such as electricity.

There should be a focus on one or more enabling technologies that will demonstrate an effective and efficient HOTS system. Examples of possible enabling technologies may include (though are not limited to):

- Heat recovery systems able to process high-temperature gases containing solids and condensable contaminants. May include internal cleaning systems.
- Materials able to perform at high-temperature and exposed to chemical reactions.

[38] See Figures 5 and 6 in "Beneficial Electrification in Industry." American Council for an Energy Efficient Economy. July 2020. Available at: https://www.aceee.org/sites/default/files/pdfs/ie2002.pdf.

- High-temperature phase change materials with high heat capacity able to tolerate the cyclic nature of the waste heat source.
- Coatings able to withstand the corrosive nature of waste gas streams and thermal storage media. Of special interest are coatings resistant to corrosion by molten aluminum.
- Systems with a small footprint to enable retrofit into existing space-constrained plants.

Applications may include lifetime testing, detailed engineering analyses/modeling, preliminary data demonstrating successful performance of components, detailed cost analysis, and a preliminary design of a commercial-scale concept.

Applicants must clearly describe how their technology will ensure 24-hour facility operation, either by 100% stored thermal energy or a hybrid combination of TES and grid-supported energy. Applicants must show how their innovation would significantly reduce GHG emissions. All applications are strongly encouraged to include an Industry Partner on the team from a related industry, and applicant teams should have strong engagement with industry stakeholders who will inform the design of the technology and its feasibility and cost. AOI 1 seeks only Tier 2 applications. During the award performance period, an assessment of carbon emissions, energy intensity and cost must be validated via LCA and TEA.

Candidate Metrics & Targets: Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Proposed targets and measurement of progress toward meeting targets must be substantiated. Metrics should be specific to the proposed technology and must define appropriate benchmarks or baselines, minimum targets, and stretch targets. Applicants should justify that their technology will have a significant impact on fuel consumption and/or CO_2 emissions. Applicants are encouraged to consider (though are not limited to) the following metrics as examples:

Objective/Goal	Metric	Minimum	Stretch target	Baseline Performance
Input efficiency	(Heat stored/energy input) * 100	≥70%	≥90%	*Applicant defined*
Output efficiency	(Heat delivered/heat output) * 100	≥70%	≥90%	*Applicant defined*
Storage temperature	Celsius	400°C	1,500°C	*Applicant defined*
Thermal cycles	Charge-Discharge cycles	1,000	10,000	*Applicant defined*

Thermal Capacity	MW·h	5	50	*Applicant defined*
Max power rating	MW	0.5	5	*Applicant defined*
Discharge time	hours	10	24	*Applicant defined*
Cost	$/kW·h	Cost analysis should indicate parity with other readily available energy sources.		

Area of Interest 2 – Electric Generation from Low Temperature Waste Heat

Area of Interest 2 Background: As noted in AOI 1, high temperature heat is relatively easy to capture and store. In contrast, heat below approximately 225°C, often in very diffuse form, is much harder to address. It has been estimated that as much as 60% of the waste heat is at or below this temperature.[39] An attractive option to collect some of this wasted energy is to convert it directly to electricity. Waste heat to power (WHP, also known as bottoming cycle combined heat and power) is a source of clean energy that captures thermal energy and converts it to useful electricity.[40] A number of technologies (for example, steam Rankine cycle, organic Rankine cycle, Kalina cycle, and supercritical CO_2) have been used or are proposed for high temperature waste heat. Low temperature waste heat is another matter.

Area of Interest 2 Opportunity: While thermo-electric (TE) technologies can be used to convert this heat directly into electricity, historically their low efficiencies (<10%) and high costs (>$3/watt) have made them unattractive options. Advances in nanotechnology and nanofabrication have enabled new direct conversion (heat to electricity) technologies that have the potential to surpass the performance of TE systems. Some illustrative examples include plasmonics,[41] thermionic emission,[42] and vibration energy harvesting.[43] These are only for illustration. Other low temperature recovery technologies may be proposed.

Area of Interest 2 Technology Focus: This AOI seeks applications for novel low-cost approaches to direct energy conversion for low temperature (<225°C) industrial waste heat streams that could significantly reduce the carbon footprint of the industrial sector. Applications outside of the examples above are welcome, as they are for illustrative purposes only. The proposed technology must have adequate

[39] See page xii of https://www1.eere.energy.gov/manufacturing/intensiveprocesses/pdfs/waste_heat_recovery.pdf

[40] Waste Heat to Power Market Assessment, ICF for Oak Ridge National Lab, March 2015 http://www.heatispower.org/wp-content/uploads/2015/02/ORNL-WHP-Mkt-Assessment-Report-March-2015.pdf

[41] Novotny, Lukas; Hecht, Bert (2012). Principles of Nano-Optics. Norwood: Cambridge University Press. ISBN 9780511794193.

[42] J. H. Ingold, "Calculation of the Maximum Efficiency of the Thermionic Converter," Journal of Applied Physics, vol. 32, pp. 769-772, 1961.

[43] S. Rafique, "Piezoelectric Vibration Energy Harvesting," Springer, 2018.

robustness for utilization in challenging industrial operations. Performance targets are outlined below. Applications submitted under this area of interest must address at least one of the following subjects:

Development (Tier 1): Applications must focus on relatively early stage (TRL 3 to 4) development of novel technologies for conversion of low temperature waste heat directly to electricity. Evidence for the suitability for application in an industrial environment must be established. Applications must provide a credible path from early-stage development through to ultimate commercialization. The application must address the performance metrics summarized below.

First of a kind demonstration (Tier 2): Applications must focus on first of a kind field demonstration of a technology for direct conversion of low temperature waste heat directly to electricity. Applications must establish the suitability of the proposed technology for use in an industrial environment. A thorough techno-economic assessment for the technology must be provided. The following performance metrics must be addressed.

