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

Smart Manufacturing Technologies for Material and Process Innovation

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FOA Issue Date:	7/18/2024
Submission Deadline for Concept Papers:	8/22/2024 5:00 p.m. ET
Submission Deadline for Full Applications:	11/18/2024 5:00 p.m. ET
Expected Submission Deadline for Replies to Reviewer Comments:	1/14/2025 5:00 p.m. ET
Expected Date for EERE Selection Notifications:	April 2025
Expected Timeframe for Award Negotiations:	Apr-Jun 2025

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

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

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

- **Unique Entity Identifier (UEI) and System for Award Management (SAM) -** Each applicant (unless the applicant is excepted from those requirements under 2 CFR 25.110) is required to: (1) register in the SAM at **https://www.sam.gov** before submitting an application; (2) provide a valid UEI number in the application; and (3) maintain an active SAM registration with current information when the applicant has an active federal award or an application or plan under consideration by a federal awarding agency. DOE may not make a federal award to an applicant until the applicant has

complied with all applicable UEI and SAM requirements and, if an applicant has not fully complied with the requirements by the time DOE is ready to make a federal award, DOE will determine that the applicant is not qualified to receive a federal award and use that determination as a basis for making a federal award to another applicant.

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

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I. Funding Opportunity Description

A. Background and Context

i. Background and Purpose

This funding opportunity announcement (FOA) is being issued by the U.S. Department of Energy's (DOE) Advanced Materials and Manufacturing Technologies Office (AMMTO). The mission of AMMTO is: "We inspire people and drive innovation to transform materials and manufacturing for America's energy future." This is in alignment with AMMTO's vision for the future – a globally competitive U.S. manufacturing sector that accelerates the adoption of innovative materials and manufacturing technologies in support of a clean, decarbonized economy.

To realize a clean, decarbonized economy, we must drive innovation to transform resources, materials, and manufacturing for energy applications. The U.S. ramp up of production of technologies that are needed for this energy transition will require new materials, new manufacturing processes, and new circular materials flows.

The modernization of manufacturing can help bring these innovations on-line at the needed scale and quality faster. Among the most important trends to impact the manufacturing sector is the drive toward digitalization, which is the process of employing digital technologies and information to transform the manufacturing enterprise system and business operations across the total production lifecycle. Smart manufacturing provides a systemic approach for the digital transformation of manufacturing that holds great promise to significantly improve productivity, efficiency, safety, security, and sustainability of U.S. manufacturing and energy systems.

While there has been significant support of digitization innovation, the manufacturing sector has been relatively slow to adopt digital technologies. This is problematic as digital transformation—through its improvements in cost, quality, productivity, time to market, efficiency, safety, security, and sustainability—holds great promise to transform how we manufacture products and materials for our energy future.

Smart manufacturing refers to the suite of platform technologies that directly support the digital transformation of the manufacturing enterprise across the entire production lifecycle, which includes design, process, production, supply network, and enterprise levels. Platform technologies are manufacturing technologies that can be applied to manufacture multiple products. The digital transformation of manufacturing through smart manufacturing platform technologies would promote the development of cyberphysical systems (CPS) for manufacturing. A vision for CPS for manufacturing is the development of modular, interconnected systems that combine physical processes, computational resources, and networked communication to create a highly automated,

efficient, and flexible manufacturing environment. In such systems, physical components (e.g., machinery, robots, sensors) would be interconnected with software and data networks, enabling real-time monitoring, control, and optimization of manufacturing processes. This would enable a host of significant capabilities including real-time data processing and feedback, advanced automation and control, enhanced flexibility and adaptability, and improved efficiency and quality.

	Smart Manufacturing Technology Program Pillars				
Smart Manufacturing Technology Areas	Enhance Product Quality	Support Process Innovation	Accelerate Materials Development	Enable Materials Circularity	Drive Asset Optimization
Operational Technologies	X	X	X	X	X
Data Connectivity	X	X	X	X	X
Data Interoperability	X	X	X	X	X
Digital Twin	X	X	X	X	X
Artificial Intelligence	X	X	X	X	X
Predictive Analytics	X	X	X	X	X
Materials Informatics			X		
Cloud/Edge Computing	X	X	X	X	X
High Performance Computing	X	X	X	X	X
Collaborative Automation		X	X	X	
Cybersecurity		X			X
	Crosscutting Program Pillar - Increase Workforce Readiness				

Figure 1. Smart manufacturing program pillars and associated smart manufacturing technologies.

AMMTO's smart manufacturing priorities address major end-use industrial opportunities for smart manufacturing in the energy sector. Figure 1 lays out AMMTO's primary pillars of smart manufacturing, which include: (1) Enhance Product Quality, (2) Support Process Innovation, (3) Accelerate Materials Development, (4) Enable Materials Circularity, (5) Drive Asset Optimization and (6) Increase Workforce Readiness.

a. Concepts and Definitions:

As used by AMMTO and in this FOA, smart manufacturing comprises the following concepts and definitions. Smart manufacturing builds upon the pillars of lean manufacturing, digital manufacturing, and continuous manufacturing to achieve superior throughput, efficiency, quality, and precision in the manufacturing process. The term lean manufacturing refers to creating maximum outputs with reduced inputs in terms of cost, time, energy, and effort. Digital manufacturing emphasizes the digitization and integration of manufacturing activities with the properties and performance of products. Continuous manufacturing transforms the traditional batch manufacturing

process into an integrated process to enable faster production. Smart manufacturing frameworks are being applied across most industry sectors and can be leveraged beyond traditional manufacturing processes. For example, the principles of smart manufacturing can also be applied to improve how new materials are designed or to enhance how materials are recovered at the end of a product's life. At its core, smart manufacturing is a framework that encompasses generating, sharing, and using data through a combination of physical and virtual processes to enable leveraging complex data for a resilient, responsive, and efficient manufacturing sector.

For the full background and for specific terms and concepts, refer to Appendix I.

b. Purpose and Desired Impact:

This FOA supports administration goals by developing options for a national plan for smart manufacturing technology development and deployment as per the language set forth in The Energy Act of 2020, Sec. 6006 on pages 1113 and 1115. DOE, in partnership with the National Academies of Science, Engineering, and Medicine (NASEM), conducted workshops to study the options for developing a national plan for smart manufacturing. The final consensus study report[1] examined the technical frameworks and processes, identified possible timelines and necessary resources, and explored policies and general roles for government, industry, and academia to address near-, medium-, and long-term challenges to improve the productivity and energy efficiency of the manufacturing sector of the United States and ensure U.S. competitiveness.

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"[2] to the benefit of all Americans by demonstrating how U.S. manufacturing can be significantly improved and aid in meeting these goals through the use of smart manufacturing. 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. Critical minerals and materials are a key element of the ongoing transition to an energy economy that is decarbonizing and lowering energy costs to American families and businesses, and also critical to national competitiveness–for grid storage, for

[1] Options for a National Plan for Smart Manufacturing | National Academies

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

the resilience of homes and businesses, and for electrification of the transportation sector.

The research and development (R&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.

ii. Technology Space and Strategic Goals

This FOA seeks applications to address the development of smart manufacturing technologies –including through "smart RD&D" – that can contribute to a resilient, responsive, leading-edge, and efficient manufacturing sector that delivers the technologies needed for the nation's clean energy transition. The manufacturing community can reduce manufacturing costs and accelerate time-to-market by integrating performance characteristics of final products with processes aided by a smart manufacturing framework. The information-driven collaborative orchestration of physical and digital processes across the entire value chain is one aspect of smart manufacturing. Smart manufacturing relies on a combination of physical and virtual technologies to make designing, processing, and manufacturing faster, higher value-added, more resilient, sustainable, and more cost-effective. Individual processes within a plant, factory, or entire value chain are integrated and continually monitored with sensing, process modeling, and predictive analytics. The physical processes focus on controlling and optimizing processing conditions for desired outcomes, while virtual processes uncover underlying complex interactions between the physical processes and provide insight into better ways to design and manufacture products (i.e., feedback for physical processes). This FOA seeks to implement smart manufacturing across several diverse application areas and market sectors to: (a) show the benefits of incorporating smart manufacturing in areas aligned with AMMTO's mission, and (b) to provide practical experience which will be used to further refine AMMTO's smart manufacturing strategy and future R&D direction. Detailed technical descriptions of the specific Topic Areas are provided in the sections that follow.

B. Topic Areas

Topic Areas

This FOA includes four topic areas, all involving aspects of smart manufacturing.

Topic #	Topic Area
1	Smart Manufacturing for a Circular Economy

2	Smart Manufacturing of Tooling and Equipment for Sustainable Transportation
3	Smart Manufacturing for High Performance Materials
4	Smart Technologies for Sustainable and Competitive U.S. Mining

Applications under these topic areas should meet the following requirements:

- Applicants must describe their innovation's connection to smart manufacturing. Technologies that have applications in more than one industry sector are encouraged.
- While the topics are written broadly to be inclusive of a variety of approaches, proposed efforts should be specific and clearly describe the technology being developed and validated.
- Applicants must propose to perform a techno-economic analysis (TEA) and a lifecycle assessment (LCA) as part of their potential projects except where noted in the following Topics. These analyses must include a comparison of the current, commercially available state-of-the-art technology with the proposed approach, including comparisons of functionality. The comparison should include an initial TEA and an initial LCA that considers: 1) current, commercially available state-of-the-art technology; 2) relevant preliminary data that demonstrates the current developmental stage of the proposed solution (experimental, literature-based, or both); and 3) the proposed solution's targets that will be achieved by end of project. The preliminary TEA and LCA must be included in the technical volume of the application, should be conducted using credible methodologies and assumptions and will need to be updated throughout the life of selected projects. Proposed technologies/approaches must demonstrate economic feasibility and a net decrease in overall lifecycle energy consumption.
- In all cases, letters of commitment from partner organizations, and especially those that pledge cost share, will make for stronger applications.
- Applications must include the process improvements required for their proposed solutions to move to the next step in commercialization.
- The role of modeling and simulations, experimentation, lab, bench, and pilot-scale testing should be explained. Anticipated technical barriers should be described, along with a planned approach to overcome them. Applicants should explain the underlying research to date, including any literature review or experimental data to support the proposed R&D approach and justify the R&D needs.
- 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).

- All applications must also define credible and measurable baselines, supported by prior data from literature and/or experimentation, against which their user defined metrics will be evaluated. The quality and scientific depth of these proposed baselines and metrics will be an important element of the technical evaluation of applications.
- Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Applicants are encouraged to also review the Adoption Readiness Level (ARL) framework and describe their technology's ARL as well.[3] ARL represents important risk factors for commercialization beyond technology readiness.

Recognizing that not all applicants may have prior experience with TEA and LCA at the appropriate level of sophistication, the DOE has developed tools such as the Greenhouse gases, Regulated Emissions, and Energy use in Technologies model (GREET) developed by the Argonne National Laboratory[4] and[5] tool. Appendix G includes additional TEA and LCA resources available to applicants.

If selected for award negotiations, project teams should be sensitive to cybersecurity and describe in their cybersecurity plans how they will use best practices to protect their data; it is recommended that applicants follow NIST 800-171 or similar methods to ensure best practices are used. Projects that have higher data management risks (e.g., projects that utilize large data sets, projects involving software development, etc.) may be required to develop more extensive data management and/or cybersecurity plans.

Applicants who plan to generate data sets to inform machine learning (ML) or artificial intelligence (AI) that would be broadly applicable to other AMMTO projects may be required during award negotiation to make such data available in an agreed data repository. These applicants may also be required to submit an expanded data management plan to include an explanation of the handling protocol for generated data, identification of potential sensitive data and how it will be handled, identification of personal privacy protection protocols, and other intellectual property (IP) and data management considerations as determined to be appropriate for the scope of work.

[3] DOE Office of Technology Transitions. *Adoption Readiness Levels (ARL): A Complement to TRL*. Available from: https://www.energy.gov/technologytransitions/adoption-readiness-levels-arl-complement-trl

[4] Argonne National Laboratory. *Greenhouse Gases, Regulated Emissions, and Energy use in technologies model (GREET)*. 2022; Available from: https://greet.es.anl.gov/.

[5] Materials Flows through Industry Supply Chain Modeling Tool | Advanced Manufacturing Research | NREL

i. Topic 1: Smart Manufacturing for a Circular Economy

Background:
The aim of this FOA topic is to increase the viability of circular supply chains (Re-X pathways), such as recycling, repairing, remanufacturing, and reuse, by improving their efficiency and economics. Smart manufacturing technologies have the potential to address key challenges in deploying economically viable Re-X supply chains that reduce environmental impacts and encourage secure and sustainable domestic supply chains.[6] There are three areas of interest within this topic area: smart manufacturing technologies for improved sorting and characterization, interoperable and open supply chains for expanded Re-X, and improved data transparency for accurate LCAs.

Area of Interest 1: Smart Manufacturing Technologies for Improved Sorting and Characterization
The challenge of sorting and characterizing materials is one of the primary barriers to broader implementation of Re-X pathways. For example, many manufacturers are interested in incorporating greater proportions of recycled materials ("secondary feedstocks") into their products, but they encounter difficulty in sourcing feedstock streams that are of a consistent and acceptable quality and price. This issue is relevant across various high-volume materials including, but not limited to, glass, plastics, metals, paper, textiles, and building materials, as well as specialty material streams such as composites, specialty alloys, and critical materials. To facilitate the recovery and recycling of these materials into new products, it is crucial to improve our ability to identify, sort, and/or characterize these streams. Flat and real-time data collection has the potential to address this challenge by integrating sensors and machine learning tools to enhance sortation and characterization processes. This integration enables a wider utilization of secondary materials. For example, Google has demonstrated that using this approach can substantially reduce contamination in recycling streams, leading to higher quality secondary material outputs.[7,8] However, this required significant computing power; deployable technologies that facilitate improved sorting without requiring large data centers are needed.

[6] Schumacher, K., Last, N., Morris, K., Ferrero, V., Hapuwatte, B., Mathur, N. and Reslan, M., *Fostering a Circular Economy of Manufacturing Materials Workshop Report.* 2023; https://doi.org/10.1520/amcoe-economy-of-manufacturing-materials.
[7] Herzog, A., Rao, K., Hausman, K., Lu, Y., Wohlhart, P., Yan, M., Lin, J., Arenas, M.G., Xiao, T., Kappler, D. and Ho, D., 2023. *Deep RL at scale: Sorting waste in office buildings with a fleet of mobile manipulators*. arXiv preprint arXiv:2305.03270.
[8] Werner, Mike. (April 11, 2024). Keynote Address: 2024 REMADE Circular Economy Tech Summit and Conference. Washington, DC., United States.

Applications to this area of interest encompass a range of potential solutions. These may involve the development of new sensors crucial for identifying and characterizing contamination within secondary material streams, the establishment of a framework that leverages commercially available sensors to collect and utilize data collected during secondary material handling processes, and/or developing software or machine learning tools to analyze collected data, thereby facilitating appropriate sorting and grading of secondary material streams. This challenge extends beyond traditional material recovery facilities (MRFs) and is also applicable to various material streams relevant to clean energy supply chains, such as critical materials and composites.

Area of Interest 2: Interoperable and Open Supply Chains for Expanded Re-X
Another barrier to Re-X implementation lies in the complexity of repairing or remanufacturing products not initially designed for Re-X. For example, refurbishment and remanufacturing are often hindered by the diversity of products on the market. To effectively repair a product and prolong its service life, tools capable of identifying which components require replacement are crucial. This task becomes particularly challenging when dealing with a mixed stream of goods. Smart manufacturing approaches offer potential solutions to this challenge by fostering more interoperable and open supply chains. These approaches facilitate Re-X interventions aimed at extending product lifetimes through strategies such as reuse and repair, and make it feasible to recover usable components for remanufacture.

Applicants may apply these principles to enhance the ability for products to enter circular pathways regardless of whether they were initially designed with Re-X in mind. For example, applicants could propose to develop technologies aimed at collecting and analyzing data to identify components within products and identify what interventions are required to prolong their service life. This task presents challenges, particularly when dealing with a mixed stream of discarded products like consumer electronics, which feature a diverse range of components and assemblies. However, smart manufacturing tools may enable valuable components and materials to be recovered from these streams to improve circularity. Approaches to monitor and assess the health of product components to determine when repair or replacement is required to maximize product lifetimes is also of interest.

