FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

Department of Energy (DOE)
Office of Fossil Energy and Carbon Management (FECM)

Advancing Technology Development for Securing a Domestic Supply of Critical Minerals and Materials (CMM)

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002956
FOA Type: Modification 000002
Assistance Listing Number: 81.089 Fossil Energy Research and Development

FOA Issue Date:	09/25/2024
Submission Deadline for Full Applications:	11/26/2024 5:00 PM ET
FOA Modification 000001 Issue Date:	10/25/2024
FOA Modification 000002 Issue Date:	11/18/2024
Expected Date for Selection Notifications:	May 2025
Expected Date for Award:	September 2025

Awards issued under this Notice of Funding Opportunity (NOFO, previously Funding Opportunity Announcement (FOA)) will adopt the 2024 Revisions to 2 CFR.

Applicants may review a summary of changes at CFO.gov | Uniform Guidance: Title 2 of the Code of Federal Regulations.

Modifications

All changes to this Notice of Funding Opportunity (NOFO, previously Funding Opportunity Announcement (FOA)) as a result of Modification 000001 are highlighted in yellow.

Modification No.	Date	Description of Amendment
000001	10/25/2024	• Inserted 2024 Revisions to 2 CFR disclaimer on page 1. • Sections I.C. and I.D. updated to incorporate "bench-scale" and other language to clarify technical considerations concerning FOA AOI-1.
000002	11/18/2024	• Removed Strategic Partnership Projects requirement from Section IV.B.x. • Revised the compliance requirements box in Section IV.A., removing the "References" language to clarify that endnotes and footnotes are included in the page count; whereas the bibliography is not included in the page count. • Revised language concerning the photographs component of the requirements table in Section IV.B.ii.

- To apply to this FOA, applicants must register with and submit application materials through NETL eXCHANGE at https://NETL-Exchange.energy.gov/.

- Applicants must designate primary and backup points-of-contact in eXCHANGE with whom DOE 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.

- Applicants are discouraged from submitting information considered proprietary unless it is deemed essential for proper evaluation of the application. If the application contains information that the applicant organization considers to be trade secrets, information that is commercial or financial, or information that is privileged or confidential, the pages containing that information should be identified as specified in the application instructions. When such information is included in the application, it is furnished to the Federal government in confidence, with the understanding that the information will be used or disclosed only for evaluation of the application. The information contained in the application will be protected by DOE from unauthorized disclosure, consistent with the need for merit review of applications of financial assistance awards to assure the integrity of the competitive process and the accuracy and completeness of the information. If a Federal financial assistance award is made as a result of or in connection with an application, the Federal government has the right to use or disclose the information to the extent authorized by law. This restriction does not limit the Federal government's right to use the information if it is obtained without restriction from another source."

- **Unique Entity Identifier (UEI) and System for Award Management (SAM)** - Each applicant 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 (unless the applicant is excepted from those requirements under 2 CFR 25.110). 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 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. Authorizing Statutes

The programmatic authorizing statutes are:

- Public Law (PL) 95-91, DOE Organization Act, as amended
- P.L. 116-260, Div. Z, Energy Act of 2020, Title VII, Sec. 7001, as amended, codified at 42 U.S.C. 13344
  P. L. 109–58, Energy Policy Act of 2005, Title IX, § 902 (a)(3) codified at 42 U.S.C. 16181(a)(3)R

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

B. Background/Description

i. Background and Purpose

In 2023 the United States imported more than half its consumption for at least 39 of the 50 critical minerals (including the rare earth elements [REE])[1] designated by the Department of the Interior (DOI), with 15 of those critical minerals having no domestic production.[2] Additionally, the Department of Energy (DOE) has developed its own list of critical materials essential to clean energy technologies that includes aluminum (Al), cobalt (Co), copper (Cu), dysprosium (Dy), electrical steel, fluorine (F), gallium (Ga), iridium (Ir), lithium (Li), magnesium (Mg), natural graphite, neodymium (Nd), nickel (Ni), platinum (Pt), praseodymium (Pr), silicon (Si), silicon carbide (SiC), and terbium (Tb).[3] Together, the DOI and DOE's lists comprise the set of critical minerals and

[1] U.S. Geological Survey, Department of the Interior, Final List of Critical Minerals 2022, 87 Fed. Reg 10381 (February 24, 2022). https://www.federalregister.gov/documents/2022/02/24/2022-04027/2022-final-list-of-critical-minerals.

[2] U.S. Geological Survey, Department of the Interior, Mineral Commodity Summaries 2024, (January 31, 2024). https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf.

[3] U.S. Department of Energy, Notice of Final Determination on 2023 DOE Critical Materials List, https://www.federalregister.gov/documents/2023/08/04/2023-16611/notice-of-final-determination-on-2023-doe-critical-materials-list, 88 FR 51792 (Accessed June 14, 2024).

materials (CMM).[4] As evidenced by several Executive Orders,[5,6] the Bipartisan Infrastructure Law (BIL),[7] and DOE's first ever strategy on securing America's supply chains,[8] transitioning the production of these CMM and their associated supply chains back to the United States is a strategic priority.

The subject FOA focuses on rebuilding the U.S. leadership role in the economically viable, environmentally benign CMM extraction, separation, and refining technologies arena. Strengthening these domestic capabilities will support the generation of sustainable U.S. domestic supply networks for onshore production of CMM for the commercial commodities, clean energy, and national defense industries thereby reducing our dependence on international supply chains; the creation of high-quality U.S. jobs; and the Administration's goals of decarbonizing the electricity sector by 2035 and the economy by 2050.[9]

As part of the whole-of-government approach to advance equity and encourage worker organizing and collective bargaining,[10,11,12] this FOA and any related activities will seek to encourage meaningful engagement and participation of labor unions, underserved communities, and underrepresented groups including consultation with tribal nations.[13,14] Consistent with Executive Order 14052, this FOA is designed to help meet the goal that 40% of the overall benefits from certain Federal investments in climate and clean energy flow to disadvantaged communities though the Justice40 Initiative and to drive the creation of good-paying jobs through a focus on high labor standards and the free and fair chance for workers to join a union.

[4] By definition, CMM is inclusive of REE. In this FOA, REE is used in addition to CMM when there is a special emphasis placed on REE exclusive of other CMM.

[5] Executive Order 13817, A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals (December 20, 2017). *See also* U.S. Department of the Interior, Final List of Critical Minerals 2018, 83 Fed. Reg 23295 (May 18, 2018).

[6] Executive Order 14017, America's Supply Chains (February 24, 2021).

[7] Infrastructure Investment and Jobs Act, Public Law 117–58 (November 15, 2021) https://www.congress.gov/bill/117th-congress/house-bill/3684/text. This document uses the more common name "Bipartisan infrastructure Law" [Hereinafter BIL].

[8] https://www.energy.gov/policy/securing-americas-clean-energy-supply-chain.

[9] https://www.whitehouse.gov/wp-content/uploads/2021/10/US-Long-Term-Strategy.pdf.

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

[11] Executive Order 14025, "Worker Organizing and Empowerment" (April 26, 2021).

[12] Executive Order 14052, "Implementation of the Infrastructure Investment and Jobs Act" (November 15, 2021).

[13] Executive Order 13175, "Consultation and Coordination With Indian Tribal Governments" (November 6, 2000) charges all executive departments and agencies with engaging in regular, meaningful, and robust consultation with Tribal officials in the development of Federal policies that have Tribal implications.

[14] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/26/memorandum-on-tribal-consultation-and-strengthening-nation-to-nation-relationships/, "Memorandum on Tribal Consultation and Strengthening Nation-to-Nation Relationships" (January 26, 2021).

DOE has coordinated the Critical Minerals and Materials Program[15] around the following strategic pillars (Figure 1):

- **Diversify & Expand Supply:** Identify and secure substantial resources from a wide variety of feedstocks including primary and secondary sources, coproduced materials from existing operations, and international partners;
- **Develop Alternatives:** Produce new materials that have less disruption potential and design manufactured parts and systems that require little to no critical materials to function;
- **Materials and Manufacturing Efficiency:** Design for atom economy, reduce waste through efficient use, and improve overall efficiency of mining through manufacturing and recycling to minimize environmental impacts while maximizing yield; and
- **Circular Economy:** Remanufacture, refurbish, repair, reuse, recycle, and repurpose all materials that are used in a modern economy to extend the lifetime of materials and/or partially offset the need for virgin material extraction.

Figure 1. DOE's Critical Minerals and Materials Program strategic pillars.

DOE supports these strategy pillars by enabling activities, cross-cutting functions to enable and enhance research, development, demonstration, and deployment efforts across four areas: (1) Analysis & advanced tools; (2) Market assessment & development; (3) International engagement & standards; and (4) Education & workforce development.

[15] https://www.energy.gov/criticalmaterials.

The Office of Fossil Energy and Carbon Management (FECM) and the Advanced Materials and Manufacturing Technologies Office (AMMTO) are just two of many offices in the DOE working toward the goal of a sustainable domestic supply chain for the energy transition. To learn more, please visit https://www.energy.gov/cmm/critical-materials-around-department-energy. FECM and DOE, along with several other Federal agencies participate in the U.S. Geological Survey's Federal Mining Dialogue Critical Minerals Subcommittee. Together, these Federal agencies are working together "supporting demonstration projects to reprocess, reclaim, remediate and restore abandoned mine wastes".[16]

Since its inception in 2014, the FECM CMM Program (hereafter the CMM Program), formerly the Feasibility of Recovering Rare Earth Elements Program, has served to accelerate socially and environmentally sustainable domestic CMM resource characterization, extraction, and processing through its in-house research activity as well as the awarding of federal research dollars to academic, industry, and national lab partners with the goal of developing and maturing technologies that ensure responsible recovery while minimizing environmental impact. In 2014, work in FECM began by showing the feasibility of extracting REE from coal and coal byproducts and has since supported small pilot-scale REE extraction, separation, and refining facilities and now, in support of the Bipartisan Infrastructure Law, through demonstration-scale facilities. The CMM Program is focused on the following goals: i) validate the technical and economic feasibility of domestic small pilot-scale facilities to produce high-purity CMM from unconventional resources such as coal and coal-based resources and other secondary mining wastes,[17] ii) produce 1–3 tonnes/day of high-purity, mixed rare earth oxides/salts in domestic demonstration-scale facilities and refine to metals or alternative user-specified products with co-recovery of other CMMs as required for use in the CMM supply chain using coal-based and alternative resources as feedstock materials, and iii) develop a national prospectus of CMM and novel high-value, nonfuel carbon-based products.

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

[16] https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf, The White House, Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017 June 2021, p. 197.

[17] Secondary or unconventional feedstock materials include coal, coal mine waste/refuse, power generation ash, carbonaceous shale/clay, or other materials such as, but not limited to, hard rock mine waste, phosphogypsum (the solid waste byproduct from processing phosphate ore to make phosphoric acid used in the fertilizer industry), or red mud (from bauxite).

sector that accelerates the adoption of innovative materials and manufacturing technologies in support of a clean, decarbonized economy. AMMTO's Critical Minerals and Materials (CMM) portfolio addresses high-impact opportunities and challenges across the entire life cycle of high priority CMM for energy technologies.[18] One such high-impact opportunity is recycling of CMM. Recycling from end-of-life systems like electric vehicles and offshore wind turbines could eventually meet a significant percentage of the nation's critical materials requirement. Recycling can dramatically decrease cost, energy use, and water use compared to conventional mining. In the near term, sourcing rare earth elements by recycling electronic scrap (e-scrap), magnet swarf (magnet manufacturing waste), and other end-of-life materials and products can diversify the U.S. supply chain and further environmental sustainability.

This FOA further develops technologies to bring the U.S. to self-sufficiency and self-reliance in the REE and, more broadly, the CMM space.

As successful technology commercialization and deployment requires a ready workforce, recipients of an award under this FOA will be required to complete a Workforce Readiness Plan as part of the project. A suggested format for this Plan is contained in the "Workforce Readiness Plan Template" Appendix of this FOA. The Plan must include: (i) a description of the skillset and availability of the workforce; (ii) a description of the training required to prepare the workforce such as apprenticeships, certificates, certifications, or academic training; and (iii) if needed, a plan to collaborate with training providers or other stakeholders to develop necessary training that would not be otherwise available.

Societal Considerations and Impacts

To achieve the greatest impact for all Americans, it is critical that funded projects invest in America's workforce, mitigate new impacts, and deliver benefits to our communities. Projects that fail to do this may fail to gain social support, and may in turn decrease support for future projects.

To ensure projects offer opportunities and minimize negative impacts, applications must include a Societal Considerations and Impacts (SCI) package which includes:

- A Diversity, Equity, Inclusion, and Accessibility (DEIA) Plan;
- An Economic Revitalization and Job Creation Questionnaire; and
- An Environmental Justice Questionnaire.

[18] Critical Minerals and Materials | Department of Energy

If awarded, applicants must implement, evaluate, and update the DEIA Plan and questionnaires throughout the life of the project. These considerations are explained in more detail in Section C. Objectives Areas of Interest.

C. Objectives/Areas of Interest

The objective of DE-FOA-0002956 is to support DOE's current vision to develop secure, diverse, resilient, domestic CMM supply chains by expanding the Programs at FECM and AMMTO to fund additional processing research and development (R&D) for the recovery and refining of CMM, as required for critical supply chain use. The overall objectives of the FOA are to (1) continue to advance CMM technology development, not only in the area of new advanced recovery concepts, but also to (2) expand and improve process systems development, optimization, and efficiency, to (3) improve CMM process system economic feasibility and align production costs with existing market sectors, and to (4) produce CMM from multiple, diverse feedstocks including recycled materials. These objectives will be achieved by focusing R&D efforts on (a) coproduction of REE, other CMM, and non-fuel industrial carbon products from coal, coal waste and other unconventional carbon-based feedstocks, (b) new technology development for the recovery from unconventional feedstocks of individual heavy rare earth elements (HREE) and other CMM deemed most critical, (c) separation and recovery of CMM from produced water, especially oil and gas produced water, and (d) production of mixed rare earth oxides or salts (MREO/MRES) from multiple, diverse feedstocks including recycled materials, with the option of coproduction of other CMM or value-added materials.

Projects will advance existing CMM technology development through testing and validation of bench-scale to small pilot-scale facilities (or larger) focusing on the recovery of Li, HREE and other CMM deemed critical to the nation's supply chain and to meet critical supply chain needs utilizing secondary and unconventional feedstocks such as those described by the Department of Energy[19] and recycled materials in the case of area of interest (AOI)-4 only.

As a project deliverable, Recipients will be required to provide NETL with single split samples of materials produced in the performance of projects funded by this FOA. In addition, regarding analytical characterization data, Recipients will be required to provide the following information with unlimited rights:

[19] Granite, Evan J. February 2023, "Potential Resources from Abundant Domestic Wastes, Byproducts and Non-Traditional Sources", DOE Critical Minerals & Materials Workshop, Alaska Pacific University. Available online at https://www.energy.gov/sites/default/files/2023-04/doe-critical-minerals-materials-potential-resources-from-abundant-domestic-wastes-byproducts-non-traditional-sources.pdf.

- State-specific, county-specific, and site-specific information, as well as analytic characterization information (i.e., elemental concentrations, proximate/ultimate analyses, ash content, phase identification/concentrations, morphology information) for feedstock materials that are used or generated in the performance of projects funded by this FOA; and
- Analytical characterization data (i.e., elemental REE and/or CMM concentrations, REE and/or CMM percent purity, proximate/ultimate analyses, ash content, phase identification/concentrations, morphology (scanning electron micrographs (SEM) information), as well as REE and/or CMM percent recovery information, for MREO/MRES and/or CMM that are produced in the performance of projects funded by this FOA.

NETL will provide award Recipients access to an Excel spreadsheet template for entry of all analytical characterization data and information generated. NETL intends to make this information publicly available through inclusion of the Recipient's spreadsheet in NETL's Energy Data eXchange (EDX) database platform which can be found by accessing the following URL link: https://edx.netl.doe.gov/ree-cmm.

Area of Interest 1 - Coproduction of CMM and Carbon Manufacturing Precursor Materials from Coal, Coal Waste and Other Unconventional Carbon-based Feedstocks

Research Sought

U.S. Department of Energy-funded research has separately developed the use of secondary coal-based resources as feedstocks for CMM and carbon-based end-products.[20,21] These feedstocks have included run-of-mine coal, lignite, coal ash (fresh or legacy impounded) and combustion residuals, pre-combustion coal refuse, coal-based AMD, and carbonaceous sedimentary over/under-burden material. This AOI aims to integrate the production of CMM[22] (i.e., REE and other, coproduced CMM) and a carbon manufacturing precursor material (CMPM) from carbon-rich ore (such as coal or carbonaceous shale/clay) or waste into a single modular process circuit. CMPM is defined here as a purified carbon-based material (elemental carbon

[20] "DOE Invests $6 Million to Develop Useful Products from Coal and Coal Wastes in Support of a Clean Energy Economy," Energy.gov. Available: https://www.energy.gov/fecm/articles/doe-invests-6-million-develop-useful-products-coal-and-coal-wastes-support-clean.

[21] "Project Selections for FOA 3002: University Training and Research for Fossil Energy and Carbon Management," Energy.gov. Available: https://www.energy.gov/fecm/project-selections-foa-3002-university-training-and-research-fossil-energy-and-carbon.

[22] CMM production must include the production of REE and other CMM. If this cannot be achieved, then applicants must provide a rationale as to why this is not possible (e.g., the original resource feedstock material does not contain REE).

or bonded carbon in solid form) that is saleable to manufacturers of end-use products that may include, but are not limited to, activated carbons, coke, chars, (synthetic) graphite and carbon electrodes, graphene, nanocarbons, composites and alloys, carbon fibers, carbon building materials, carborundum (silicon carbide), and industrial diamonds. A successful CMPM must meet quality standards of the analogous commercial-grade carbon product(s) and be saleable without further processing. For the purposes of this AOI, synthetic graphite is considered a coproduced, value-added product and is not considered a CMM.

Proposed projects will require working or collaborating with an owner or operator of an existing bench-scale or small pilot-scale or larger facility producing CMM (with >90% purity) from secondary carbon-based feedstocks. The carbon-based feedstocks to be used in these R&D projects must be actual, sourced materials and not a synthesized or model compound, mixture, or fluid. If the feedstock used has already been through the CMM processing circuit, the sourced material mixed rare earth oxide/salt (MREO/MRES) must be produced from a bench-scale or small pilot-scale (or larger) facility. As necessary, carbon-based or carbon-containing feedstocks may undergo treatment to remove nitrogen (N), sulfur (S), and potentially hazardous species (e.g., Hg, As, Se, Cd, Sb, Pb) to an extent that the carbon content is comparable to commercial analogues (see Appendix L). Proposed R&D must include scope to characterize the quantity and fate of potentially hazardous species, during the process or in the produced material. This scope should include the experiments necessary to determine how hazardous species will be quantified in the gas, liquid, or solid byproducts and in the final CMPM itself.

The integration of the CMPM circuit must not require changes to the existing CMM processing steps being carried out at the bench-scale or small pilot-scale (or larger) facility. However, if the feedstock undergoes carbon separation before CMM extraction, the CMM process circuit may be modified to accept the carbon-depleted feedstock so long as CMM yield, purity, production time, or economics are not significantly affected. In this case, the applicant is required to qualify and quantify how, these items in the CMM process circuit would or would not be affected. Some minimal CMM-stream modification in the CMPM circuit is allowed so that the carbon-depleted feedstock is ready to “plug and play” into the CMM process circuit; however, this should not be the focus of an awarded project. Notably, CMM process circuit upgrades or optimization are not the focus of this AOI.

The CMPM circuit must be environmentally benign and should not affect the environmental safety of the CMM production operation. Colocation of the CMPM circuit with the CMM production plant is not required. The CMPM circuit should be at least a bench-scale (minimum scale required) or small pilot-scale unit (preferred),

and the design of the CMPM circuit should allow for integration into other existing bench-scale or small pilot-scale (or larger scale) operations extracting CMM from (secondary) carbon-based feedstocks with comparable methods. Applicants must provide a technical description of the source of the carbon-based feedstock, including its availability and chemical composition including percent of impurities (impurities profile), percent carbon content, and percent ash content. Applicants/projects must also provide a detailed description of the integrated CMPM and CMM process circuits, and a CMPM analysis and testing plan to demonstrate material properties and purity comparable to commercial analogues. Once the CMPM is characterized, projects must pass a Go/No-Go decision point to advance to the next stage of testing (see FOA section VI. B. xii for details).

With authorization to pass the Go/No-Go decision point, projects will manufacture a proof-of-concept prototype end-use product (e.g., graphite) from their CMPM for bench-scale testing and analysis of product performance metrics. The prototype must be of a form that is sufficient to demonstrate relevant performance characteristics, but does not need to resemble the final product to be sent to market. For example, a coin cell test could be used to validate an experimental CMPM-derived Li-ion battery anode. Similarly, experimental CMPM-derived activated carbons could undergo sorbent testing (following existing/established standards, where applicable) to show successful performance. The end-use prototype must be created with the experimentally-produced CMPM, and may only be mixed with commercial carbon feedstocks to a degree that simulates the production process of the consumer-grade end-use product. Applicants are encouraged to pursue R&D partnerships with industry or academic researchers if prototype production would require substantial funds to purchase manufacturing and testing equipment. The manufacture and testing of the prototype should be developed only to a level that achieves proof-of-concept demonstration and the proposed effort for this task(s) should be the minimal amount of total personnel hours and equipment/supply costs necessary to meet the AOI objective. The manufacture and testing of the prototype are not a major focus of the project. Projects should compare the CMPM-prototype performance metrics to that of a commercially-made product in order to show CMPM can be used to meet or exceed current standards of performance.