All applications are strongly encouraged to include an Industry Partner on the team from a related industry. During the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

Candidate Metrics & Targets: Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Proposed targets and measurement of progress toward meeting targets must be substantiated. Metrics should be specific to the proposed technology and must define appropriate benchmarks or baselines, minimum targets, and stretch targets. Applicants should justify that their technology will have a significant impact on fuel consumption and/or CO_2 emissions. The following performance metrics must be addressed:

Objective/ Goal	Example Metric	Example Minimum	Example Stretch Target	Baseline Performance/ Cost
Efficiency of conversion of waste heat to electricity	Percent	25%	30%	*Applicant Defined*
Electricity production costs of the WHP system	$/Watt	$1.00	$0.90	*Applicant Defined*

Area of Interest 3 – Industrial Heat Pumps

Area of Interest 3 Background: Decarbonizing the industrial sector will require large-scale electrification, and industrial heat pumps (IHP) are a prospective decarbonizing

technology.[44] IHPs could help reshape the industrial sector and drive down overall energy use and GHG emissions. Industry overall is looking towards decarbonizing their industrial process heating operations including both Scope 1 and Scope 2 emissions. Today 50% of on-site energy uses thermal energy to prepare materials and produce manufactured goods (process heat) impacting both Scope 1 and Scope 2 emissions. IHPs can reduce both Scope 1 and Scope 2 emissions with beneficial electrification and the use of low-carbon electricity generation sources, enhancing the replacement of fuel combustion for heat generation.

Energy conversion will be a key factor for the industrial sector to use electrified heat processes, the conversion of electrical energy into thermal energy. Compared to other electrified heating technologies (resistive heating, induction heating, infrared heating, etc.) that can approach 100% efficiency, heat pumping technologies can most often significantly exceed this metric by moving heat instead of conversion alone, bypassing the limitations of energy conversions. Using electrical energy to move thermal energy also enables and leverages the availability of on-site or locally sourced low-grade heat (lower-temperature, source) that is wasted or goes unused; increasing its conversion into higher quality heat (higher-temperature, sink) will make IHPs more cost effective and higher performing. The metric that captures heat pump performance is called the coefficient of performance (COP), instead of efficiency. COP is defined by the ratio of useful heating divided by the work (electrical energy) required. This theoretical limit is defined by a Carnot cycle, a theoretical ideal thermodynamic cycle, that provides the upper limit for the conversion of work into heat – which is not even close to being reached.

Area of Interest 3 Opportunity: IHPs are an ideal active heat-recovery equipment that will play an important role in the electrification of process heating. This subtopic solicits applications for cost effective IHP systems, focusing on industrial process heating. IHP solutions are available today with sink temperatures in the range of 90 to 150°C. IHPs are a solution that can be implemented today and made better by increasing their sink temperature above 150°C. This AOI seeks IHP applications that go up to 200°C. This higher temperature range is a technical challenge but covers more of the range for industrial processes for waste heat recovery include drying, sterilization, papermaking, food preparation and preheating applications. There is substantial overlap between this technical challenge and applications that offer the greatest opportunity to decarbonize. For example, European statistics show that 67% of the process heat demand between 100°C and 200°C was directly supplied by fossil fuels.[45] From this, a considerable application

[44] ACEEE IHP report, available at: https://www.aceee.org/research-report/ie2201.
[45] Strengthening Industrial Heat Pump Innovation: Decarbonizing Industrial Heat, https://www.sintef.no/globalassets/sintef-energi/industrial-heat-pump-whitepaper/2020-07-10-whitepaper-ihp-a4.pdf.

potential for industrial heat pumps and their associated emission reductions can be derived by pushing the IHP range up to 200°C.

In the United States, the "Accelerating Decarbonization of the U.S. Energy System"[46] report by National Academies of Sciences, Engineering, and Medicine calls for deploying 1–2 GW of advanced industrial heat pumps (IHPs), with early development/demonstrations at industrial clusters to lower barriers, for a range of process heat, drying, evaporator trains, and other applications lowering CO_2 emissions with the electricity coming from low-carbon sources.

IHPs can contribute to GHG emissions reductions both directly through refrigerant emissions reductions and moving away from fuels, as well as indirectly by reducing emissions from power generation through energy efficiency. Refrigerants are essential in vapor compression cycles: they absorb heat at a relatively low temperature in the evaporator and releases it at a higher temperature in the condenser. Low global warming potential (GWP) refrigerants are required in new IHPs since a transition is taking place towards them. Given the importance of both refrigerant emissions and efficiency requirements for IHPs, both direct and indirect emissions targets are included for this subtopic.

Area of Interest 3 Technology Focus: This AOI focuses on the integration of IHP technology into existing industrial process heating systems, supplying heat at or below 200°C. Integration of IHPs in existing industrial processes will require a systems approach, because waste heat is not constant during operation and application. Research advances are required in all heat pump components, including better heat exchangers and compressors and potentially new materials, refrigerants, and non-refrigerant-based solutions (e.g., non-vapor compression solutions, functional materials).

AOI 3 seeks both Tier 1 and Tier 2 applications. All applications are strongly encouraged to include an Industry Partner on the team from a related industry. During the award performance period, an assessment of carbon emissions, energy intensity, and cost must be validated via LCA and TEA.

Candidate Metrics & Targets: Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Proposed targets and

[46] National Academies of Sciences, Engineering, and Medicine, 2021, New Report Charts Path to New-Zero Carbon Emissions by 2050, Recommends Near-Term Policies to Ensure Fair and Equitable Economic Transition and Revitalization of Manufacturing Industry, https://www.nationalacademies.org/news/2021/02/new-report-charts-path-to-net-zero-carbon-emissions-by-2050-recommends-near-term-policies-to-ensure-fair-and-equitable-economic-transition-and-revitalization-of-manufacturing-industry#:~:text=Accelerating%20Decarbonization%20of%20the%20U.S.%20Energy%20System%20says,will%20need%20further%20innovation%20to%20achieve%20cost-effective%20decarbonization

measurement of progress toward meeting targets must be substantiated. Given the wide range of technology suitable for this AOI, targets for specific use applications are not defined but innovations must exceed the state-of-the-art performance significantly. Metrics should be specific to the proposed technology and must define appropriate benchmarks or baselines, minimum targets, and stretch targets. Applicants should justify that their technology will have a significant impact on fuel consumption and/or CO_2 emissions. Applicants are encouraged to consider the following metrics as examples:

Objective/ Goal	Metric	Minimum	Stretch Target	Baseline Performance
Payback period, cost effectiveness	Years	≤ 3 years	≤ 2 years	*Applicant Defined*
Coefficient of performance (COP) @ Highest Supply Temperature	Percent	≥ 45% Carnot COP	≥ 55% Carnot COP	*Applicant Defined*
Energy intensity reduction	Percent	≥ 40%	≥ 70%	*Applicant Defined*
Lifetime	Years	≥ 12 years	≥ 20 years	*Applicant Defined*
Low global warming potential (GWP) refrigerants, direct emissions	GWP value	≤ 150	≤ 10	*Applicant Defined*
Physical size, feasibility	Yes/No	Can be integrated into existing manufacturing systems		*Applicant Defined*

C. Applications Specifically Not of Interest

The following types of applications will be deemed nonresponsive and will not be reviewed or considered (See Section III.D. of the FOA):

- Applications that fall outside the technical parameters specified in Section I.A. and I.B. of the FOA.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Applications pertaining to geologic carbon sequestration after capture.

- In Topic 1, applications focused on the production of alternative feedstocks, including the capture of carbon dioxide, or focused on production of fuels from byproducts or wastes.
- In Topic 2, applications focused on CCUS, on-site electricity generation, production of fuels/chemicals from byproducts or wastes, or product end-use carbon reduction.
- In Topic 3, applications focused on CCUS, on-site electricity generation, or the production of fuels/chemicals from byproducts or wastes.
- In Topic 4, applications focused on geologic carbon sequestration or on-site electricity generation.
- In Topic 5, applications focused on CCUS, on-site electricity generation, or the production of fuels/chemicals from byproducts or wastes.

D. Authorizing Statutes

The programmatic authorizing statute is § 911 (a)(2)(C) of the Energy Policy Act of 2005, as codified at 42 U.S.C. § 16191(a)(2)(C).

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

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make a total of approximately $104,000,000 of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 20-38 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary, ranging between up to $750,000 and up to $10 million, depending on Topic Area and Tier, as outlined in the table below.

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

Topic Area Number	Topic Area Title	Anticipated Number of Awards	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	Anticipated Period of Performance (months)

1	Decarbonizing Chemicals	15-30	$1,000,000	Tier 1: $3 million Tier 2: $10 million	$85,000,000	24-36
2	Decarbonizing Iron and Steel		$1,000,000	Tier 1: $4 million Tier 2: $10 million		24-36
3	Decarbonizing Food and Beverage Products		$1,000,000	Tier 1: $3 million Tier 2: $6 million		24-36
4	Decarbonizing Cement and Concrete		$1,000,000	Tier 1: $4 million Tier 2: $10 million		24-36
5	Decarbonizing Paper and Forest Products		$1,000,000	Tier 1: $3 million Tier 2: $8 million		24-36
6	Cross-sector Decarbonization Technologies	5-8	$750,000	Tier 1: $3 million Tier 2: $5 million	$19,000,000	24-36

EERE may establish more than one budget period for each award and fund only the initial budget period(s). Funding for all budget periods, including the initial budget period, is not guaranteed.

ii. Period of Performance

EERE anticipates making awards that will run from 24 months up to 36 months in length, comprised of one or more budget periods. Project continuation will be contingent upon several elements, including satisfactory performance and Go/No-Go decision review. For a complete list and more information on the Go/No-Go review see Section VI.B.xiv.

iii. New Applications Only

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

B. EERE Funding Agreements

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

i. Cooperative Agreements

EERE generally uses cooperative agreements to provide financial and other support to prime recipients.

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

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

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

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

For-profit entities, educational institutions, and nonprofits that are organized, chartered or incorporated (or otherwise formed) under the laws of a particular state or territory of the United States and have a physical location for business operations in the United States are eligible to apply for funding as a prime recipient or subrecipient.

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

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

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

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

Entities banned from doing business with the United States 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

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

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

iii. Incorporated Consortia

Domestic incorporated consortia are eligible to apply for funding as a prime recipient or subrecipient. For consortia incorporated (or otherwise formed) under the laws of a state or territory of the United States, please refer to "Domestic Entities" above. For consortia incorporated in foreign countries, please refer to the requirements in "Foreign Entities" above.

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

iv. Unincorporated Consortia

Unincorporated Consortia must designate one member of the consortium to serve as the prime recipient/consortium representative. The prime recipient/consortium representative must be incorporated (or otherwise

formed) under the laws of a state or territory of the United States. The eligibility of the consortium will be determined by the eligibility of the prime recipient/consortium representative under Section III.A. of the FOA.

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

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

B. Cost Sharing

For Tier 1 project applications, the cost share must be at least 20% of the total allowable costs (i.e., the sum of the government share, including FFRDC costs if applicable, and the recipient share of allowable costs equals the total allowable cost of the project) for research and development projects.

Tier 2 project applications should be organized into at least one of the three distinct phases and must include activities in Phase 2 or Phase 3: research and development (Phase 1); design and testing (Phase 2); and installation and demonstration (Phase 3). The cost share for Phase 1 and Phase 2 must be at least 20% of the total allowable costs. For Phase 3, the demonstration phase, the cost share must be at least 50% of total allowable costs. Applications must clearly identify what work and which costs are associated with each phase.

The cost share must come from non-federal sources unless otherwise allowed by law. (See 2 CFR 200.306 and 2 CFR 910.130 for the applicable cost sharing requirements.)

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

i. Legal Responsibility

Although the cost share requirement applies to the project as a whole, including work performed by members of the project team other than the prime recipient,

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

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

ii. Cost Share Allocation

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

iii. Cost Share Types and Allowability

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

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

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

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

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

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

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

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

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

Applicants are encouraged to refer to 2 CFR 200.306 as amended by 2 CFR 910.130 for additional 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

EERE requires prime recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the prime recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a

minimum, the cost sharing percentage negotiated). As FFRDC funding will be provided directly to the FFRDC(s) by DOE, prime recipients will be required to provide project cost share at a percentage commensurate with the FFRDC costs, on a budget period basis, resulting in a higher interim invoicing cost share ratio than the total award ratio.