Applicants may also propose to redesign products with Re-X in mind, making them interoperable and accessible for repair, remanufacturing, and other Re-X pathways. This involves incorporating flexibility into the design to accommodate new Re-X tools as they become available. This area of interest includes the need for both software and hardware, including design software and the physical tools necessary for product construction and disassembly. Improved tools and

processes are crucial to facilitate broader adoption of these Re-X approaches to extend the usable life of products. Applicants should describe how their innovation goes beyond state-of-the-art manufacturability analyses or design for disassembly and is uniquely optimal for design for Re-X in a way that existing platforms are not.

For all applications to this area of interest, applicants must describe the business model for their innovation and consider required stakeholders across the supply chain for the entire lifecycle of the product. Extending the useful life of products can be seen as eating into profits that would come from replacing that product on a periodic basis. Furthermore, the supply chain can be complex. It is important that technologies designed for Re-X are supported by a functional business model – for example, a product designed for repair or remanufacture should consider not only who will manufacture the original product but also who will perform the Re-X interventions, where they will take place, and where the product will be used after the intervention. Similarly, redesign efforts to make products more interoperable by standardization across manufacturers should discuss the business case for this and how it encourages participation by multiple manufacturers at all relevant points across the supply chain. The business cases for these innovations are complex, and applicants should consider what is needed to make the innovation commercially viable and logistically feasible considering the need for industry cooperation. Project teams should have representation by all key stakeholders across the supply chain that the chosen business model requires.

Area of Interest 3: Improved Data Transparency for Accurate Lifecycle Assessments

A third challenge to broaden implementation of Re-X throughout the economy is the limited availability and transparency of data across supply chains. Enhancing the availability and transparency of data is crucial to bolster market acceptance of secondary materials. Additionally, it is vital for providing manufacturers with access to more precise data for conducting LCAs, enabling them to better understand the impacts of their process decisions.

A smart manufacturing approach to product development and manufacture involves collection and sharing of data across the supply chain. It is essential to have comprehensive knowledge of the components within a device and the production processes involved in their creation. This data can also be leveraged to improve the accuracy of LCAs to guide decision making. Applicants to this area of interest should clearly describe the challenge the proposed innovation is solving and how it goes beyond existing approaches (e.g., linking a controller to a database) to provide broader value to the community. Approaches that improve data transparency to provide stakeholders across the supply chain better

visibility both forwards and backwards along the supply chain (e.g., the sub systems that make up a part and the device that part is used in) are of interest. Applications should clearly describe how the data will be leveraged and how it will increase the viability of Re-X pathways.

Institutions of higher education and nonprofit organizations may request a cost share waiver for an application submitted under this Topic Area to Area of Interest 3 only. For more information, see Section III. B.

Applicants should indicate in their submission which area of interest they are applying to. A single solution that helps address more than one area of interest is acceptable. Only one submission is permitted to this topic per applicant.

Across all three areas of interest, this FOA topic targets technologies that utilize smart manufacturing strategies. These strategies encompass a variety of approaches including the implementation of AI/ML, the integration of sensors and imaging techniques, and the collection and sharing of data throughout the supply chain. Practical examples include, but are not limited to, increasing the purity of recycled materials exiting MRFs and efforts to characterize and mitigate contamination in scrap streams, such as copper contamination in steel, and in complex mixed streams, such as composites. Additionally, rapid characterization of secondary material streams to certify their composition and/or adherence to relevant standards, as well as endeavors to increase the rates of repair and remanufacturing for mixed streams, such as streams containing more than one model of device. Use of smart manufacturing technologies to improve circularity of building materials (e.g., demolition debris, flat glass, and building systems such as HVAC systems) is also of interest.

Proposals that develop cross cutting technologies applicable to multiple applications are encouraged. When identifying opportunities to leverage smart manufacturing tools to address circularity-related challenges, applicants are encouraged to consider both the challenges in accessing a given supply chain and the complexities associated with implementing the selected smart manufacturing approach, with the goal of identifying areas for highest impact. It is important to thoroughly consider the supply chain specific to the proposed application space. For example, recycled feedstocks are often logistically constrained as it is cost prohibitive to ship end-of-life materials to a centralized facility. In such cases, pre-sorting at the point of collection to avoid excess shipping may be beneficial. Similarly, the transportation of heavy machinery to a repair or remanufacture facility presents challenges, so tools to enable remanufacture on site or to encourage maintenance to extend the useable lifetime before components degrade may be beneficial. The challenges of implementing the smart manufacturing approach should also be considered. For

example, novel sensors that require significant R&D prior to deployment may need to be de-risked. Applicants are encouraged to explain how their proposed approach would address challenges associated with accessing the supply chain or advancing difficult-to-implement smart manufacturing technologies.

All applications should involve industry participation, with representation by all key stakeholders across the relevant supply chain. Applicants are encouraged to involve stakeholders from small and medium businesses, as well as underrepresented groups, within these teams. This inclusive approach enhances the diversity of perspectives and expertise, fostering comprehensive solutions and promoting equitable participation in the innovation process. Proposed projects should have already demonstrated proof of concept (TRL 3) and target a 24 to 36 month scope of work that focuses on validating the capability of the technology in a relevant environment (TRL 6). Project teams must include representation of stakeholders across the supply chain and applicants should describe what additional stakeholder engagement will be required to deploy the technology.

Candidate Metrics and Targets:
A successful project should demonstrate pathways to reduce waste, reduce energy consumption and carbon emissions, reduce other environmental emissions, demonstrate cost competitiveness, and improve supply chain resiliency. Applicants must identify and justify appropriate target metrics (e.g., material, energy, and emissions benefits), and clearly indicate how the proposed project will satisfy the metrics. Metrics should be specific to target material waste streams and Re-X strategy, and must define appropriate baselines, minimum targets, and stretch targets. Metrics should also illustrate the value of the smart manufacturing approach being utilized. Successful applicants must undergo periodic assessments of their metrics during the award period to evaluate potential impacts. Examples of metrics include the following:

Objective	**Metric**	**Minium Target**	**Stretch Target**	**Baseline**
Reduce energy consumption	energy/unit (product mass or part basis)	10%	50%	*Applicant Defined*
Increased purity of secondary feedstock exiting MRF	% purity of selected material stream	10%	30%	*Applicant Defined*
Increased production of secondary feedstock	Metric Tons	20%	60%	*Applicant Defined*
Reduce carbon intensity	% Carbon intensity change as measured	20%	25%	*Applicant Defined*

	by ton CO2e/kg product			
Reduce Production Cost	% reduction $/unit	10%	25%	*Applicant Defined*
Increased number of use cycles for product components	cycles/component	10%	30%	*Applicant Defined*

Applications Specifically Not of Interest:

- Applications that do not advance technology beyond state of the art or incremental improvements to existing technologies
- Applications without metrics tied to the benefits of the selected smart manufacturing approach(es)
- Technologies that do not advance Re-X (recycling, repair, remanufacturing, etc.)
- Technologies that have no pathway to economic viability
- Applications that duplicate work funded by DOE in previous solicitations or projects
- Technologies that target fuel production from waste streams (e.g. plastic waste to fuels)
- Technologies focused on Re-X for energy storage/battery materials.

ii. Topic 2: Smart Manufacturing of Tooling and Equipment for Sustainable Transportation

Background:

This topic focuses on developing and validating broadly applicable smart manufacturing technologies that can advance manufacturing processes and strengthen supply chains for production of sustainable transportation. In the context of this FOA, sustainable transportation refers to transitioning from traditional internal combustion engine-based vehicles to electric vehicles (based on either batteries or fuel cells across all vehicle types from automobiles to fleets to all truck classes) as selected by applicant. Successful projects would: (a) make tooling and equipment needed to produce applicant-selected key components of these vehicles faster and more economically through the application of smart manufacturing concepts, or (b) focus on reducing component defects and enabling new functionalities by means of smart manufacturing. Many project innovations may also apply to other clean energy applications. Detailing any such broader application potential is not required but is encouraged.

Machinery, industrial controls, and automation are one of the largest and most competitive sectors of the U.S. manufacturing economy. Advancing machinery manufacturing is crucial as it impacts all other manufacturing sectors. After a sharp decline in exports in 2009 and subsequent recovery, exports of machinery manufacturing totaled $166 billion in 2015. Machinery production and use are vital for the U.S trade balance. Machinery helps create output in almost all the other sectors of the U.S. economy:

- Some machines are used to manufacture other goods,
- Machinery, industrial controls, and automation are used in sustainable transportation (for example, automotive and aerospace industry),
- Construction machinery is used to build structures,
- Agricultural machinery is used to harvest and process crops, and
- Mining and oil field machinery are used to produce energy.

The U.S. is highly reliant on imports for machine tools, and increasing global demand will make it more difficult for U.S. manufacturers to import enough. The continuous decline of machine tool production and enabling capabilities, alongside dependency on foreign markets, threatens the foundation of U.S. innovation, productivity, competitiveness, and even national security. For the machinery, industrial controls, and automation industry, technology-specific challenges still exist for flexibility (product platforms that create a common core that invites third parties to develop and market an increasing number of product variants), high precision and repeatability, production rate, delivery cycle, reliability and maintainability, safety, ergonomics, environmental response, and user-friendliness. This is further coupled with the need for improved and secure controls that cater to automation for next-generation cyber-physical systems.

Moving forward, in the machinery, industrial controls, and automation industry there is a need for:

- Raising productivity in the nation’s supplier base,
- Broadening participation in exports,
- Ramping up skilled workforce development, and
- Exploring opportunities to upgrade plants and equipment for next-generation cyber-physical systems.

In particular, small and midsize suppliers in the U.S. industrial base need next-generation equipment and technologies to boost productivity. Sales of many types of machinery inherently accompany a variety of high-value services, including specialized architecture, engineering, and logistics. Therefore, innovations and technology development that cater to improving domestic capability and promoting U.S. competitiveness are needed.

There are several opportunities for the U.S. to play a pivotal role in shaping the economy of the machinery manufacturing subsector. These include innovation and R&D in areas such as smart manufacturing encompassing, for example, digital thread and digital twin, smart sensor networks for advanced automation and control, AI/ML for next generation smart machinery, a related products industrial machinery supply network, machinery asset management, advancing infrastructure critical to digital connectivity, and training the next-generation skilled workforce.

The U.S. is well-poised to handle the opportunities and challenges associated with advancing automation and controls for secure next-generation cyber-physical manufacturing systems. The U.S. has a strong leadership position in relevant software and hardware technologies: digital thread and digital twin, and Industrial Control Systems (ICS); advanced control systems and interfaces; sensors and networks for advanced machine control and optimization; and high-performance computing facilities. AMMTO looks to connect these U.S. advantages to meet known challenges when increasing sustainable transportation volumes. Representative example challenges include the long lead time and high cost of molds and stamping tools used for producing many automotive components and costs of downtime. In 2006, auto industry manufacturing executives showed stopped production cost on average of $22,000/minute or $1.3M/hour. Smart manufacturing principles can be used to help reduce and mitigate these costs, performance constraints, and other issues that result in sub-optimal productivity for the level of capital and operating expenditures that can be tolerated. Descriptions of desired technology focus areas and related R&D follow.

Applications can focus on:

- a tooling and equipment manufacturing and/or operational subsector or industry that supports sustainable transportation.
- addressing smart manufacturing technology area(s) applicable to a wide range of industries.

To overcome the challenges described before and claim the benefits of smart manufacturing for tooling and equipment, AMMTO seeks projects that focus on development of broadly applicable smart manufacturing platforms that can be adapted to augment the production of a variety of tooling or equipment, relating to one or more of the following areas of interest:

Area of Interest 1: Automation

For automation, R&D efforts should focus on the integration of hardware and software systems in manufacturing tooling and equipment to improve

component productivity. For example, this might require interfaces and interoperability of machinery, tools, and products to enable connected systems across a plant's production line, or an enterprise system across multiple plant locations and companies. Process control automation will dramatically improve the productivity of connected systems to either: (a) produce tooling and equipment more quickly and cost effectively, and/or (b) increase functionality of the tooling and equipment. For the latter, it is critical to build on industry-driven reference architecture based on open standards and protocols to enable the next generation of digital machinery including cybersecurity for "things" – devices, sensors, actuators, and controllers.

Smart manufacturing innovations for tooling and equipment for sustainable transportation areas can include but are not limited to:

- AI/ML for smart machines and control;
- Advanced sensors and control and data acquisition, open control interfaces, for machinery manufacturing, tools, or components to improve inter-connected system productivity;
- Digital thread and digital twin for smart manufacturing for tooling and equipment;
- Computing and industrial infrastructure for advanced control systems and prescriptive analytics for machinery, automation, digital twin for "things" – devices, sensors, actuators, and controllers;
- Open ecosystem for the implementation and deployment models, application tool kits, apps, and marketplace for apps for manufacturing machinery;
- Industry standards for open control systems and interfaces and actual control systems.

Based on industry state-of-the-art benchmarks, activities are expected to:

At the Build Stage:

- Significantly increase domestic tooling and equipment production though innovation both in hardware and software; and
- Significantly increase the domestic tooling and equipment components (tools, jigs, fixtures, etc.) supply network and production.

At the Use Stage:

- Reduce or eliminate the true downtime cost (planned and unplanned) by a significant factor;
- Refine computation and overall equipment effectiveness (OEE) and improve OEE by a significant factor;

- Reduce or eliminate maintenance costs (preventive, unscheduled, and most importantly unnecessary maintenance), and
- Facilitate transitioning from traditional ICE vehicles to electric vehicles (batteries and fuel cells).

At the Optimization Stage:

- Increase energy productivity of tooling and equipment through better scheduling optimization using the industrial internet of things and advanced control interfaces, and
- Optimize the tooling and equipment life based on data analytics and increasing the prediction accuracy of component failures and of the remaining life of parts and components.

Area of Interest 2: Manufacturing Asset Management for Improving System Performance

For supply network and manufacturing asset management, R&D efforts will potentially focus on improving the performance (cost, quality, and throughput) of the tooling and equipment, industrial controls, and automation network. Efforts must integrate activities at the machine, machine tool, machine part, and component level. Equipment capability needs to include energy-aware and efficient operations with standardization and integration. Recent advances in modeling and simulation, machine learning, and AI can be leveraged to improve productivity and performance of sustainable transportation tooling and equipment while reducing breakdowns, unplanned downtimes, and scheduled repairs.

Practical examples and target metrics of applying smart manufacturing (automation, asset management, etc.) include, but are not limited to:

- Current state of the art automotive industry tooling and equipment for composite material components manufactured using processes such as injection molding or compression molding typically cost hundreds of thousands of dollars and require months to procure. Similarly expensive tooling and equipment with long lead-times are required for metal stamped parts. Smart manufacturing concepts can be utilized to speed production of this tooling and equipment, reduce both capital expenditures and operating expenses costs, increase functionality and reliability, and boost productivity of component manufacturing, for example by significantly reducing downtime.
- Develop software and hardware technologies to enable increased domestic implementation and deployment of industrial control systems, interfaces,

and automation (for example, advanced motion controls, smart sensors, edge computing at the device level) by 3X
- Increase productivity of manufacturing through the advanced use of machinery, industrial controls, and automation by 2X.
- Decrease the overall lifecycle cost of machinery and equipment by 2X.

Proposed technologies may address one or both of the areas of interest described above. Applicants responsive to this topic will identify their team that comprehensively covers the tooling and equipment design, fabrication, and utilization supply chain.

Proposed projects should:
- Include original equipment manufacturers (OEMs) or Tier 1 suppliers, including in the Northern Great Lakes region, in the sustainable transportation market sector,
- Clearly describe how proposed work advances the current state of technology,
- If applicable, clearly indicate how the proposed work builds on prior and ongoing R&D,
- Clearly indicate how the proposed work addresses identified gap(s),
- Clearly indicate how the proposed work will advance smart manufacturing in this – and ideally additional – market sector(s), and
- Be responsive to the request for a TEA. LCA is not a requirement for Topic 2.