Applicants should perform a preliminary techno-economic analysis (TEA)[23] that discusses market size, required selling price of the CMPM product, gross revenue,

[23] A preliminary techno-economic analysis (TEA) could be similar in scope to an AACE Class 5 estimate as defined in 18R-97: Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries (aacei.org). Additional information can be found in Appendix M for a high-level TEA to be conducted during the performance of the award.

predicted compound annual growth rate (CAGR) of the market, and predicted operating costs (including carbon-based feedstock acquisition, transport, and processing; see Appendix L). Projects at this stage are not required to achieve economically viable production volumes of CMPM but should demonstrate a clear plan for scaling of the CMPM circuit technology toward defined economic targets. Successful projects will update their original Appendix L submission and provide a more detailed TEA during the performance of their award.

Technical Elements that must be included in AOI-1 applications include:

- A letter of commitment from the CMM-facility partner for collaboration with an existing CMM bench-scale or small pilot-scale (or larger) facility using carbon-based feedstocks, if the Applicant is not the owner of the CMM-facility.
- A letter of support from any company, agency, or other party that has ownership/rights to any proposed feedstock materials where applicable (e.g., if utilizing coal ash, please provide a letter of support from the power or coal company who is producing the ash). If no letters of support can be obtained, please provide an explanation in the Project Narrative as to why they are not necessary, or how the necessary samples/data needed for research are intended to be obtained.
- A detailed description, including applicable photographs, of the existing CMM production facility and process circuits. The photo(s) should include some reference gauge of dimension (e.g., a quarter, a person, etc.), and should also include captions describing the circuit(s) depicted.
- A clear experimental plan that includes process flow diagrams with mass and energy fluxes during normal CMM production and after the addition of the CMPM circuit, as well as target CMPM properties based on commercial analogues.
- A description of the CMM circuit and the CMM to be produced from the CMM circuit. The CMM circuit used must produce REE in addition to other CMM (not just REE alone or other CMM exclusive of REE). If this cannot be achieved, then applicants must provide a rationale in the Project Narrative as to why this is not possible (e.g., the original resource feedstock material does not contain REE).
- A clear plan for manufacturing of the end-use prototype and analysis of performance characteristics, including success metrics and material requirements, that is within the allotted budget constraints for execution of the project.
- A completed CMPM State Point Data Table (Appendix L) including a high-level techno-economic analysis (TEA) of the CMPM-CMM production operation. The TEA should include justification as to how the research will be economically and technologically advantageous when compared to conventional methods and techniques, including a current techno-economic evaluation of the carbon-based feedstock material(s) used. This evaluation should define the quantity and quality of the carbon-based feedstock material(s); estimate maintenance costs, waste disposal

costs, or any other financial burdens associated with the carbon-based feedstock; and provide any information regarding current concentration and composition estimates of REE and other CMM contained within the carbon-based feedstock.

- Description of all byproducts of the proposed work in detail. Predicted waste materials should be described in terms of volume, toxicity, potential radioactivity, reusability, and disposal methods.
- A detailed research proposal and estimated timeline of research work and development.

Anticipated Technology Readiness Level

Beginning of project: Technologies proposed for development must have a beginning TRL 3.

- TRL 3: Analytical and experimental critical function and/or characteristic proof of concept.

End of project: Technologies should have a goal to advance to TRL 5 or 6.

- TRL 5: Laboratory/bench scale, similar system validation in relevant environment.
- TRL 6: Engineering/pilot-scale, similar (prototypical) system validation in relevant environment.

Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned.

Success Metric(s)

Successful projects will develop a bench-scale (minimum scale required) or small pilot-scale (preferred) CMPM production circuit that can integrate with an existing CMM bench-scale or small pilot-scale (or larger) facility that uses carbon-based feedstocks. A proof-of-concept prototype product will be made from the experimentally produced CMPM and tested for performance characteristics. Testing should demonstrate that the experimentally-produced CMPM meets or exceeds current standards of performance as required for application in the desired manufactured product(s).

Technology Maturation Plan

A technology maturation plan (TMP) is not required with the application. However, a TMP will be required as a deliverable under the award. A draft TMP is required within 90 days of award, and a final TMP is due within 90 days of project completion.

Workforce Readiness Plan

A Workforce Readiness Plan will be required as a deliverable in the SOPO for AOI-1.

Societal Considerations and Impacts (SCI)

Diversity, Equity, Inclusion, and Accessibility Plan

DOE supports opportunities that improve job access and foster safe, healthy, and inclusive workplaces and communities. Applicants are highly encouraged to include individuals from groups historically underrepresented[24,25] in Science Technology Engineering and Mathematics (STEM) and/or applicable workforces on their project teams. Minority Serving Institutions[26], Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to apply as the prime applicant or participate on an application as a proposed partner to the prime applicant.

Applicants are also required to describe how diversity, equity, inclusion, and accessibility objectives will be incorporated throughout the life of the project in a

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

[25] See also. Note that Congress recognized in Section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329: (1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

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

Diversity, Equity, Inclusion, and Accessibility Plan ("DEIA Plan") that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM and/or applicable workforces, advance equity, and encourage the inclusion of individuals from these groups in the project. The plan should include at least one SMART (Specific, Measurable, Assignable, Realistic and Time-Related) milestone per budget period supported by metrics to measure the success of the proposed actions. This plan will be evaluated as part of the technical review process. If awarded, applicants must implement, evaluate, and update these plans throughout the life of the project. In addition, applicants will be required to report on DEIA progress and outcomes throughout the project lifecycle and the final report if selected.

Questionnaires

An "Economic Revitalization and Job Creation Questionnaire" is provided as FOA Appendix J. A completed Economic Revitalization and Job Creation Questionnaire will be required for this AOI as an attachment to the final report, and a preliminary Economic Revitalization and Job Creation Questionnaire will also be required with applications and evaluated for this AOI. (The preliminary version will later be updated in the final report.)

An "Environmental Justice Questionnaire" is provided as FOA Appendix K. A completed Environmental Justice Questionnaire will be required for this AOI as an attachment to the final report, and a preliminary Environmental Justice Questionnaire will also be required with applications and evaluated for this AOI. (The preliminary version will later be updated in the final report.)

Area of Interest 2 - Recovery of Heavy Rare Earth Elements (HREE) from Secondary and Unconventional Resources

Research Sought

Critical mineral and material extraction technologies typically begin with mineral and material processing, that includes but is not limited to crushing, grinding, density separations, and magnetic separations. Recovery of rare earth elements and/or critical minerals and materials typically employs either energy-intensive pyrometallurgical or reagent-intensive hydrometallurgical techniques or a combination of the two. Pyrometallurgical methods utilize heating feedstock to temperatures ranging from 300 – 1600 °C and are more efficient for higher-grade ores. Hydrometallurgical methods are more suited to lower-grade ores and are conducted at much lower temperatures (i.e., less than 200 °C). Hydrometallurgical

methods use large and costly volumes of reagents such as sulfuric acid (H_2SO_4), nitric acid (HNO_3), and hydrochloric acid (HCl) and create large volumes of both liquid and solid industrial wastes and often times produce large volumes of toxic and potentially radioactive materials.[27,28]

Separation of the individual rare earths from each other is difficult due to their highly similar atomic properties and common form as stable trivalent ions. Rare earth solvent extraction (SX) processes—the most commonly used method for recovery—are generally classified as primary separations, which focus on separating REE from gangue materials, and secondary separations, which produce single or mixed (typically 2 or 3) rare earth products from mixed rare earth streams that are produced by primary separations. Up to hundreds of stages of mixers and settlers may be assembled to achieve the necessary extent of separation and product purity. Commercially, D2EHPA, HEHEHP, Versatic 10, TBP, and Aliquat 336 have been widely used in rare earth SX processes.[29,30] Due to stringent environmental regulations in the U.S., these industrial reagents are typically handled and disposed of in an environmentally safe and benign manner, especially when compared to countries with less restrictive environmental laws or lax enforcement.

Relative to light rare earth elements (LREE), heavy rare earth elements (HREE) are often nonexistent or found in limited quantities in industry's conventional feedstock materials. Coal-based resources, in contrast, are known to contain higher HREE concentrations in comparison to conventional feedstock materials. When present, HREE currently require more intensive processing than separation and recovery of traditionally separated LREE.[31] To advance manufacturing of critical Clean Energy and National Security defense components, HREE as terbium (Tb) and dysprosium (Dy) are essential. Therefore, production of HREE at reduced costs from coal-based and/or other alternate unconventional resources is the focus of AOI-2.

Projects under this AOI will use conventional separations technologies or, preferably, build upon conventional technologies to develop new, advanced, unconventional REE extraction, separation, and refining concepts at the bench-scale,

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[27]Y. He, S. H. Guo, K. H. Chen, S. W. Li, L. B. Zhang and S. H. Yin, "Sustainable green production: a review of recent development on rare earths extraction and separation using microreactors," ACS Sustainable Chemistry & Engineering, vol. 7, no. 21, 2019.
[28] F. Xie, T. A. Zhang, D. Dreisinger and F. Doyle, "A Critical Review on Solvent Extraction of Rare Earths from Aqueous Solutions," Minerals Engineering, vol. 56, pp. 10-28, 2014.
[29]D. Kołodyńska, D. Filla, B. Gajda, J. Gęga and Z. Hubicki, "Rare Earth Elements—Separation Methods Yesterday and Today," Applications of Ion Exchange Materials in the Environment, pp. 161-185, 2019.
[30]B. Fu, J. C. Hower, W. Zhang, G. Luo, H. Hu and H. Yao, "A Review of Rare Earth Elements and Yttrium in Coal Ash: Content, Modes of Occurrences, Combustion Behavior, and Extraction Methods," Progress in Energy and Combustion Science, vol. 88, 2022.
[31] DOE. (2017). Report to Congress: Report on Rare Earth Elements from Coal and Coal Byproducts. Retrieved from https://www.energy.gov/sites/prod/files/2018/01/f47/EXEC-2014-000442%20-%20for%20Conrad%20Regis%202.2.17.pdf

small pilot-scale, and/or larger-scale. Technologies may include, but are not limited to, hydro-, pyro-, and bio-metallurgy, electrochemical, mechanochemical, and supercritical fluid technology, hydrogen decrepitation, and ionic liquid technology, and methods such as liquid-liquid extraction separation, liquid-solid separation, supported liquid extraction, column chromatographic separation, or solid extraction and separation. Projects will be required to produce a minimum of four (4) HREE, with primary focus on Tb and Dy and secondary focus on other HREE (gadolinium (Gd), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu)). A minimum of 1-5 g of high-purity (>99-99.99% purity) individually separated HREE shall be produced for each targeted HREE. Note: Although yttrium (Y) is classified as an HREE, it is not the focus of this AOI; applications that plan to include Y production must still meet the requirement of producing a minimum of four other HREE.

The primary objective of this AOI is to improve the techno-economics of the production of *individual* market-ready, high-purity (e.g., ≥99-99.99%) heavy rare earth metals, oxides, and/or compounds from secondary and unconventional sources.[32] Emphasis must also be placed on the overall reduction of produced waste materials (e.g., in terms of hazards, toxicity, and volume) and the improvement of their manageability (disposability, reusability, possible salability, etc.). A high-level techno-economic analysis (TEA)[33] must be completed (preliminary-level for application submission) that provides direct comparison to conventional separation and refining techniques or methods that produce similar end-products and includes produced waste materials and disposal costs. Waste materials should be described in terms of volume, toxicity, potential radioactivity, reusability, disposal methods, and other applicable details. Projects at this stage are not required to achieve economically viable production volumes of HREE or other coproduced CMM but should demonstrate a clear plan for scaling of the proposed technology toward defined economic targets.

Research goals *must* include individually separated Tb and Dy market-ready end-products (typically high-purity grades of ≥99.9% and ≥99.5%, respectively) for use in domestic supply chains. **Projects must use actual concentrates of MREO/MRES and CMM, if CMM is applicable, as their R&D feedstock for this work. These feedstocks must have been produced from already existing bench-scale, small pilot-scale, or larger-scale facilities that extracted MREO/MRES and CMM from secondary or unconventional resources.** This AOI is not requiring development of or work on the input circuit (i.e., hydrometallurgical or physical beneficiation stages that result in

[32] "Domestic Wastes and Byproducts: A Resource for Critical Material Supply Chains", Evan J. Granite, Grant Bromhal, Jennifer Wilcox, and Mary Anne Alvin, National Academy of Engineering, The Bridge, 53(3), 59-66, Fall 2023, available online at https://www.nae.edu/300449/Domestic-Wastes-and-Byproducts-A-Resource-for-Critical-Material-Supply-Chains.
[33] TEA, *supra* note 23.

the production of MREO/MRES and CMM concentrates). Optimization and/or modification of this circuit is allowable; however, it must not be the focus of this AOI. Co-recovery of additional CMM (e.g., gallium (Ga), germanium (Ge), others), and especially additional HREE beyond the minimum of four HREE this AOI requires, is encouraged. Model compounds and/or synthetic mixtures are not considered adequate feedstock materials and should not be used for R&D.

Applicants must demonstrate that produced materials resulting from this AOI will be of equal or better quality than similar materials currently used in domestic manufacturing of supply chain intermediate and/or end-use products. Applicants must demonstrate that their proposed materials are currently in demand or that there is clear anticipation of near-term domestic demand (e.g., relevant manufacturing projects currently in development; terbium in REE magnets or mobile phone batteries, etc.). Applicants should provide an overview of the supply chain(s) and market(s) relevant to their proposed end-product(s) and clearly demonstrate which step(s) of the supply chain would be affected by a successful outcome of their project.

Partnerships and collaboration with industry stakeholders, experts, and/or supply chain end-users is required. Guidance and support from these partners and collaborators to inform the applicant on product development and specifications and purities needed for use in American industry is also encouraged. Letters of support from these partners are encouraged.

Technical Elements that must be included in AOI-2 applications include:

- A clear description of the secondary or unconventional feedstock material(s) used as the initial resource for recovery of REE and CMM, a clear description of the circuit(s) that precede production of the MREO/MRES that will be used in the effort, and similarly, a clear description of the process to produce the HREE (and other CMM, as applicable).
- Use concentrates of MREO/MRES and CMM (if CMM are applicable), produced in bench-scale, or, more preferably, small pilot-scale (or larger) facilities that use secondary or unconventional feedstocks at the start of processing.
- A description of each individually separated HREE (oxide or metal) (or equivalent compound) (minimum of four HREE excluding Y required) that will be the focus of the proposed work, the expected resultant products (i.e., phase, composition, and purity), and where these materials fit into their respective supply chains, providing examples of current domestic consumers of such materials.

- A list and description of additional CMM (or equivalent compounds), if any, that are expected to be produced as corecovered materials as a result of the proposed work. Relevant details should be provided including phase, composition, and purity and where these materials fit into their respective supply chains including providing examples of current domestic consumers of such materials.
- A detailed research proposal and estimated timeline of research execution and development.
- A preliminary TEA that demonstrates techno-economic viability and competitiveness as to the cost of producing individually separated HREE and CMM, if any, using commercial solvent extraction or metallothermic reduction to metals in comparison to the advanced processing being proposed.
- A justification as to how the research will be economically and technologically advantageous when compared to conventional separation and refining methods and techniques, including produced waste materials and disposal costs.
- A description of expected waste materials in terms of volume, toxicity, potential radioactivity, reusability, disposal methods, and other applicable details.
- Letters of support from any company, agency, or other party that has ownership/rights to any proposed feedstock materials where applicable (e.g., if utilizing coal ash, please provide a letter of support from the power or coal company who is producing the ash). If no letters of support can be obtained, please provide an explanation in the Project Narrative as to why they are not necessary, or how the necessary samples/data needed for research are intended to be obtained.
- A letter of commitment from the CMM facility partner for collaboration with a CMM bench-scale or small pilot-scale (or larger) facility using secondary and unconventional feedstocks, if Applicant is not the owner of the CMM facility.
- A detailed description, including applicable photographs, of the existing CMM production facility and process circuits. The photo(s) should include some reference gauge of dimension (e.g., a quarter, a person, etc.), and should also include captions describing the circuit(s) depicted.

Anticipated Technology Readiness Level

Beginning of project: Technologies proposed for development must have a beginning TRL 2-3.

- TRL 2: Technology concept and/or application formulated.
- TRL 3: Analytical and experimental critical function and/or characteristic proof of concept.

End of project: Technologies should have a goal to advance to TRL 5 or 6.

- TRL 5: Laboratory/bench scale, similar system validation in relevant environment.
- TRL 6: Engineering/pilot-scale, similar (prototypical) system validation in relevant environment.

Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned.

Success Metric(s)

Any proposed technique or method must extract, separate, and/or refine heavy rare earth oxides, metals, or compounds that are of similar or higher purity than materials currently produced via conventional separation and/or refining technologies. Successful projects will recover a minimum of four HREE including Tb, Dy, and at least two others (not including Y). Successful projects will produce HREE, and, if applicable, coproduce CMM to market-ready and/or end-market product specifications. Tb and Dy products should be produced at high-purity grades of ≥99.9 and ≥99.5%, respectively, or ultra-high purity (≥99.99%), meeting industry's specifications for the supply chain material(s) of interest.

Successful projects will demonstrate economically efficient production of consumer-grade rare earth oxides, metals, or compounds or a clear path to achieving defined economic targets. Applicants/projects must provide preliminary and final TEAs of their proposed techniques, methods, and products in comparison to current conventional and relevant commercially viable extraction, separation, and refining processes, in addition to any other similar research.

Projects will need to address in the TMP, and elsewhere, as applicable, potential future scale up of the advanced HREE separation and refining processes being developed in their application. Discussion should involve implementing a scaled-up process into the footprint of an integrated facility such as the DOE BIL-funded REE Demonstration Facility.[34,35]

[34] BIL, *supra* note 7.
[35] https://netl.doe.gov/node/12069.

Technology Maturation Plan

A technology maturation plan (TMP) is not required with the application. However, a TMP will be required as a deliverable under the award. A draft TMP is required within 90 days of award, and a final TMP is due within 90 days of project completion.

Workforce Readiness Plan

A Workforce Readiness Plan will be required as a deliverable in the SOPO for AOI-2.

Societal Considerations and Impacts (SCI)

Diversity, Equity, Inclusion, and Accessibility Plan

DOE supports opportunities that improve job access and foster safe, healthy, and inclusive workplaces and communities. Applicants are highly encouraged to include individuals from groups historically underrepresented[36,37] in Science Technology Engineering and Mathematics (STEM) and/or applicable workforces on their project teams. Minority Serving Institutions[38], Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to apply as the prime applicant or participate on an application as a proposed partner to the prime applicant.

Applicants are also required to describe how diversity, equity, inclusion, and accessibility objectives will be incorporated throughout the life of the project in a

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

[37] See also. Note that Congress recognized in Section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329: (1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

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

Diversity, Equity, Inclusion, and Accessibility Plan ("DEIA Plan") that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM and/or applicable workforces, advance equity, and encourage the inclusion of individuals from these groups in the project. The plan should include at least one SMART (Specific, Measurable, Assignable, Realistic and Time-Related) milestone per budget period supported by metrics to measure the success of the proposed actions. This plan will be evaluated as part of the technical review process. If awarded, applicants must implement, evaluate, and update these plans throughout the life of the project. In addition, applicants will be required to report on DEIA progress and outcomes throughout the project lifecycle and the final report if selected.

Questionnaires

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Area of Interest 3 - Critical Mineral Recovery from Produced Water

Research Sought

A primary challenge to securing a U.S. lithium (Li) supply chain is a lack of domestic production opportunities. Current global Li production from brines is highly climate-dependent, relying on open-air evaporation of continental brines in arid environments to sufficiently concentrate dissolved Li for commodity production. As an alternative to traditional continental or seawater brine feedstocks, oil and gas (O&G) waste brine commonly contains several hundred ppm Li and is being explored as an unconventional resource for U.S. Li production. Combined onshore and offshore U.S. O&G operations in 2021 produced more than one trillion gallons of waste brine, roughly a 20% increase from 2007, and of which only 0.05% was

beneficially reused outside the O&G industry.[39] If commercial-scale is achieved, Li extraction from O&G produced water (OGPW) could yield megatonne-scale domestic Li production, reducing our reliance on foreign imports.[40] For the purposes of AOI-3, the general term produced water (PW) will be used as inclusive of produced water associated with fossil energy and carbon management (FECM) operations such as oil and gas produced water, extracted water from carbon storage operations, and produced water associated with subsurface gas hydrate production. Produced water from geothermal drilling operations or surface water from O&G wastewater pits are not of interest.

Bench- to pilot-scale research has achieved Li extraction from a variety of synthetic and natural aqueous solutions including geothermal brines and OGPW. Research is needed to improve upon leading technologies for Li extraction from PW which, relative to continental and seawater brines used in traditional Li extraction, have notably dilute Li^+ ion concentrations and high proportions of inhibitory matrix components like Mg^{2+} ions and organic material, creating unique challenges for commercial scale-up. Successful Li extraction techniques must optimize Li-ion selectivity (ability to isolate Li from the chemical matrix), separation efficiency (proportion of Li extracted from the feedstock), Li recovery (proportion recovered from the extracting phase), and material lifetime (resistance to the technology's physical degradation).[41] Direct lithium extraction (DLE) involves the selective extraction of lithium ions directly from lithium-rich liquid feedstocks. Compared to traditional Li extraction techniques, DLE allows for reduced water consumption, faster extraction rates, and reduced environmental impact.