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

C. Compliance Criteria

Concept Papers, Full Applications, and Replies to Reviewer Comments must meet all compliance criteria listed below or they will be considered noncompliant. EERE will not review or consider noncompliant submissions. Specifically, all applicant submissions must:

- comply with the applicable content and form requirements listed in Section IV of the FOA;
- include all required documents;
- be successfully uploaded in EERE Exchange https://eere-Exchange.energy.gov, including clicking the "Submit" button; and
- be submitted by the deadline stated in the FOA.

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 in advance of the submission deadline), applicants should allow at least 1 hour to submit a Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE Exchange, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made to any of these documents, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline. DOE 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/National Nuclear Security Agency (NNSA) Federally Funded Research and Development Centers (FFRDC) 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.
> (end of acceptable authorization)

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 Federally Funded Research and Development Centers Included as a Subrecipient

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

i. 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.

ii. 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.

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

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

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

vi. *Limit on FFRDC Effort*
The scope of work to be performed by the FFRDC may not be more significant than the scope of work to be performed by the applicant.

vii. *Requirement for DOE/NNSA FFRDCs to Use a Cooperative Research and Development Agreement (CRADA) with the Prime Recipient*

DOE/NNSA FFRDC project team members funded directly by DOE must work with their fellow project team members under a cooperative research and development agreement (CRADA), unless otherwise approved by the Contracting Officer, to ensure accountability for project work and appropriate management of intellectual property (IP), e.g., data protection and background IP.

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

An entity may only submit one Concept Paper and one Full Application for each topic area of this FOA. If an entity submits more than one Concept Paper and one Full Application to the same topic area, EERE will request a determination from the applicant's authorizing representative as to which application should be reviewed. Any other submissions received listing the same entity as the applicant for the same topic area will not be eligible for further consideration. This limitation does not prohibit an applicant from collaborating on other applications (e.g., as a potential subrecipient or partner) so long as the entity is only listed as the applicant on one Concept Paper and one Full Application for each topic area of this FOA.

G. Questions Regarding Eligibility

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

IV. Application and Submission Information

A. Application Process

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

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

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

- Each must be submitted in Adobe PDF format unless stated otherwise;
- Each must be written in English;
- All pages must be formatted to fit on 8.5 x 11 inch paper with margins not less than one inch on every side. Use 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;

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

i. Additional Information on EERE eXCHANGE

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

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

B. Application Forms

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

Note: The maximum file size that can be uploaded to the EERE eXCHANGE website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the FOA, it must be broken into parts and denoted to that effect. For example:
TechnicalVolume_Part_1
TechnicalVolume_Part_2

C. Content and Form of the Concept Paper

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

i. Concept Paper Content Requirements

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

The Concept Paper must conform to the following content requirements:

Section	Page Limit	Description
Cover Page	1 page maximum	The cover page should include the project title, the specific announcement Topic Area and Area of Interest (AOI(s)) being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Technology Description	4 pages maximum	Applicants are required to describe succinctly: • The proposed technology, including its basic operating principles and how it is unique and innovative; • The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target could be met); • The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; • The potential impact that the proposed project would have on the relevant field and application; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project.
Addendum	1 page maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: • Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has worked together with its teaming partners on prior projects or programs; and • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities. • Applicants may provide graphs, charts, or other data to supplement their Technology Description.

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

D. Content and Form of the Full Application

Applicants must complete the following application forms found on the EERE eXCHANGE website at https://eere-eXCHANGE.energy.gov/, in accordance with the instructions.

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

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

i. Full Application Content Requirements

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

Component	File Format	Page Limit	File Name
Technical Volume	PDF	25	ControlNumber_LeadOrganization_TechnicalVolume
Resumes	PDF	2 pages each	ControlNumber_LeadOrganization_Resumes
Letters of Commitment	PDF	1 page each	ControlNumber_LeadOrganization_LOCs
Statement of Project Objectives	MS Word	15	ControlNumber_LeadOrganization_SOPO
SF-424	PDF	n/a	ControlNumber_LeadOrganization_App424
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, if applicable (see DOE O 412.1A, Attachment 3)	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
Foreign Entity and Foreign Work Waivers	PDF	n/a	ControlNumber_LeadOrganization_Waiver
Buy America Requirements for Infrastructure Projects Waiver Requests	PDF	n/a	ControlNumber_LeadOrganization_BAWaiver
Diversity Equity and Inclusion Plan	PDF	5	ControlNumber_LeadOrganization_DEIP
Current and Pending Support	PDF	n/a	ControlNumber_LeadOrganization_CPS

Note: The maximum file size that can be uploaded to the EERE eXCHANGE website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the FOA it must be broken into parts and denoted to that effect. For example:
TechnicalVolume_Part_1
TechnicalVolume_Part_2

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

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

ii. Technical Volume

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

Applicants must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical

Volume. However, EERE and reviewers are under no obligation to review cited sources.

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

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

SECTION/PAGE LIMIT	DESCRIPTION
Cover Page	The cover page should include the project title, the specific FOA Topic Area and AOI(s) being addressed, both the technical and business points of contact, names of all team member organizations, names of the senior/key personnel and their organizations, 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 their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.

Technical Description, Innovation, and Impact (Approximately 30% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state-of-the-art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state-of-the-art/technical baseline if the project is successful.
Workplan and Market Transformation Plan (Approximately 40% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed SOPO is separately requested. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes. • Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on Go/No-Go decision points). The applicant should describe the specific expected end result of each performance period. • WBS and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard WBS for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an adequately detailed task plan to

	describe the proposed project and the plan for addressing the objectives of this FOA. The summary provided should be consistent with the SOPO. The SOPO will contain a more detailed description of the WBS and tasks. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be Specific, Measurable, Achievable, Relevant, and Timely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO. • Go/No-Go Decision Points (See Section VI.B.xiv for more information on the Go/No-Go Review): 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.xiv. The applicant should also provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. The summary provided should be consistent with the SOPO. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone. • End of Project Goal: The applicant should provide a summary of the end of project goal(s). At a minimum, each project must have one SMART end of project goal. The summary provided should be consistent with the SOPO. • Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points. • Buy America Requirements for Infrastructure Projects: Within the first 2 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 D 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: • Describe the project team's unique qualifications and expertise, including those of key subrecipients. • Describe the project team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable.