Candidate Metrics and Targets:
Applicants should propose a comprehensive approach and what specific activities, outputs, outcomes, and impacts are expected in the sustainable transportation sector. Rather than prescribing a specific set of targets and deliverables, DOE is requesting applicants to address industry needs. The applicant must identify clear metrics and impacts (for example: cycle time, energy intensity/embodied energy, repeatability, high volume cost estimate, performance targets, etc.) and how their proposed innovation(s) will demonstrate progress towards the defined targets for the award period. These should be reported at regular intervals and show a path to achieve them. Applicants should define appropriate benchmarks/baselines, minimum targets, and stretch targets. Some example metric categories are provided for reference in the table below; proposed metrics should not be limited to these examples. The quality and scientific depth of these proposed baselines and metrics will be an important element of the technical evaluation of applications.

Objective	Metric	Minimum Target	Stretch Target	Baseline
Reduce or eliminate downtime	To be defined by applicant	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Provide real-time computation of Key Performance Indicators (KPIs) and use for data-driven control to increase Overall Equipment Effectiveness (OEE)9	To be defined by applicant	*Applicant Defined*	*Applicant Defined*	*Applicant Defined*
Decrease tooling fabrication lead times	Delivery time from order	at least 25% decrease in lead time for the same cost	*Applicant Defined*	*months*

Applications Specifically Not of Interest:

- Applications that do not advance technology beyond state of the art,
- Applications that duplicate work funded by DOE in previous solicitations or projects, including:
    - Battery-related projects.
    - Projects that duplicate efforts funded under AMO's FY20 and FY21 Multi-Topic FOAs, which included machine learning topics.[10,11,12]

9 **Overall equipment effectiveness** (**OEE**) is the industry gold standard for measuring manufacturing productivity. It measures of how well a manufacturing operation is performing (utilizing facilities, time and material) compared to its ideal performance. It identifies the percentage of manufacturing time that is truly productive. An OEE of 100% means that only good parts are produced (100% *quality-Q*), at the maximum speed (100% *performance-P*), and without interruption (100% *availability-A*). OEE is normally calculated as OEE = Availability (A) x Performance (P) x Quality (Q), where A = Run Time / Planned Production Time, P = (Ideal Cycle Time × Total Count) / Run Time, and Q = Good Count / Total Count. Data-driven machine learning approaches can significantly improve the computation and optimization of OEE. Traditionally, OEE is computed manually. By leveraging data collection from smart sensors, predictive analytics (AI/ML), continuous improvement, and automation, manufacturers can automate and significantly improve the computation of OEE leading to increased efficiency and productivity.

[10] Financial Opportunities: Funding Opportunity Exchange (energy.gov) , FY20 Multi-topic FOA

[11] Financial Opportunities: Funding Opportunity Exchange (energy.gov), FY21 Multi-topic FOA

[12] https://www.energy.gov/eere/amo/advanced-manufacturing-office-fy20-multitopic-foa-selections-table

iii. Topic 3: Smart Manufacturing for High Performance Materials

Background:
Smart manufacturing approaches can help to accelerate material advances and corresponding process innovation, ensuring stable, domestic high-performance material (HPM) supply chains. This topic aims to develop, validate, and prototype new HPMs and their manufacturing processes. Of particular interest are manufacturing processes and fabrication techniques for HPMs for the clean energy transition, such as a) high-conductivity materials and b) materials for harsh service conditions.

This topic has two distinct areas of interest. Area of Interest 1 (High-performance Materials and Process Discovery) is generally lower TRL and is focused on optimizing materials and process discovery that is enabled by smart manufacturing approaches for materials characterization, manufacturing, and testing platforms. Proposed projects may include demonstration of proof of concept (TRL 3) but should show progress over the project period to at least TRL 5. Area of Interest 2 (High-performance Materials Manufacturing, Assembly and Scaleup) is generally higher TRL and is focused on smart manufacturing for materials processing to optimize scale-up of manufacturing processes and assembly for these materials (e.g., embedded sensing, monitoring, control, etc.). Proposed projects may begin after proof of concept (TRL 4) but should then proceed to production of components for clean energy technologies at industrially relevant scales (TRL 6). For this area of interest, methods for tuning manufacturing process parameters to achieve optimal component designs tailored according to application requirements are encouraged.

For both Areas of Interest, high-throughput experimentation, modeling, and simulation for machine learning, physics-informed models, analytical models, or combinations thereof are encouraged. In addition to unprecedented performance in targeted metrics, proposals should conform with the other principles in Table 1.

Table 1: Principles for high-performance materials, or materials processing technologies

Performance	Develop materials, components, and processes that exhibit performance that significantly exceeds the current state-of-the-art (SOTA) for targeted metrics and is competitive for other key metrics and are at SOTA levels for the other principles.
Scalability	Demonstrate a pathway to scale manufacturing to reach industrial levels (e.g. SOTA) and the potential for a commercially viable production throughput rate.

Energy Efficiency	Evaluate the energy requirements associated with the material during its use phase in widespread energy applications identified by the applicant compared to the current SOTA.
Embodied Energy	Evaluate the energy requirements of the material manufacturing process and quantify the material's embodied energy compared to the current SOTA.
Lifecycle Energy	Evaluate the total embodied energy, energy efficiency, and energy of recycling, reuse, or disposal compared to the current SOTA.
Affordability	Evaluate reduction in lifecycle cost of the material in key energy applications over the current SOTA.
Reliability	Evaluate reproducibility and consistency of performance in relevant operating conditions over relevant time periods that are competitive with the current SOTA.
Resource Efficiency	Identify chemical, water, and energy intensity of material manufacturing relative to competing (e.g. SOTA) technologies.

High-performance materials of interest in this topic include enhanced conductivity materials and harsh environment materials. For these two subsets of HPMs, this topic seeks unprecedented improvements in key material performance characteristics for energy related technologies. For example, for conductivity-enhanced materials only silver (Ag) at 108% IACS (62.9 MS/m) can beat the conductivity of copper (Cu) (Electrolytic copper is 101% IACS (58.6 MS/m)). However, Ag is approximately 100 times more expensive per gram (at $0.97) at 1/3 the strength (0.1 gigapascals) compared to Cu. Over the past century, process improvements to copper have increased its conductivity for commercial applications by only ~1%, so achievement of the sought after 7% conductivity improvement (>62.9 MS/m) with other properties (cost, strength etc.) the same or better than Ag would be truly unprecedented. Similarly, for harsh environment materials (HEMs), cost-competitive and sustainable metals/alloys with uncompromised mechanical properties (e.g., high-temperature strength, ductility, and toughness) are needed for the most demanding energy production and utilization applications.

Note that proposals developing an enhanced conductivity material or material system that also is durable in harsh service environments are of high interest and are encouraged but not required.

The exciting rapid emergence of AI/ML and the parallel prospects for collection of high-throughput experiments collecting and publishing large amounts of materials data makes this era unique in the long history of materials development. An improved understanding of manufacturing process fundamentals, control parameters, and their effects on material properties acquired through various digital tools is expected to drive high-performance

materials innovation further and faster.[13] A more complete knowledge of the manner in which processing parameters (individually and collectively) influence materials properties across multiple length scales allows for not only geometry-enabled advances in part design (net shaping), but also material microstructural control.[14]

Therefore, smart manufacturing solutions are needed to design and produce high-performance materials and components with consistent high-quality conformance to design specifications and application requirements, and with the highest possible degree of process repeatability and reproducibility. For example, multi-scale science-based deterministic modelling and simulation (e.g., integrated computational materials engineering) and probabilistic data-driven machine learning (supervised or unsupervised) can be used with high-throughput strategies to facilitate the exploration and design of advanced high-performance materials to meet application requirements by the traditional direct route (given a material, find its properties) or the inverse route (given the required properties, identify suitable materials).[15-16] Computational approaches can also be used in conjunction with sensors, actuators, and instrumentation in closed-loop-controlled manufacturing processes to construct autonomous, self-learning digital twins that do not just provide operators with data for monitoring and on-the-fly adjustment, but which use artificial intelligence and machine learning to make decisions to alter fabrication processes in real-time and therefore most efficiently produce components having the desired properties.

This topic seeks transformational HPMs and manufacturing process solutions to meet the extreme demands of the clean energy transition while providing lifecycle energy savings and other benefits. For enhanced conductivity materials applications of interest include technologies that involve the conduction of electric and thermal energy needed for decarbonization through electrification, ranging from transportation (e.g., electric cars, trains, and planes) to smartphones and heat pumps. There is an urgent need for enhanced conductivity materials that can lower costs and improve grid performance—including resilience against extreme weather events—as well as the performance of everything connected to the grid. While the sought after performance improvement – a 7-15% improvement in conductivity—may seem incremental, it would be a true quantum leap in performance, and it is what is needed to meet

[13] National Strategy for Advanced Manufacturing. A Report by the Subcommittee on Manufacturing Committee on Technology of the National Science and Technology Council, October 2022.
[14] D. Schreiber et al., *Materials properties characterization in the most extreme environments;* MRS Bulletin, Volume 47, Nov. 2022.
[15] Z. Lu, *Computational discovery of energy materials in the era of big data and machine learning: A critical review*; Materials Reports: Energy 1 (2021) 100047 (https://doi.org/10.1016/j.matre.2021.100047).
[16] A. Zunger, *Inverse design in search of materials with target functionalities*; Nat. Rev. Chem. **2**, 0121 (2018).

the extreme growth projections for the aforementioned widespread electrification technologies (e.g., power lines 3X, heat pumps 30X, electric vehicles 60X) domestically.

Harsh environment materials include those subjected to extreme solar, wind, ocean, nuclear, and hydrogen exposure needed for power generation, industrial processes (e.g., the production of chemicals, petrochemicals, textiles, food & beverage, pulp & paper, semiconductors, glass, cement, and metals), and other clean energy transition technologies. Extreme weather events are one type of harsh service condition, or material stressor. Others include extreme temperatures, thermal cycling, hydrogen attack, extreme pressures, corrosive chemicals, dust and particulates, mechanical wear, and neutron irradiation. Individually these conditions present substantial challenges, though materials are rarely subjected to a single stressor. These environments result in accelerated degradation of a component's operation/functionality, material attributes, and/or durability/longevity.[17]

The overarching objective of this topic applied to harsh environment materials is to advance materials and manufacturing technologies that increase the performance and/or durability, reduce the production cost and/or embodied energy, and increase the manufacturability and scalability of high-performance materials and components.

These tools can be used for process monitoring, diagnostics, prognostics, or control to optimize materials or process performance and to drive further development of more competitive high-performance materials and fabrication techniques.

Applications submitted under Topic 3 must address one of the two Areas of Interest stated below.

Area of Interest 1: High-performance Materials and Process Discovery
High throughput strategies for conductivity-enhanced and harsh environment materials synthesis/testing, used in conjunction with computational tools, are sought. The computational approaches can range from semi-empirical phenomenological/continuum methods (e.g., Calculation of Phase Diagrams methodology (CALPHAD), the finite element method (FEM)) to multi-scale modeling and simulation approaches (mod-sim) such as integrated computational materials engineering (ICME) that are capable of bridging multiple length/time scales, such as discrete (e.g., atomistic) with

[17] 2020 Workshop on Materials for Harsh Service Conditions Advanced Manufacturing Office, Office of Fossil Energy, and Office of Nuclear Energy; INL/EXT-21-62085. OSTI ID# 1772461.

phenomenological modeling. These may be coupled with probabilistic data-driven ML (supervised, unsupervised etc.) and other appropriate AI to connect the various material and process facets to lead to more accurate predictions of materials' microstructure, properties, and behavior both in the as-manufactured state and while in service at relevant timescales.

TEA/LCA is not a requirement for Area of Interest 1.

Area of Interest 2: High-performance Materials Manufacturing, Assembly and Scaleup

Competitive manufacturing and assembly approaches are sought. For both targeted types of HPMs, desired are materials manufacturing that uses smart manufacturing tools, such as:

- Sensors/actuators combined with high-throughput strategies,
- Model-based feed-forward and measurement-based feedback loops,
- AI, ML, as well as deterministic and stochastic computational methods to enable advanced manufacturing, assembly and scaleup capabilities.

For example, a feed-forward intelligent sensor can be coupled in an actuator/control system with feed-back on materials properties collected *in-situ* for a closed loop system capable of precise, real-time process optimization. In-situ monitoring data of interest for materials or components includes 3D geometric dimensions, microstructural evolution, defects, chemical composition, crystal structure, or other applicable physical properties. Actuator/control systems may supplement data collected *in-situ* with representative process and materials property data from sources such as NIST's Materials Data Repository. This real-time data must be useable by an operator for on-the-fly process monitoring and control or to an AI system for precise and potentially automated process control. As an example of an application for HEMs, high strength steel alloys and advanced high strength steels for the automotive lightweighting sector have traditionally presented difficulties such as surface cracking and breakouts during high-speed continuous casting of rolled products for these critical applications due to peritectic solidification. Most producers attempt to avoid the peritectic sensitivity range through alloy design. Digital twin-model-base frameworks could possibly alleviate the problem by enabling dynamic control of the continuous casting process.

For conductor system assembly, this area of interest can include co-development of system components for additional strength, advanced cooling (including cryogenic) infrastructure suitable for distributed applications (e.g., microfluidics for power lines). For harsh environment materials system assembly, technologies can include lost cost, durable, high-throughput coating methods.

Candidate Metrics and Targets:
Targets for material or production improvements to be developed within this topic must be specified in the application, as well as an analysis of the performance improvements possible with their proposed end uses. Applicants must identify and justify appropriate target metrics for their technology and application, and clearly indicate how the proposed innovation will satisfy them. Metrics should be specific to the proposed technology and must define appropriate benchmarks or baseline, minimum targets, stretch targets, and the gain in energy productivity when the new material is applied. Applicants should consider the metrics in Table 3 and, where possible, how they compare to currently deployed technologies. Proposed metrics should not be limited to the ones suggested below.

Objective	**Metric**	**Minimum Target**	**Stretch Target**	**Baseline**
Conductivity-enhanced materials or materials system performance	MS/m for copper substitutes	62.9	65	N/A
Harsh environment materials key performance indicators	Value varies according to energy application, but often includes maximum melting temperature, cycle time, minimum corrosion	20%	50%	*Applicant defined*
Cost competitiveness	Cost per unit of HPM produced at an industrial scale	*Applicant defined*	*Applicant defined*	*Applicant defined*
Application Energy Efficiency	Annual energy use reduction in wide-spread clean energy application compared to state of the art	20%	50%	*Applicant defined*
Maintain or improve other (non-targeted) material performance characteristics	[value varies according to clean energy application, but "other" properties generally include mechanical properties such as strength]	*Applicant defined*	*Applicant defined*	*Applicant defined*

Value added through additional process steps (e.g. coatings, additives)	$ added per unit of material produced*	*Applicant defined*	*Applicant defined*	*Applicant defined*
Resource efficiency: reduced water or chemical consumption, for process sustainability	% decrease in volume of resource (water or chemical) per unit of HPM Produced	20% Reduction	50% reduction	*Applicant defined*

*Applicants should note the nature of price fluctuations for value added materials and the implications on economic viability of a process.

Applications Specifically Not of Interest:

- Applications that duplicate previously funded work.
- Technologies that are not relevant to HPMs.

iv. Topic 4: Smart Technologies for Sustainable and Competitive U.S. Mining

Background:

Novel smart manufacturing technologies can be applied to create more sustainable, safer, and competitive mining in the United States. Moreover, fostering advances in mining will enable a more resilient, diverse, and secure domestic supply of critical minerals and materials that are foundational to ensuring our economic prosperity and national security, and enhancements to quality of life. This topic has two areas of interest, as described below.

Area of Interest 1: Sustainable and Competitive Domestic Mining

Mining activities require the input and flow of energy, water, and other resources to excavate, comminute (i.e., pulverize), extract, concentrate, and purify critical minerals and materials from ore deposits. In the process of these and related mining activities, solid, liquid, and gaseous byproducts are generated. These byproducts can pose potential health and environmental risks and be costly to remediate if treated as waste. However, some byproducts can be used to make beneficial products by extracting additional critical minerals or through chemical conversion to higher value materials such as fertilizers.

While physical, mechanical, and metallurgical approaches to mining operations are the norm, alternative approaches which are bioinspired and/or make use of engineered nanomaterials or bio-engineered organisms (e.g., bacteria, fungi, plant) remain nascent.