Under this AOI, projects should not propose development of new Li extraction technologies, but, instead, should scale-up existing bench-scale Li extraction technologies to that of a small pilot-scale processing facility. Projects must provide a letter of commitment from an industry partnership(s) granting access to PW from an operation with workable Li concentrations for use in project conduct. PW samples must be pretreated,[42] preferably by the sourcing partner using conventional methods, to remove suspended particulates, oil droplets, microbes, dissolved organics, and scale-forming divalent ions such as Ca^{2+}, Sr^{2+}, Ba^{2+}, and SO_4^{2-}. If lacking pretreatment capabilities, applicants are encouraged to pursue slipstream samples

[39] Ground Water Protection Council, "U.S. Produced Water Volumes and Management Practices in 2021," 2022. Available: https://www.gwpc.org/wp-content/uploads/2021/09/2021_Produced_Water_Volumes.pdf.

[40] A. Kumar, H. Fukuda, T. A. Hatton, and J. H. V. Lienhard, "Lithium Recovery from Oil and Gas Produced Water: A Need for a Growing Energy Industry," *ACS Energy Lett.*, vol. 4, no. 6, pp. 1471–1474, Jun. 2019, doi: 10.1021/acsenergylett.9b00779.

[41] O. Murphy and M. N. Haji, "A review of technologies for direct lithium extraction from low Li+ concentration aqueous solutions," *Frontiers in Chemical Engineering*, vol. 4, 2022.

[42] N. Siefert and M. Wenzlick, "Standard Water Treatment Techniques and their Applicability to Oil & Gas Produced Brines of Varied Compositions," Routledge, New York, NY, US, DOE/NETL-2021/2800, Jun. 2022. doi: 10.1201/9781003091011-3.

from regional clean brine (from PW) treatment facilities rather than PW direct from the well pad. Applicants are required to use actual PW and may not use model compounds or synthesized materials for R&D or in the performance of the scope of work. R&D related to PW pretreatment is within the purview of the NETL Water Management Program[43] and will not be funded under this AOI, nor should applicants propose to purchase capital equipment related to pretreatment. Applicants may query areas of interest using Department of Energy online resources[44,45] which report REE and non-REE CMM concentrations of OGPW nationwide. Coproduction of CMM (e.g., Ni, Co, Mg, Mn, Ge, Ga, other) at sufficient purity for sale to midstream or downstream processors, and sufficient volume to benefit process economics, is viewed as an enhancement to the project but is not required. Similarly, extraction/coproduction of REE (e.g., Nd, Pr, Dy and Tb, other HREE) is preferred, but is not required. Lithium production is the primary focus of this AOI, and any coproduction of any material, if proposed, is a secondary focus.

Applicants must justify any proposed coproduction of REE or other CMM (at a minimum recovery processing level of pre-concentrates of MREO/MRES or other CMM) by including support information regarding the market need, potential users or offtakers as well as purity, volume, and economic data estimates in their application. Applicants must show that the coproduced product(s) meet(s) existing market (or offtaker) specifications and demand in order to justify the benefit of coproduction. Projects are not required to further process or refine any of the coproduced REE or other CMM (except Li), if coproduction is part of the proposed project. If coproduction is proposed, projects may partner with existing CMM bench or small pilot-scale (or larger) facilities for demonstration purposes, but this effort should be minimal and does not need to be colocated.

Projects should address challenges related to Li extraction technology scale-up while considering Li^+ capacity, selectivity, separation efficiency, recovery, regeneration, cyclical stability, thermal stability, environmental durability, product quality, extraction time, and energy consumption. Regarding acid-intensive processes, projects should minimize waste production and must characterize waste stream composition, toxicity, refinement/re-use potential, and appropriate disposal methods. Lithium extraction technologies of interest may include technologies for DLE, but are not limited to, solid adsorbent, non-electrochemical membrane, solvent extraction, electrochemical system (battery or membrane), and any relevant sub-category. Applications may generate reusable water as a product or a byproduct

[43] National Energy Technology Laboratory, "Water Management Program," [Online]. Available: https://netl.doe.gov/carbon-management/water-management.
[44] N. Siefert, Z. Belarbi, and M. Wenzlick, "NEWTS USGS Produced Waters Database." [Online]. DOI: 10.18141/1890178.
[45] Department of Energy, "National Critical Minerals Data Dashboard." [Online]. Available: https://arcgis.netl.doe.gov/portal/apps/dashboards/284f6103948b4080b604d311509df50e.

from PW; however, reusable water is not the focus of this AOI. Reusable water as a product from PW is within the purview of the NETL Water Management Program[46] and applications that propose R&D in this area will not be funded.

Projects should describe how the proposed technology improves upon the logistical and environmental shortcomings of traditional evaporative extraction, namely the depletion of freshwater resources, the generation of large amounts of solid waste and labile contaminants, long production times (>1 year from brine extraction), requirement of high Li concentration in brine (>500 ppm), and restriction to arid environments.

Applications/projects must identify the following performance and production parameters (applications: estimates/projections; selected projects: actual values based on Li small pilot-scale facility operations):

- Expected Li processing facility total annual capacity in terms of gallons of PW throughput;
- The Li processing facility utilization timeline attributed to the proposed project (i.e., the timeline should present how much of the project time will be directed to shakedown, testing, continuous operation);
- The projected annual production capacity for Li and, if proposed, for coproduced REE and/or other CMM if the Li processing facility is fully operational;
- The amounts of Li and coproduced REE and/or other CMM resulting from the proposed project; and
- The identity and descriptions of the purities of the Li and coproduced product(s), impurity profiles, and waste products.

Technical Elements that must be included in AOI-3 applications include:

- A clear description of the Li extraction technology that the application considers for scale up. The description must include the technical challenges and aspects of the technology that are being improved, if any, in this project compared to technology at the bench/lab scale.
- A clear description of the intended end-use of extracted Li and associated requirements for purity and product phase being produced (e.g., lithium carbonate).
- A description, if applicable, of each coproduced REE or other CMM and the expected product phase. Any description(s) should include purity, volume, potential users or offtaker need, and economic data estimates to justify the benefits of coproduction.

[46] Water Management Program, *supra* note 43.

- A description of all byproducts of the proposed work, including unused experimental PW sample material. Any predicted waste materials should be described in terms of phase, composition, volume, toxicity, potential radioactivity, reusability, and disposal methods.
- A detailed research proposal and estimated timeline of research work and development.
- Letters of support from any company, agency, or other party that has ownership/rights to any proposed feedstock material(s) where applicable. If no letters of support can be obtained, please provide an explanation in the Project Narrative as to why they are not necessary, or how the necessary samples/data needed for research are intended to be obtained.
- Justification as to how the technology being scaled up and tested will be economically and technologically advantageous when compared to conventional methods, techniques, and processes, including a current technical and economic evaluation of feedstock materials (i.e., the water from the PW well(s) selected by the Applicant) that defines the quantity and quality of feedstock material, estimates of maintenance costs, waste disposal costs, or any other financial burdens associated with the feedstock, and any information regarding current estimates of REE and other CMM contained within the feedstock.
- If a partnership with an existing CMM production facility is proposed for processing coproduced pre-concentrates of MREO/MRES and other CMM, provide a detailed description, including applicable photographs, of the existing CMM production facility and process circuits. The photo(s) should include some reference gauge of dimension (e.g., a quarter, a person, etc.), and should also include captions describing the circuit(s) depicted.
- If a partnership with an existing CMM production facility is proposed for a demonstration of processing of coproduced pre-concentrates of MREO/MRES and other CMM, if applicable, provide a letter of commitment from the CMM facility partner, if the Applicant is not the owner of the CMM facility.

Anticipated Technology Readiness Level

Beginning of project: Technologies proposed for development must have a beginning TRL of 3.

- TRL 3: Analytical and experimental critical function and/or characteristic proof of concept.

End of project: Technologies should have a goal to advance to TRL 6.

- TRL 6: Engineering/pilot-scale, similar (prototypical) system validation in relevant environment.

  Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned.

  Success Metric(s)

  Success will be quantified by:

  Production of high-quality data that clearly demonstrates:

- Improvement in the recovery, efficiency, material durability, energy consumption, waste production, economics, and/or environmental cost of Li separated from OGPW by the studied Li extraction method relative to published demonstrations of comparable Li extraction methods where applicable.
- A first achievement of Li extraction at small pilot-scale from OGPW using the selected technology if previously published attempts found significant technological issues.
- Highly desired (but not required): Coproduced REE or other CMM at acceptable volume and purity for end-use applications specified by the Applicant. The demonstrated technology does not need to improve upon existing extraction techniques that are dedicated to coproduction of REE or other CMM.
- Continuous operation of the small pilot-scale facility for a period of time (e.g., 3 to 6 months) to demonstrate its capability to produce materials (e.g. Li, coproduced REE or other CMM, etc.) in sufficient quantity to prove the viability of the facility. These data points will be required in the final report.

  Technology Maturation Plan

  A technology maturation plan (TMP) is not required with the application. However, a TMP will be required as a deliverable under the award. A draft TMP is required within 90 days of award, and a final TMP is due within 90 days of project completion.

  Workforce Readiness Plan

  A Workforce Readiness Plan will be required as a deliverable in the SOPO for AOI-3.

Societal Considerations and Impacts (SCI)

Diversity, Equity, Inclusion, and Accessibility Plan

DOE supports opportunities that improve job access and foster safe, healthy, and inclusive workplaces and communities. Applicants are highly encouraged to include individuals from groups historically underrepresented[47,48] in Science Technology Engineering and Mathematics (STEM) and/or applicable workforces on their project teams. Minority Serving Institutions[49], Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to apply as the prime applicant or participate on an application as a proposed partner to the prime applicant.

Applicants are also required to describe how diversity, equity, inclusion, and accessibility objectives will be incorporated throughout the life of the project in a Diversity, Equity, Inclusion, and Accessibility Plan ("DEIA Plan") that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM and/or applicable workforces, advance equity, and encourage the inclusion of individuals from these groups in the project. The plan should include at least one SMART (Specific, Measurable, Assignable, Realistic and Time-Related) milestone per budget period supported by metrics to measure the success of the proposed actions. This plan will be evaluated as part of the technical review process. If awarded, applicants must implement, evaluate, and update these plans throughout the life of the project. In

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

[48] See also. Note that Congress recognized in Section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329: (1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

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

addition, applicants will be required to report on DEIA progress and outcomes throughout the project lifecycle and the final report if selected.

Questionnaires

An "Economic Revitalization and Job Creation Questionnaire" is provided as FOA Appendix J. A completed Economic Revitalization and Job Creation Questionnaire will be required for this AOI as an attachment to the final report, and a preliminary Economic Revitalization and Job Creation Questionnaire will also be required with applications and evaluated for this AOI. (The preliminary version will later be updated in the final report.)

An "Environmental Justice Questionnaire" is provided as FOA Appendix K. A completed Environmental Justice Questionnaire will be required for this AOI as an attachment to the final report, and a preliminary Environmental Justice Questionnaire will also be required with applications and evaluated for this AOI. (The preliminary version will later be updated in the final report.)

Area of Interest 4 - Process Diversification: Production of Rare Earth Elements from Secondary/Unconventional Resources and Recycled Materials

Research Sought

62 billion kg of electronic waste (e-waste) was generated globally in 2022.[50] Neodymium-iron-boron magnets (NdFeB) found in e-waste contain neodymium and praseodymium – light rare earth elements needed to manufacture NdFeB magnets whose demand is being driven by the electric vehicle and offshore wind turbine deployment.[51] NdFeB magnets used in hard disk drives also often contain dysprosium or terbium, heavy rare earth elements which are added to increase the magnet operating temperature. Hard disk drives in particular contain 2.5 to 4.6 g of REE per voice-coil actuator and in spindle drive motor components.[52] If approached prudently, recycled feedstocks, such as e-waste, amongst others, could be leveraged as domestic resources for REEs.

Area of Interest 4 (AOI-4) seeks projects to provide proof-of-concept at the bench-scale (TRL 2-4) of the production of mixed rare earth oxides or salts (MREO/MRES) from multiple feedstocks, with the option of coproduction of other critical minerals and materials (CMM) and/or other value-added materials. The intent of AOI-4 is to

[50] https://ewastemonitor.info/the-global-e-waste-monitor-2024/.
[51] https://www.energy.gov/sites/default/files/2023-05/2023-critical-materials-assessment.pdf.
[52] https://doi.org/10.1007/s11837-017-2399-2.

demonstrate that the use of diverse feedstocks (i.e., number and type of feedstock resources) could be processed at a single commercial facility, thereby potentially increasing the agility and resilience of the domestic rare earth supply chain.

Projects are required to include at least one secondary and unconventional feedstock *and* one recycled feedstock, such as but not limited to the materials included in Table 1. A mass ratio basis of one-to-one for critical material elements contained in the secondary and unconventional feedstock to recycled feedstock is suggested, but not required. No less than 10% of the MREO/MRES produced shall result from either secondary and unconventional feedstocks or recycled feedstocks. Projects may, but are not required to, mix the feedstocks prior to applying an extractive metallurgical method to produce MREO/MRES. New extractive metallurgical extraction/separation approaches are not required in the design of the process. Proposals should describe any pre-treatment needed to handle each feedstock considered in the project. Projects must use actual end of life feedstocks and actual secondary and unconventional feedstocks and not model compounds or synthesized materials (including those purchased commercially).

Table 1. Potential feedstocks for AOI-4.

Secondary and Unconventional Feedstocks	Recycled Feedstocks
• Refuse/tailings from coal preparation facilities • Coal seam over/under-burden clay and shale materials • Coal-based power generation ash • Legacy ash impoundment materials • Coal-based acid mine drainage • Mineral/metal acid mine drainage • Produced waters from oil and natural gas • Bauxite tailings (Red mud) • Phosphate fertilizer sludge • Hard rock mine tailings • Industrial byproducts/wastes • Other	• Magnet swarf (magnet manufacturing waste) • Off-spec or end-of-life magnets • Shredded hard disk drives • Electronic waste • Nickel metal hydride batteries • Fluorescent lighting • Other

Projects are encouraged to consider the full life-cycle implications of the process developed. Reduction of energy, water, and chemical intensity is encouraged.

Applications to AOI-4 should propose work that addresses the following considerations:

- During the award performance period, life-cycle considerations should be assessed, including but not limited to, carbon, energy, chemical, and/or water intensity. Life-cycle analyses may be required to validate the assessment.

- During the award performance period, the cost of proposed technologies and/or processes should be validated by techno-economic analyses (TEA).

  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 Material Flows through Industry (MFI)[53] tool developed by National Renewable Energy Laboratory. 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 Critical Materials Collaborative (CMC). They have developed critical material-specific TEA and LCA open-source tools. Critical Materials Life Cycle Assessment Tool (CMLCAT)[54] and LSM Techno-Economic Analysis.[55] Table 2 is provided as a resource example of potential metrics an Applicant may consider for their proposed project. The table is not all-inclusive.

Table 2. Example metrics.

Example Metric	Example Unit	Example Minimum	Example Stretch Target	Baseline Performance/Cost
Improved beneficiation of rare earth ores	Improvement in recovery rate	60%	75%	Applicant Defined
Improved purity of REO	Purity of oxide	>85%	>99%	Applicant Defined
Selectivity	-	-	-	Applicant Defined
Resource efficiency for process sustainability: reduced water or chemical consumption	% decrease in volume of resource (water or chemical) per unit of CMM produced	20% reduction	50% reduction	Applicant Defined
Value-added through coproduct(s) or byproduct(s)	$ added per unit of CMM produced	N/A	N/A	Applicant Defined
CMM production as a byproduct in a new or existing process	% of domestic demand potentially met by sourcing CMM as a byproduct	5%	10%	Applicant Defined
Energy efficient processes	% decrease in energy expended per unit of CMM produced	20% decrease in energy expenditure	50% decrease in energy expenditure	Applicant Defined
Reduced carbon footprint	Reduced carbon dioxide equivalent (CO_2e) per unit of CMM produced	20% reduction in emissions in process or lifecycle	50% reduction in emissions in process or lifecycle	Applicant Defined
Reduced waste	Reduced waste per unit of CMM produced	20% reduction in process or lifecycle waste	50% reduction in process or lifecycle waste	Applicant Defined
Maintain or improve process performance	CMM purity	N/A	N/A	Applicant Defined

[53] https://www.nrel.gov/manufacturing/mfi-modeling-tool.html.
[54] https://ecn-deviis.ecn.purdue.edu/CMLCAT.
[55] Contact DE-FOA-0002956@netl.doe.gov for access.

Technical Elements that must be included in AOI-4 applications include:

- Domestically sourced recycling feedstock(s). This does not include manufacturing country of origin prior to end-of-life.
- A description of the anticipated technical barriers along with a planned approach to overcome them.
- An explanation of the underlying research to date, including any literature review or experimental data to support the proposed R&D approach and to justify the R&D needs.
- A definition of credible and measurable baselines, supported by prior data from literature and/or experimentation, against which the Applicant's user-defined metrics will be evaluated (see Table 2 for example metrics).
- An explanation of the process improvements required for their proposed solutions to move to the next step in commercialization.
- An explanation, as applicable, of the role of modeling and simulations; experimentation; and lab-, bench-, prototype-, and pilot-scale testing in the proposed project.

Anticipated Technology Readiness Level

Beginning of project: Technologies proposed for development should have a beginning TRL of 2.

- TRL 2: Technology concept and/or application formulated.

End of project: Technologies should have a goal to advance to TRL 4.

- TRL 4: Component and/or system validation in laboratory environment.

Applications must clearly identify the starting and ending TRL for the project and justify the TRLs assigned.

Success Metric(s)

At completion, successful projects will have demonstrated proof-of-concept, at a TRL of 4, that the use of diverse feedstocks (i.e., number and type of feedstock resources) can be processed at a single commercial facility for the production of mixed rare earth oxides or salts (MREO/MRES) from multiple feedstocks, with the option of coproduction of other critical minerals and materials (CMM) and/or other value-added materials. Successful projects will use multiple feedstocks (at least one secondary and unconventional feedstock and one recycled feedstock). Successful

projects will assess life-cycle considerations including but not limited to, carbon, energy, chemical, and/or water intensity and cost and baseline performance of proposed technologies and/or processes.

Technology Maturation Plan

A technology maturation plan (TMP) is not required with the application. However, a TMP will be required as a deliverable under the award. A draft TMP is required within 90 days of award, and a final TMP is due within 90 days of project completion.

Workforce Readiness Plan

A Workforce Readiness Plan will be required as a deliverable in the SOPO for AOI-4.

Societal Considerations and Impacts (SCI)

Diversity, Equity, Inclusion, and Accessibility Plan

DOE supports opportunities that improve job access and foster safe, healthy, and inclusive workplaces and communities. Applicants are highly encouraged to include individuals from groups historically underrepresented[56,57] in Science Technology Engineering and Mathematics (STEM) and/or applicable workforces on their project teams. Minority Serving Institutions[58], Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements

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

[57] See also. Note that Congress recognized in Section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329: (1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

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

are encouraged to apply as the prime applicant or participate on an application as a proposed partner to the prime applicant.

Applicants are also required to describe how diversity, equity, inclusion, and accessibility objectives will be incorporated throughout the life of the project in a Diversity, Equity, Inclusion, and Accessibility Plan ("DEIA Plan") that describes the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM and/or applicable workforces, advance equity, and encourage the inclusion of individuals from these groups in the project. The plan should include at least one SMART (Specific, Measurable, Assignable, Realistic and Time-Related) milestone per budget period supported by metrics to measure the success of the proposed actions. This plan will be evaluated as part of the technical review process. If awarded, applicants must implement, evaluate, and update these plans throughout the life of the project. In addition, applicants will be required to report on DEIA progress and outcomes throughout the project lifecycle and the final report if selected.

Questionnaires

An "Economic Revitalization and Job Creation Questionnaire" is provided as FOA Appendix J. A completed Economic Revitalization and Job Creation Questionnaire will be required for this AOI as an attachment to the final report, and a preliminary Economic Revitalization and Job Creation Questionnaire will also be required with applications and evaluated for this AOI. (The preliminary version will later be updated in the final report.)

An "Environmental Justice Questionnaire" is provided as FOA Appendix K. A completed Environmental Justice Questionnaire will be required for this AOI as an attachment to the final report, and a preliminary Environmental Justice Questionnaire will also be required with applications and evaluated for this AOI. (The preliminary version will later be updated in the final report.)

i. Other Considerations

- All process feedstocks must be domestically sourced within the United States.
- For all projects, CMM processing (and commercial carbon manufacturing precursor material production – AOI-1) will be restricted to geographic locations within the United States.
- All projects will be designed to operate in an environmentally benign manner, being compliant with all federal, state, and local laws and regulations with respect to emissions and waste treatment and disposal.

- Work performed will not be duplicative of previous or existing work (currently) funded by the DOE or another federal agency.
- Industrial and manufacturing partners are strongly encouraged to participate as project team members, in order to provide guidance as to critical material specifications such as purity or composition (metal, oxides, carbonates, etc.); market/supply needs; and/or to assist in potential market entry (including possible off-take agreements) of the produced REE, CMM, and/or carbon manufacturing precursor materials or newly developed advanced separation, recovery, and/or refining processes/circuits.