	• For multi-organizational or multi-investigator projects, describe succinctly: ○ The roles and the work to be performed by each PI and senior/key personnel; ○ Business agreements between the applicant and each PI and senior/key personnel; ○ How the various efforts will be integrated and managed; ○ Process for making decisions on scientific/technical direction; ○ Publication arrangements; ○ Intellectual Property issues; and ○ Communication plans

iii. Resumes

A resume provides information that can be used by reviewers to evaluate the individual's skills, experience, and potential for leadership within the scientific community. Applicants are required to submit two-page resumes for the Principal Investigator and all Senior/Key Personnel that include the following:

1. Contact Information;
2. Education and training: Provide 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; and
6. Synergistic Activities: List up to five professional and scholarly activities related to the proposed effort.

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

In future FOAs, EERE may require a biographical sketch for the PI and senior/key personnel. In the meantime, in lieu of 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/, and is also available at https://nsf.gov/bfa/dias/policy/nsfapprovedformats/biosketch.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.

iv. Letters of Commitment

Submit letters of commitment from all subrecipient and third-party cost share providers. If applicable, also include any letters of commitment from partners/end users (one-page maximum per letter). Save the letters of commitment in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_LOCs".

v. Statement of Project Objectives (SOPO)

Applicants are required to complete a SOPO. A SOPO template is available on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/. The SOPO, including the Milestone Table, must not exceed 15 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".

vi. SF-424: Application for Federal Assistance

Applicants are required to complete the SF-424 Application for Federal Assistance. This form is available on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/. Complete all required fields in accordance with the instructions on the form. The list of certifications and assurances in Field 21 can be found at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms, under Certifications and Assurances. Note: The dates and dollar amounts on the SF-424 are for the complete project period and not just the first project year, first phase or other subset of the project period. Save the SF-424 in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_424".

vii. Budget Justification Workbook

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

viii. Summary/Abstract for Public Release

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

ix. Summary Slide

Applicants are required to provide a single slide summarizing the proposed project. This slide is used during the evaluation process.

The Summary Slide template requires the following information:

- A technology summary;
- A description of the technology's impact;
- Proposed project goals;
- Any key graphics (illustrations, charts and/or tables);
- The project's key idea/takeaway;

- Project title, prime recipient, Principal Investigator, and 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".

x. Subrecipient Budget Justification (if applicable)

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

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

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE WP in accordance with the requirements in DOE Order 412.1A, Work Authorization System, Attachment 3, available at: https://www.directives.doe.gov/directives-documents/400-series/0412.1-BOrder-a-chg1-AdmChg Save the WP in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_WP".

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

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

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

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

Prime recipients and subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-federal funds have not been paid and will not be paid to any

person for influencing or attempting to influence any of the following in connection with the application:

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

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

xiv. Waiver Requests: Foreign Entity and Foreign Work (if applicable)

i. **Foreign Entity Participation:**
As set forth in Section III.A., all prime recipients must qualify as domestic entities. See Section III. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. Appendix C lists the necessary information that must be included in a request to waive this requirement.

ii. **Performance of Work in the United States (Foreign Work Waiver)**
As set forth in Section IV.J.iii., all work under EERE funding agreements must be performed in the United States. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. Appendix C lists the necessary information that must be included in a foreign work waiver request.

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

xv. Waiver of the Build America, Buy America Requirement for Infrastructure Projects

As set forth in Section IV.J.vii., federally assisted projects which 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.

In limited circumstances, DOE may grant a waiver of this requirement. Appendix D to this FOA provides guidance on how "infrastructure work" is defined,

explains the applicable justifications under which a waiver may be granted, and lists the information that must be included in the waiver request.

Save the Waiver in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_BAWaiver".

xvi. Diversity, Equity and Inclusion Plan

As part of the application, applicants are required to describe how diversity, equity, and inclusion objectives will be incorporated in the project. Specifically, applicants are required to submit a Diversity, Equity, and Inclusion Plan that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from groups underrepresented in STEM, advance equity, and encourage the inclusion of individuals from these groups in the project; and the extent the project activities will be located in or benefit underserved communities (also see Section I.A.iii.). The plan should include at least one SMART milestone per Budget Period supported by metrics to measure the success of the proposed actions, and will be incorporated into the award if selected. The Diversity, Equity, and Inclusion Plan should contain the following information:

- Equity Impacts: the impacts of the proposed project on underserved communities, including social and environmental impacts.
- Benefits: The overall benefits of the proposed project, if funded, to underserved communities; and
- How diversity, equity, and inclusion objectives will be incorporated in the project.

The following is a non-exhaustive list of actions that can serve as examples of ways the proposed project could incorporate diversity, equity, and inclusion elements. These examples should not be considered either comprehensive or prescriptive. Applicants may include appropriate actions not covered by these examples.

a. Include faculty or students from Minority Serving Institutions as PI/co-PI, senior personnel, and/or student researchers, as applicable;
b. Enhance or collaborate with existing diversity programs at your home organization and/or nearby organizations;
c. Collaborate with students, researchers, and staff in Minority Serving Institutions;
d. Disseminate results of research and development in Minority Serving Institutions or other appropriate institutions serving underserved communities;
e. Implement evidence-based, diversity-focused education programs (such as implicit bias training for staff) in your organization;

f. Identify Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses and Veteran Owned Businesses to solicit as vendors and sub-contractors for bids on supplies, services and equipment.

The Diversity, Equity, and Inclusion Plan must not exceed 5 pages. Save the Diversity, Equity and Inclusion Plan in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_DEIP".

xvii. 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 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 – end date)
- The person-months of effort per year being dedicated to the award or activity

If required 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.

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 format approved by the National Science Foundation (NSF), which may be generated by the Science Experts Network Curriculum Vita (SciENcv), a cooperative venture maintained at https://www.ncbi.nlm.nih.gov/sciencv/, and is also available at https://www.nsf.gov/bfa/dias/policy/nsfapprovedformats/cps.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. If the NSF format is used, the individual must still include a signature, date, and a certification statement using the language included in the paragraph above.

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 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 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 DOE award.[47]

[47] 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.