Smart manufacturing technologies such as sensors, controls, and automation can provide health, safety, environmental, and economic benefits to mining operations. For example, sensors can be used to detect fugitive emissions that, if captured and put to beneficial use, could add economic and environmental benefit to the operation. Some mining operations are already starting to take advantage of automation and see it as a necessity to staying competitive.[18] Smart manufacturing techniques can also be used to develop active agents (e.g., biological, chemical, nanotechnological) that can extract high concentration elements and/or perform in situ remediation.

Applicants of this subtopic are encouraged to propose development and/or application of novel smart manufacturing technologies to one or more of the mining activities mentioned above- which substantially minimizes mining byproducts through remediation, conversion, and/or valorization. Tunable technologies that valorize mining wastes and/or byproducts and that adjust to both ore/tailings input and market conditions for sale or output are of particular interest. Possible markets for mining byproducts include agricultural applications or building and infrastructure materials. Technologies should be in the applied research and development (TRL 2-4) range and should seek to advance to pre-pilot or later stages (TRL 4-6) by the end of the award. While DOE is interested in significantly advancing more mature technologies, smaller awards for earlier stage research (lower TRL) may be considered based on merit and as available funding permits.

Proposals must substantially and directly relate to operations on rock or clay deposits and/or other mining activities related to production of critical minerals and materials as defined in the 2023 DOE Critical Materials Assessment.[19] Applicants proposing production of agricultural products or building and infrastructure materials as byproducts must clearly and convincingly demonstrate their technology's economic competitiveness with the industrial state-of-the-art for that product.

Area of Interest 2: Sensing, Analytics, and Data-Driven Decision Making in Mining

Prospecting, developing, and mining require the use of significant quantities of resources, sampling, and information (e.g., satellite imagery, sensors, chemical/spectroscopic analysis, etc.) to determine the economic viability of deposits, the location and extents of deposit(s), and the chemical composition and minerology of the deposit. The information is combined and analyzed for data-driven decision making that informs everything from whether to mine or

[18] Automation in Australia: how the future of mining could change - Mining Technology (mining-technology.com)
[19] 2023 DOE Critical Materials Assessment | Department of Energy

not, to where exactly to mine in 3-dimensions.

DOE is interested in the next generation of mining technologies which will be integral parts of high-precision, high-resolution, and distributed data-decision making processes. Applicants are encouraged to propose new and transformative technologies in sensors and/or in instruments for chemical analysis which are less expensive to end-users, compact, portable, distributable, have lower limits of detection, enable high throughput and faster sampling, and offer other benefits over the current commercially available state-of-the-art. DOE is interested in increasing accessibility and affordability of advanced analytical instruments and sensors, reducing the need to send samples off-site for analysis, and enabling near real-time decision making. Technologies should be in the applied research and development (TRL 2-4) range and should seek to advance to technology demonstration or later stages (TRL 5-6) by the end of the award.

Proposals must substantially and directly relate to operations on rock or clay deposits and/or other mining activities related to production of critical minerals and materials as defined in the 2023 DOE Critical Materials Assessment.[20]

Proposed instrument or sensor technologies must present significant benefits over existing commercially available technologies in one or more of the following areas: inexpensive to end-users, more compact or portable, or enabling high throughput and faster sampling. Additional benefits over commercial state-of-the-art technologies, including but not limited to: sensitivity, linear dynamic range, limits of detection, and minimization of interferents, are highly recommended. The benefits over existing technologies should be captured in the proposal's technical merit section as well as the applicant's proposed metrics.

Across both areas of interest, all selected projects in Topic 4 will be required to participate as a member of the Critical Materials Collaborative (CMC), which is a coalition of DOE offices, federal agencies & federally funded R&D programs to support DOE's Critical Mineral and Material (CMM) Vision. See Appendix J to read more about engaging with the CMC. In all cases, letters of commitment from partner organizations, and especially those that pledge cost share, will make for stronger applications. The role of modeling and simulations, experimentation, lab, bench, prototype, and pilot-scale testing should be explained. Anticipated technical barriers should be described, along with a planned approach to overcome them. Applicants should explain the underlying research to date, including any literature review or experimental data to support the proposed R&D approach and justify the R&D needs. All applications must

[20] 2023 DOE Critical Materials Assessment | Department of Energy

also define credible and measurable baselines, supported by prior data from literature and/or experimentation, against which their user defined metrics will be evaluated. The quality and scientific depth of these proposed baselines and metrics will be an important element of the technical evaluation of applications.

The Critical Materials Innovation (CMI) Hub is a DOE-funded consortium focused on applied research and development to address critical materials and plays an important role in the CMC. They have developed critical material-specific TEA and LCA open-source tools: Critical Materials Life Cycle Assessment Tool (CMLCAT) and LSM Techno-Economic Analysis. Appendix H includes additional TEA and LCA resources available to applicants.

Applicants may partner with existing AMMTO-supported teams focused on foundational platform technology development so long as the proposed work scope is clearly delineated, and supportive of existing funded work. Applicants should indicate in their submission which area of interest they are applying to. While a single solution that helps address more than one area of interest is acceptable, only one submission is permitted to this topic per applicant.

Both areas of interest in this FOA topic target technologies that use smart manufacturing strategies. These strategies encompass a variety of approaches including the implementation of machine learning/artificial intelligence, the integration of sensors and imaging techniques, and the use of data and controls for automation. All applications should improve the environmental and economic outcomes of the application their technology will be applied to and should include an estimate of the anticipated impacts.

Candidate Metrics and Targets:
Applicants must identify and justify appropriate target metrics for their technology and specify an appropriate baseline for comparison. Proposed targets should aim to address the specific considerations listed above and showcase the technical merit of the proposed solution. Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned. Benchmarks/baselines, minimum targets, and stretch targets should be specified for each metric. Metrics should also illustrate the value of the smart manufacturing approach being utilized. DOE is seeking metrics which differentiate and exemplify a technology's potential over existing commercial and research states-of-the-art toward process intensification, energy/resource efficiency, waste/byproduct conversion, and human/environmental benefits (e.g., capture of fugitive gas emissions, acid/base use reduction, reduction/substitution of toxic or hazardous substances). Topic-specific metric

categories are provided for reference in the table below; proposed metrics should not be limited to these examples.

Objective	Metric	Minium Target	Stretch Target	Baseline
Reduce energy consumption	energy/unit (product mass or part basis)	10%	50%	*Applicant Defined*
Reduce water consumption	% reduction in mass or volume of water used per unit of main product	20%	80%	*Applicant Defined*
Waste reduction or waste capture	% reduction in mass or volume of waste generated per unit of main product	20%	50%	*Applicant Defined*
Byproduct conversion	% of byproduct converted from total available byproduct in mass or volume	25%	75%	*Applicant Defined*
Reduced Production Cost	% reduction in cost per unit of main product	20%	50%	*Applicant Defined*

Applications Specifically Not of Interest:

Area of Interest 1:

- Proposals that are substantially and/or directly focused on one or more of the following: geothermal brines, salar brines, brines, oil and gas (O&G), produced waters, and carbon ores (e.g., coal, shale, tar sands, etc.) are ineligible. Parties interested in these areas are recommended to follow future funding opportunities from the Geothermal Technologies Office (GTO), Office of Manufacturing and Energy Supply Chains (MESC), and Office of Fossil Energy and Carbon Management (FECM).

- Proposals which propose the electrification of vehicles or other mining equipment are ineligible. Parties interested in these areas are recommended to follow future funding opportunities from the Vehicle Technologies Office (VTO), MESC, and FECM.
- As it pertains to conversion or valorization products, organic products (i.e., hydrocarbon products) are not of interest and are therefore ineligible for funding.

Area of Interest 2:

- Proposed technologies that are substantially and/or directly focused on one or more of the following: geothermal brines, salar brines, brines, oil and gas (O&G), produced waters, and carbon ores (e.g., coal, shale, tar sands, etc.) are ineligible. Parties interested in these areas are recommended to follow future funding opportunities from GTO, MESC, and FECM.
- Sensors for temperature, humidity, proximity, and other mature sensor types are not of interest.
- Proposals which combine existing technologies, or which only add online/communication/internet capabilities to a technology will be considered unresponsive.

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

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 Sections I.A. and I.B. of the FOA.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Applications that do not have defined connections to smart manufacturing.

D. Research & Development (R&D) Community Benefits Plan

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

To support the goal of building a clean and equitable energy economy, projects funded under this FOA are expected to (1) advance diversity, equity, inclusion, and accessibility (DEIA); (2) contribute to the Justice40 Initiative[21] and other considerations linked with energy and/or environmental justice; and (3) invest in quality jobs. To ensure these objectives are met, applications must include a Research and Development Community Benefits Plan (R&D Community Benefits Plan) that addresses the three objectives stated above. See Section IV.D.viii. for more information on the R&D Community Benefits Plan content requirements.

Applicants are encouraged to visit AMMTO's CBP webpage for additional information regarding community benefits plans.[22]

E. Authorizing Statutes

The programmatic authorizing statute is P.L. 118-42, Consolidated Appropriations Act of 2024. The activities to be supported under this FOA are authorized under § 911 (a)(1) of the Energy Policy Act of 2005, as codified at 42 U.S.C. § 16191(a)(1).

Awards made under this announcement will fall under the purview of 2 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 $33.7M of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 16-36 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $0.35M and $3M.

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

[21] The Justice40 initiative, established by EO 14008, sets a goal that 40% of the overall benefits of certain federal investments flow to disadvantaged communities. Consistent with Justice40 guidance, DOE recognizes disadvantaged communities as the census tracts defined and identified as disadvantaged by the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), located at https://screeningtool.geoplatform.gov/, as well as all Federally Recognized Tribes (whether or not they have land). See https://www.whitehouse.gov/wp-content/uploads/2023/01/M-23-09_Signed_CEQ_CPO.pdf.

[22] https://energy.gov/eere/ammto/community-benefits-plans-advanced-materials-and-manufacturing-technologies-office

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)
Topic 1	Smart Manufacturing for a Circular Economy	4-10	$0.5M	$2M	$8.2M	24-36
Topic 2	Smart Manufacturing of Tooling and Equipment for Sustainable Transportation	3-6	$1M	$2M	$6M	24-36
Topic 3	Smart Manufacturing for High Performance Materials	4-10	$0.35M	$2M	$4.5M	24-36
Topic 4	Smart Technologies for Sustainable and Competitive U.S. Mining	5-10	$1M	$3M	$15M	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, comprised of one or more budget periods. Project continuation will be contingent upon several elements, including satisfactory performance and Go/No-Go decision. For a complete list, 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 U. S. government.

i. Cooperative Agreements

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

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

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

ii. Funding Agreements with Federally Funded Research and Development Center (FFRDCs)[23]

When FFRDCs are not funded as subrecipients, 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.

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

A. Eligible Applicants

i. Domestic Entities

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

1. Institutions of higher education;
2. For-profit entities;
3. Nonprofit entities;
4. State and local governmental entities; and
5. Indian Tribes, as defined in section 4 of the Indian Self-Determination and Education Assistance Act, 25 U.S.C. § 5304[24]

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

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

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

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

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

[24] "**Indian Tribe**," for the purposes of this FOA and as defined in in section 4 of the Indian Self-Determination and Education Assistance Act (25 U.S.C. § 5304), [1]means any Indian tribe, band, nation, or other organized group or community, including any Alaska Native village or regional or village corporation as defined in or established pursuant to the Alaska Native Claims Settlement Act (85 Stat. 688) [43 U.S.C. § 1601, et seq.], which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians. Federally Recognized Indian Tribes are also considered disadvantaged communities for the purposes of Justice40 requirements in this FOA per https://www.whitehouse.gov/wp-content/uploads/2023/01/M-23-09_Signed_CEQ_CPO.pdf.

Nonprofit organizations described in Section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995, are **not** eligible to apply for funding.

ii. Foreign Entities

In general, foreign entities are not eligible to apply as either a prime recipient or subrecipient. In limited circumstances, DOE may approve a waiver to allow a foreign entity to participate as a prime recipient or subrecipient. A foreign entity may submit a Full Application to this FOA, but the Full Application must be accompanied by an explicit written waiver request. Likewise, if the applicant seeks to include a foreign entity as a subrecipient, the applicant must submit a separate explicit written waiver request in the Full Application for each proposed foreign subrecipient.

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

B. Cost Sharing

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

Cost Sharing Generally

The cost share must be at least 20% of the total project costs[25] for research and development projects.[26]

For Topic Area 1, Area of Interest 3 **ONLY**: Cost sharing is not required for institutions of higher education and nonprofit organizations. This waiver is granted per Section 10725 of the Research and Development, Competition, and Innovation Act, P.L. 117-167, which extends the cost share waiver pilot program enacted by Section 108 of the Department of Energy Research and Innovation Act, Public Law 115–246 (Innovation Act) and provides an exemption for institutions of higher education and nonprofit organizations from the 20% cost share requirement for Research and Development activities. The exemption is available for the two-year period beginning on August 9, 2022. Codified at 42 U.S.C. 16352.

[25] Total project costs is the sum of the government share, including FFRDC costs if applicable, and the recipient share of project costs.

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

All cost share must come from non-federal sources unless otherwise allowed by law.

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

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

ii. Cost Share Allocation

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

iii. Cost Share Types and Allowability

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

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

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

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

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

The recipient and subrecipient(s) may not use the following sources to meet its cost share obligations:

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

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

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

Applicants are encouraged to refer to 2 CFR 200.306 as 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

DOE requires prime recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the prime recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a minimum, the cost sharing percentage negotiated). 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 Contracting Officer may approve a request by the prime recipient to meet its cost share requirements on a less frequent basis, such as monthly or quarterly. Regardless of the interval requested, the prime recipient must be up to date on cost share at each interval. Such requests must be sent to the Contracting Officer during award negotiations and include the following information: (1) a detailed justification for the request; (2) a proposed schedule of payments, including amounts and dates; (3) a written commitment to meet that schedule; and (4) such evidence as necessary to demonstrate that the prime recipient has complied with its cost share obligations to date. The Contracting Officer must approve all such requests before they go into effect.

C. Compliance Criteria

All applicant submissions must:

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

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

Applicants must submit a Concept Paper by 5:00 p.m. ET on the due date listed on the FOA cover page to be eligible to submit a Full Application. **Applicants who do not submit a Concept Paper cannot submit a full application.**

Applicants are strongly encouraged to submit their Concept Papers, Full Applications, and Replies to Reviewer Comments at least 48 hours in advance of the submission deadline. Under normal conditions (i.e., at least 48 hours before the submission deadline), applicants should allow at least one hour to submit Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE eXCHANGE, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made to any of these documents, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline. EERE will not extend the submission deadline for applicants that fail to submit required information by the applicable deadline due to server/connection congestion.

D. Responsiveness Criteria

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

E. Other Eligibility Requirements

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

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

The following wording is acceptable for the authorization:

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

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

ii. Requirements for DOE/NNSA and Non-DOE/NNSA FFRDCs Included as a Subrecipient

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

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

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

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

c. Funding, Cost Share, and Subaward with FFRDCs
The value of and funding for the FFRDC portion of the work will not normally be included in the award. DOE/NNSA FFRDCs participating as a subrecipient on a project will be funded directly through the DOE Work Authorization process in accordance with DOE O 412.1A. Non-DOE/NNSA FFRDCs participating as a subrecipient will be funded through an interagency agreement with the sponsoring agency. Although the FFRDC portion of the work is excluded from the award, 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.

Unless instructed otherwise by the DOE Grants Officer for the DOE financial assistance award, all FFRDCs are required to enter into a Cooperative Research and Development Agreement (CRADA) or, if the role of the DOE/NNSA FFRDC is limited to technical assistance and intellectual property

(IP) is not anticipated to be generated from the DOE/NNSA FFRDC's work, a Technical Assistance Agreement (TAA), with at least the prime recipient.

The CRADA is used to ensure accountability for project work and provide the appropriate management of IP, e.g., data protection and background IP. A Data Management Plan is not suited for this purpose. If IP will not be generated from the DOE/NNSA FFRDC's work, a TAA is sufficient. The CRADA or TAA must be approved by the cognizant DOE/NNSA or other sponsoring agency Contracting Officer for the FFRDC or be compliant with a Master Scope of Work process prior to the FFRDC starting work directly allocable to the FA award. Any questions regarding the use of a CRADA or TAA should be directed to the cognizant DOE intellectual property counsel.