Critical Materials Collaborative (CMC)

All awardees will be required to participate as a member of the Critical Materials Collaborative, which is a coalition of DOE offices, federal agencies and federally funded R&D programs to:

- Align the DOE research portfolio to achieve climate goals and crosscutting Science and Technology 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.

Principal investigators or a member of their research team are expected to participate in coordination efforts including, but not limited to, an in-person annual symposium, virtual coordination meetings, and periodically give a presentation on research progress.

There are no fees associated with this participation in the CMC.

ii. Teaming Partner List

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

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

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

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

D. Applications Specifically Not of Interest

The following types of applications will be deemed nonresponsive and will not be reviewed or considered (See Section III, Eligibility Information; Responsiveness Criteria):

- An application exceeding the identified funding level (see section II. C. i. for details).
- An application exceeding the project narrative 30-page count, including cover page, table of contents, charts, graphs, maps, photographs, tables, and other pictorial presentations, when printed using standard 8.5-inch by 11-inch paper with 1-inch margins (top, bottom, left, and right) single spaced with a font not smaller than 11 point.
- Submissions for basic research aimed solely at discovery and/or fundamental knowledge generation.
- Submissions for large-scale demonstration projects of existing technologies.
- Submissions that describe a technology but do not propose a R&D plan that allows DOE to evaluate the submission under the applicable merit review criteria provided in Section V, "Application Review Information; Review Criteria" of the FOA.
- Submissions that fall outside the technical parameters specified in Section I, "Funding Opportunity Description; Objectives/Areas of Interest" of the FOA.

- Submissions for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Applications using feedstocks from coal mines that commenced operation on or after September 19, 2022.
- Applications that use monazite or bastnaesite ore as feedstock materials.
- Applications that use resources from geothermal or salar brines.
- For AOI-1, AOI-2, and AOI-3: Applications that use recycled materials (e.g., hard drives, fluorescent lightbulbs, magnets, batteries, etc.) or e-scrap(s)/e-recycled materials/components as feedstock materials.
- For AOI-4: Applications that only use secondary or unconventional feedstock materials, or applications that only use recycled materials as feedstock materials.
- Applications that use model compounds or synthesized materials (including those purchased commercially) instead of actual materials (feedstock or CMM concentrates) produced in existing bench-scale or small pilot-scale (or larger) facilities or from actual PW as described in AOI-3.
- For AOI-1, AOI-2, and AOI-3: Applications that do not result in market-ready saleable materials.
- Utilization of produced REE and/or CMM for further processing that results in the production of alloys (inclusive of master alloys, superalloys, and intermetallics) and/or other manufactured components (intermediate products as magnets, batteries, and/or other Clean Energy Transition products) and/or end-use products.
- Utilization of produced carbon for further processing that results in the manufacturing of carbon-based products (exception: prototype manufacture and testing as specified in AOI-1).

Area of Interest 1

- Projects that propose fundamental or novel CMM processing and R&D as a part of their CMPM circuit.
- Projects that propose R&D on the CMM processing circuit.
- Projects that propose to refine carbon-based materials for fuel production. For example, refinement of coal for use in gasification or combustion applications.
- Submissions that do not provide a written agreement of commitment/collaboration (letter of support) with a coal-based CMM production facility if applicants are not current operators of the existing bench-scale or small pilot-scale (or larger) facility.

- Applications requiring carbon-based feedstock material/data that do not include a letter of support from the material/data owner, or a valid explanation of why this letter is not needed.
- Applications that use system input feedstocks (as the input of the original circuit into the CMM-production circuit) of newly-developed coal mining sites (commenced operation on or after September 19, 2022). If the feedstock used is coal or coal-based, experimental research must be focused on coal and coal-based feedstocks from previous and sustaining coal mining operations including legacy stockpiles of waste coals or coal byproducts only. A tenet of this AOI is promoting reuse of mined materials and reduction of waste.

Area of Interest 2

- Applications that do not primarily consider extraction, separation, or refining as related to the recovery of HREE and other CMM, if proposed, from secondary and unconventional feedstocks.
- Applications that do not primarily focus on individual recovery of Tb, Dy, and two additional HREE (not including Y). At least four individually separated HREE (not including Y) (oxides or metals) market-ready end-product materials are required.
- Applications that propose, as their primary focus, producing additional individually separated HREE (e.g., Gd, Ho, Er, Tm, Yb, Lu) and CMM (e.g., Ga and Ge) market-ready end-product material.
- Applications that include scope to produce metal alloys or manufactured products, such as permanent magnets.
- Applications requiring feedstock material/data that do not include a letter of support from the material/data owner, or a valid explanation of why this letter is not needed.
- Applications that use newly-developed coal mining site (commenced operation on or after September 19, 2022) feedstock material(s). If the feedstock used is coal or coal-based, experimental research must be focused on coal and coal-based feedstocks from previous and sustaining coal mining operations including legacy stockpiles of waste coals or coal byproducts only. A tenet of this AOI is promoting reuse of mined materials and reduction of waste.

Area of Interest 3

- Applications whose primary focus is to produce reusable water as product or byproduct from PW or that propose R&D to produce reusable water.
- Applications that do not use actual PW for R&D and instead use model compounds or synthesized materials.
- Applications of Li extraction from any substance that is not PW produced at the well pad or from a clean brine (from PW) treatment facility produced water from geothermal drilling operations or surface water from O&G wastewater pits will not be considered.
- Applications that propose R&D related to PW pretreatment.
- Applications that propose to purchase capital equipment related to PW pretreatment.
- Applications requiring feedstock material/data that do not include a letter of support from the material/data owner, or a valid explanation of why this letter is not needed.

Area of Interest 4

- Applications that propose less than 10% of the MREO/MRES produced resulting from either secondary and unconventional feedstocks or recycled feedstocks.

II. Award Information

A. Type of Application

DOE will accept only new applications under this announcement.

B. Type of Award Instrument

Cooperative Agreements
DOE anticipates awarding cooperative agreements under this funding opportunity announcement (See Section VI, "Award Administration Information; Statement of Substantial Involvement").

C. Award Overview

i. Estimated Funding, Number of Awards, Anticipated Award Size, and Maximum DOE Share

DOE expects to make Federal funding available for new awards under this FOA as follows:

Areas of Interest with Cost Share

Area of Interest	Estimated Federal Funding	Anticipated No. of Awards	Anticipated Individual Award Size			Maximum DOE Share of Award
			DOE Share $/%	Cost Share $/%	Total $	
1	$5,000K	2	2,500/80	625/20	3,125K	$2,500K
2	$5,000K	2	2,500/80	625/20	3,125K	$2,500K
3	$7,500K	2	3,750/80	937.5/20	4,687.5K	$3,750K
4	$2,000K	4	500/80	125/20	625K	$500K
Total	**$19,500K**	**10**			**24,375K**	

DOE may issue awards in one, multiple or none of the areas of interests.

APPLICATIONS WHICH EXCEED THE "MAXIMUM DOE SHARE OF AWARD" SPECIFIED ABOVE WILL BE CONSIDERED NONCOMPLIANT (SEE SECTION III, "ELIGIBILITY INFORMATION; COMPLIANCE CRITERIA"). DOE WILL NOT REVIEW OR CONSIDER NONCOMPLIANT APPLICATIONS.

DOE 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. Funding for all awards and future budget periods are contingent upon the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority.

Project continuation will be contingent upon satisfactory performance and go/no-go decision review. At the go/no-go decision points, DOE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, DOE will make a determination to continue the project, re-direct the project, or discontinue funding the project.

ii. Estimated Project Period of Performance per Area of Interest

Estimated Project Period of Performance
DOE anticipates making awards with an estimated project period of performance of 3 years (36 months).

III. Eligibility Information

A. General

To be considered for substantive evaluation, an applicant's submission must meet the criteria set forth below. If the application does not meet these initial requirements, it will be considered non-responsive, removed from further evaluation, and ineligible for any award.

B. Eligible Applicants

i. Domestic Entities

The proposed prime recipient and subrecipient(s) must be domestic entities. 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. Non-profit 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[59].

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 or under the laws of the United States; have majority domestic ownership and control; and have a physical place of business in the United States.

[59] "**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.

DOE/NNSA FFRDCs are eligible to apply for funding as a subrecipient. **NETL is not eligible for award under this announcement and may not be proposed as a subrecipient on another entity's application. An application that includes NETL as a prime recipient or subrecipient will be considered non-responsive.**

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 United States government, such as entities debarred, suspended, or otherwise excluded from or ineligible for participating in Federal programs, are not eligible.

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

ii. Foreign Entities

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.

The Waiver Requests: Foreign Entity Participation as the Prime Recipient and Performance of Work in the United States" Appendix 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.

iii. Federally Funded Research and Development Centers and National Laboratories

DOE/National Nuclear Security Administration (NNSA) Federally Funded Research and Development Centers (FFRDCs) and National Laboratories (NL) are eligible to apply for funding as a Subrecipient (only) but are not eligible to apply as a Prime Recipient. Non-DOE/NNSA FFRDCs and National Laboratories are

eligible to apply for funding as a Subrecipient but are not eligible to apply as a Prime Recipient.

NETL is not eligible for award under this announcement and may not be proposed as a subrecipient on another entity's application. An application that includes NETL as a prime recipient or subrecipient will be considered non-responsive.

Authorization. The cognizant contracting officer for the DOE/NNSA FFRDC/NL or the non-DOE/NNSA Federal agency sponsoring the FFRDC/NL contractor must authorize in writing the use of the FFRDC/NL on the proposed project and this authorization must be submitted with the application. The use of a FFRDC/NL must be consistent with its authority under its award and will not place the laboratory in direct competition with the domestic private sector.

The following wording is acceptable for this authorization:

> "Authorization is granted for the [Name] Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complimentary to the missions of the laboratory, will not adversely impact execution of the [DOE/NNSA/or FEDERAL AGENCY] assigned programs at the laboratory, and will not place the laboratory in direct competition with the domestic private sector."

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

The applicant should prepare the budgets using rates appropriate for funding the FFRDCs through subawards. The applicant's cost share requirement will be based on the total cost of the project, including the applicant's, the subrecipient's, and the FFRDC's portions of the project. The FFRDC/NL's effort, in aggregate, shall not exceed 25 percent of the total

estimated cost of the project, including the DOE Share, applicant share, and the FFRDC/NL's portions of the effort.

Responsibility. The applicant, if successful, 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 applicant and the FFRDC/NL.

C. Cost Sharing

i. Cost Share Requirements

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

DOE understands that projects selected under this FOA may require the use of existing data. For purposes of this FOA, DOE will consider data that is commercially available at an established market price to be an allowable cost under the project (either as DOE share or non-federal cost share) but DOE will not consider in-kind data (e.g., data, owned by an entity, that is not routinely sold commercially but is instead donated to the project and assigned a value) to be an allowable cost under the project, including as Recipient cost share. Estimation methods used by the Recipient to assign a value to in-kind data cannot be objectively verified by DOE and therefore will not be accepted by DOE as an allowable cost under any project selected from this FOA. Consequently, DOE will not recognize in-kind data costs in any resulting approved DOE budget.

To assist applicants in calculating proper cost share amounts, DOE has included a cost share information sheet and sample cost share calculation in the "Cost Share Information" Appendix of this FOA.

ii. Legal Responsibility

Applicants will be bound by the cost share proposed in their applications and incorporated into their award.

The cost share requirement applies to the project as a whole, including work performed by members of the project team other than the Prime Recipient. The Prime Recipient is legally responsible for paying the entire cost share. The Prime Recipient's cost share obligation is expressed in the Assistance Agreement as a static amount in U.S. dollars (cost share amount) and as a percentage of the Total Project Cost (cost share percentage). 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.

iii. Cost Share Allocation

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

iv. Cost Share Types and Allowability

Every cost share contribution must be allowable under the applicable Federal cost principles, as described in Section IV, "Application and Submission Information; Funding Restrictions". 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. 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 Federal Government did not provide the funding to the state or local government.

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

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

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

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

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

Please refer to the "Cost Share Information" Appendix of the FOA.

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 the "Cost Share Information" Appendix A of the FOA.

vi. Cost Share Contributions by FFRDCs

Because FFRDCs and NLs are funded by the Federal Government, costs incurred by FFRDCs and NLs generally may not be used to meet the cost share requirement. FFRDCs and NLs may contribute cost share only if the contributions are paid directly from the contractor's Management Fee or another non-Federal source. In such instance, the FFRDC and NLs must certify in writing that the cost share comes from non-Federal sources.

D. Compliance Criteria

A review of all submitted documents and information is performed to determine if the submissions are in compliance with the FOA requirements. **All submitted information and documents must meet all Compliance Criteria listed below to be eligible for review or the submission will be considered noncompliant. DOE will NOT review or consider noncompliant submissions**.

Full Applications are deemed compliant if:

- The Full Application complies with the maximum DOE share of the individual award size in Section II, "Award Information; Award Overview" of the FOA;
- The Full Application complies with the content and form requirements in Section IV, "Application and Submission Information; Form and Content Requirements," and Section IV, "Application and Submission Information; Full Applications "of the FOA; and
- be successfully uploaded to NETL eXCHANGE at https://NETL-Exchange.energy.gov/, including clicking the "Submit" button; and
- be submitted by the deadline stated in the FOA.

E. Responsiveness Criteria

A review of all submitted documents and information is performed to determine if the submissions are responsive to the FOA requirements. **All submitted information and documents must meet all of the Responsiveness Criteria listed below to be eligible for review or the submission will be considered non-responsive. DOE will NOT review or consider non-responsive submissions.**

Full Applications are deemed responsive if:

- The application meets the technical requirements as described in the "Objectives/Areas of Interest" contained in Section I, "Funding Opportunity Description" of the FOA; and
- The Applicant/application meets the Eligibility Criteria in Section III, "Eligibility Information" of the FOA.

Only compliant/responsive applications will be eligible for a comprehensive merit review.

F. Number of Submittals Eligible for Review

Applicants may submit multiple applications under each area of interest of this FOA; **HOWEVER**, applicants may not submit duplicate applications under multiple areas of interest. Put simply, each submitted application should be distinct and tailored to the specific area of interest.

G. Questions Regarding Eligibility

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

IV. Application and Submission Information

A. Form and Content Requirements

All submissions must conform to the following form and content requirements, including maximum page limits (described below) and must be submitted as specifically stated. **Applications which do not meet ALL of the form and content requirements listed below will be considered noncompliant (See Section III, "Eligibility Information; Compliance Criteria"). DOE will NOT review or consider noncompliant applications.** DOE will not review or consider submissions submitted through means other than specifically stated in the FOA, submissions submitted after the applicable deadline, and incomplete submissions. DOE will not extend deadlines for applicants who fail to submit required information and documents by the applicable deadline due to server/connection congestion.

Full Applications must conform to ALL of the following requirements in order to be considered compliant:

- Each must be submitted in Adobe PDF format unless stated otherwise.
- Each must be written in English.
- All pages must be formatted to fit on 8.5 x 11 inch paper with margins not less than one inch on every side. Use Times New Roman typeface, a black font color, and a font size of 11 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. Footnotes and endnotes must be in a font size of 10 or larger and are counted toward the maximum page requirement.
- Each submission must not exceed the specified maximum page limit (described below) when printed using the formatting requirements set forth above and **single** spaced. The maximum page limitation includes the cover page, references, charts, graphs, data, maps, photographs, other pictorial presentations, and other reference material the applicant may include its submission.

Full Applications which do not conform to ALL of the requirements listed above will be considered noncompliant (See Section III, "Eligibility Information; Compliance Criteria"). DOE will not review or consider noncompliant submissions.

Applicants are responsible for meeting the submission deadline. Applicants are strongly encouraged to submit their Full Applications at least 48 hours in advance of

the submission deadline. Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), applicants should allow at least 1 hour to submit a Full Application. Once the Full Application is submitted, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made, the applicant must resubmit the Full Application, before the applicable deadline.

DOE urges applicants to carefully review their Full Applications and to allow sufficient time for the submission of required information and documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V, "Application Review Information; Review Criteria" of the FOA.

B. Full Applications

Applicants must submit a Full Application by the specified due date and time to be considered for funding under this FOA. Applicants must complete the mandatory forms and any applicable optional forms (e.g., SF-LLL- Disclosure of Lobbying Activities) in accordance with the instructions on the forms and the additional instructions below. Files that are attached to the forms must be in Adobe Portable Document Format (PDF) unless otherwise specified in this announcement.

i. Application Forms

To access application forms and instructions available on NETL eXCHANGE, go to https://NETL-Exchange.energy.gov/ and select the appropriate funding opportunity number.

Note: The maximum file size that can be uploaded to the NETL eXCHANGE website is 50MB. Files in excess of 50MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 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.

ii. Content and Form of Full Application

DOE will not review or consider ineligible Full Applications (see Section III, "Eligibility Information; Compliance Criteria" of the FOA).

Each Full Application must be limited to a **single** area of interest. Concepts or technologies unrelated to the specific area of interest should not be consolidated into a single Full Application.

Full Applications must conform to the following requirements:

Components	Format	Page Limit	File Name
SF-424	PDF	N/A	ControlNumber_LeadOrganization_App424
Project Narrative (see chart below for further instruction)	PDF	30	ControlNumber_LeadOrganization_Project
Summary for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary
Project Management Plan	PDF	10	ControlNumber_LeadOrganization_PMP
Resumes	PDF	3 pages each	ControlNumber_LeadOrganization_Resumes
Budget Justification	Microsoft Excel	N/A	ControlNumber_LeadOrganization_Budget Justification
Subaward Budget Justification, if applicable	Microsoft Excel	N/A	ControlNumber_LeadOrganization_Subrecipient _Budget Justification
Budget for DOE/NNSA FFRDC/NLs or non-DOE/NNSA FFRDC/NLs, (if applicable)	Microsoft Excel	N/A	ControlNumber_LeadOrganization_FFRDCName _Budget Justification
Authorization from cognizant Contracting Officer for DOE/NNSA FFRDC/NL or non-DOE FFRDC/NL, if applicable	PDF	N/A	ControlNumber_LeadOrganization_FFRDCAuth
Environmental Questionnaire	PDF	N/A	ControlNumber_LeadOrganization_ENV
Cost Share Commitment Letters, if applicable	PDF	1 page each	ControlNumber_LeadOrganization_CSCL
SF-LLL Disclosure of Lobbying Activities, if applicable	Form	N/A	ControlNumber_LeadOrganization_SF-LLL

Foreign Entity Participation Waiver Requests and Foreign Work Waiver Request, if applicable	PDF	N/A	ControlNumber_LeadOrganization_Waiver
Data Management Plan	PDF	N/A	ControlNumber_LeadOrganization_DMP
Diversity Equity Inclusion and Accessibility Plan	PDF	5	ControlNumber_LeadOrganization_DEIAP
Environmental Justice Questionnaire	PDF	5	ControlNumber_LeadOrganization_EJQ
Economic Revitalization and Job Creation Questionnaire	PDF	5	ControlNumber_LeadOrganization_ERJCQ
Current and Pending Support	PDF	N/A	ControlNumber_LeadOrganization_CPS
Transparency of Foreign Connections	PDF	N/A	ControlNumber_LeadOrganization_TFC
Potentially Duplicative Funding Notice, if applicable	PDF	N/A	ControlNumber_LeadOrganization_PDFN
Photographs of the existing CMM production facility and process circuits if applicable.	PDF	N/A	ControlNumber_LeadOrganization_PHOTOS
Completed CMPM state point data table – AOI-1 only	PDF	N/A	ControlNumber_LeadOrganization_CMPM
Letter(s) of Support or Commitment, as applicable	PDF	N/A	ControlNumber_LeadOrganization_LOS

Note: The maximum file size that can be uploaded to the NETL eXCHANGE website is 50MB.

Detailed guidance on the content and form of each component is listed below.

iii. SF-424: Application for Federal Assistance

Applicants must complete the SF-424: Application for Federal Assistance, which is available on NETL eXCHANGE at https://NETL-Exchange.energy.gov/. The list of certifications and assurances in Field 21 can be found at https://www.energy.gov/management/financial-assistance-forms-and-information-applicants-and-recipients, under Certifications and Assurances.

iv. Project Narrative

The Project Narrative File must be submitted in Adobe PDF format. The project narrative must not exceed **30** pages, including cover page, table of

contents, footnotes/endnotes, charts, graphs, maps, photographs, and other pictorial presentations, when printed using standard 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right) **single** spaced. The font must not be smaller than 11 point. The **Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers, and Bibliography sections are NOT included in the project narrative page limitation**. Do not include any Internet addresses (URLs) that provide information necessary to review the application. See Section VIII, "Other Information; Treatment of Application Information" for instructions on how to mark proprietary application information.

Submissions that exceed the maximum page limits indicated above will be considered noncompliant and DOE will not review or consider the submission (See Section III, "Eligibility Information; Compliance Criteria").

Save the Project Narrative in a single PDF using the following convention for the title: "ControlNumber_LeadOrganization_Project".