E. Content and Form of Replies to Reviewer Comments

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

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

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

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

F. Post Selection Information Requests

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

- 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);
- Indirect cost information;

- Other budget information;
- Commitment Letters from Third Parties Contributing to Cost Share, if applicable;
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5);
- Representation of Limited Rights Data and Restricted Software, if applicable; 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) Be registered in the SAM at https://www.sam.gov before submitting its application; (2) provide a valid UEI in its application; and (3) continue to maintain an active SAM registration with current information at all times during which it has an active federal award or an application or plan under consideration by a federal awarding agency. DOE may not make a federal award to an applicant until the applicant has complied with all applicable 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, the DOE will determine that the applicant is not qualified to receive a federal award and use that determination as a basis for making a federal award to another applicant.

H. Submission Dates and Times

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

I. Intergovernmental Review

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

J. Funding Restrictions

i. Allowable Costs

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

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

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

ii. Pre-Award Costs

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

Pre-award costs cannot be incurred prior to the Selection Official signing the Selection Statement and Analysis.

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

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

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

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

completing a NEPA review, the prime recipient is doing so at risk of not receiving federal funding and such costs may not be recognized as allowable cost share.

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

1. Requirement

All work performed under EERE awards must be performed in the United States. 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 C lists the necessary 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 U.S. flag carrier, if service is available. Foreign travel costs

are allowable only with the written prior approval of the Contracting Officer assigned to the award.

vi. Equipment and Supplies

Property disposition will be required at the end of a project if the current fair market value of property exceeds $5,000. For-profit entity disposition requirements are set forth at 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 200.310 – 200.316.

vii. Buy America Requirements for Infrastructure Projects

Federally assisted projects which 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 dependant on several factors, such as the recipient's entity type, whether the work involves "infrastructure," as that term is defined in Section 70914 of of the Bipartisan Infrastructure Law, and whether the infrastructure in question is publicly owned or serves a public function.

Applicants are strongly encouraged to consult Appendix D 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.

viii. Lobbying

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

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

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

ix. Risk Assessment

Prior to making a federal award, the DOE is required by 31 U.S.C. 3321 and 41 U.S.C. 2313 to review information available through any Office of Management and Budget (OMB)-designated repositories of government-wide eligibility qualification or financial integrity information, such as SAM Exclusions and "Do Not Pay."

In addition, DOE evaluates the risk(s) posed by applicants before they receive federal awards. This evaluation may consider: results of the evaluation of the applicant's eligibility; the quality of the application; financial stability; quality of management systems and ability to meet the management standards prescribed in this part; history of performance; reports and findings from audits; and the applicant's ability to effectively implement statutory, regulatory, or other requirements imposed on non-federal entities.

In addition to this review, DOE must comply with the guidelines on government-wide suspension and debarment in 2 CFR 180, and must require non-federal entities to comply with these provisions. These provisions restrict federal awards, subawards and contracts with certain parties that are debarred, suspended or otherwise excluded from or ineligible for participation in federal programs or activities.

x. Invoice Review and Approval

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

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

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.

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

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

Concept Paper Criterion: Overall FOA Responsiveness and Viability of the Project (Weight: 100%)
This criterion involves consideration of the following factors:

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

ii. Full Applications

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

Criterion 1: Technical Merit, Innovation, and Impact (50%)
This criterion involves consideration of the following factors:
Technical Merit and Innovation

- Extent to which the proposed technology or process is innovative;
- Degree to which the current state of the technology and the proposed advancement are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state-of-the-art to the proposed advancement; and

- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work.

Impact of Technology Advancement

- How the project supports the topic area objectives and target specifications and metrics; and
- The potential impact of the project on advancing the state-of-the-art, achieving emissions reduction and energy efficiency improvements in the industrial sector, and providing any co-benefits.

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

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

Market Transformation Plan

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

Criterion 3: Team and Resources (15%)

This criterion involves consideration of the following factors:

- The capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success.

The qualifications, relevant expertise, and time commitment of the individuals on the team;

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

Criterion 4: Diversity, Equity, and Inclusion (10%)

This criterion involves consideration of the following factors:

- The quality and manner in which the measures incorporate diversity, equity and inclusion goals in the project; and
- Extent to which the project benefits underserved communities.

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 is likely to lead to increased employment and manufacturing in the United States;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty; and
- 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 diversity, equity, and inclusion elements, including but not limited to team members from Minority Serving Institutions (e.g. Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions), Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or members within underserved communities.

D. Evaluation and Selection Process

i. Overview

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

ii. Pre-Selection Interviews

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

EERE will arrange to meet with the invited applicants in person at EERE's offices or a mutually agreed upon location. EERE may also arrange site visits at certain

applicants' facilities. In the alternative, EERE may invite certain applicants to participate in a one-on-one conference with EERE via webinar, videoconference, or conference call.

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

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

iii. Pre-Selection Clarification

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

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

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

iv. Recipient Integrity and Performance Matters

DOE, prior to making a federal award with a total amount of federal share greater than the simplified acquisition threshold, is required to review and consider any information about the applicant that is in the designated integrity

and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313).

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

DOE will consider any written comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under federal awards when completing the review of risk posed by applicants as described in 2 CFR 200.206.

v. Selection

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

E. Anticipated Notice of Selection and Award Negotiation Dates

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

VI. Award Administration Information

A. Award Notices

i. Ineligible Submissions

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

ii. Concept Paper Notifications

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

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

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

iii. Full Application Notifications

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

iv. Successful Applicants

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

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

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

v. Alternate Selection Determinations

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

vi. Unsuccessful Applicants

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

B. Administrative and National Policy Requirements

i. Registration Requirements

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

1. EERE 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.

Beginning on July 29, 2022*, eXCHANGE will be updated to integrate with Login.gov. As of September 30, 2022*, potential applicants will be required to have a Login.gov account to access EERE eXCHANGE. 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.

* Please note that these dates are tentative and subject to change.

It is recommended that each organization or business unit, whether acting as a team or a single entity, use only one account as the contact point for each submission. Applicants should also designate backup points of contact so they may be easily contacted if deemed necessary. **This step is required to apply to this FOA.** The 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. However, please note that Concept Papers and Full Applications will not be accepted through Grants.gov.