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

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

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

An entity may submit only 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 apply in response to this FOA lies solely with the applicant.

IV. Application and Submission Information

A. Application Process

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

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

- Each must be submitted in Adobe PDF format unless stated otherwise;
- Each must be written in English;
- All pages must be formatted to fit on 8.5" x 11" paper with margins not less than one inch on every side. Use Calibri typeface, a black font color, and a font size of 12-point or larger (except in figures or tables, which may be 10-point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies. References must be included as footnotes or endnotes in a font size of 10 or larger. Footnotes and endnotes are counted toward the maximum page requirement;
- A **control number** will be issued when an applicant begins the EERE eXCHANGE application process. The control number must be included with all application documents. Specifically, the control number must be prominently displayed on the upper right corner of the header of every page and included in the file name (i.e., *Control Number_Applicant Name_Full Application*);
- Page numbers must be included in the footer of every page; and
- Each submission must not exceed the specified maximum page limit, including cover page, charts, graphs, maps, and photographs when printed using the formatting requirements set forth above and single spaced. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages.

i. Additional Information on EERE eXCHANGE

EERE eXCHANGE is designed to enforce the deadlines specified in this FOA. The "Apply" and "Submit" buttons will automatically disable at the defined submission deadlines.

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

B. Application Forms

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

Note: The maximum file size that can be uploaded to the EERE eXCHANGE website is 50MB. Files larger than 50MB cannot be uploaded and hence cannot be submitted for review. If a file is larger than 50MB but is still within the maximum page limit specified in the FOA, it must be broken into parts and denoted to that effect. For example:
TechnicalVolume_Part_1
TechnicalVolume_Part_2

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

C. Content and Form of the Concept Paper

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

Section	Page Limit	Description
Cover Page	1 page maximum	The cover page should include the project title, the specific announcement Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, names of project managers, the PI, Senior/Key Personnel and their organizations, the project location(s), and any statements regarding confidentiality.
Technology Description	4 pages maximum	Applicants are required to succinctly describe: • The proposed technology, including its basic operating principles and how it is unique and innovative; • The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target could be met); • The current state of the art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application;

		• The potential impact that the proposed project would have on the relevant field and application; • How the proposed location of the proposed project will support technology development and long-term success; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project.
R&D Community Benefits Plan	1 page maximum	Applicants are required to succinctly describe their approach to the Community Benefits Plan, addressing the three core elements: • Advance diversity, equity, inclusion, and accessibility (DEIA); • Contribute to the Justice40 Initiative and other considerations linked with energy and/or environmental justice; and • Invest in quality jobs.
Addendum	2 pages maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed project team, including: • Whether the Principal Investigator (PI) and project team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities; and • Applicants may provide graphs, charts, or other data to supplement their Technology Description.

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

D. Content and Form of the Full Application

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

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

All Full Application documents must be marked with the Control Number issued to the applicant.

i. Full Application Content Requirements

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

Component	File Format	Page Limit	File Name
SF-424: Application for Federal Assistance	PDF	n/a	ControlNumber_LeadOrganization_424
Technical Volume	PDF	25	ControlNumber_LeadOrganization_TechnicalVolume
Resumes	PDF	3 pages each	ControlNumber_LeadOrganization_Resumes
Letters of Commitment	PDF	1 page each	ControlNumber_LeadOrganization_LOCs
Impacted Indian Tribes Documentation	PDF	n/a	ControlNumber_LeadOrganization_ImpactedTribes
Statement of Project Objectives	MS Word	10	ControlNumber_LeadOrganization_SOPO
R&D Community Benefits Plan	PDF	5	ControlNumber_LeadOrganization_CBP
Budget Justification Workbook	MS Excel	n/a	ControlNumber_LeadOrganization_Budget_Justification
Summary/Abstract for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary
Summary Slide	MS PowerPoint	1	ControlNumber_LeadOrganization_Slide
Subrecipient Budget Justification	MS Excel	n/a	ControlNumber_LeadOrganization_Subrecipient_Budget_Justification
DOE Work Proposal for FFRDC, (see DOE O 412.1A, Attachment 2)	PDF	n/a	ControlNumber_LeadOrganization_WP
Authorization from cognizant Contracting Officer for FFRDC	PDF	n/a	ControlNumber_LeadOrganization_FFRDCAuth
SF-LLL Disclosure of Lobbying Activities	PDF	n/a	ControlNumber_LeadOrganization_SF-LLL

Waiver Requests	PDF	n/a	ControlNumber_LeadOrganization_ Waiver
Current and Pending Support	PDF	n/a	ControlNumber_LeadOrganization_ CPS
Transparency of Foreign Connections	PDF	n/a	ControlNumber_LeadOrganization_ TFC
Potentially Duplicative Funding Notice	PDF	n/a	ControlNumber_LeadOrganization_ PDFN

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

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

ii. SF-424: Application for Federal Assistance

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

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

Note: The dates and dollar amounts on the SF-424 are for the complete project period and not just the first project year, first phase, or other subset of the project period.

Save the SF-424 in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_424".

iii. Technical Volume

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

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

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 information in the table below. The applicant should consider the weighting of each of the technical review criteria (see Section V.A.ii. of the FOA) when preparing the Technical Volume.

The Technical Volume should clearly describe and expand upon information provided in the Concept Paper.

Technical Volume Content Requirements	
SECTION/PAGE LIMIT	**DESCRIPTION**
Cover Page	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, names of the PI, Senior/Key Personnel and their organizations, the project location(s), and any statements regarding confidentiality.
Project Overview (Approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: The applicant should discuss the background of its organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact (Approximately 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	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go

(Approximately 40% of the Technical Volume)	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 Specific, Measurable, Attainable, Realistic, and Timely (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): The applicant should provide a summary of project-wide Go/No-Go decision points at

	appropriate points in the Workplan. At a minimum, each project must have at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of the project. 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 two pages of the Workplan, include a short statement on whether the project will involve the construction, alteration, and/or repair of infrastructure in the United States. See Appendix 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: o The overall approach to and organization for managing the work; o The roles of each project team member; o Any critical handoffs/interdependencies among project team members; o The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices; o The approach to project risk management; o A description of how project changes will be handled; o If applicable, the approach to Quality Assurance/Control; o How communications will be maintained among project team members. • Market Transformation Plan: The applicant should provide a market transformation plan, including the following: o Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan;

	○ Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, and product distribution.
Technical Qualifications and Resources (Approximately 20% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • A description of the project team's unique qualifications and expertise, including those of key subrecipients; • A description of the project team's existing equipment and facilities, or equipment or facilities already in place on the proposed project site, that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project; • Relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives; • The time commitment of the key team members to support the project; • A description of the technical services to be provided by DOE/NNSA FFRDCs, if applicable; • The skills, certifications, or other credentials of the construction and ongoing operations workforce; • For multi-organizational projects, describe succinctly: ○ The roles and the work to be performed by the PI and Senior/Key Personnel at the prime and sub levels; ○ Business agreements between the applicant and sub; ○ How the various efforts will be integrated and managed; ○ Process for making decisions on technical direction; ○ Publication arrangements; ○ Intellectual property issues; and ○ Communication plans

iv. Resumes

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

1. Contact information;

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

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

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

v. Letters of Commitment

Submit letters of commitment from all subrecipient and third-party cost share providers. If applicable, the letter must state that the third party is committed to providing a specific minimum dollar amount or value of in-kind contributions allocated to cost sharing. The following information for each third party contributing to cost sharing should be identified: (1) the name of the organization; (2) the proposed dollar amount to be provided; and (3) the

proposed cost sharing type (cash or in-kind contributions). Each letter must not exceed one page.

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

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

vi. Impacted Indian Tribes Documentation

For any application that potentially impacts Indian Tribes or is on Tribal land[27], including when the potentially impacted Indian Tribe is the applicant, applicants are required to submit additional documentation at the time of application, and possibly during negotiation and prior to award. For any project that potentially impacts Indian Tribes, applicants are required to submit documentation demonstrating that an authorized representative[28] of each potentially impacted Indian Tribe is, at a minimum, aware of the nature of the application and its potential impacts to the relevant Indian Tribes. The notified authorized representative must be holding their position while the award is open for applications, and documentation must demonstrate affirmative awareness of the application (e.g. a delivery record from certified mail, a reply by the authorized representative).

For any project intended to be sited on Tribal land(s) or intersecting with Tribal subsurface rights, applicants are required to submit documentation demonstrating support from the relevant Indian Tribes at the time of application. Documentation of support submitted at the time of application will be considered to also demonstrate awareness of an Indian Tribe (specified above). Documentation may include either:

• A letter of support from Tribal leadership. The letter must be signed by an authorized representative of the Indian Tribe. The signer(s) must be holding their position while the award is open for applications or negotiations.

• A Tribal Council Resolution, Board resolution (including the Board of Directors of an Alaska Native Corporation (ANC)), or similar act passed by the legislative

[27] Tribal land is as defined in 25 U.S.C. §§ 3501(2), (3), (4)(A) and (13)

[28] An authorized representative must be an elected official or designated leader according to the traditions, constitution, or charter of the Indian Tribe, or someone with relevant delegated authority within the Tribal government. Examples include: Chief, Chairman, Chairwoman, Governor, Nation Representative, President, Chief Executive Officer, Chief Financial Officer, Speaker of the Council, Speaker of the Congress, Tribal administrator

body of the Tribal government or Board of Directors of an ANC, expressing support for the project.

Applicants are encouraged to reference or include any applicable community benefits agreements in the Tribal support documentation, and to integrate any Tribal support documentation in the community benefits plan as appropriate, For projects not intended to be sited on Tribal land(s) or intersecting with Tribal subsurface rights, but that may have other potential impacts on Tribal resources or reserved rights, letters of support or resolutions of support are strongly encouraged and, depending on the nature of the impact, may be required if selected for negotiation of an agreement. Applicants are encouraged to reach out to Indian Tribes as early as possible in the application process to give Indian Tribes ample time to evaluate and respond.

The following resources may be useful to help determine if a project may impact an Indian Tribe(s) resources or reserved rights and the appropriate contacts. These resources are not exhaustive, and many Indian Tribes have resources or reserved rights which extend beyond their Tribal lands, or are covered within treaties, statutes, or case-law. Applicants are encouraged to do additional research:

• Map of Indian Lands: https://bia-geospatialinternal.geoplatform.gov/indianlands/

• Tribal Treaties Database: https://treaties.okstate.edu/

• Directory of federally recognized Tribes and Tribal leaders: https://www.bia.gov/service/tribal-leaders-directory

• Best Practices for Identifying and Protecting Tribal Treaty Rights, Reserved Rights, and other similar rights in federal regulatory actions: https://www.bia.gov/sites/default/files/dup/inline-files/best_practices_guide.pdf

To help determine if an Indian Tribe's resources or reserved rights may be impacted by the project, applicants must address the following elements. If the applicant is an Indian Tribe, these elements should be addressed to ascertain impacts to Indian Tribes other than the applicant. Applicants do not need to reveal specific details about sacred sites such as specific location or specific ceremonies:

• Identify any critical materials which will be quantified/modeled on or near Tribal land, traditional homelands, Tribal historic sites, sacred sites, or in areas

where an Indian Tribe maintains rights to any critical materials. Identify which Indian Tribe(s) may be impacted? Explain any instances of uncertainty or confidentiality.

• Identify any Tribal mineral rights, subsurface, or water rights at or near the proposed project location. Explain any relevant studies already performed, such as groundwater studies? Identify which Indian Tribe(s) might be impacted. Explain any instances of uncertainty and any potential for subsurface resource migration which has been considered.

• Identify any other proposed actions which may impact an Indian Tribe(s) resources or reserved rights. Tribal resources and reserved rights include, and are not limited to, an Indian Reservation or Land (as defined in 25 U.S.C. § 3501) [or intersecting Tribal sub-surface rights], historic homelands from which they were removed, cultural sites, sacred sites, water rights, mineral and other subsurface rights, fishing rights, and hunting rights. Identify the Tribe(s) potentially impacted and any sources of uncertainty or confidentiality.

• Explain any actions taken by the applicant to mitigate or address any potential impacts identified above, including engaging with the potentially impacted Indian Tribe(s), in the application.

Applicants are required to document any efforts taken to identify any potential impacts to Indian Tribes, Indian lands, Alaska Native regional and village land, traditional homelands, Tribal rights, or Tribal historic sites, or sacred sites. This includes any correspondence with Indian Tribes. These documents should be available on request to DOE. An applicant's failure to submit documentation of an Indian Tribe's awareness, or a letter of support, when required as described above, may constitute grounds for determining an application ineligible, non-responsive to the FOA/OT solicitation, not subject to further review and/or not otherwise subject to selection or award.

Any application that may potentially impact Indian Tribe(s) may be shared with the potentially impacted Indian Tribe(s). Applicants should include a Notice of Restriction on Disclosure and Use of Data identifying any business sensitive, trade secrets, proprietary, or otherwise confidential information. Such information shall be used or disclosed only for evaluation of the application or to determine whether the proposed project affects an Indian Tribe(s). If an applicant determines an Indian Tribe(s) will be impacted, the applicant must provide information on the project location, potential impacts and how the applicant will engage with Indian Tribe(s), during the period of performance of the agreement, and, if necessary, after the end of the agreement. Approval by DOE must be obtained before any activities take place that could impact Tribal

resources or reserved rights, including but not limited to lands, cultural sites, sacred sites, water rights, mineral rights, fishing rights, and hunting rights. DOE will determine if formal government-to-government consultation is needed, and DOE will conduct that consultation accordingly, in addition to any engagement by the applicant.

Save the Impacted Indian Tribes Documentation in a single PDF using the following convention for the title "ControlNumber_LeadOrganization_ ImpactedTribes".

vii. Statement of Project Objectives (SOPO)

Applicants must complete a SOPO. A SOPO template is available on EERE Funding Application and Management Forms and on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/. The SOPO, including the Milestone Table, must not exceed 10 pages when printed using standard 8.5" x 11" paper with 1" margins (top, bottom, left, and right) with font not smaller than 12-point (except in figures or tables, which may be 10-point font).

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

viii. R&D Community Benefits Plan

The R&D Community Benefits Plan must set forth the applicant's approach to ensuring the federal investments advance the following three objectives: (1) advancing DEIA; (2) contributing to the Justice40 Initiative and other considerations linked with energy and/or environmental justice; and (3) investing in quality jobs. Applicants must address all three sections.

For your convenience, a Community Benefits Plan Template is available on EERE eXCHANGE at https://eere-exchange.energy.gov/. Applicants are strongly encouraged to use the template to complete their specific Plan. If the template is not used, the Plan must address all of the elements described below, and as outlined in the template.

The applicant's R&D Community Benefits Plan should include at least one Specific, Measurable, Achievable, Relevant, and Timely (SMART) milestone per budget period to measure progress on the proposed actions. The R&D Community Benefits Plan will be evaluated as part of the technical review process. If a project is selected, the selectee is responsible for developing a Community Benefits Outcomes and Objectives (CBOO) document. DOE will incorporate the CBOO into the award and the recipient must implement the CBOO when carrying out its project. Public transparency around the plan and SMART commitments ensure accountability. As such, DOE plans to make the

content of each CBOO available publicly. DOE will evaluate the recipient's progress throughout the life of the award, including as part of the Go/No-Go review process.

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

The R&D Community Benefits Plan must not exceed [five] pages. It must be submitted in PDF format using the following convention for the title: "ControlNumber_LeadOrganization_CBP." This Plan must address the technical review criterion titled "R&D Community Benefits Plan." See Section V. of the FOA.

The R&D Community Benefits Plan must address the following three sections:

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

2) The Justice 40 Initiative and other considerations linked with energy and/or environmental justice:

This section should include information on how the project will advance the Justice40 Initiative's goal[29]. In addition, this section must articulate the applicant's consideration of long-term equity implications of the research and any implications for environmental justice. It must identify how the specific project integrates equity and environmental justice considerations into the project design to support equitable outcomes for affected communities if the innovation is successful. Like cost reductions and commercialization plans, the R&D Community Benefits Plan requires description of the implications of the innovation for local affected communities.

3) Quality Jobs:

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

See the Community Benefits Plan Template and About Community Benefits Plans for more guidance.