The project narrative (**30** page limitation) must include:

SECTION	MAXIMUM PAGE LIMIT* (if applicable)	DESCRIPTION
Cover Page	Included in the page limitation (1-page maximum)	The cover page should include the project title, the specific FOA area of interest being addressed, the Applicant's name, and the names of all team member organizations. In addition, provide the Applicant's technical and business points of contact along with e-mail addresses and telephone numbers, names of project manager, Senior/Key personnel and their organizations. The cover page should also include the federal and non-federal share of costs associated with each team member's proposed effort. Applicants should ensure the cost information is consistent with the submitted budget justification(s).
Table of Contents	Included in the page limitation	Applicant to capture, at a minimum, all of the required sections identified in this table.
Project Objectives	Included in the page limitation	This section should provide a clear, concise statement of the specific objectives/aims of the proposed project. Buy America Requirements for Infrastructure Projects: Within the first two (2) pages of the Narrative, include a short statement on whether the project will involve the construction, alteration, and/or

		repair of infrastructure in the United States. See the "Required Use of American Iron, Steel, Manufactured Products, and Construction Materials – Buy America Requirements for Infrastructure Projects" Appendix for applicable definitions and other information to inform this statement.
Merit Review Criterion Discussion	Included in the page limitation	The section should be formatted to address each of the merit review criterion and sub-criterion listed in Section V, "Application Review Information; Review Criteria". Provide sufficient information so that reviewers will be able to evaluate the application in accordance with these merit review criteria. DOE/NNSA WILL EVALUATE AND CONSIDER ONLY THOSE APPLICATIONS THAT ADDRESS SEPARATELY EACH OF THE MERIT REVIEW CRITERION AND SUB-CRITERION.
Statement of Project Objectives	**Included in the page limitation**	The project narrative must contain a single, detailed Statement of Project Objectives that addresses how the project objectives will be met. The Statement of Project Objectives must contain a clear, concise description of all activities to be completed during project performance. It is therefore required that it shall not contain proprietary or confidential business information. The Statement of Project Objectives is generally less than 15 pages in total for the proposed work. Applicants shall prepare the Statement of Project Objectives in the format provided in the "Statement of Project Objectives Template" Appendix of the FOA.
Relevance and Outcomes/Impacts	Included in the page limitation	This section should explain the relevance of the effort to the objectives in the program announcement and the expected outcomes and/or impacts. The justification for the proposed project should include a clear statement of the importance of the project in terms of the utility of the outcomes and the target community of beneficiaries.
Roles of Participants	Included in the page limitation	For multi-organizational or multi-investigator projects, describe the roles and the work to be performed by each participant/investigator, business agreements between the applicant and participants, and how the various efforts will be integrated and managed.

Multiple Principal Investigators	Included in the page limitation	The applicant, whether a single organization or team/partnership/consortium, must indicate if the project will include multiple PIs. This decision is solely the responsibility of the applicant. If multiple PIs will be designated, the application must identify the Contact PI/Project Coordinator and provide a "Coordination and Management Plan" that describes the organization structure of the project as it pertains to the designation of multiple PIs. This plan should, at a minimum, include: - process for making decisions on scientific/technical direction; - publications; - intellectual property issues; - communication plans; - procedures for resolving conflicts; and - PIs' roles and administrative, technical, and scientific responsibilities for the project.
Facilities and Other Resources	Included in the page limitation	Identify the facilities (e.g., office, laboratory, computer, etc.) to be used at each performance site listed and, if appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Describe only those resources that are directly applicable to the proposed work. Provide any information describing the other resources available to the project such as machine and electronics shops.
Equipment	Included in the page limitation	List important items of equipment already available for this project and, if appropriate, note the location and pertinent capabilities of each. If you are proposing to acquire equipment, describe comparable equipment, if any, already at your organization and explain why it cannot be used.
Identification of Potential Conflicts of Interest or Bias in Selection of Reviewers	**Not included in the page limitation**	Provide the following information in this section: ▪ Collaborators and Co-editors: List in alphabetical order all persons, including their current organizational affiliation, who are, or who have been, collaborators or co-authors with you on a research project, book or book article, report, abstract, or paper during the 48 months preceding the submission of this application. Also, list any individuals who are currently, or have been, co-editors with you on a special issue of a journal, compendium, or conference proceedings during the 24 months preceding the submission of this application. If there are no collaborators or co-editors to report, state "None." ▪ Graduate and Postdoctoral Advisors and Advisees: List the names and current organizational affiliations of your graduate advisor(s) and principal postdoctoral sponsor(s) during the last 5 years. Also, list the names and current organizational affiliations of your graduate students and postdoctoral

		associates.
Bibliography	Not included in the page limitation	If applicable: Provide a bibliography for any references cited in the Project Narrative section. This section must include only bibliographic citations.

*As indicated above, a maximum page limit has been established for the project narrative so when the project narrative sections identified in the table above as included in the page limitation are totaled together (including the cover page, table of contents, footnotes/endnotes, charts, graphs, maps, photographs, and other pictorial presentations) it should not exceed **30** pages. Full Applications which do not conform to ALL of the requirements listed above will be considered noncompliant (See Section III, "Eligibility Information; Compliance Criteria"). DOE will not review or consider noncompliant submissions.

v. Summary for Public Release File (April 2023)

The project summary/abstract must contain a one-page summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant, the project director/principal investigator(s), the project title, the objectives of the project, a description of the project, including methods to be employed, the potential impact of the project (i.e., benefits, outcomes), major participants (for collaborative projects), and the project's commitments and goals described in the Community Benefits Plan. This document must not include any proprietary or sensitive business information as the Department may make it available to the public after selections. The project summary must not exceed one (1) page when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) **single** spaced with font no smaller than 11 point. Save the Summary for Public Release in a single PDF file using the following convention for the title: "ControlNumber_LeadOrganization_Summary".

vi. Project Management Plan

The Project Management Plan (PMP) must not exceed 10 pages including cover page, table of contents, footnotes/endnotes, charts, graphs, maps, photographs, and other pictorial presentations, when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) **single** spaced with font no smaller than 11 point. Applicants shall prepare the PMP in the format provided in the "Project Management Plan Template" Appendix of the FOA. Save the PMP in a single Microsoft Word file using the following convention for the title: "ControlNumber_LeadOrganization_PMP".

vii. Resume File (April 2023)

Provide a resume for each key person proposed, including subawardees and consultants if they meet the definition of key person. A key person is any individual who contributes in a substantive, measurable way to the execution of the project. The biographical information for each resume must not exceed 3 pages when printed on 8.5" by 11" paper with 1 inch margins (top, bottom, left, and right) **single** spaced with font no smaller than 11 point and should include the following information, if applicable:

- Contact Information;
- Education and Training. Undergraduate, graduate and postdoctoral training, provide institution, major/area, degree and year.
- Research and Professional Experience. Beginning with the current position list, in chronological order, professional/academic positions 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;
- Awards and honors;
- Publications. Provide 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. 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;
- Patents, copyrights, and software systems developed may be provided in addition to or substituted for publications.
- Synergistic Activities. List no more than 5 professional and scholarly activities related to the effort proposed.
- There should be no lapses in time over the past ten years or since age 18, which ever time 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/, and is also available at https://nsf.gov/bfa/dias/policy/nsfapprovedformats/biosketch.pdf. The use

of a format required by another agency is intended to reduce the administrative burden to researchers by promoting the use of common formats.

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

viii. Budget Justification File

Applicants are required to provide a detailed budget justification for the project as a whole, including all work to be performed by the Applicant and its Subrecipients and Contractors, and provide all requested documentation (e.g., a Federally-approved rate agreement, contractor quotes). Applicants should include costs associated with the Buy America Requirements for Infrastructure projects and the Diversity Equity Inclusion and Accessibility Plan, required annual audits and incurred cost proposals in their proposed budget documents. Such costs may be reimbursed as direct or indirect costs.

For your convenience, a Budget Justification Workbook template is available on NETL eXCHANGE at https://NETL-Exchange.energy.gov/. Applicants are strongly encouraged to use the suggested template. If applicants choose not to use the suggested template, you must also submit an SF-424A Budget Information form (available on grants.gov) and include a breakdown of all costs by Budget Category as outlined in the SF-424A and the Budget Justification suggested template, including all work to be performed by the prime recipient and its subrecipients and contractors.

The "Instructions and Summary" included with the Budget Justification workbook will auto-populate as the applicant enters information into the workbook. Applicants must carefully read the "Instructions and Summary" tab provided within the Budget Justification workbook. In addition, Applicants must carefully read and note each "Instructions" Summary contained within each individual tab of the Budget Justification workbook. **As stipulated within the Budget Justification workbook, all direct costs must be identified by specific task. All cost should include the basis of cost and justification of need, as applicable. Of specific note is the necessity to identify personnel costs for each individual proposed for all tasks to which they are assigned.** Note EXAMPLES provided within each tab for further clarification.

DOE understands that projects selected under this FOA may require the use of existing data. For purposes of this FOA, DOE will consider data that is commercially available at an established price to be an allowable cost under the project (either as DOE share or non-federal cost share) but DOE will not consider in-kind data (e.g., data, owned by an entity, that is not routinely sold commercially but is instead donated to the project and assigned a value) to be an allowable cost under the project, including as Recipient cost share. Estimation methods used by the Recipient to assign a value to in-kind data cannot be objectively verified by DOE and therefore will not be accepted by DOE as an allowable cost under any project selected from this FOA. Consequently, DOE will not recognize in-kind data costs in any resulting approved DOE budget.

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

ix. Subaward Budget Justification (if applicable)

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

x. Budget for DOE/NNSA FFRDC/NLs or non-DOE/NNSA FFRDC/NLs, (if applicable)

If proposed, FFRDC/NLs will be treated as subawards for applicants. Therefore, prepare the budgets utilizing rates appropriate for such an arrangement. You must provide a separate detailed budget justification for each FFRDC/NL proposed that is expected to perform work estimated to be more than $250,000 or 25 percent of the total work effort (whichever is less).

The budget justification must include the same justification information described in the "Budget Justification Workbook" section above. Save each subrecipient budget justification in a Microsoft Excel file using the following

convention for the title:
"ControlNumber_LeadOrganization_FFRDCName_Budget_Justification".

xi. Authorization for DOE/NNSA FFRDC/NLs or non-DOE/NNSA FFRDCs/NLs (if applicable)

The cognizant contracting officer for the DOE/NNSA FFRDC/NL or the non-DOE/NNSA Federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC on the proposed project, and this authorization, as specified in Section III, "Eligibility Information" of the FOA, 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".

xii. Environmental Questionnaire

The Applicant must submit an environmental questionnaire providing for the work of the entire project. The Applicant is also responsible for submitting a separate environmental questionnaire for each proposed subrecipient performing at a different location. The environmental questionnaire is available at https://netl.doe.gov/sites/default/files/2018-02/451_1-1-3.pdf. Save the questionnaire in a single PDF file using the following convention for the title: "ControlNumber_LeadOrganization_ENV" and use "ControlNumber_LeadOrganization_TEAM MEMBER NAME_ENV" if multiple submissions are made.

NOTE: If selected for award and if a subrecipient's location is not known at the time of application, a subsequent environmental questionnaire will be needed prior to them beginning work at an alternate location.

xiii. Cost Share Commitment Letters (if applicable)

Cost share commitment letters are required from any party (other than the organization submitting the application) proposing to provide all or part of the required cost share (including subrecipients). The letter should state the party is committed to providing a specific minimum dollar amount of cost share, identify the type of proposed cost share (e.g., cash, services, and/or property) to be contributed, and be signed by the person authorized to commit the expenditure of funds by the entity. The applicant should submit

the letter(s) in PDF format. Save the letter(s) in a single PDF using the following convention for the title: “ControlNumber_LeadOrganization_CSCL”.

xiv. SF-LLL: Disclosure of Lobbying Activities (if applicable)

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.

If applicable, complete SF-LLL. Applicability: If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the grant/cooperative agreement, you must complete and submit Standard Form - LLL, "Disclosure of Lobbying Activities."

Save the SF_LLL in a single PDF using the following convention for the title: “ControlNumber_LeadOrganization_SF-LLL”.

xv. Waiver Requests (if applicable) (April 2023)

i. Foreign Entity Participation

For projects selected under this FOA, all recipients and subrecipients must qualify as domestic entities. See Section III, “Eligibility Information; Eligible Applicants”. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. The “Waiver Requests: Foreign Entity Participation as the Prime Recipient and Performance of Work in the United States” Appendix lists the information that must be included in a waiver request.

ii. Foreign Work Waiver Request

As set forth in Section IV, “Application and Submission Information; Performance of Work in the United States (Foreign Work Waiver), 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. The “Waiver Requests: Foreign Entity Participation and Performance of Work in the United States Appendix lists the information that must be included in a foreign work waiver request.

Save the Waivers in a single PDF file using the following convention for the title: “ControlNumber_LeadOrganization_Waiver”.

xvi. Data Management Plan

Applicants are required to submit a Data Management Plan as part of their Full Application. The Data Management Plan is a document that outlines the proposed plan for data sharing or preservation. Submission of this plan is required with the full application, and failure to submit the plan may result in rejection of the application without further consideration. Applicants shall prepare the DMP in the format provided in the “Data Management Plan” Appendix of this FOA. Save the DMP in a single PDF file using the following convention for the title: “ControlNumber_LeadOrganization_DMP”.

xvii. Diversity, Equity, Inclusion, and Accessibility Plan

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

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

The following is a non-exhaustive list of actions that can serve as examples of ways the proposed project could incorporate diversity, equity, and inclusion elements. This non-exhaustive list of actions must be made in a non-discriminatory manner without superseding merit selection principles. These examples should not be considered either comprehensive or prescriptive. Applicants may include appropriate actions not covered by these examples.

a) Include persons from groups underrepresented in STEM as PI, co-PI, and/or other senior personnel;
b) Include persons from groups underrepresented in STEM as student researchers or post-doctoral researchers;
c) Include faculty or students from Minority Serving Institutions as PI/co-PI, senior personnel, and/or student researchers, as applicable;
d) Enhance or collaborate with existing diversity programs at your home organization and/or nearby organizations;
e) Collaborate with students, researchers, and staff in Minority Serving Institutions;
f) Disseminate results of research and development in Minority Serving Institutions or other appropriate institutions serving underserved communities;
g) Implement evidence-based, diversity-focused education programs (such as implicit bias training for staff) in your organization;
h) Identify Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses and Veteran Owned Businesses to solicit as vendors and sub-contractors for bids on supplies, services and equipment.
i) Partnerships with workforce intermediaries (community colleges, etc.), labor, non-profits, or community-based organizations;
j) An effort to engage with anchor institutions to develop a sector-based approach to job training and support.

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

xviii. Environmental Justice Questionnaire

Provide information as outlined in the Appendix K of this FOA, such that DOE can determine adequacy and completeness of the preliminary responses provided to the Environmental Justice Questionnaire. The section should be formatted to address merit review criterion 4 listed in Section V.A.ii. Submission of this document is required with the full application, and failure to submit responses to the questionnaire will result in rejection of the applicant's application without further consideration. The Environmental

Justice Questionnaire must not exceed 5 pages when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) single spaced with font no smaller than 11 point (except in figures, tables, or footnotes, which may be 10 point font). Save the questionnaire in a single PDF file using the following convention for the title:
"ControlNumber_LeadOrganization_EJQ".

xix. Economic Revitalization and Job Creation Questionnaire

Provide information as outlined in the Appendix J of the FOA such that DOE can determine adequacy and completeness of the preliminary responses provided to the Economic Revitalization and Job Creation Questionnaire. The section should be formatted to address merit review criterion 4 listed in Section V.A.ii. Submission of this document is required with the full application, and failure to submit responses to the questionnaire will result in rejection of the applicant's application without further consideration. The Economic Revitalization and Job Creation Questionnaire must not exceed 5 pages when printed using standard 8.5" by 11" paper with 1" margins (top, bottom, left and right) single spaced with font no smaller than 11 point (except in figures, tables, or footnotes, which may be 10 point font). Save the plan in a single PDF file using the following convention for the title:
"ControlNumber_LeadOrganization_ERJCQ".

xx. Current and Pending Support (April 2023)

Current and pending support is intended to allow the identification of potential duplication, overcommitment, potential conflicts of interest or commitment, and all other sources of support. As part of the application, the principal investigator and 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 being 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 project period of performance of the award should circumstances change which impact the responses provided above.*

The information may be provided in the format approved by the National Science Foundation (NSF), which may be generated by the Science Experts Network Curriculum Vita (SciENcv), a cooperative venture maintained at https://www.ncbi.nlm.nih.gov/sciencv/, and is also available at https://www.nsf.gov/bfa/dias/policy/researchprotection/commonform_cps.pdf.

The use of a format required by another agency is intended to reduce the administrative burden to researchers by promoting the use of common formats. If the NSF format is used, the individual must still include a signature, date, and a certification statement using the language included in the paragraph above.

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

Definitions:

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

Foreign Government-Sponsored Talent Recruitment Program – An effort directly or indirectly organized, managed, or funded by a foreign government, or a foreign government instrumentality or entity, to recruit

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

Senior/Key Personnel – An individual who contributes in a substantive, meaningful way to the scientific development or execution of a research, development and demonstration (RD&D) project proposed to be carried out with DOE award.[60]

xxi. U.S. Competitiveness

A primary objective of DOE's multibillion-dollar research, development and demonstration investments is to cultivate new research and development ecosystems, manufacturing capabilities, and supply chains for and by U.S. industry and labor. Therefore, in exchange for receiving taxpayer dollars to support an applicant's project, the applicant must agree to the following U.S. Competitiveness Provision as part of an award under this FOA.

U.S. Competitiveness
The Recipient agrees that any products embodying any subject invention or produced through the use of any subject invention will be manufactured substantially in the United States unless the Recipient can show to the satisfaction of DOE that it is not commercially feasible. In the event DOE agrees to foreign manufacture, there will be a requirement

[60] 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.

that the Government's support of the technology be recognized in some appropriate manner, e.g., alternative binding commitments to provide an overall net benefit to the U.S. economy. The Recipient agrees that it will not license, assign or otherwise transfer any subject invention to any entity, at any tier, unless that entity agrees to these same requirements. Should the Recipient or other such entity receiving rights in the invention(s): (1) undergo a change in ownership amounting to a controlling interest, or (2) sell, assign, or otherwise transfer title or exclusive rights in the invention(s), then the assignment, license, or other transfer of rights in the subject invention(s) is/are suspended until approved in writing by DOE. The Recipient and any successor assignee will convey to DOE, upon written request from DOE, title to any subject invention, upon a breach of this paragraph. The Recipient will include this paragraph in all subawards/contracts, regardless of tier, for experimental, developmental or research work.

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 shall ensure that these requirements also apply to subrecipients.

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

requesting entity must continue to perform according to the existing terms and conditions. More information and guidance on the waiver and modification request process can be found in the DOE Financial Assistance Letter on this topic.

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, "Other Information; Intellectual Property Developed Under This Program" of this FOA for more information on the DEC and DOE Patent Waiver.

xxii. Transparency of Foreign Connections

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

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

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

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

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

xxiii. Potentially Duplicative Funding Notice (if applicable)

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".

xxiv. Photograph(s)

Applicants are required to submit photograph(s) of the existing CMM production facility and process circuits. The photo(s) should include some reference gauge of dimension (e.g., a quarter, a person, etc.), and should also include captions describing the circuit(s) depicted.

Save the Photograph(s) in a single PDF file using the following convention for the title: "ControlNumber_LeadOrganization_PHOTOS".

xxv. Completed CMPM State Point Data Table – AOI-1 Only

Applicants to AOI-1 only are required to submit a completed CMPM State Point Data Table as described in Section C – AOI-1. The CMPM State Point Data Table is included in Appendix L.

Save the completed CMPM State Point Data Table in a single PDF file using the following convention for the title: "ControlNumber_LeadOrganization_CMPM".

xxvi. Letter(s) of Support or Commitment (if applicable)

Applicants are required to include letters of support or commitment as outlined in Section I. C. Objectives/Areas of Interest.

Save the Letter(s) of Support or commitment in a single PDF file using the following convention for the title: "ControlNumber_LeadOrganization_LOS".

C. Post Selection Information Requests (April 2023)

If selected for award negotiations, DOE 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 non-exhaustive list of examples of information that may be required:

- Personnel proposed to work on the project and collaborating organizations (See Section VI, "Award Administration Information; Participants and Collaborating Organizations");
- Current and Pending Support (See Section VI, "Award Administration Information; Current and Pending Support");
- Indirect cost information;
- Other budget information;
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5);
- Listing of Protected Data and Unlimited Rights Data, if applicable;
- Representation of Limited Rights Data and Restricted Software, if applicable;
- Updated Commitment Letters from Third Parties Contributing to Cost Share, if applicable;
- Updated Environmental Questionnaire, if applicable;
- Foreign National Participation; and
- Information for the DOE Office of Civil Rights to process assurance reviews under 10 CFR 1040.

D. Submission Dates and Times

Full Applications must be received no later than the time/dates provided on the cover page of this FOA. **APPLICATIONS RECEIVED AFTER THE DEADLINE WILL NOT BE REVIEWED OR CONSIDERED FOR AWARD.**

E. Intergovernmental Review

This program is not subject to Executive Order 12372 - Intergovernmental Review of Federal Programs.

F. Other Submission and Registration Requirements

i. Registration Process

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

G. Funding Restrictions (April 2023)

Funding for all awards and future budget periods are contingent upon the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority.

Costs must be allowable, allocable and reasonable in accordance with the applicable federal cost principles referenced in 2 CFR part 200 as amended by 2 CFR part 910. 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.