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

ii. Award Administrative Requirements

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

iii. Foreign National 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 foreign national's participation in the award. Likewise, DOE may elect to deny a foreign national's access to a DOE sites, 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 in response to this FOA, the applicant represents that:

   a. It is **not** a corporation that has been convicted of a felony criminal violation under any federal law within the preceding 24 months; and

   b. It is **not** a corporation that has any unpaid federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

   For purposes of these representations the following definitions apply:

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

3. **Nondisclosure and Confidentiality Agreements Representations**
   In submitting an application in response to this FOA the applicant represents that:

   a. It **does not and will not** require its employees or contractors to sign internal nondisclosure or confidentiality agreements or statements prohibiting or otherwise restricting its employees or contactors from lawfully reporting waste, fraud, or abuse to a designated investigative or law enforcement representative of a federal department or agency authorized to receive such information.

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

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

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

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

viii. Statement of Federal Stewardship

EERE will exercise normal federal stewardship in overseeing the project activities performed under EERE awards. Stewardship Activities include, but are not limited to, conducting site visits; reviewing performance and financial reports; providing assistance and/or temporary intervention in unusual circumstances to

correct deficiencies that develop during the project; assuring compliance with terms and conditions; and reviewing technical performance after project completion to ensure that the project objectives have been accomplished.

ix. Statement of Substantial Involvement

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

1. EERE shares responsibility with the recipient for the management, control, direction, and performance of the project.
2. EERE may intervene in the conduct or performance of work under this award for programmatic reasons. Intervention includes the interruption or modification of the conduct or performance of project activities.
3. EERE may redirect or discontinue funding the project based on the outcome of EERE's evaluation of the project at the Go/No-Go decision point(s).
4. EERE participates in major project decision-making processes.

x. Interim Conflict of Interest Policy for Financial Assistance Policy

The DOE interim Conflict of Interest Policy for Financial Assistance (COI Policy)[48] 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 EERE funded projects, the recipient must include all financial conflicts of interest (FCOI) (i.e., managed and unmanaged/ unmanageable) in their 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

[48] 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.

DOE's interim COI Policy. To provide some flexibility, EERE 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.**

xi. Subject Invention Utilization Reporting

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

xii. Intellectual Property Provisions

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

xiii. Reporting

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

xiv. Go/No-Go Review

Each project selected under this FOA will be subject to a periodic project evaluation referred to as a Go/No-Go Review. 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 actually 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 EERE program goals and objectives. Federal funding beyond the Go/No-Go decision point (continuation

funding) is contingent upon (1) availability of federal funds appropriated by Congress for the purpose of this program; (2) the availability of future-year budget authority; (3) recipient's technical progress compared to the Milestone Summary Table stated in Attachment 1 of the award; (4) recipient's submittal of required reports; (5) recipient's compliance with the terms and conditions of the award; (6) EERE's Go/No-Go decision; (7) the recipient's submission of a continuation application; and (8) written approval of the continuation application by the Contracting Officer.

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

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

xv. Conference Spending

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

xvi. Uniform Commercial Code (UCC) Financing Statements

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

Properly record, and consent to the Department's ability to properly record if the recipient fails to do so, UCC financing statement(s) for all equipment in excess of

$5,000 purchased with project funds. These financing statement(s) must be approved in writing by the Contracting Officer prior to the recording, and they shall provide notice that the recipient's title to all equipment (not real property) purchased with federal funds under the financial assistance agreement is conditional pursuant to the terms of this section, and that the government retains an undivided reversionary interest in the equipment. The UCC financing statement(s) must be filed before the Contracting Officer may reimburse the recipient for the federal share of the equipment unless otherwise provided for in the relevant financial assistance agreement. The recipient shall further make any amendments to the financing statements or additional recordings, including appropriate continuation statements, as necessary or as the Contracting Officer may direct.

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

States, local governments, or other public entities may not condition sub-awards in a manner that would discriminate, or disadvantage sub-recipients 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.E.xvii.

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 U.S.

industry and labor. Therefore, in exchange for receiving taxpayer dollars to support an applicant's project, the applicant must agree to a U.S. Competitiveness provision requiring 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 the Department of Energy (DOE) that it is not commercially feasible. Award terms, including possible restrictions around change of control and reassignment of subject inventions related to the U.S. Competitiveness Provision, are available at https://www.energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards.

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.

As noted in the U.S. Competitiveness Provision, at any time in which 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 U.S. manufacturing plan. The statement or plan would contain specific and enforceable commitments that would be beneficial to the U.S. economy and competitiveness. Commitments could include manufacturing specific products in the U.S., making a specific investment in a new or existing U.S. manufacturing facility, keeping certain activities based in the U.S. or supporting a certain number of jobs in the U.S. related to the technology. If DOE, in its sole discretion, determines that the proposed modification or waiver promotes commercialization and provides substantial U.S. economic benefits, DOE may grant the request and, if granted, modify the award terms and conditions for the requesting entity accordingly.

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. Data Management Plan (DMP)

Each applicant whose Full Application is selected for award negotiations will be required to submit a 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 in order 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.

xxii. 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 (currently FAPIIS). 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.

VII. Questions/Agency Contacts

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

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

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

VIII. Other Information

A. FOA Modifications

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

B. Government Right to Reject or Negotiate

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

C. Commitment of Public Funds

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

D. Treatment of Application Information

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

requirement in the FOA. Applicants are advised to not include any critically sensitive proprietary detail.

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

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

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

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

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

E. Evaluation and Administration by Non-Federal Personnel

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

F. Notice Regarding Eligible/Ineligible Activities

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

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

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

H. Requirement for Full and Complete Disclosure

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

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

I. Retention of Submissions

EEREexpects 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. In order to avail itself of the class waiver, a domestic large business must agree that any products embodying or produced through the use of a subject invention first created or reduced to practice under this program will be substantially manufactured in the United States;
- Advance and Identified Waivers: For an applicant not covered by a Class Patent Waiver or the Bayh-Dole Act, the applicant may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784; and
- 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 Committments 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.