3) Workforce Implications:

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

See Appendix H for more guidance.

ix. Budget Justification Workbook

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

[29] The Justice40 Initiative, established by EO 14008, sets a goal that 40% of the overall benefits of certain federal investments flow to disadvantaged communities. Consistent with Justice40 guidance, DOE recognizes disadvantaged communities as the census tracts defined and identified as disadvantaged by the White House Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), located at https://screeningtool.geoplatform.gov/, as well as all Federally Recognized Tribes (whether or not they have land). See https://www.whitehouse.gov/wp-content/uploads/2023/01/M-23-09_Signed_CEQ_CPO.pdf.

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".

x. Summary for Public Release

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

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

xi. Summary Slide

Applicants must provide a single slide summarizing the proposed project. The Summary Slide template is available on EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/ and must include the following information:

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

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

xii. Subrecipient Budget Justification (if applicable)

Applicants must provide a separate budget justification for each subrecipient that is expected to perform work estimated to be more than $250,000 or 25% of

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

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

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

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

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

xiv. 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".

xv. SF-LLL: Disclosure of Lobbying Activities

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

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

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

- An officer or employee of Congress; or
- An employee of a Member of Congress.

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

xvi. Waiver Requests

Foreign Entity Participation
For projects selected under this FOA, all recipients and subrecipients 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 information that must be included in a waiver request.

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

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

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 or Lead Project Manager and all Senior/Key Personnel at the applicant and subrecipient level must provide a list of all sponsored activities, awards, and appointments, whether paid or unpaid; provided as a gift with terms or conditions or provided as a gift without terms or conditions; full-time, part-time, or voluntary; faculty, visiting, adjunct, or honorary; cash or in-kind; foreign or domestic; governmental or private-sector; directly supporting the individual's research or indirectly supporting the individual by supporting students, research staff, space, equipment, or other research expenses. All connections with foreign government-sponsored talent recruitment programs must be identified in current and pending support.

For every activity, list the following items:

- The sponsor of the activity or the source of funding;

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

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

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

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

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

The information may be provided in the approved common disclosure format available at Common Form for Current and Pending (Other) Support (nsf.gov). Regardless of the format used, the individual must 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 physically relocate to the foreign state for the above purpose. Some programs allow for or encourage continued employment at United States research facilities or receipt of federal research funds while concurrently working at and/or receiving compensation from a foreign institution, and some direct participants not to disclose their participation to United States entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement

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

Senior/Key Personnel – An individual who contributes in a substantive, meaningful way to the scientific development or execution of a research, development, and demonstration (RD&D) project proposed to be carried out with a DOE award.[30]

xviii. Transparency of Foreign Connections

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

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

[30] 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.

8. Any technology licensing or intellectual property sales to a foreign country of risk, during the 5-year period preceding submission of the proposal;
9. Any foreign equipment that will be used on the project:
    a. Coded equipment where the source code is written in a foreign country of risk.
    b. Equipment from a foreign country of risk that will be connected to the internet or other remote communication system.
    c. Any companies from a foreign country of risk that will have physical or remote access to any part of the equipment used on the project after delivery.
10. Any foreign business entity, offshore entity, or entity outside the United States related to the proposed recipient or subrecipient;
11. Complete list of all directors (and board observers), including their full name, citizenship and shareholder affiliation, date of appointment, duration of term, as well as a description of observer rights as applicable;
12. Complete capitalization table for your entity, including all equity interests (including LLC and partnership interests, as well as derivative securities). Include both the number of shares issued to each equity holder, as well as the percentage of that series and all equity on a fully diluted basis.
13. Identify the principal place of incorporation (or organization) for each equity holder. If the equity holder is a natural person, identify the citizenship(s). If the recipient or subrecipient is a publicly traded company, provide the above information for shareholders with an interest greater than 5%;
14. A summary table identifying all rounds of financing, the purchase dates, the investors for each round, and all the associated governance and information rights obtained by investors during each round of financing; and
15. An organization chart to illustrate the relationship between your entity and the immediate parent, ultimate parent, and any intermediate parent, as well as any subsidiary or affiliates. Identify where each entity is incorporated.

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

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

xix. Potentially Duplicative Funding Notice

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

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

E. Content and Form of Replies to Reviewer Comments

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

EERE will post the reviewer comments in EERE eXCHANGE. The expected submission deadline is on the cover page of the FOA; however, it is the applicant's responsibility to monitor EERE eXCHANGE if the expected date changes. The deadline will not be extended for applicants who are unable to timely submit their Reply due to failure to check EERE eXCHANGE or relying on the expected date alone. Applicants should anticipate having approximately three (3) business days to submit a Reply.

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

F. Post Selection Information Requests

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

- Personnel proposed to work on the project and collaborating organizations (See Section VI.B.xx. Participants and Collaborating Organizations);
- Current and Pending Support (See Sections IV.D.xvii. and VI.B.xx. Current and Pending Support);
- A Data Management Plan describing how all research data displayed in publications resulting from the proposed work will be digitally accessible at the time of publications, in accordance with Section VI.B.xxi.;
- Indirect cost information;
- Other budget information;
- Letters of Commitment from third parties contributing to cost share, if applicable;
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5);
- Information for the DOE Office of Civil Rights to process assurance reviews under 10 CFR 1040;
- Representation of Limited Rights Data and Restricted Software, if applicable; and
- Environmental Questionnaire.

G. Unique Entity Identifier (UEI) and System for Award Management (SAM)

Each applicant (unless the applicant is an individual or federal awarding agency that is excepted from those requirements under 2 CFR 25.110(b) or (c), or has an exception approved by the federal awarding agency under 2 CFR 25.110(d)) is required to: (1) register in the SAM at https://www.sam.gov before submitting an application; (2) provide a valid UEI in the application; and (3) maintain an active SAM registration with current information at all times during which it has an active federal award or an application or plan under consideration by a federal awarding agency. DOE may not make a federal award to an applicant until the applicant has complied with all applicable UEI and SAM requirements. If an applicant has not fully complied with the requirements by the time DOE is ready to make a federal award, DOE will determine that the applicant is not qualified to receive a federal award and use that determination as a basis for making a federal award to another applicant.

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

H. Submission Dates and Times

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

I. Intergovernmental Review

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

J. Funding Restrictions

i. Allowable Costs

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

ii. Pre-Award Costs

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

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

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

1. **National Environmental Policy Act (NEPA) Requirements Related to Pre-Award Costs**
   EERE's decision whether and how to distribute federal funds under this FOA is subject to NEPA. Applicants should carefully consider and should seek legal counsel or other expert advice before taking any action related to the proposed project that would have an adverse effect on the environment or limit the choice of reasonable alternatives prior to EERE completing the NEPA review process.

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

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

1. **Requirement**
   All work performed under awards issued under this FOA 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 DOE. Appendix C lists the information that must be included in a request for a foreign work waiver.

   Save the waiver request(s) in a single PDF file. The applicant does not have the right to appeal DOE's decision concerning a waiver request.

iv. Construction

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

v. Foreign Travel

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

vi. Equipment and Supplies

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

vii. Build America Buy America Requirements for Infrastructure Projects

Pursuant to the Build America Buy America Act, subtitle IX of BIL (Buy America or BABA), and in accordance with 2 CFR Part 184, no funds for federal financial assistance which is subject to BABA requirements may be used for a project unless:

- All iron and steel used in the infrastructure work are produced in the United States;

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

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

Applicants are strongly encouraged to consult Appendix 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.

BABA requirements apply to DOE prime recipients that are "non-Federal entities." In accordance with OMB Memorandum M-24-02 and 2 CFR 200.1, the term "non-Federal entity" includes states, local governments, territories, Indian Tribes, Institutes of Higher Education or non-profit organizations. DOE does not apply BABA requirements to for-profit entities. A Program Policy Factor that the Selection Official may consider in determining which Full Applications to select for award negotiations by for-profit entities may be applied pursuant to Section V.C.i., Program Policy Factors. The relevant Program Policy Factor considers the degree to which the proposed project will employ procurement of U.S. iron, steel, manufactured products, and construction materials.

Subawards should conform to the terms of the prime award from which they flow; in other words, for-profit prime recipients are not required to flow down these Buy America requirements to subrecipients, even if those subrecipients are non-Federal entities as defined above. Conversely, prime recipients which are non-Federal entities must flow the Buy America requirements down to all subrecipients, even if those subrecipients are for-profit entities.

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

and for good cause shown. Further details on requesting a waiver can be found in Appendix D and the terms and conditions of an award.

Applicants are strongly encouraged to consult Appendix D and 2 CFR Part 184 for more information.

viii. Lobbying

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

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

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

ix. Risk Assessment

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

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

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

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

In addition to this review, DOE must comply with the guidelines on government-wide suspension and debarment in 2 CFR 180 and must require non-federal

entities to comply with these provisions. These provisions restrict federal awards, subawards and contracts with certain parties that are debarred, suspended, or otherwise excluded from or ineligible for participation in federal programs or activities.

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

x. Invoice Review and Approval

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

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

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

a. Prohibition

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

believed to be participating in a foreign government talent recruitment program of a foreign country of risk. DOE may modify and add requirements related to this prohibition to the extent required by law.

b. Definitions

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

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

xii. Affirmative Action and Pay Transparency Requirements

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

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

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

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

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

DOL's Office of Federal Contractor Compliance Programs (OFCCP) uses a neutral process to schedule compliance evaluations. Consult OFCCP's Technical Assistance Guide[31] to gain an understanding of the requirements and possible actions the recipients, subrecipients, contractors, and subcontractors must take. Additional guidance may also be found in the National Policy Assurances, produced by DOE.

xiii. Foreign Collaboration Considerations

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

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

c. Description of collaborations that should be reported. In general, a collaboration will involve some provision of a thing of value to, or from, the

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

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

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

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

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

This criterion involves consideration of the following factors:

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

ii. Full Applications

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

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

Technical Merit and Innovation

- Extent to which the proposed technology, process, or project is innovative or replicable;
- Degree to which the current state of the technology and the proposed advancement (with an eye ultimately towards demonstration and commercialization) are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state of the art to the proposed advancement;
- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations, and discussion of prior work, with analyses that support the viability of the proposed work;
- Extent to which project has buy-in from needed stakeholders to ensure success of the R&D;
- Degree to which key manufacturing and supply chain challenges are considered, as applicable, for viable scale-up in this and future demonstrations;
- Degree to which siting and environmental constraints are considered for deployment;
- Extent to which project has the potential to reduce emissions and provide clean energy acceleration benefits for a community or region; and
- Sufficiency of existing infrastructure to support addition of proposed demonstration.

Impact of Technology Advancement

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

Project Management

- Adequacy of proposed project management systems including the ability to track scope, cost, and schedule progress and changes;

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

Criterion 2: Project Research and Market Transformation Plan (25%)
This criterion involves consideration of the following factors:

Research Approach, Workplan, and SOPO

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

Identification of Technical Risks

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

Baseline, Metrics, and Deliverables

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

Market Transformation Plan

- Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including mitigation plan; and

- Comprehensiveness of market transformation plan including but not limited to product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, and product distribution.

Industry Adoption Plan

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

Criterion 3: Team and Resources (10%)

This criterion involves consideration of the following factors:

- Capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. The qualifications, relevant expertise, and time commitment of the individuals on the team;
- Diversity of expertise and perspectives of the team and the inclusion of industry partners that will amplify impact;
- Sufficiency of the facilities to support the work;
- Degree to which the proposed consortia/team demonstrates the ability to facilitate and expedite further demonstration, development, and commercial deployment of the proposed technologies;
- Level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan; and
- Reasonableness of the budget and spend plan for the proposed project and objectives.

Criterion 4: Community Benefits Plan (R&D) (15%)

This criterion involves consideration of the following factors:

Diversity, Equity, Inclusion, and Accessibility

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

The Justice 40 Initiative and other considerations linked with energy and/or environmental justice

- Clear workplan tasks, staffing, research, and timeline for engaging energy equity and community and/or environmental justice stakeholders and/or evaluating the possible near- and long-term implications of the project for the benefit of the American public, including but not limited to public health and public prosperity benefits;
- Approach, methodology, and expertise articulated in the plan for addressing energy and/or environmental justice questions or concerns associated with the technology innovation;
- Description of how the project will advance the Justice40 Initiative's goal of having 40% of the overall benefits of covered investments flow to disadvantaged communities; and
- Likelihood that the plan will result in improved understanding of distributional public benefits and costs related to the innovation if successful.

Quality Jobs

- Clear and comprehensive workplan tasks, staffing, research, and timeline for engaging workforce stakeholders and/or evaluating the possible near- and long-term implications of the project for the U.S. workforce;
- Approach to document the knowledge, skills, and abilities of the workforce required for successful commercial deployment of innovations resulting from this research; and
- Likelihood that the plan will result in improved understanding of the workforce implications related to the innovation if successful.

iii. Criteria for Replies to Reviewer Comments

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

B. Standards for Application Evaluation

Applications that are determined to be eligible will be evaluated in accordance with this FOA, by the standards set forth in EERE's Notice of Objective Merit Review Procedure (76 Fed. Reg. 17846, March 31, 2011) and the guidance provided in the "DOE Merit Review Guide for Financial Assistance," effective October 1, 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 demonstration and commercialization and overcome key market barriers;
- The degree to which the proposed project is likely to lead to increased high-quality employment and manufacturing in the United States;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty;
- The degree to which the proposed project, or group of projects, represent a desired geographic distribution (considering past awards and current applications);
- The degree to which the proposed project incorporates applicant or team members from Minority Serving Institutions (e.g., Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs)); and partnerships with Minority Business Enterprises, minority-owned businesses, woman-owned businesses, veteran-owned businesses, or Indian Tribes;
- The degree to which the proposed project, when compared to the existing DOE project portfolio and other projects to be selected from the subject FOA, contributes to the total portfolio meeting the goals reflected in the Community Benefits Plan criteria; and
- The degree to which the proposed project will employ procurement of U.S. iron, steel, manufactured products, and construction materials.

D. Evaluation and Selection Process

i. Overview

The evaluation process consists of multiple phases; each includes an initial eligibility review and a thorough technical review. Rigorous technical reviews of eligible submissions are conducted by reviewers that are experts in the subject

matter of the FOA. Ultimately, the Selection Official considers the recommendations of the reviewers, along with other considerations such as program policy factors and risk reviews, 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.ii. of the FOA). The invited applicant(s) will meet with EERE representatives to provide clarification on the contents of the Full Applications and to provide EERE an opportunity to ask questions regarding the proposed project. The information provided by applicants to EERE through pre-selection interviews contributes to EERE's selection decisions.

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

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

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

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

iii. Pre-Selection Clarification

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

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

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

iv. Recipient Responsibility and Qualifications

DOE, prior to making a federal award with a total amount of federal share greater than the simplified acquisition threshold, is required to review and consider any responsibility and qualification information about the applicant that is in the entity information domain in SAM.gov (see 41 U.S.C. 2313).

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

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

v. Selection

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

E. Anticipated Notice of Selection and Award Negotiation Dates

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

VI. Award Administration Information

A. Award Notices

i. Ineligible Submissions

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

ii. Concept Paper Notifications

EERE will notify applicants of its determination to encourage or discourage the submission of a Full Application. EERE will post these notifications to EERE eXCHANGE. EERE may include general comments provided from reviewers on an applicant's Concept Paper in the encourage/discourage notifications.

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

A notification encouraging the submission of a Full Application does not authorize the applicant to commence performance of the project.

iii. Full Application Notifications

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

iv. Applicants Selected for Award Negotiations

DOE may stagger its selection determinations. As a result, some applicants may receive their notification letter in advance of other Applicants. Successful

applicants will receive written notification that they have been selected for award negotiations. Receipt of a notification letter selecting a Full Application for award negotiations does not authorize the applicant to commence performance of the project. If an application is selected for award negotiations, it is not a commitment by EERE to issue an award nor is it a guarantee of federal government funding. Applicants do not receive an award unless and until award negotiations are complete and the Contracting Officer executes the funding agreement, accessible by the prime recipient in FedConnect.