H. Pre-Award Costs

Recipients may charge to an award resulting from this announcement pre-award costs that were incurred within the ninety (90) calendar day period immediately preceding the effective date of the award, if the costs are allowable in accordance with the applicable Federal cost principles referenced in 2 CFR part 200 as amended by 2 CFR part 910 [DOE Financial Assistance Regulation]. Recipients must obtain the prior approval of the contracting officer for any pre-award costs that are for periods greater than this 90-day calendar period.

Pre-award costs are incurred at the applicant's risk. DOE is under no obligation to reimburse such costs if for any reason the applicant does not receive an award or if the award is made for a lesser amount than the applicant expected.

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

DOE'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 DOE completing the NEPA review process.

DOE 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 the project and such costs may not be recognized as allowable cost share. Nothing contained in the pre-award cost reimbursement regulations or any pre-award costs approval letter from the Contracting Officer override these NEPA requirements to obtain the written authorization from the Contracting Officer prior to taking any action that may have an adverse effect on the environment or limit the choice of reasonable alternatives. Likewise, if a project 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 DOE 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.

J. Performance of Work in the United States (Foreign Work Waiver) (April 2023)

i. Requirement

All work performed under DOE awards issued under this FOA must be performed in the United States. The prime recipient must flow down this requirement to its subrecipients.

ii. Failure to Comply

If the prime recipient fails to comply with the Performance of Work in the United States requirement, DOE 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.

iii. Waiver

To seek a foreign work waiver, the applicant must submit a written waiver request to DOE. The "Waiver Requests: Foreign Entity Participation and Performance of Work in the United States" Appendix lists the information that must be included in a request for a foreign work waiver.

It is noted that direct labor associated with foreign travel to attend or present at a scientific/technical conference or consortium that has been approved by DOE does not require a waiver.

K. Foreign Travel

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

L. Equipment and Supplies

Property disposition may be required at the end of a project if the current fair market value of property exceeds $5,000. For-profit entity disposition requirements are set forth at 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 200.310 – 200.316. However, pursuant to the FY23 Consolidated Appropriations Act (Pub. L. No. 117-328), Division D, Title III, Section 309, the Secretary, or a designee of the Secretary may, at their discretion, vest unconditional title or other property interests acquired under this project regardless of the fair market value of the property at the end of the award period.

M. Buy America Requirements for Infrastructure Projects (April 2023)

Pursuant to the Build America Buy America Act, subtitle IX of the Infrastructure Investment and Jobs Act[61], more commonly known as the Bipartisan Infrastructure Law (BIL) (Buy America, or "BABA"), Federally assisted projects that involve infrastructure work, undertaken by applicable recipient types, require that:

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

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

Applicants are strongly encouraged to consult the "Required Use of American Iron, Steel, Manufactured Products, and Construction Materials-Buy America Requirement for Infrastructure Projects" Appendix of this FOA to determine whether their project may have to apply this requirement, both to make an early determination as to the need of a waiver, as well as to determine what impact, if any, this requirement may have on the proposed project's budget.

Please note that, based on the implementation guidance from the Office of Management and Budget (OMB) issued on April 18, 2022, the Buy America requirements of the BIL do not apply to DOE projects in which the prime recipient is a for-profit entity; the requirements only apply to projects whose prime recipient is a "non-Federal entity," e.g., a State, local government, Indian tribe, Institution of Higher Education, or nonprofit organization. Subawards should conform to the terms of the prime award from which they flow; in other words, for-profit prime recipients are not required to flow down these Buy America requirements to subrecipients, even if those subrecipients are non-Federal entities as defined above. Conversely, prime recipients which are non-Federal entities must flow the Buy America requirements down to all subrecipients, even if those subrecipients are for-profit entities. Finally, for all applicants—both non-Federal entities and for-profit entities—DOE is including a Program Policy Factor that the Selection Official may consider in determining which Full Applications to select for award negotiations that considers whether

[61] Infrastructure Investment and Jobs Act, Public Law 117-58 (November 15, 2021). https://www.congress.gov/bill/117th-congress/house-bill/3684.

the applicant has made a commitment to procure U.S. iron, steel, manufactured products, and construction materials in its project.

The DOE financial assistance agreement will require each recipient: (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 manufactured products domestically 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 the "Required Use of American Iron, Steel, Manufactured Products, and Construction Materials – Buy America Requirements for Infrastructure Projects" Appendix and the terms and conditions of an award.

Applicants are strongly encouraged to consult the "Required Use of American Iron, Steel, Manufactured Products, and Construction Materials – Buy America Requirements for Infrastructure Projects" Appendix for more information.

V. Application Review Information

A. Review Criteria

i. Compliance/Responsiveness Review

Prior to a comprehensive merit evaluation, DOE will (1) perform a compliance review to determine that submissions are timely and the information required by the FOA has been submitted (form and content requirements); and (2) perform a responsiveness review to determine that the Applicant is eligible for an award and the proposed project is responsive to the objectives of the FOA. Applications that fail the compliance and responsiveness review will not be forwarded for merit review and will be eliminated from further consideration.

ii. Full Application Merit Review Criteria

The following evaluation criteria will be utilized by the Technical Evaluation Committee and Federal Merit Review Panel members in conducting their evaluations of applications subjected to comprehensive merit review.

Merit Review Criterion 1: Scientific and Technological Merit (45%)

- Thoroughness of the description of the proposed technology and degree to which the proposed technology or methodology meets the stated objectives of the AOI.
- Degree to which the Applicant comprehensively advances arguments and provides details that clearly distinguishes the proposed R&D and why it is needed relative to prior work.
- Feasibility of the proposed concept; the degree to which the proposed work is based on sound scientific and engineering principles.
- Likelihood of the proposed project meeting the success metrics of the AOI and the degree to which the proposed project meets or exceeds the goal of coproducing CMM and CMPM from unconventional carbon-based feedstocks (AOI-1 only), or recovering HREE from unconventional resources (AOI-2 only), or critical mineral recovery from PW (AOI-3 only).
- AOI-1 only: In instances where the Applicant proposed a CMM process circuit modification due to carbon separation before CMM extraction, the degree to

which the Applicant qualifies and quantifies the extent of any potential affects to CMM yield, purity, production time, or economics.

- AOI-4 only: Likelihood that the proposed R&D will lead to reduced criticality of materials for energy technologies.
- AOI-4 only: The quality, scientific depth, and relevance of the proposed baselines and metrics against which the Applicant's user-defined metrics will be evaluated.

Merit Review Criterion 2: Technical Approach and Understanding (30%)

- Adequacy and feasibility of the Applicant's approach to achieving the objectives of the AOI.
- AOI-1 only: Appropriateness of the proposed effort to manufacture and test the proof-of-concept prototype end-use product made from the Applicant's experimentally-produced carbon manufacturing precursor materials (CMPM).
- Feasibility, appropriateness, rationale, and completeness of the proposed Statement of Project Objectives, such that there is a logical progression of work.
- The adequacy and completeness of the Project Management Plan (PMP) in establishing baselines (technical scope, budget, schedule) and in managing project performance relative to those baselines; defining the actions that will be taken when these baselines must be revised; and identification of project risks and strategies for mitigation.

Merit Review Criterion 3: Technical and Management Capabilities (20%)

- Demonstrated experience of the applicant and partnering organizations in the technology areas addressed in the application and in managing projects of similar size, scope, and complexity.
- Credentials, capabilities, and experience of key personnel and partnering organizations.
- Clarity and likely effectiveness of the project organization, including sub-recipients or partners, to successfully complete the project.
- Adequacy and availability of proposed personnel, facilities, and equipment to perform project tasks.

Merit Review Criterion 4: Societal and Community Impacts (5%)

- Extent to which the DEIA Plan and the application describes measurable actions the recipient will take to advance diversity, equity, inclusion, and accessibility within the project and in impacted communities.
- Adequacy and completeness of the preliminary responses provided to the "Environmental Justice Questionnaire."
- Adequacy and completeness of the preliminary responses provided to the "Economic Revitalization and Job Creation Questionnaire."

Budget Information Evaluation Criteria

The budget evaluation, which is not point scored, will be conducted to determine the following:

- Reasonableness, allowability, and allocation of the proposed cost and cost share.
- Completeness and adequacy of the supporting documentation for the cost estimate.
- Alignment and agreement of the SOPO tasks to the budget, and adequacy of associated supporting documentation.
- Correspondence between the budget estimate and the magnitude of the work proposed.

The Selection Official (SO) may consider the results of this evaluation when making selections.

Environmental Evaluation Criteria

The Applicant must submit an environmental questionnaire providing for the work of the entire project. The Applicant is also responsible for submitting a separate environmental questionnaire for each proposed subrecipient performing at a different location. The environmental questionnaire is available at https://netl.doe.gov/sites/default/files/2018-02/451_1-1-3.pdf. NOTE: If selected for award and if a subrecipient's location is not known at the time of application, a subsequent environmental questionnaire will be needed prior to the subrecipient beginning work at an alternate location.

The SO may consider the results of this evaluation when making selections.

B. 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:

- It may be desirable to select for award a project, or group of projects, that represent a diversity of technical approaches and methods under this FOA or the overall program.
- It may be desirable to support complementary and/or similar projects which, when taken together, will best achieve the program's research goals and objectives.
- It may be desirable that different kinds and sizes of organizations be selected for award in order to provide a balanced programmatic effort and a variety of technical perspectives under this FOA or the overall program. For example, it may be desirable to select a project, or group of projects, that exhibit team member diversity, with participants including but not limited to those from minority serving institutions (MSIs) (e.g. HBCUs/OMIs).[62]
- In order to best achieve the program's research goals and objectives, it may be desirable to select for award a project or group of projects with a broad or specific geographic distribution under this FOA or the overall program.
- It may be desirable to select a project, or group of projects, if such a selection will optimize use of available funds.
- It may be desirable to select a project, or group of projects, if such a selection presents lesser schedule risk, lesser budget risk, lesser technical risk, and/or lesser environmental risks. Environmental risk includes, but is not limited to, an adverse impact to air, soil, water, or increase in overall cradle to grave greenhouse gas footprint (carbon dioxide equivalent, CO_2e).
- It may be desirable to select an entity located in an urban and economically distressed area including a Qualified Opportunity Zone (QOZ) or to select a project, or group of projects, if the proposed project(s) will occur in a QOZ or otherwise advance the goals of a QOZ,

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

including spurring economic development and job creation in distressed communities throughout the United States.

- It may be desirable to select a project considering the degree to which applicant has made a commitment to procure U.S. iron, steel, manufactured products, and construction materials in its project.

C. Other Review Requirements

i. Risk Assessment (May 2023)

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:

- Financial stability;
- Quality of management systems and ability to meet the management standards prescribed in 2 CFR 200 as amended by 2 CFR 910;
- History of performance;
- Audit reports and findings; and
- 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 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.

ii. Recipient Responsibility and Qualifications (May 2023)

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 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 - Federal awarding agency review of risk posed by applicants.

D. Review and Selection Process

i. Merit Review

Applications that pass the compliance/responsiveness review will be subjected to a merit review in accordance with the Merit Review Criteria listed in the FOA and the guidance provided in the "Merit Review Guide for Financial Assistance and Unsolicited Proposals." This guide is available at https://energy.gov/management/financial-assistance.

ii. Selection

The Selection Official may consider the merit review, program policy factors, and the amount of funds available in arriving at selections for this FOA.

iii. Discussions and Award

The Government may enter into discussions with a selected applicant for any reason deemed necessary, including but not limited to: (1) the budget is not appropriate or reasonable for the requirement; (2) only a portion of the application is selected for award; (3) the Government needs additional information to determine that the recipient is capable of complying with the requirements in 2 CFR part 200 as amended by 2 CFR part 910 [DOE Financial Assistance Regulation]; and/or (4) special terms and conditions are required. Failure to resolve satisfactorily the issues identified by the Government will preclude award to the applicant.

VI. Award Administration Information

A. Notices

i. Ineligible Submissions

Ineligible 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 NETL eXCHANGE. The notification letter will state the basis upon which the Full Application is ineligible and not considered for further review.

ii. Full Application Notifications

DOE 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 NETL eXCHANGE. The notification letter will inform the applicant whether or not its Full Application was selected for award negotiations. Alternatively, DOE 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.

(a) Successful Applicants

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

The award negotiation process may take up to 60 days. Applicants must designate a primary and a backup point-of-contact in NETL eXCHANGE with whom DOE 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, DOE will cancel the award negotiations and rescind the

Selection. DOE reserves the right to terminate award negotiations at any time for any reason.

Please refer to Section IV, "Application and Submission Information; Pre-Award Costs" of the FOA for guidance on pre-award costs.

(b) Unsuccessful Applicants

DOE shall promptly notify in writing each applicant whose application has not been selected for negotiation or award. This notice will explain why the application was not selected.

(c) Alternate Selection Determinations

In some instances, an applicant may receive a notification that its application was not selected for award and DOE designated the application to be an alternate. As an alternate, DOE 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. DOE may ultimately determine to select or not select the Full Application for award negotiations.

(d) Notice of Award

An Assistance Agreement issued by the Contracting Officer is the authorizing award document. It normally includes either as an attachment or by reference: (1) Special Terms and Conditions; (2) Applicable program regulations, if any; (3) Application, which includes the project description and budget, as approved by DOE; (4) 2 CFR part 200 as amended by 2 CFR part 910; (5) National Policy Assurances To Be Incorporated As Award Terms; (6) Budget Summary; (7) Federal Assistance Reporting Checklist and Instructions, which identifies the reporting requirements; (8) Intellectual Property; (9) Federal-wide Research Terms and Conditions; (10) Agency Specific Requirements; and (11) any award specific terms and conditions.

B. Administrative and National Policy Requirements

i. Award Administrative Requirements

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

DOE Special Terms and Conditions for Use in Most Grants and Cooperative Agreements. The DOE Special Terms and Conditions for Use in Most Grants and Cooperative Agreements are located at https://www.energy.gov/management/financial-assistance-forms-and-information-applicants-and-recipients under Award Terms.

National Policy Requirements. The National Policy Assurances that are incorporated as a term and condition of award are located at: https://www.energy.gov/management/financial-assistance-forms-and-information-applicants-and-recipients.

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

ii. Unique Entity Identifier Requirements and System for Award Management (April 2023)

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

NOTE: Due to the high demand of UEI requests and SAM registrations, entity legal business name and address validations are taking longer than expected to process. 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 utilize 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**.**

iii. 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 (federal and/or non-federal), and when the Federal share of the financial assistance agreement is more than $1,000,000, the recipient or subrecipient must:

Properly record, and consent to the Department's ability to properly record if the recipient fails to do so, Uniform Commercial Code (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.

Note: All costs associated with filing UCC financing statements, UCC financing statement amendments, and UCC financing statement terminations, are allowable and allocable costs to be charged to the Federal award.

iv. Foreign National Participation (April 2023)

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, will be required to provide DOE with specific information about each foreign national to satisfy requirements

for foreign national participation and access approvals. 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.

Approval for foreign nationals in Principal Investigator/Co-Investigator roles, from countries of risk (i.e., China, Iran, North Korea and Russia), or from countries identified on the U.S. Department of State's list of State Sponsors of Terrorism (https://www.state.gov/state-sponsors-of-terrorism/) may require written authorization from DOE before they can participate in the performance of any work under an award.

A "foreign national" is defined as any person who is not a United States citizen by birth or naturalization. DOE may elect to deny foreign national's participation in the award. Likewise, DOE may elect to deny a foreign national's access to a DOE sites, information, technologies, equipment, programs, or personnel.

Applicants selected for award negotiations must include this requirement in subawards.

v. Export Control (April 2023)

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

vi. Statement of Federal Stewardship

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

vii. Statement of Substantial Involvement

Cooperative agreements will be awarded under this announcement. There will be substantial involvement between the DOE and the Recipient during performance of this Cooperative Agreement.

Recipient's Responsibilities. The Recipient is responsible for:

- Performing the activities supported by this award in accordance with the Project Management Plan (PMP), including providing the required personnel, facilities, equipment, supplies and services;
- Managing and controlling project activities in accordance with established processes and procedures to ensure tasks and subtasks are completed within schedule and budget constraints defined by the current Project Management Plan;
- Implementing an approach to identify, analyze, and respond to project risks that is commensurate with the complexity of the project;
- Defining and revising approaches and plans, submitting the plans to DOE for review, and incorporating DOE comments;
- Coordinating related project activities with subrecipients and external suppliers, including contractors, to ensure effective integration of all work elements;
- Attending annual project review meetings and reporting project status;
- Participating in peer review evaluations of the project, or peer review evaluations of the program that their project supports;
- Submitting technical reports and publicly releasable documents that incorporate DOE comments; and
- Presenting the project results at appropriate technical conferences or meetings as directed by the DOE Project Officer.

DOE Responsibilities. DOE is responsible for:

- Reviewing in a timely manner project plans, including project management, testing and technology transfer plans, and recommending alternate approaches, if the plans do not address critical programmatic issues;
- Participating in project management planning activities, including risk analysis, to ensure DOE's program requirements or limitations are considered in performance of the work elements;
- Conducting annual project review meetings to ensure adequate progress and that the work accomplishes the program and project objectives. Recommending alternate approaches or shifting work emphasis, if needed;
- Providing substantial involvement to ensure that project results address critical system and programmatic goals established by the DOE Office of Fossil Energy and Carbon Management (FECM), in coordination with DOE's Critical Minerals Processing Program and, for AOI-4, in coordination with the DOE Office of Energy Efficiency and Renewable Energy's Advanced Materials and Manufacturing Technologies Office (AAMTO);
- Promoting and facilitating technology transfer activities, including disseminating program results through presentations and publications;
- Serving as scientific/technical liaison between awardees and other program or industry staff; and
- Reviewing and concurring with ongoing technical performance to ensure that adequate progress has been obtained within the current Budget Period authorized by DOE before work can commence on subsequent Budget Periods.

viii. 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, DOE may require that each prime recipient holding title to a subject invention submit annual reports for 10 years from the date the subject invention was disclosed to DOE on the utilization of the subject invention and efforts made by prime recipient or its 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 DOE may specify.

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

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

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

x. Conference Spending

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

xi. Indemnity

Awards resulting from this FOA will contain the following provision reminding Recipients of DOE's rights of indemnification.

The Recipient shall indemnify the Government and its officers, agents, or employees for any and all liability, including litigation expenses and attorneys' fees, arising from suits, actions, or claims of any character for death, bodily injury, or loss of or damage to property or to the environment, resulting from the project, except to the extent that such liability results from the direct fault or negligence of Government officers, agents or employees,

or to the extent such liability may be covered by applicable allowable costs provisions.

xii. Go/No-Go Review

Each project selected under AOI-1 of this FOA will be subject to a periodic project evaluation referred to as a Go/No-Go Review. At this time, Go/No-Go decision points are not being required for projects selected under AOI-2, AOI-3, and AOI-4. However, depending on the nature of the potentially selected application(s), one or more Go/No-Go decision point(s) may be negotiated at program discretion. At the Go/No-Go decision points, DOE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the DOE program goals and objectives. Federal funding beyond the Go/No Go decision point (continuation funding), is contingent on (1) the availability of 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) DOE's Go/No-Go decision; (7) the recipient's submission of a continuation application; and (8) written approval of the continuation application by the Contracting Officer.

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

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

xiii. Interim Conflict of Interest Policy for Financial Assistance

The DOE interim Conflict of Interest Policy for Financial Assistance (COI Policy)[63] 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 their initial and ongoing FCOI reports.

It is understood that non-Federal entities and individuals receiving DOE financial assistance awards will need sufficient time to come into full compliance with 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 interim COI Policy.**

xiv. 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 within 30 days after the applicant is notified of the selection. Recipients will have an ongoing responsibility to notify DOE of changes to the personnel and

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

collaborating organizations, and submit updated information during the life of the award.

xv. 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, "Application and Submission Information; Current and Pending Support".

xvi. Fraud, Waste and Abuse (April 2023)

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:

> 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. Failure to make required disclosures can result in any of the

remedies described in § 200.339. (See also 2 CFR part 180, 31 U.S.C. 3321, and 41 U.S.C. 2313.) [85 FR 49539, Aug. 13, 2020]

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

xvii. Human Subjects Research (April 2023)

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: https://science.osti.gov/ber/human-subjects.

xviii. Real Property and Equipment

Subject to the vesting of any property pursuant to Section 309 of the FY23 Consolidated Appropriations Act (Pub. L. No. 117-328), Division D, Title III, property disposition may be required at the end of a project if the current fair market value of property exceeds $5,000. For-profit entity disposition requirements are set forth at 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 200.310 – 200.316.

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 award under this FOA, the recipient 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 where 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 at 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 310-200.316. However, pursuant to the FY23 Consolidated Appropriations Act (Pub. L. No. 117-328), Division D, Title III, Section 309, the Secretary or a designee of the Secretary may, at their discretion, vest unconditional title or other property interests acquired under this project regardless of the fair market value of the property at the end of the award period.

C. Reporting

i. Reporting Requirements

Reporting requirements are identified on the Federal Assistance Reporting Checklist and Instructions, DOE F 4600.2, attached to the award agreement. A sample checklist is available at: https://www.netl.doe.gov/sites/default/files/netl-file/4600.2-FE.pdf.

ii. Subaward and Executive Reporting

Prime Recipients awarded a new Federal financial assistance award greater than or equal to $30,000 as of October 1, 2010 are subject to Federal Funding and Transparency Act of 2006 (FFATA) sub-award reporting requirements as outlined in 2 CFR Chapter 1, Part 170 REPORTING SUB-AWARD AND EXECUTIVE COMPENSATION INFORMATION.