K. Government Rights in Subject Inventions

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

i. Government Use License

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

ii. March-In Rights

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

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

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

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

L. Rights in Technical Data

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

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

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

M. Copyright

The prime recipient and subrecipients may assert copyright in copyrightable works, such as software, first produced under the award without EERE approval. When copyright is asserted, the government retains a paid-up nonexclusive, irrevocable worldwide license to reproduce, prepare derivative works, distribute copies to the public, and to perform publicly and display publicly the copyrighted work. This license extends to contractors and others doing work on behalf of the government.

N. Export Control

The 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 uses 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, then 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 of the terms in the titles specific to regulations applicable to cost sharing. EERE almost always uses the term "cost sharing," as it conveys the concept that non-federal share is calculated as a percentage of the Total Project Cost. An exception is the State Energy Program Regulation, 10 CFR 420.12, State Matching Contribution. Here "cost matching" for the non-federal share is calculated as a percentage of the federal funds only, rather than the Total Project Cost.

How Cost Sharing Is Calculated

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

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

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

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

What Qualifies For Cost Sharing

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

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

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

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

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

General Cost Sharing Rules on a DOE Award

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(B) Valuing and documenting contributions

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

will be consumed in the performance of the award or fully depreciated by the end of the award. In cases where the full value of a donated capital asset is to be applied as cost sharing or matching, that full value must be the lesser or the following:

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

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

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

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

(4) Valuing property donated by third parties.

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

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

i. The value of donated space must not exceed the fair rental value of comparable space as established by an independent appraisal of comparable space and facilities in a privately-owned building in the same locality.

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

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

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

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

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

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

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

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

Each task must be calculated individually as follows:

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

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

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

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

The calculation may then be completed as follows:

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

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

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

1. Waiver for Foreign Entity Participation as the Prime Recipient

As set forth in Section III.A., all prime recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a state or territory of the United States and have a physical location for business operations in the United States. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

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 U.S. 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 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 United States research, development and manufacturing, including contributions to employment in the United States and growth in new markets and jobs in the United States;
    - How the project will promote domestic American manufacturing of products and/or services;
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.

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

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

As set forth in Section IV.J.iii., all work under EERE funding agreements must be performed in the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit an explicit waiver request in the Full Application. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

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

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

EERE may require additional information before considering the waiver request.

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

APPENDIX D -- 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, 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[49] —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.

In addition to the above, the infrastructure in question must be publically-owned or must serve a public function; privately owned infrastructure that is solely utilized for private use is not considered "infrastructure" for purposes of Buy America applicability. 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, 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:

[49] BIL, § 70917(c)(1).

(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[50] are manufactured in the United States—this means that all manufacturing processes for the construction material occurred in the United States. The Buy America requirements only applies 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 a 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.

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.

These requirements must flow down to all sub-awards, all contracts, subcontracts and purchase orders for work performed under the proposed project.

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: https://www.whitehouse.gov/wp-content/uploads/2022/04/M-22-11.pdf

C. DOE Submission Requirements for Full Application

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

Within the first two pages of the workplan, applicants must provide a short statement on whether the project will involve the construction, alteration, and/or repair of infrastructure in the United States. The ultimate determination about whether a project includes infrastructure remains with DOE, but the applicant's statement will assist project planning and integration of domestic preference requirements, which may impact the project's proposed budget.

D. Waivers

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 percent.

If an applicant is seeking a waiver of the Buy America requirements, it must include a written waiver request with the Full Application. 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
- 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 [link to awarding agency web site with information on currently applicable general applicability waivers].

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

APPENDIX E – GLOSSARY

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

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

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

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

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

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

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

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

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

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

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

APPENDIX F – DEFINITION OF TECHNOLOGY READINESS LEVELS

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

APPENDIX G – LIST OF ACRONYMS

AMO	Advanced Manufacturing Office
AOI	Area of Interest
ASTM	American Society for Testing and Materials
BF	Blast furnace
BOF	Basic oxygen furnace
CCUS	Carbon capture, utilization, and storage
CFR	Code of Federal Regulation
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent (greenhouse gas emissions)
COI	Conflict of Interest
CRADA	Cooperative Research and Development Agreement
DEC	Determination of Exceptional Circumstances
DEI	Diversity, Equity, and Inclusion
DOE	Department of Energy
EAF	Electric arc furnace
EERE	Energy Efficiency and Renewable Energy
FAPIIS	Federal Awardee Performance and Integrity Information System
FAR	Federal Acquisition Regulation
FOA	Funding Opportunity Announcement
FFATA	Federal Funding and Transparency Act of 2006
FFRDC	Federally Funded Research and Development Center
GHG	Greenhouse gases
HBCUs	Historically Black Colleges and Universities
HOTS	High operating temperature storage
IHP	Industrial heat pumps
kWh	Kilowatt-hour
LCA	Lifecycle assessment
LCFFES	Low-carbon fuels, feedstocks, and energy sources
M&O	Management and Operating
MFA	Multi-Factor Authentication
MMT	Million metric tons
MPIN	Marketing Partner ID Number
MSI	Minority-Serving institution
MW	Megawatt
MYPP	Multi-Year Program Plan
NAICS	North American Industrial Classification System
NDA	Non-Disclosure Acknowledgement
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Agency
NO_x	Nitrogen oxides

NSF	National Science Foundation
OIG	Office of Inspector General
OMB	Office of Management and Budget
OPC	Ordinary Portland Cement
OSTI	Office of Scientific and Technical Information
PGM	Platinum group metal
PII	Personal Identifiable Information
PM	Particulate matter
POC	Point of Contact
R&D	Research and Development
RD&D	Research, development, and demonstration
RDD&D	Research, development, demonstration and deployment
SAM	System for Award Management
SciENcv	Science Experts Network Curriculum Vita
SCM	Supplementary cementitious material
SMART	Specific, Measurable, Assignable, Realistic and Time-Related
SOPO	Statement of Project Objectives
SSNs	Social Security Numbers
STEM	Science, Technology, Engineering, and Mathematics
TBtu	Trillion British thermal units
TEA	Technoeconomic analysis
TES	Thermal energy storage
TRL	Technology Readiness Level
UCC	Uniform Commercial Code
UEI	Unique Entity Identifier
U.S.	United States
WBS	Work Breakdown Structure
WP	Work Proposal