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

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

v. Alternate Selection Determinations

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

vi. Unsuccessful Applicants

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

B. Administrative and National Policy Requirements

i. Registration Requirements

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

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

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

   Each organization or business unit, whether acting as a team or a single entity, should use only one account as the contact point for each submission. Applicants should also designate backup points of contact. **This step is required to apply to this FOA.** The eXCHANGE registration does not have a delay; however, **the remaining registration requirements below could take several weeks to process and are necessary for a potential applicant to receive an award under this FOA.**

2. **System for Award Management**
   Register with the SAM at https://www.sam.gov. Please update your SAM registration annually.

3. **FedConnect**
   Register in FedConnect at https://www.fedconnect.net. For more information about FedConnect, review the FedConnect Ready, Set, Go! Guide at https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf.

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

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

ii. Award Administrative Requirements

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

iii. Foreign National Participation

All applicants selected for an award under this FOA and project participants (including subrecipients and contractors) who anticipate involving foreign nationals in the performance of an award, may be required to provide DOE with specific information about each foreign national to satisfy requirements for foreign national participation. A "foreign national" is defined as any person without U.S. citizenship or nationality (may include a stateless person). The volume and type of information collected may depend on various factors associated with the award. DOE concurrence may be required before a foreign national can participate in the performance of any work under an award.

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

iv. Subaward and Executive Reporting

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

v. National Policy Requirements

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

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

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

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

National Historic Preservation Act (NHPA)

DOE must comply with the requirements of Section 106 of the National Historic Preservation Act (NHPA) prior to deciding whether or how to distribute federal funds. Section 106 requires DOE to identify and consider adverse effects to historic properties that are listed in or eligible for listing in the National Register of Historic Places. DOE will perform a NHPA review under the umbrella of its NEPA review and will require applicants to assist in this review and consider impacts to historic, Tribal, and cultural resources.

vii. Flood Resilience

Applications should indicate whether the proposed project location(s) is within a floodplain, how the floodplain was defined, and how flooding will factor into the project's design. The base floodplain long used for planning has been the 100-year floodplain, which has a 1% chance of flooding in any given year. As directed by Executive Order 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input (2015), federal agencies, including DOE, must continue to avoid development in a floodplain to the extent possible. When doing so is not possible, federal agencies are directed to "expand management from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended." The higher flood elevation is based on one of three approaches: climate-informed science (preferred), freeboard value, or 0.2% annual flood change (500-year floodplain). EO 13690 and related information is available at: https://www.energy.gov/nepa/articles/eo-13690-establishing-federal-flood-risk-management-standard-and-process-further.

viii. Applicant Representations and Certifications

1. Lobbying Restrictions

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

2. **Corporate Felony Conviction and Federal Tax Liability Representations**
In submitting an application to this FOA, the applicant represents that:

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

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

   For purposes of these representations, a corporation is any for-profit or nonprofit entity that has filed articles of incorporation in any of the 50 states, the District of Columbia, or the various territories of the United States [but not foreign corporations].

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

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

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

      (1) *''These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or*

mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this agreement and are controlling.''

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

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

ix. 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.

x. Statement of Substantial Involvement

EERE has substantial involvement in work performed under awards made as a result of this FOA. EERE does not limit its involvement to the administrative requirements of the award. Instead, EERE has substantial involvement in the

direction and redirection of the technical aspects of the project. Substantial involvement includes, but is not limited to, the following:

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

xi. Subject Invention Utilization Reporting

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

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 beginning the execution of future phases. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. Federal funding beyond the Go/No-Go decision point (continuation funding) is

contingent upon (1) availability of federal funds appropriated by Congress for the purpose of this program; (2) the availability of future-year budget authority; (3) recipient's technical progress compared to the Milestone Summary Table stated in Attachment 1 of the award; (4) recipient's submittal of required reports; (5) recipient's compliance with the terms and conditions of the award; (6) EERE's Go/No-Go decision; (7) the recipient's submission of a continuation application;[32] 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 U.S. 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

[32] A continuation application is a non-competitive application for an additional budget period within a previously approved project period. At least ninety (90) days before the end of each budget period, the recipient must submit its continuation application, which includes the following information:

i. A progress report on the project objectives, including significant findings, conclusions, or developments, and an estimate of any unobligated balances remaining at the end of the budget period. If the remaining unobligated balance is estimated to exceed 20 percent of the funds available for the budget period, explain why the excess funds have not been obligated and how they will be used in the next budget period.
ii. A detailed budget and supporting justification if there are changes to the negotiated budget, or a budget for the upcoming budget period was not approved at the time of award.
iii. A description of any planned changes from the SOPO and/or Milestone Summary Table.

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 million the recipient or subrecipient must:

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

xvii. Real Property and Equipment

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

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

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

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

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

xix. 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 proposed 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.

xx. Current and Pending Support

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

xxi. U.S. Manufacturing Commitments

A primary objective of DOE's multi-billion-dollar research, development, and demonstration investments is to cultivate new research and development ecosystems, manufacturing capabilities, and supply chains for and by United States industry and labor. Therefore, in exchange for receiving taxpayer dollars to support an applicant's project, the applicant/recipient and any subrecipient and contractor must agree to a U.S. Competitiveness provision requiring that any products embodying any subject invention or produced through the use of any subject invention will be manufactured substantially in the United States unless the applicant/recipient can show to the satisfaction of DOE that it is not

commercially feasible. Award terms, including the specific U.S. Competitiveness Provision applicable to the various types of recipients and projects, are available at https://www.energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards.

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

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

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

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

xxii. Interim Conflict of Interest Policy for Financial Assistance

The DOE interim Conflict of Interest Policy for Financial Assistance (COI Policy)[33] is applicable to all non-Federal entities applying for, or that receive, DOE funding by means of a financial assistance award (e.g., a grant, cooperative agreement, or technology investment agreement) and, through the implementation of this policy by the entity, to each Investigator who is planning to participate in, or is participating in, the project funded wholly or in part under the DOE financial assistance award. The term "Investigator" means the PI and any other person, regardless of title or position, who is responsible for the purpose, design, conduct, or reporting of a project funded by DOE or proposed for funding by DOE. Recipients must flow down the requirements of the interim COI Policy to any subrecipient non-federal entities. Further, for DOE funded projects, the recipient must include all financial conflicts of interest (FCOI) (i.e., managed and unmanaged/unmanageable) in its initial and ongoing FCOI reports.

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

xxiii. Data Management Plan

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

[33] DOE's interim COI Policy can be found at https://www.energy.gov/management/department-energy-interim-conflict-interest-policy-requirements-financial-assistance.

xxiv. Fraud, Waste, and Abuse

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

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

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

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

Applicants/recipients 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.

xxv. Human Subjects Research

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

VII. Questions/Agency Contacts

Upon the issuance of a FOA, EERE personnel are prohibited from communicating (in writing or otherwise) with applicants regarding the FOA except through the established question and answer process described below. Questions regarding this FOA must be submitted to SM.FOA.FY24@ee.doe.gov no later than three (3) business days prior to the application due date and time. Please note, feedback on individual concepts will not be provided through Q&A.

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

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

VIII. Other Information

A. FOA Modifications

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

B. Government Right to Reject or Negotiate

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

C. Commitment of Public Funds

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

D. Treatment of Application Information

Applicants should not include trade secrets or business-sensitive, proprietary, or otherwise confidential information in their application unless such information is necessary to convey an understanding of the proposed project or to comply with

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

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

If an applicant chooses to submit trade secrets or business-sensitive, proprietary, or otherwise confidential information, the applicant must provide **two copies** of any document of the submission (e.g., Concept Paper, Full Application) that contains such information. The first copy should be marked "non-confidential," with the information believed to be confidential deleted. The second copy should be marked "confidential" and must clearly and conspicuously identify the trade secrets or business-sensitive, proprietary, or otherwise confidential information and must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The federal government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose as authorized by law.

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

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

In addition, (1) the header and footer of every page that contains trade secrets or business-sensitive, proprietary, or otherwise confidential information must be

marked as follows: "Contains Trade Secrets, Business-Sensitive, Proprietary, or Otherwise Confidential Information Exempt from Public Disclosure," and (2) every line or paragraph containing such information must be clearly marked with double brackets or highlighting. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

E. Evaluation and Administration by Non-Federal Personnel

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

F. Notice Regarding Eligible/Ineligible Activities

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

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

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

H. Requirement for Full and Complete Disclosure

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

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

I. Retention of Submissions

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

J. Title to Subject Inventions

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

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

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

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

- DEC: On June 07, 2021, DOE approved a Determination of Exceptional Circumstances (DEC) under the Bayh-Dole Act to further promote domestic manufacture of DOE science and energy technologies. In accordance with this DEC, all awards, including sub-awards, under this FOA shall include the U.S. Competitiveness Provision in accordance with Section VI.B.xxi. U.S. Manufacturing Commitments of this FOA. A copy of the DEC can be found at https://www.energy.gov/gc/determination-exceptional-circumstances-decs.

Pursuant to 37 CFR § 401.4, any nonprofit organization or small business firm as defined by 35 U.S.C. 201 affected by any DEC has the right to appeal it by providing written notice to DOE within 30 working days from the time it receives a copy of the determination.

- DOE may issue and publish further DECs on the website above prior to the issuance of awards under this FOA. DOE may require additional submissions or requirements as authorized by any applicable DEC.

K. Government Rights in Subject Inventions

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

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 government contractors.

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 United States manufacturing requirement has not been met.

Any determination that march-in rights are warranted must follow a fact-finding process in which the recipient has certain rights to present evidence and witnesses, confront witnesses and appear with counsel and appeal any adverse

decision. To date, DOE has never exercised its march-in rights to any subject inventions.

L. Rights in Technical Data

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

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

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

For this FOA, selectees and recipients may request an extended period of protection (more than 5 years and not to exceed 30 years) if reasonably required for commercialization for specific categories of data first produced under the resulting awards in accordance with 15 U.S.C. § 3710a(c)(7)(B)(ii) and the Energy Policy Acts of 1992 and 2005, or 42 U.S.C. § 7256(g)(5) for OTAs, if applicable. Further direction will be provided during the negotiation process upon request.

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 investigations, indictments, charges, convictions, and violations upon occurrence, 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; exercise an option to procure, or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that use *covered telecommunications equipment or services* as a substantial or essential component of any system, or as critical technology as part of any system. As described in Section 889 of Public Law 115-232, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

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

P. Personally Identifiable Information (PII)

All information provided by the applicant must to the greatest extent possible exclude PII. The term "PII" refers to information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother's maiden name. (See OMB Memorandum M-17-12 dated January 3, 2017)

By way of example, applicants must screen resumes to ensure that they do not contain PII such as personal addresses, personal landline/cell phone numbers, and

personal emails. **Under no circumstances should Social Security Numbers (SSNs) be included in the application**. Federal agencies are prohibited from the collecting, using, and displaying unnecessary SSNs. (See, the Federal Information Security Modernization Act of 2014 (Pub. L. No. 113-283, Dec 18, 2014; 44 U.S.C. § 3551).

Q. Annual Independent Audits

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

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

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

APPENDIX A – COST SHARE INFORMATION

Cost Sharing or Cost Matching

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

How Cost Sharing Is Calculated

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

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

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

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

What Qualifies for Cost Sharing

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

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

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

In addition to the above regulations, other factors may also come into play such as timing of donations and length of the project period. For example, the value of 10 years of donated maintenance on a project that has a project period of five years would not be fully allowable as cost share. Only the value for the five years of donated maintenance that corresponds to the project period is allowable and may be counted as cost share.

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

General Cost Sharing Rules on a DOE Award

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

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

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

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

DOE Financial Assistance Rules 2 CFR Part 200 as 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 million 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 FOR: 1. FOREIGN ENTITY PARTICIPATION; AND 2. FOREIGN WORK

1. Waiver for Foreign Entity Participation

Many of the technology areas DOE funds fall in the category of critical and emerging technologies (CETs). CETs are a subset of advanced technologies that are potentially significant to United States national and economic security.[34] For projects selected under this FOA, all recipients and subrecipients must be organized, chartered, or incorporated (or otherwise formed) under the laws of a state or territory of the United States; have majority domestic ownership and control; and have a physical location for business operations in the United States. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

Waiver Criteria

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

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

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

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

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

DOE may also require:

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

DOE may require additional information before considering the waiver request.

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

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

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

Overall, a waiver request must demonstrate to the satisfaction of DOE that it would further the purposes of this FOA and is otherwise in the economic interests of the

United States to perform work outside of the United States. A request for a foreign work waiver must include the following:

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

DOE may require additional information before considering the waiver request.

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

APPENDIX 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, based both on the statute and OMB Guidance Document dated April 18, 2022, the following definitions apply:

Construction materials includes an article, material, or supply—other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives[35] —that is or consists primarily of:

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

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

Moreover, according to the OMB guidance document:

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

[35] BIL, § 70917(c)(1).

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

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

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

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

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

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

(3) all construction materials[36] are produced in the United States—this means that all manufacturing processes for the construction material occurred in the United States.

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

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

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

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

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

C. Waivers

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

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

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

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

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

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

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

DOE may require additional information before considering the waiver request.

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

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

APPENDIX E – 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 F – LIST OF ACRONYMS

AI	Artificial Intelligence
AMMTO	Advanced Materials and Manufacturing Technologies Office
ARL	Adoption Readiness Level
CETs	Critical and Emerging Technologies
COI	Conflict of Interest
CPHS	Cyber-Physical-Human System
CRADA	Cooperative Research and Development Agreement
DEC	Determination of Exceptional Circumstances
DEI	Diversity, Equity, and Inclusion
DMP	Data Management Plan
DOE	Department of Energy
DOI	Digital Object Identifier
EERE	Energy Efficiency and Renewable Energy
FAR	Federal Acquisition Regulation
FCOI	Financial Conflicts of Interest
FECM	Office of Fossil Energy and Carbon Management
FFATA	Federal Funding and Transparency Act of 2006
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
FFRDC	Federally Funded Research and Development Center
GAAP	Generally Accepted Accounting Principles
GREET	the Greenhouse gases, Regulated Emissions, and Energy use in Technologies model
GTO	Geothermal Technologies Office
HEM	Harsh Environment Material
HPM	High-Performance Material
ICE	Internal Combustion Engine
ICME	Integrated Computational Materials Engineering
ICS	Industrial Control Systems
IPMP	Intellectual Property Management Plan
IRB	Institutional Review Board
KPI	Key Performance Indicator
LCA	Lifecycle Assessment
M&O	Management and Operating
MESC	Office of Manufacturing and Energy Supply Chains
MFA	Multi-Factor Authentication
ML	Machine Learning
MFI	Material Flows through Industry
MPIN	Marketing Partner ID Number
MRF	Material Recovery Facility
MSI	Minority-Serving institution
MYPP	Multi-Year Program Plan

NASEM	National Academies of Science, Engineering, and Medicine
NDA	Non-Disclosure Acknowledgement
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NNSA	National Nuclear Security Agency
NSF	National Science Foundation
OIG	Office of Inspector General
OEE	Overall Equipment Effectiveness
OEM	Original Equipment Manufacturers
OFCCP	Office of Federal Contractor Compliance Programs
OMB	Office of Management and Budget
OSTI	Office of Scientific and Technical Information
OTA	Other Transactions Authority
PII	Personal Identifiable Information
PPF	Program Policy Factor
RD&D	Research, development and demonstration
R&D	Research and Development
RFI	Request for Information
RFP	Request for Proposal
SAM	System for Award Management
SciENcv	Science Experts Network Curriculum Vita
SM	Smart Manufacturing
SMART	Specific, Measurable, Attainable, Realistic, and Timely
SMMs	Small and Medium-Sized Manufacturers
SOPO	Statement of Project Objectives
SPOC	Single Point of Contact
STEM	Science, Technology, Engineering, and Mathematics
TAA	Technical Assistance Agreement
TEA	Techno-economic Analysis
TIA	Technology Investment Agreement
TRL	Technology Readiness Level
UCC	Uniform Commercial Code
UEI	Unique Entity Identifier
VTO	Vehicle Technologies Office
WBS	Work Breakdown Structure
WP	Work Proposal

APPENDIX G – TEA/LCA RESOURCES

The following list of resources provides basic information on greenhouse gas emissions inventory, life cycle assessment (LCA), techno-economic assessment (TEA), and more.

i. Life cycle analysis and techno-economic analysis training [USDOE]
This series of short videos provide trainings on best practices for conducting LCA and TEA analysis. Produced by the Advanced Materials and Manufacturing Technologies Office (AMMTO) and Industrial Efficiency and Decarbonization Office (IEDO) at USDOE. Life Cycle Assessment and Techno-Economic Analysis Training | Department of Energy

ii. Embodied energy
Indirect embodied carbon can be estimated using an inventory analysis and emissions data from LCA databases such as ICE (managed by Circular Ecology). Embodied Carbon Footprint Database - Circular Ecology.