The FFATA Subaward Reporting System (FSRS) is the reporting tool Federal prime awardees (i.e. prime contractors and prime grants recipients) use to capture and report subaward and executive compensation data regarding their first-tier subawards to meet the FFATA reporting requirements. Prime awardees must register with the new FSRS database and report the required data on their first tier subawardees/subrecipient at https://www.fsrs.gov.

Prime awardees must report the executive compensation for their own executives as part of their registration profile in the System for Award Management (SAM). The sub-award information entered in FSRS will then be displayed on https://www.usaspending.gov/ associated with the prime award furthering Federal spending transparency.

Applicants must ensure they have the necessary processes and systems in place to comply with the reporting requirements should they receive funding.

D. Applicant Representations and Certifications

i. 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.

ii. Nondisclosure and Confidentiality Agreements Representations

In submitting an application in response to this FOA the applicant represents that:

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.

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.''

The limitation above shall not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

2) 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.

iii. Corporate Felony Convictions and Tax Liabilities Representations (March 2014)

In submitting an application in response to this FOA the Applicant represents that:

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

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

For purposes of these representations the following definition applies:

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

VII. Questions/Agency Contacts

A. Questions

Upon the issuance of a FOA, DOE personnel are prohibited from communicating (in writing or otherwise) with applicants regarding the FOA except through the established question and answer process as described below. Questions regarding this FOA must be submitted to DE-FOA-0002956@netl.doe.gov no later than three business days prior to the application due date. 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 the NETL eXCHANGE at https://NETL-Exchange.energy.gov/. You must first select the FOA Number to view the questions and answers specific to this FOA. DOE will attempt to respond to a question within three 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 NETL eXCHANGE website should be submitted to NETL-ExchangeSupport@hq.doe.gov.

VIII. Other Information

A. Modifications

Amendments to this FOA will be posted on NETL eXCHANGE and the Grants.gov systems. 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. DOE 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

DOE 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.

Funding for all awards and future budget periods are contingent upon the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority.

D. Treatment of Application Information (April 2023)

Applicants should not include trade secret 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.

The Freedom of Information Act, 5 U.S.C. 552, requires DOE to release certain Federal financial assistance documents and records requested by members of the public regardless of the intended use of the information. DOE will release funded applications and funded progress reports, including award data, as legally releasable at the conclusion of the competitive funding process. However, DOE will generally

withhold this information during the pendency of competitive stages of the funding process.

If an application includes trade secret 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 Government's right to use the information if it is obtained from another source.

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

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

follows: “Contains Business Sensitive, Trade Secrets, Proprietary, 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, 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. The applicant, by submitting its application, consents to the use of non-Federal reviewers/administrators. Non-Federal reviewers must sign conflict of interest and non-disclosure agreements prior to reviewing an application. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

F. Intellectual Property Developed Under This Program (September 2021)

Patent Rights: The government will have certain statutory rights in an invention that is conceived or first actually reduced to practice under a DOE award. 42 U.S.C. 5908 provides that title to such inventions vests in the United States, except where 35 U.S.C. 202 provides otherwise for nonprofit organizations or small business firms. However, the Secretary of Energy may waive all or any part of the rights of the United States subject to certain conditions.

Class Patent Waiver: Pursuant to 10 CFR Part 784, the DOE has issued a class patent waiver that applies to this FOA. Under this class waiver, any domestic entity other than a domestic small business firm or domestic nonprofit organization may elect title to their subject inventions similar to the right provided to domestic small business firms and domestic nonprofit organization by law (see below). In order to avail itself of the class waiver, such a domestic entity must agree, among other things, that any products embodying or produced through the use of a subject invention (conceived or first actually reduced to practice under this program) will be substantially manufactured in the United States, unless DOE agrees otherwise.

Right to Request Patent Waiver: A selected entity may request a waiver of all or any part of the rights of the United States in inventions conceived or first actually reduced to practice in performance of an agreement as a result of this

announcement, in advance of or within 30 days after the effective date of the award. Even if such advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver of the rights of the United States in identified inventions, i.e., individual inventions conceived or first actually reduced to practice in performance of the award. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784 see https://www.energy.gov/gc/services/technology-transfer-and-procurement/office-assistant-general-counsel-technology-transf-1 for further information.

Domestic small businesses and domestic nonprofit organizations: Domestic small businesses and domestic nonprofit organizations will receive the patent rights clause at 37 CFR 401.14, i.e., the implementation of the Bayh-Dole Act. This clause permits domestic small business and domestic nonprofit organizations to retain title to subject inventions. Therefore, small businesses and nonprofit organizations do not need to request a patent waiver.

- 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 IV, "Application and Submission Information; U.S. Competitiveness" 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 on the website above further DECs prior to the issuance of awards under this FOA. DOE may require additional submissions or requirements as authorized by any applicable DEC.

G. Government Rights in Subject Inventions

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

Government Use License

The United States 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.

March-In Rights

The United States 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.

H. 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": Except as otherwise provided in this FOA, the United States 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 United States 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 DOE 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 awards intellectual property terms and conditions and a listing of unlimited rights data (i.e., non-protected data) must be inserted into the data clause in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

I. Copyright

The prime recipient and subrecipient(s) may assert copyright in copyrightable works, such as software, first produced under the award without DOE 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.

J. Energy Data eXchange (EDX) Requirements (December 2022)

The DOE is required to improve access to federally funded research results, proper archiving of digital data, and expanded discovery and reuse of research datasets per DOE and Executive Orders. The Energy Data eXchange (EDX) is a data laboratory developed and maintained by NETL to find, connect, curate, use, and re-use data to advance fossil energy and environmental research and development (R&D).

Data products generated under the resulting award will be required to be submitted in the EDX at https://edx.netl.doe.gov/. Data products include but are not limited to software code, tools, applications, webpages, portfolios, images, videos, and datasets.

EDX uses federation and web services to elevate visibility for publicly approved assets in the system, including connections with DOE's Office of Scientific and Technical Information (OSTI) systems, Data.gov, and Re3Data. This ensures compliance with federal requirements, while raising visibility for researcher's published data products to promote discoverability and reuse.

EDX supports a wide variety of file types and formats including: 1) data, 2) metadata, 3) software/tools, and 4) articles (provided that there is an accompanying

Government use license). A partial list of file formats accepted by EDX is provided below, however, EDX is designed for flexibility and accepts all types of file formats.

- Common Data Product Submission Formats: ASC, AmiraMesh, AVI, CAD, CSV, DAT, DBF, DOC, DSV, DWG, GIF, HDF, HTML, JPEG2000, JPG, MOV, MPEG4, MSH/CAS/DAT, NetCDF, PDF, PNG, PostScript, PPT, RTF, Surface, TAB, TIFF, TIFF Stacks, TXT, XLS, SML, Xradio, ZIP, and others.
- Geographic Formats: APR, DBF, DEM, DLG, DRG, DXF, E00, ECW, GDB, GeoPDF, GeoTIFF, GML, GPX, GRID, IMG, KML, KMZ, MOB, MrSID, SHP, and others.

Information provided to EDX will be made publicly available, unless authorized under the resulting award. Additional information on EDX is available at https://edx.netl.doe.gov/about.

When data products are submitted to EDX, the data product will need to be registered with a digital object identifier (DOI) through OSTI to ensure more visibility in other search repositories (i.e., osti.gov, data.gov, Google Scholar, etc.). The OSTI DOI can be established through an application programming interface (API) by completing just a few additional fields.

The Recipient or subrecipient should coordinate with the Project Manager on an annual basis to assess if there is data that should be submitted to EDX and identify the proper file formats prior to submission. All final data products shall be submitted to EDX by the Recipient prior to the completion of the project.

K. Notice Regarding Eligible/Ineligible Activities

Eligible activities under this program 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.

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

DOE 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).

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

Applicants should be advised that identifying information regarding all applicants, including applicant names and/or points of contact, may be subject to public disclosure under the Freedom of Information Act, whether or not such applicants are selected for negotiation of award.

N. 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.

O. Retention of Submissions

DOE expects to retain copies of all submissions. No submissions will be returned. By applying to DOE for funding, applicants consent to DOE's retention of their submissions.

P. Protected Personally Identifiable Information

In responding to this FOA, applicants must ensure that Protected Personally Identifiable Information (PII) is not included in the application documents. These documents will be used by the Merit Review Committee in the review process to evaluate each application. PII is defined by the Office of Management and Budget (OMB) as:

Any information about an individual maintained by an agency, including but not limited to, education, financial transactions, medical history, and criminal or employment history and information that can be used to distinguish or trace an individual's identity, such as their name, social security number, date and place of

birth, mother's maiden name, biometric records, etc., including any other personal information that is linked or linkable to an individual.

This definition of PII can be further defined as: (1) Public PII and (2) Protected PII.

1. Public PII: PII found in public sources such as telephone books, public websites, business cards, university listing, etc. Public PII includes first and last name, address, work telephone number, email address, home telephone number, and general education credentials.

2. Protected PII: PII that requires enhanced protection. This information includes data that if compromised could cause harm to an individual such as identity theft.

Listed below are examples of Protected PII that applicants must not include in the application files listed above to be evaluated by the Merit Review Committee. This list is not all inclusive.

- Social Security Numbers in any form
- Place of Birth associated with an individual
- Date of Birth associated with an individual
- Mother's maiden name associated with an individual
- Biometric record associated with an individual
- Fingerprint
- Iris scan
- DNA
- Medical history information associated with an individual
- Medical conditions, including history of disease
- Metric information, e.g. weight, height, blood pressure
- Criminal history associated with an individual
- Employment history and other employment information associated with an individual
- Ratings
- Disciplinary actions
- Performance elements and standards (or work expectations) are PII when they are so intertwined with performance appraisals that their disclosure would reveal an individual's performance appraisal
- Financial information associated with an individual
- Credit card numbers
- Bank account numbers

- Security clearance history or related information (not including actual clearances held)

Q. Annual Compliance Audits

If an institution of higher education, non-profit organization, or state/local government is a Prime Recipient or Subrecipient and has expended $750,000 or more of Federal funds during the non-Federal entity's fiscal year, then a single or program-specific audit is required. For additional information, please refer to 2 C.F.R. § 200.501 and Subpart F.

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

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

R. Accounting System

If your application is selected for negotiation toward award, you should have an accounting system that meets government standards for recording and collecting costs. Reference 2 CFR 200 Subpart D for the applicable standards. If you have not had prior government awards or a recent accounting system review, DOE may request that the Defense Contract Audit Agency (DCAA) or an independent auditor verify that the accounting system is acceptable. A resulting award may contain a Term and Condition that prohibits DOE reimbursement until the system is deemed acceptable.

S. Indirect Rates

Potential recipients and major subrecipients will need to demonstrate how indirect rates are developed using an acceptable government methodology or current rate agreement. The Prime Recipient and major subrecipients may be subject to a DCAA or independent auditor indirect rate review if there has not been a certified rate audit within the previous twelve months. Additionally, annual indirect cost reconciliations are required, as applicable.

T. Prohibition on Certain Telecommunications and Video Surveillance Services or Equipment (April 2023)

As set forth in 2 CFR 200.216, recipients and subrecipients are prohibited from obligating or expending project funds (federal and recipient cost share) to procure or obtain; extend or renew a contract to procure or obtain; or enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115-232, section 889, 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.

U. Prohibition Related to Foreign Government-Sponsored Talent Recruitment Programs (April 2023)

i. **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.

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

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

V. Implementation of Executive Order 13798, Promoting Free Speech and Religious Liberty (November 2020)

States, local governments, or other public entities may not condition sub-awards in a manner that would discriminate, or disadvantage subrecipients based on their religious character.

W. Affirmative Action and Pay Transparency Requirements

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

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

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

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

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

DOL's Office of Federal Contractor Compliance Programs (OFCCP) uses a neutral process to schedule compliance evaluations. Consult OFCCP's Technical Assistance Guide[64] 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.

X. Foreign Collaboration Considerations

a. Consideration of new collaborations with foreign entities and governments. The recipient will be required to provide DOE with advanced written notification of any potential collaboration with foreign entities 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 or government regarding the potential collaboration or negotiating the terms of any potential agreement.

b. Existing collaborations with foreign entities 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

[64] 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.

IX. Appendices

Appendix A – Cost Share Information

Cost Sharing or Cost Matching

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

How Cost Sharing Is Calculated

As stated above, cost sharing is calculated as a percentage of the Total Project Cost. FFRDC/NL costs must be included in Total Project Costs.

Example – 20% cost share
The following is an example of how to calculate cost sharing amounts for a project with $1,000,000 in federal funds with a minimum 20% non-federal cost sharing requirement:

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

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

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

What Qualifies For Cost Sharing

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

Government under another award unless authorized by Federal statute to be used for cost sharing.

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

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

In addition to the regulations referenced above, other factors may also come into play such as timing of donations and length of the project period of performance. For example, the value of ten years of donated maintenance on a project that has a project period of performance 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 of performance is allowable and may be counted as cost share.

Additionally, DOE 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, DOE generally does not allow pre-award costs prior to the signing of the Selection Statement by the DOE Selection Official.

General Cost Sharing Rules on a DOE Award

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

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

3. Funds from other federal sources MAY NOT be counted as cost share. This prohibition includes FFRDC subrecipients. Non-federal sources include any source not originally derived

from federal funds. Cost sharing commitment letters from subrecipients must be provided with the original application.

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

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

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

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

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

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

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

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

a. For-profit organizations. Allowability of costs incurred by for-profit organizations and those nonprofit organizations listed in Attachment C to OMB Circular A–122 is determined in accordance with the for-profit cost principles in 48 CFR Part 31 in the Federal Acquisition Regulation, 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

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

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

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

(B) Valuing and documenting contributions

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

a. The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation; or
b. The current fair market value. If there is sufficient justification, the Contracting Officer may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project. The Contracting Officer may accept the use of any reasonable basis for determining the fair market value of the property.

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

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

(4) Valuing property donated by third parties.

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

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

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

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

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

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

Appendix B – Waiver Requests: Foreign Entity Participation and Performance of Work in the United States

i. Waiver for Foreign Entity Participation as the Prime Recipient

As set forth in Section III, "Eligibility Information", all Prime Recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

Overall, the applicant 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 have a foreign entity serve as the Prime Recipient. A request to waive the *Foreign Entity Participation as the Prime Recipient* requirement must include the following:

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

DOE may require additional information before considering the waiver request.

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

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

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

Overall, a waiver request must demonstrate to the satisfaction of 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 to waive the *Performance of Work in the United States* requirement must include the following:

- The rationale for performing the work outside the U.S. ("foreign work");
- A description of the work and the percentage of the direct labor (including subrecipients) proposed to be performed outside the U.S.;
- An explanation as to how the foreign work is essential to the project;
- A description of the anticipated benefits to be realized by the proposed foreign work and the anticipated contributions to the US economy;
    - The associated benefits to be realized and the contribution to the project from the foreign work;
    - How the foreign work will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
    - How the foreign work will promote domestic American manufacturing of products and/or services;
- A description of the likelihood of Intellectual Property (IP) being created from the foreign work and the treatment of any such IP;
- The total estimated cost (DOE and Recipient cost share) of the proposed foreign work;
- The countries in which the foreign work is proposed to be performed; and
- The name of the entity that would perform the foreign work, by country (if more than one foreign country is proposed).
- Information about the entity(ies) involved in the work proposed to be conducted outside the United States. (i.e., entity seeks a waiver and the entity(ies) that will conduct the work).

DOE may require additional information before considering the waiver request.

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

Appendix C – Required Use of American Iron, Steel, Manufactured Products, and Construction Materials - Buy America Requirements for Infrastructure Projects (April 2023)

A. Definitions

For purposes of the Buy America Requirements, based both on 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[65] — 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 non-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 indication of infrastructure, while projects with the latter quality have fewer. Projects consisting

[65] BIL, § 70917(c)(1).

solely of the 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[66] 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.

[66] 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, Institute of Higher Education, or nonprofit 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: https://www.whitehouse.gov/wp-content/uploads/2022/04/M-22-11.pdf

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 manufactured products domestically that are deemed available in sufficient and reasonable 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 percent.

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 Product Service Codes (PSC) and North American Industry Classification System (NAICS) code for each.
- Waiver justification including due diligence performed (e.g., market research, industry outreach) by the applicant or recipient
- Anticipated impact if no waiver is issued

DOE may require additional information before considering the waiver request.

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

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

Appendix D – Statement of Project Objectives Template

STATEMENT OF PROJECT OBJECTIVES
Title of Project
(Insert the title of the work to be performed. Be concise and descriptive)

This should be a standalone document that states the work to be conducted and should not include any proprietary/confidential information.

A. OBJECTIVES

Include one paragraph on the overall objective(s) of the work. Note: if the project will be performed in phases, include specific objective(s) for each phase of the work.

B. SCOPE OF WORK

This section should not exceed one-half page and should summarize the effort and approach to achieve the objective(s) of the work. Note: if the project will be performed in phases, includes specific scope statement(s) for each phase.

C. TASKS TO BE PERFORMED

This section provides a brief summary of the planned approach to this project. Tasks/subtasks, concisely written, should be provided in a logical sequence and should be divided into the phases of the project, as appropriate. In writing the Statement of Project Objectives (SOPO), avoid 1) the use of proper nouns to minimize SOPO modifications in the event of changes to the project team, facilities, etc.; 2) figures and equations; 3) references to other documents and publications; and 4) details about past work and discussion of technical background (which should be covered elsewhere in the application narrative).

Task 1.0 - Project Management and Planning (REQUIRED; APPLICANT INSERT THIS TASK)

Subtask 1.1 – Project Management Plan (REQUIRED; APPLICANT INSERT THE LANGUAGE PROVIDED BELOW IN QUOTES. SEE THE "PROJECT MANAGEMENT PLAN TEMPLATE" APPENDIX FOR FORMAT.)

"The Recipient shall manage and direct the project in accordance with a Project Management Plan to meet all technical, schedule and budget objectives and requirements. The Recipient will coordinate activities in order to effectively accomplish the work. The Recipient will ensure that project plans, results, and decisions are appropriately documented and project reporting and briefing requirements are satisfied.

The Recipient shall update the Project Management Plan 30 days after award and as necessary throughout the project to accurately reflect the current status of the project. Examples of when it may be appropriate to update the Project Management Plan include: (a) project management policy and procedural changes; (b) changes to the technical, cost, and/or schedule baseline for the project; (c) significant changes in scope, methods, or approaches; or (d) as otherwise required to ensure that the plan is the appropriate governing document for the work required to accomplish the project objectives.

Management of project risks will occur in accordance with the risk management methodology delineated in the Project Management Plan in order to identify, assess, monitor and mitigate technical uncertainties as well as schedule, budgetary and environmental risks associated with all aspects of the project. The results and status of the risk management process will be presented during project reviews and in quarterly progress reports with emphasis placed on the medium- and high-risk items."

Subtask 1.2 – Technology Maturation Plan (REQUIRED; APPLICANT INSERT THE LANGUAGE PROVIDED BELOW IN QUOTES. REFERENCE THE "TECHNOLOGY MATURATION PLAN" APPENDIX FOR FORMAT.)

"The Recipient shall develop a Technology Maturation Plan (TMP) that describes the current technology readiness level (TRL) of the proposed technology/technologies, relates the proposed project work to maturation of the proposed technology, describes the expected TRL at the end of the project, and describes any known post-project research and development necessary to further mature the technology. The initial TMP is due 90 days after award and a final TMP should be submitted within 90 days of completion of the project."

Subtask 1.3 – Workforce Readiness Plan (REQUIRED; APPLICANT INSERT THE LANGUAGE PROVIDED BELOW IN QUOTES. REFERENCE THE "WORKFORCE READINESS PLAN" APPENDIX FOR FORMAT.)

"As successful technology commercialization and deployment requires a ready workforce, recipients of an award under this FOA will be required to complete a Workforce Readiness Plan as part of the project. A suggested format for this Plan is contained in the "Workforce Readiness Plan Template" Appendix I (of the FOA). The Plan must include: (i) a description of the skillset and availability of the workforce; (ii) a description of the training required to prepare the workforce such as apprenticeships, certificates, certifications, or academic training; and (iii) if needed, a plan to collaborate with training providers or other stakeholders to develop necessary training that would not be otherwise available."

Subtask 1.4 – Critical Materials Collaborative RD&D Coordination (REQUIRED; APPLICANT INSERT THE LANGUAGE PROVIDED BELOW IN QUOTES.)

"The Principal Investigator (or designee) will participate in an in-person Annual Critical Materials Collaborative (CMC) Meeting, most likely in Washington D.C., where they will give a presentation on research progress. Participation need not be limited to the PI from the project team. The coordination meeting is intended to build an innovation ecosystem and facilitate rich scientific and technical exchange and discussion. The attendees will include PIs selected from the DE-FOA-0002956, the CMC, DOE Program Offices and Federal agencies that fund relevant and related critical materials/minerals projects, and stakeholders working on critical materials projects. Additionally, project teams will attend and participate, either virtually or physically, in other critical materials RD&D related meetings convened by DOE or the CMC when relevant. Participants in the CMC will also be recommended to sign up for the CM3 MatchMaker, which is an online information resource created to help connect users across the critical minerals and materials supply chain. Participants should not disclose proprietary information. This task will cover all budget periods throughout the duration of the project and includes travel costs for the Annual CMC Meeting."