APPENDIX H – R&D COMMUNITY BENEFITS PLAN GUIDANCE

DOE is committed to pushing the frontiers of science and engineering; catalyzing high-quality domestic clean energy jobs through research, development, demonstration, and deployment; and ensuring energy equity and energy justice[37] for disadvantaged communities. Therefore, and in accordance with the Administration's priority to empower workers and harness opportunities to create good union jobs as stated in EO 14008 (Executive Order on Tackling the Climate Crisis at Home and Abroad),[38] it is important to consider the impacts of the successful commercial deployment of any innovations resulting from this FOA on the current and future workforce.

The goal of the R&D Community Benefits Plan is to allow the application to illustrate engagement in critical thought about implications of how the proposed work will benefit the American people and lead to broadly shared prosperity, including for workers and disadvantaged communities.[39] The three sections of the R&D Community Benefits Plans are considered together because there may be significant overlap among audiences considered in workforce and disadvantaged communities.

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

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

[37] DOE defines energy justice as "the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those disproportionately harmed by the energy system" (Initiative for Energy Justice, 2019). Aligned with that definition, the remainder of this document refers to "energy equity" to encompass energy justice and DOE's efforts related to Justice40. https://www.energy.gov/diversity/articles/how-energy-justice-presidential-initiatives-and- executive-orders-shape-equity

[38] https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad

[39] Pursuant to E.O. 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021, and the Office of Management and Budget's Interim Justice40 Implementation Guidance M-21-28, DOE recognizes DACs as defined and identified by the White House Council of Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), located at https://screeningtool.geoplatform.gov/ . DOE's Justice40 Implementation Guidance is located at https://www.energy.gov/sites/default/files/2022-07/Final%20DOE%20Justice40%20General%20Guidance%20072522.pdf .

Equity extends beyond diversity to equitable treatment. Equitable access to opportunity for members of the project team is paramount. This includes ensuring all members of the team, including students, are paid a living wage, provided appropriate working conditions, and provided appropriate benefits. In the execution of their project plan, applicants are asked to describe efforts in diversity, equity, inclusion, and accessibility. In this context, efforts toward DEIA are defined as:[40]

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

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

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

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

[40] https://www.whitehouse.gov/wp-content/uploads/2021/11/Strategic-Plan-to-Advance-Diversity-Equity-Inclusion-and-Accessibility-in-the-Federal-Workforce-11.23.21.pdf

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

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

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

Specific examples include:

- Building collaborations and partnerships with researchers and staff at MSIs;
- Addressing barriers identified in climate surveys to remove inequities;
- Providing anti-bias training and education in the project design and implementation teams;
- Offering training, mentorship, education, and other support to students and early/mid-career professionals from DACs;
- Providing efforts toward improving a workplace culture of inclusion;
- Developing technology and technology integration innovations to meet the

needs of DACs;
- Creating partnerships with local communities, especially under-resourced and DACs;
- Voluntary recognition of a union and informing employees of their rights, regardless of their classification;
- Making research products and engagement materials accessible in a greater variety of formats to increase accessibility of research outputs;
- Implementing training or distributing materials to reduce stigma towards individuals with disabilities;
- Designing technologies that strategically fit within the existing workforce for installation and maintenance of the potential innovation.

Energy Equity

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

Applicants should describe the influencing factors and the most likely energy equity implications of the proposed research. Applicants should describe any long-term constraints the proposed technology may pose to communities' access to natural resources and Tribal cultural resources. There may be existing equity research available to use and cite in this description, or the applicant could describe milestone-based efforts toward developing that understanding through this innovation. These near- and long-term outcomes may include but are not limited to: a decrease in the percent of income a household spends on energy costs (energy burden);38 an increase in access to low-cost capital; a decrease in environmental exposure and burdens; increases in clean energy enterprise creation and contracting (e.g., women- or minority-owned business enterprises); increased parity in clean energy technology access and adoption; increases in energy democracy, including community ownership; and an increase in energy resilience.

Specific examples include:
- Describing how a successful innovation will support economic development in diverse geographic or demographic communities;
- Creating a plan to engage equity and justice stakeholders in evaluating the

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

Workforce

The Workforce section of the R&D Community Benefits Plan should articulate the future workforce implications of the innovation or a milestone-driven plan for understanding those implications. This includes documenting the skills, knowledge, and abilities that would be required of workers installing, maintaining, and operating the technology that may be derivative of the applicant's research, as well as the training pathways and its accessibility for workers to acquire the necessary skills. There may be field-specific or relevant existing research that could be cited in this section. In addition, applicants could detail the process they will use to evaluate long-

term impacts on jobs, including job growth or job loss, a change in job quality, disruptions to existing industry and resulting changes to relationships between employers and employees and improvements or reductions in the ability of workers to organize for collective representation, and anything else that could result in changes to regional or national labor markets.

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

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

Specific examples include:
- Outlining the challenges and opportunities for commercializing the technology in the United States;

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

Inclusion of SMART milestones

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

- What needs to be accomplished?
- What measures and deliverables will be used to track progress toward accomplishment?
- What evidence suggests that the accomplishment is achievable?
- Why choose this milestone?
- When will the milestone be reached?

APPENDIX I – ADDITIONAL SMART MANUFACTURING BACKGROUND INFORMATION

Concepts and Definitions:

As used by AMMTO and in this FOA, smart manufacturing comprises the following concepts and definitions. Smart manufacturing builds upon the pillars of lean manufacturing, digital manufacturing, and continuous manufacturing to achieve superior throughput, efficiency, quality, and precision in the manufacturing process. The term lean manufacturing refers to creating maximum outputs with reduced inputs in terms of cost, time, energy, and effort. Digital manufacturing emphasizes the digitization and integration of manufacturing activities with the properties and performance of products. Continuous manufacturing transforms the traditional batch manufacturing process into an integrated process to enable faster production. Smart manufacturing frameworks are being applied across most industry sectors and can be leveraged beyond traditional manufacturing processes. For example, the principles of smart manufacturing can also be applied to improve how new materials are designed or to enhance how materials are recovered at the end of a product's life. At its core, smart manufacturing is a framework that encompasses generating, sharing, and using data through a combination of physical and virtual processes to enable leveraging complex data for a resilient, responsive, and efficient manufacturing sector.

Smart manufacturing systems are made up of technologies such as (but not limited to) machine learning (ML), artificial intelligence (AI), in-situ monitoring, sensing and sensor integration, close-loop control algorithms enabling automated production, digital twins and digital thread, interoperability of components and systems, AI in materials informatics, automated experimentation, product variation modeling, AI/ML on operational data, industrial machine vision, standards and protocols, Edge/Cloud Analytics, and supply chain collaboration platforms.

Digital Transformation: Digital transformation is the process of deploying innovative enterprise-wide applications for making better decision through automating both engineering and business processes through digital models. The critical aspect of this digital transformation that is happening in manufacturing enterprise systems (e.g. systems ranging from the machine level to the plant level to a full supply chain) across the globe is smart manufacturing (SM).

Smart manufacturing also enables modernization of the American workforce, creating new jobs. A skilled workforce is key to building a strong, vibrant, and competitive U.S. manufacturing sector.

Platform Technology: Smart Manufacturing is a platform technology (an innovative business model that creates value by bringing together manufacturers and solution providers) that enables the complete integration of manufacturing across the system lifecycle for optimizing system productivity, including energy, material, and water productivity, to:

- Optimize manufacturing enterprise system and supply chain performance;
- Improve reliability, productivity, resiliency, safety, agility, cyber security, interoperability, composability, and controllability;
- Include technology to enable manufacturing of one product or product class;
- Increase competitiveness through improved productivity and efficiency;
- Improve decision-making using manufacturing data and minimize human errors;
- Continually improve production, quality control, and ensuring on-time delivery;
- Enable value chain circularity in manufacturing.

In essence, smart manufacturing provides an effective and secure human-system platform for better decision making using data and improving the overall productivity and efficiency of manufacturing across the networked enterprise.

Smart Manufacturing Strategies: AMMTO has been actively seeking various stakeholders' inputs through workshops, industry round tables, and RFIs. The major conclusions from one such workshop[41], called the TRANSSFORM (Transformative, Resilient, Adaptive, Nimble, Sustainable, Smart, Flexible, Optimal, Robust, and Model-based) Workshop highlighted how manufacturing digitalization can improve manufacturing competitiveness and reduce energy consumption and emissions production from U.S. manufacturing, and what research, development, and demonstrations are needed to have the desired impact.

Some key takeaways from the workshop include the following:

- The critical importance of prioritizing domestic manufacturing innovations to retain economic benefits within the U.S.
- Formal approaches for digital twins to improve operational efficiencies, and manufacturing processes.
- Bridging the gap between materials discovery and practical application.

[41] https://www.energy.gov/sites/default/files/2022-12/Transsform%20Workshop%20Proceedings%20Report.pdf

- The potential of new technologies and methodologies to significantly enhance resource efficiency across manufacturing operations.
- The potential of real-time data analytics and flexible manufacturing processes to enhance the adaptability, efficiency, and resiliency of supply chains.
- Overcoming SMEs' challenges in technology adoption due to cost and existing system inertia.
- Training and education in computational science and materials integration.

At a broader level, the National Strategy for Advanced Manufacturing report[42] presents a vision for United States leadership in Advanced Manufacturing that will grow the economy, create jobs, enhance environmental sustainability, address climate change, strengthen supply chains, ensure national security, and improve healthcare. Three interrelated goals are set to achieve the stated vision:

(1) Develop and implement advanced manufacturing technologies,
(2) Grow the advanced manufacturing workforce, and
(3) Build resilience into manufacturing supply chains.

Smart manufacturing has been specifically called out in each of these goals and the report emphasizes the importance of smart manufacturing across U.S manufacturing enterprise system and innovation ecosystem.

DOE in partnership with the National Academies of Science, Engineering, and Medicine (NASEM), conducted workshops to study the options for developing a national plan for smart manufacturing. The final consensus study report[43] examined the technical frameworks and processes, identify possible timelines and necessary resources, and explore policies and general roles for government, industry, and academia to address near-, medium-, and long-term challenges to improve the productivity and energy efficiency of the manufacturing sector of the United States and ensure U.S. competitiveness. Based on this report, DOE is developing options for a national plan for smart manufacturing technology development and deployment as per the language set forth in The Energy Act of 2020, Sec. 6006 on pages 1113 and 1115.

The AMMTO smart manufacturing strategy is tailored to specific needs at multiple levels including Design, Product, Process/Equipment, Supply Chain, and Enterprise system. There are huge potential impacts through smart manufacturing deployment and skill development.

[42] https://www.whitehouse.gov/wp-content/uploads/2022/10/National-Strategy-for-Advanced-Manufacturing-10072022.pdf

[43] https://nap.nationalacademies.org/catalog/27260/options-for-a-national-plan-for-smart-manufacturing

AMMTO's smart manufacturing strategy and FOA are intended to address industry specific problems and how smart manufacturing can help in terms of platform technologies, solutions, and enabling technologies (as described in Figure 1). Table 3 explains this in terms of 1) manufacturing digital transformation, 2) end-user technology/application, and 3) facilitating technology (platform technology).

Table 2: Opportunities for SM platform technologies to address current challenges

Industry Opportunities	SM Application	SM Platform Technology (AMMTO) Cyberphysical System for manufacturing
Product quality improvements Process quality improvements	Quality Control and Assurance Real-time Manufacturing data fusion	In-situ monitoring, sensors, close-loop control algorithms, Automation, improve total factor productivity, enhancing manufacturing efficiency through automated production
Cleaner, Energy Efficiency, Clean Energy	Energy Management and Optimization, Sustainability, Supply chain optimization	Clean energy manufacturing, renewable energy for electrification, clean energy product manufacturing
Smart manufacturing for advanced materials development and processing	High-Throughput Experimentation, Additive manufacturing, AI/ML for material informatics	Digital twin, Digital Thread, AI in materials informatics, Automated experimentation, in-situ monitoring, Collaborative Platforms for Innovation
Manufacturing Operational Efficiency and Automation	Advanced manufacturing capability, skilled workforce, and production optimization, Human-machine interface, Cobots.	Smart manufacturing Platform, AI/ML, Digital Thread/Twin, Robotics and automation, Human System Interface (AR/VR/MR/IR), WFD, Training
Agility and flexibility	Flexible and customizable production processes, AI/ML model to address product variations, demand fluctuations	Digital Thread and Digital Twin for flexible production process, Product variation modeling using Product Platform, Digital Twin to enable lot size of one.
Manufacturing Enterprise Asset Management	Asset optimization, Predictive maintenance, System Thinking for Closed-Loop Value Chain, Enterprise Manufacturing Intelligence, Metrology, Control interfaces	AI/ML on operational data for OEE, Industrial machine vision, Predictive maintenance, Industrial smart sensor network for information fusion

Systems Integration and software	IT/OT integration, Cybersecurity, Verification and Validation, Interoperability, System Readiness Level	OT technology, Digital Thread/Twin, standards & protocols, Edge/Cloud Analytics, information fusion
Supply Chain optimization and resiliency	Supply chain optimization, Resiliency modeling, Risk Assessment Frameworks	Enterprise Supply chain Collaboration Platforms, Blockchain, Enterprise Manufacturing Intelligence, AI in Manufacturing Enterprise System

These smart manufacturing strategies can help address what is typically a limiting factor for increased automation, i.e., lack of comprehensive integration of hardware and software systems. Machinery, industrial controls, and data acquisition systems, though highly automated, are still limited in realizing their potential as autonomous unit systems or as connected systems within and across manufacturing sites, and as extended supply chain or procurement networks.

Autonomous machinery (smart machines) will assist humans and will require human interaction, decision-making, and planning. The current state-of-art systems have fragmented control systems, interfaces, and system drives. One of the inherent challenges is the need for manufacturers to understand and determine the level of automation and the opportunity it poses. Approaching automation and autonomy strategically will allow manufacturers to determine factors crucial to making decisions about investing in ML, AI, and other technologies.[44] Autonomy for cyber-physical machinery, advanced asset and energy management, machinery-centric real-time prescriptive data analytics for downtime mitigation, and energy usage are examples of relevant R&D.

The dynamics of the machinery, industrial controls, and automation sector are largely driven by flexibility with capacity and cost. Robust supply networks from supplier to customer are crucial for machinery manufacturers to remain competitive. Using geographic proximity, a network model could accelerate the development of, and reduce costs associated with, complex supply chains, particularly as new technologies are introduced to address critical components.

[44] https://www.mckinsey.com/business-functions/operations/our-insights/human-plus-machine-a-new-era-of-automation-in-manufacturing

APPENDIX J – CRITICAL MATERIALS COLLABORATIVE (CMC) INFORMATION

Critical minerals and materials initiatives involve multiple DOE offices to implement DOE's Vision and Strategy. DOE coordinates budget and mission crosscutting applied RD&D through the Critical Materials Collaborative (CMC). This funding announcement has been specifically coordinated through the CMC.

All selected projects under Topic 4 of this FOA will be required to participate as a member of the Critical Materials Collaborative (CMC), which is a coalition of DOE offices, federal agencies & federally-funded R&D programs to:

- Align the DOE research portfolio to achieve climate goals and crosscutting S&T objectives;
- Advance crosscutting applied RD&D related to critical minerals and materials;
- Accelerate the adoption and deployment of innovation;
- Nurture and expand the innovation ecosystem; and
- Facilitate scientific and technical exchange and discussion.

Principle investigators (PIs) or a member of their research team are expected to participate in coordination efforts including, an in-person annual symposium, virtual coordination meetings, and periodically give a presentation on research progress.

The proposed projects to this funding opportunity announcement should take into consideration possible leverage with the programs supported by other DOE program offices. There are no fees associated with participation in the CMC.

Projects funded by AMMTO as a result of this FOA will be encouraged to explore opportunities to coordinate with projects funded by other DOE Offices through the CMC, in order to maximize the scientific and technological impact.