APPLICANT continue with tasks/sub-tasks as necessary. If the project is structured in Phases, clearly delineate which tasks/subtasks are in each Phase.

Task 2.0 - (Title)
Task descriptions should include a concise description of the work to be conducted for each task. If the task includes subtasks, provide a general description of how each subtask is related to the overall scope of the task.

Subtask 2.1 - (Title)
Subtask descriptions should include a concise description of the work to be conducted for each subtask.

Subtask 2.2 - (Title)

D. DELIVERABLES (Required: Applicant insert the Language provided below in quotes and continue to complete. Note: Where "X.X" is included in the table, add the corresponding SOPO Task/Subtask Number.)

"The periodic and final reports shall be submitted in accordance with the "Federal Assistance Reporting Checklist" and the instructions accompanying the checklist. In addition to the reports specified in the "Federal Assistance Reporting Checklist", the Recipient must provide the following to the NETL Project Manager (identified in Block 15 of the Assistance Agreement as the Program Manager)**."**

Task / Subtask Number	Deliverable Title	Due Date
1.1	Project Management Plan (PMP)	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the NETL Project Manager.
1.2	Technology Maturation Plan (TMP)	An initial TMP is due 90 days after award. A final TMP is due within 90 days of project completion.
1.3	Workforce Readiness Plan	The initial Plan is due at month 12 based on the start date of the Project Period of Performance. Subsequent updates to the Plan, as necessary, are due at 12-month intervals.
X.X	Diversity, Equity, Inclusion, and Accessibility Plan	The preliminary version submitted with the Application will be updated and included as an attachment to the final report.
X.X	Environmental Justice Questionnaire	The preliminary version submitted with the Application will be updated and included as an attachment to the final report.
X.X	Economic Revitalization and Job Creation Questionnaire	The preliminary version submitted with the Application will be updated and included as an attachment to the final report.
X.X	Technoeconomic Analysis (TEA)	The preliminary version submitted with the Application will be updated and included as an attachment to the final report.
X.X	Carbon Ore to Carbon Manufacturing Precursor Materials (CMPM) State Point Data Table (AOI-1 only)	The preliminary version submitted with the Application will be updated and included as an attachment to the final report.
X.X	Chemical Characterization and Analytical Data	Analysis will be included in the Final Technical Report and be uploaded to NETL's publicly available Energy Data eXchange

		(EDX) database platform in the format provided by NETL.
X.X	Split Samples	Due 30 days prior to project completion.

APPLICANT continue to identify deliverables (other than those identified on the "Federal Assistance Reporting Checklist") that will be delivered using the format provided in the table above. Ensure the delivery date to NETL is also identified. For examples: Delivery to NETL X months after completion of task/subtask X.

NOTE: If the application is selected for award, DOE may require the Recipient to include additional deliverables, provided that such deliverables are consistent with the budget, schedule, and scope of the project.

E. BRIEFINGS/TECHNICAL PRESENTATIONS (Required: Applicant insert the language provided below in quotes and continue to complete.)

"The Recipient shall prepare detailed briefings for presentation to the NETL Project Manager at their facility located in Pittsburgh, PA, Morgantown, WV, Albany, OR, or via WebEx. The Recipient shall make a presentation to the NETL Project Manager at a project kick-off meeting held within ninety (90) days of the project start date. At a minimum, annual briefings shall also be given by the Recipient to explain the plans, progress, and results of the technical effort and a final project briefing at the close of the project shall also be given."

"Informal monthly briefings to the Federal Project Manager, Technology Manager, and HQ Program Manager will be given by the Recipient to explain the plans, progress, and results of the technical effort. At the discretion of the Awardee and/or DOE, other briefings/presentations may be added to the Statement of Project Objectives, provided that such briefings/presentations are consistent with the budget, schedule, and scope of the project."

At the Applicant's discretion, other briefings/presentations may be added to Section E of the SOPO.

NOTE: If the application is selected for award, DOE may require the Recipient to include additional briefings/presentations, provided that such briefings/presentations are consistent with the budget, schedule, and scope of the project.

Appendix E – Project Management Plan Template

The Applicant's Project Management Plan (PMP) is an approved document that defines how the Applicant will execute, monitor, and control the project to accomplish the objectives. The specific contents, level of detail, and inclusion of subsidiary planning documents are tailored according to the needs of the project. Consequently, every PMP will be different based on the risk, visibility, and/or complexity of the project and the Recipient's established processes, procedures, and systems.

Title Page:

PROJECT MANAGEMENT PLAN

{Insert Project Title}

{Date Prepared}

SUBMITTED BY
{Organization Name}
{Organization Address}
{City, State, Zip Code}

PRINCIPAL INVESTIGATOR
{Name}
{Phone Number}
{E-mail}

SUBMITTED TO
U.S. Department of Energy
National Energy Technology Laboratory

This plan should be formatted to include the following sections with each section to include the information as described below:

A. Executive Summary:

Provide a description of the project that includes the objective, project goals, and expected results. For purposes of the application, this information is included in the Project Narrative and should be simply copied to this document for completeness, so that the Project Management Plan is a stand-alone document.

B. Project Organization and Structure:

Provide the following information in this section:

- Organizational Chart(s): Include a complete project organizational chart and sub-organization charts (if applicable), accompanied by a discussion of how the organizational structure will facilitate the performance of the Tasks and achievement of the objectives described in the SOPO within the time frame specified in the application.
- Roles and Responsibilities of Participants: Provide a discussion of key project team members, and the capacity in which each team member will assist in achieving the overall objective(s) of the proposed project. For multi-organizational or multi-investigator projects, describe the roles to be performed by each participant/investigator within the context of the Task/subtask structure contained in the SOPO. Include descriptions of any business agreements or intellectual property issues between the applicant and other members of the project team, and how these agreements will be integrated and managed.
- Decision-making and Communication Strategy: Provide a discussion of how communication and decision-making will occur within the context of the organizational structure, with particular emphasis on scientific/technical direction and mechanisms for controlling project scope, cost, and schedule. Include a discussion of how the project team will communicate with DOE and external stakeholders during the performance of the project.
- Management Capabilities: Provide information relevant to the capabilities and experience of the PI and key project team members in managing technical projects of similar nature and complexity. If applicable, include examples that demonstrate the ability to successfully meet research objectives within scope, budget and schedule.

C. Risk Management Plan:

Provide a summary description of the proposed approach to identify, analyze, and respond to perceived risks associated with the proposed project. Project risk events are uncertain future events that, if realized, impact the success of the project. Risk is inherent to all projects regardless of complexity, cost, or visibility. An effective Risk Management Plan will identify perceived risks and explain mitigation strategies for each risk. At a minimum, the Risk Management Plan shall include the initial identification of significant financial, cost/schedule, technical/scope, management, planning and oversight, ES&H, external factors, and management issues that have the potential to impede project progress and strategies to minimize impacts from those issues.

The following table format is provided but is not required:

Perceived Risks and Mitigation Strategies

Perceived Risk	Risk Rating			Mitigation/Response Strategy
	Probability (Low, Med, High)	Impact	Overall	
Financial Risks:				
Cost/Schedule Risks:				
Technical/Scope Risks:				
Management, Planning, and Oversight Risks:				
ES&H Risks:				
External Factor Risks:				

D. Milestone Log:

Provide milestones for each budget period of the project. Each milestone should be linked to a specific Task or Subtask and include a title, planned completion date, and a description of the method/process/measure used to verify completion. Milestones should be quantitative and show progress toward budget period and/or project goals. Conversely, periodic, mandatory progress reports are not considered to be Milestones.

Milestones are presumed to lie on the critical path of the project, i.e., unless all milestones are achieved, the Objectives as defined in the SOPO cannot be met completely. Applicants must provide at least two milestones per year throughout the course of the project.

Milestone Format

Task/ Subtask	Milestone Title & Description	Planned Completion Date	Verification method

[Note: During project performance, the Recipient will report the Milestone Status as part of the required quarterly progress report as prescribed under the Federal Assistance Reporting Checklist. The Milestone Status will present actual performance in comparison with Planned Milestones, and include:

(1) the actual status and progress of the project,

(2) specific progress made toward achieving the project's milestones, and,

(3) any proposed changes in the project's schedule required to complete milestones.]

E. Costing Profile:

Provide a table (the Spend Plan) that projects the expenditures of government funds by fiscal year for each project team member.

Spend Plan by Fiscal Year Format

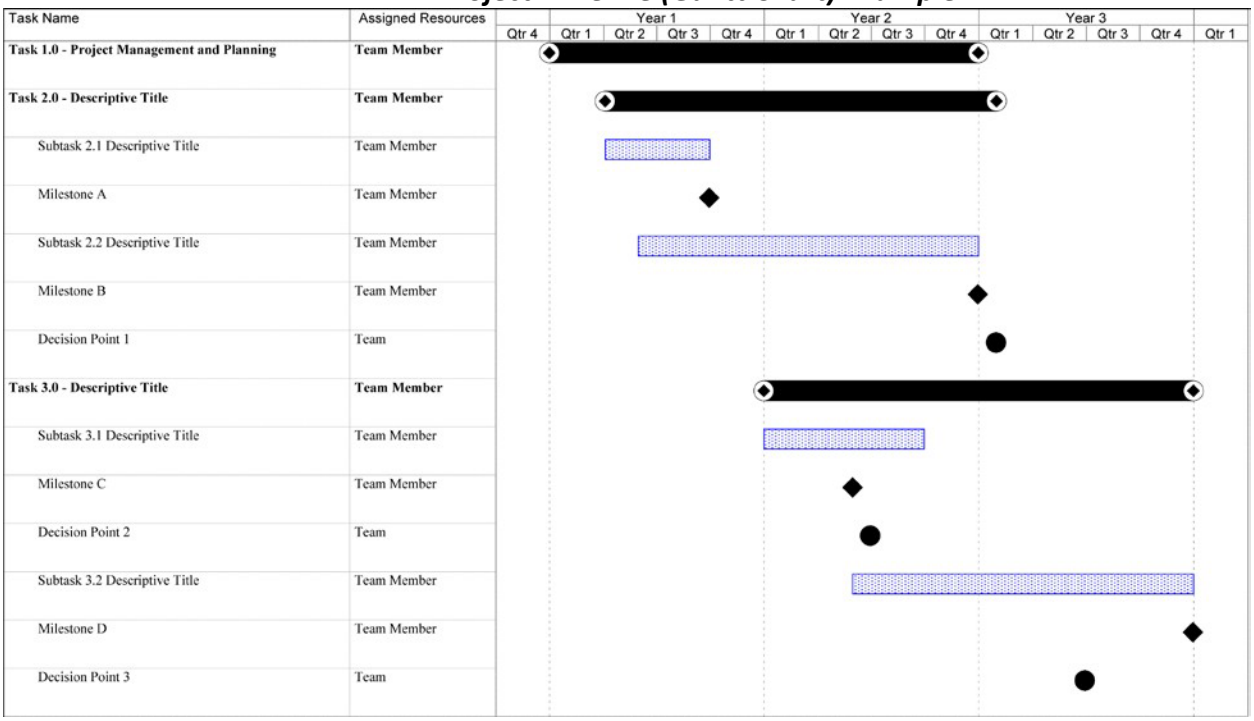
	FY 20XX		FY 20XX		FY 20XX		FY 20XX		Total	
	DOE Funds	Cost Share	DOE Funds	Cost Share	DOE Funds	Cost Share	DOE Funds	Cost Share	DOE Funds	Cost Share
Applicant										
Subrecipient A, if proposed										
Subrecipient B, if proposed										
FFRDC/NL, if proposed										
Total ($)										
Total Cost Share %										

F. Project Timeline:

Provide a timeline of the project (similar to a Gantt chart) broken down by each task and subtask, as described in the Statement of Project Objectives. The timeline should include for each task, a start date, and end date. The timeline should show

interdependencies between tasks and include the milestones that are identified in the Milestone Log (Section C).

Project Timeline (Gantt Chart) Example



G. Success Criteria:

Success criteria are used by the DOE to determine if specific goals and objectives were met at the end of budget period(s), go/no-go decision points, and/or project completion. The success criteria should be objective and stated in terms of specific, measurable, and repeatable data. Usually, the success criteria pertain to desirable outcomes, results, and observations from the project.

[Note: As the first task in the Statement of Project Objectives, successful applicants will revise the version of the Project Management Plan that is submitted with their applications by including details from the negotiation process. This Project Management Plan will be updated by the Recipient as the project progresses, and the Recipient must use this plan to report scope, schedule, and budget variances.]

Appendix F – Data Management Plan

A Data Management Plan ("DMP") explains how data generated in the course of the research or work performed under an assistance award will be shared and preserved or, when justified, explains why data sharing or preservation is not possible or scientifically appropriate.

DMP Requirements

In order for a DMP to be considered acceptable, the DMP must address the following:

At a minimum, the DMP must describe how data sharing and preservation will enable validation of the results from the proposed work, or how results could be validated if data are 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 publication. This includes data that are displayed in charts, figures, images, etc. In addition, the underlying digital research data used to generate the displayed data should be made as accessible as possible in accordance with the principles stated above. This requirement could be met by including the data as supplementary information to the published article, or through other means. The published article should indicate how these data can be accessed.

The DMP should consult and reference available information about data management resources to be used in the course of the proposed work. In particular, a DMP that explicitly or implicitly commits data management resources at a facility beyond what is conventionally made available to approved users should be accompanied by written approval from that facility. In determining the resources available for data management at DOE User Facilities, researchers should consult the published description of data management resources and practices at that facility and reference it in the DMP. Information about other DOE facilities can be found in the additional guidance from the sponsoring program.

The DMP must protect confidentiality, personal privacy, Personally Identifiable Information, and U.S. national, homeland, and economic security; recognize proprietary interests, business confidential information, and intellectual property rights; avoid significant negative impact on innovation, and U.S. competitiveness; and otherwise be consistent with all laws (i.e., export control laws), and DOE regulations, orders, and policies.

Data Determination for a DMP

The Principal Investigator should determine which data should be the subject of the DMP and, in the DMP, propose which data should be shared and/or preserved in accordance with the DMP Requirements noted above.

For data that will be generated through the course of the proposed work, the Principal Investigator should indicate what types of data should be protected from immediate public disclosure by DOE (referred to as "protected data") and what types of data that DOE should be able to release immediately. Similarly, for data developed outside of the proposed work at private expense that will be used in the course of the proposed work, the Principal Investigator should indicate whether that type of data will be subject to public release or kept confidential (referred to as "limited rights data"). Any use of limited rights data or labeling of data as "protected data" must be consistent with the DMP Requirements noted above.

Suggested Elements for a DMP

The following list of elements for a DMP provides suggestions regarding the data management planning process and the structure of the DMP:

Data Types and Sources: A brief, high-level description of the data to be generated or used through the course of the proposed work and which of these are considered digital research data necessary to validate the research findings or results.

Content and Format: A statement of plans for data and metadata content and format including, where applicable, a description of documentation plans, annotation of relevant software, and the rationale for the selection of appropriate standards. Existing, accepted community standards should be used where possible. Where community standards are missing or inadequate, the DMP could propose alternate strategies for facilitating sharing, and should advise the sponsoring program of any need to develop or generalize standards.

Sharing and Preservation: A description of the plans for data sharing and preservation. This should include, when appropriate: the anticipated means for sharing and the rationale for any restrictions on who may access the data and under what conditions; a timeline for sharing and preservation that addresses both the minimum length of time the data will be available and any anticipated delay to data access after research findings are published; any special requirements for data sharing, for example, proprietary software needed to access or interpret data,

applicable policies, provisions, and licenses for re-use and re-distribution, and for the production of derivatives, including guidance for how data and data products should be cited; any resources and capabilities (equipment, connections, systems, software, expertise, etc.) requested in the research proposal that are needed to meet the stated goals for sharing and preservation (this could reference the relevant section of the associated research proposal and budget request); and whether/where the data will be preserved after direct project funding ends and any plans for the transfer of responsibilities for sharing and preservation. A description of how the recipient intends to make the results of any resulting DOE-funded work available to the public, including the relevant technical community.

Protection: A statement of plans, where appropriate and necessary, to protect confidentiality, personal privacy, Personally Identifiable Information, and U.S. national, homeland, and economic security; recognize proprietary interests, business confidential information, and intellectual property rights; and avoid significant negative impact on innovation, and U.S. competitiveness.

Rationale: A discussion of the rationale or justification for the proposed data management plan including, for example, the potential impact of the data within the immediate field and in other fields, and any broader societal impact.

Additional Guidance

In determining which data should be shared and preserved, researchers must consider the data needed to validate research findings as described in the Requirements and are encouraged to consider the potential benefits of their data to their own fields of research, fields other than their own, and society at large.

DMPs should reflect relevant standards and community best practices and make use of community accepted repositories whenever practicable.

Costs associated with the scope of work and resources articulated in a DMP may be included in the proposed research budget as permitted by the applicable cost principles.

To improve the discoverability of and attribution for datasets created and used in the course of research, DOE encourages the citation of publicly available datasets within the reference section of publications, and the identification of datasets with persistent identifiers such as Digital Object Identifiers (DOIs). In most cases, DOE can provide DOIs free of charge for data resulting from DOE-funded research through its Office of Scientific and Technical Information (OSTI) DataID Service.

Definitions

Data Preservation: Data preservation means providing for the usability of data beyond the lifetime of the research activity that generated them.

Data Sharing: Data sharing means making data available to people other than those who have generated them. Examples of data sharing range from bilateral communications with colleagues, to providing free, unrestricted access to anyone through, for example, a web-based platform.

Digital Research Data: The term digital data encompasses a wide variety of information stored in digital form including: experimental, observational, and simulation data; codes, software and algorithms; text; numeric information; images; video; audio; and associated metadata. It also encompasses information in a variety of different forms including raw, processed, and analyzed data, published and archived data.

Research Data: The recorded factual material commonly accepted in the scientific community as necessary to validate research findings, but not any of the following: preliminary analyses, drafts of scientific papers, plans for future research, peer reviews, or communications with colleagues. This 'recorded' material excludes physical objects (e.g., laboratory samples). Research data also do not include:

(A) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published, or similar information which is protected under law; and

(B) Personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study."

Validate: In the context of DMPs, validate means to support, corroborate, verify, or otherwise determine the legitimacy of the research findings. Validation of research findings could be accomplished by reproducing the original experiment or analyses; comparing and contrasting the results against those of a new experiment or analyses; or by some other means.

Appendix G – Technology Readiness Levels

The following is a description of the DOE Technology Readiness Levels.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
System Operations	TRL 9	Actual system operated over the full range of expected mission conditions.	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	TRL 8	Actual system completed and qualified through test and demonstration.	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	TRL 7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning (1). Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Technology Demonstration	TRL 6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants.(1) Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.
Technology Development	TRL 5	Laboratory scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants (1) and actual waste (2). Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
Technology Development	TRL 4	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste (2). Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4-6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.
Research to Prove Feasibility	TRL 3	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants.(1) Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
Basic Technology Research	TRL 2	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.

Relative Level of Technology Development	Technology Readiness Level	TRL Definition	Description
	TRL 1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.

[1] Simulants should match relevant chemical and physical properties.

[2] Testing with as wide a range of actual waste as practicable and consistent with waste availability, safety, ALARA, cost and project risk is highly desirable.

Source: U.S. Department of Energy, "Technology Readiness Assessment Guide". Office of Management. 2011.

Appendix H – Technology Maturation Plan

TECHNOLOGY MATURATION PLAN
for {insert project title}
{Date Prepared}

SUBMITTED UNDER FUNDING OPPORTUNITY ANNOUNCEMENT

DE-FOA-0002956

SUBMITTED BY

{Organization Name}
{Organization Address}
{City, State, Zip Code}

PRINCIPAL INVESTIGATOR

{Name}
{Phone Number}
{E-mail}

SUBMITTED TO

U.S. Department of Energy
National Energy Technology Laboratory

A technology maturation plan (TMP) is a planning tool that summarizes the necessary research and development (R&D) steps to advance the maturation of a specified technology to a targeted technology readiness level (TRL) and defines the key performance metrics that will be used to determine if the targeted TRL has been successfully achieved. A TMP also documents the current TRL of the specified technology, defines the ultimate commercial application of the technology, and conceptualizes a future commercialization pathway in terms of additional R&D, resources and schedule. A TMP is a high-level summary document. It is not a collection of detailed test plans.

The National Energy Technology Laboratory (NETL) uses TMPs to enhance its stewardship of R&D project portfolios and improve the value of the technologies it develops. TMPs help NETL to:

- ensure that research questions are resolved in the least expensive and least risky R&D setting (i.e., scale, degree of integration, environment, fidelity)
- focus technology development on the performance metrics that are most important for technical and economic success (at component and system levels)
- identify R&D gaps and critical components that are lagging in maturity
- ensure that R&D projects address what is required for integration into higher-level systems
- make informed decisions at critical stages of research (e.g., moving a technology from a laboratory project to a larger-scale pilot project)
- improve the balance of project portfolios in terms of technology types, pathways, TRLs, redundancy, etc., to mitigate risks and increase the likelihood of R&D success, and
- forecast the cost and duration of technology development through demonstration and commercialization.

The below template should be used to complete a TMP. Instructions, shown in italics, should be deleted/replaced in the completed TMP. Section 3 is provided solely for reference but should be retained as-is in the completed TMP.

1.0 INTRODUCTION

1.1 Purpose of the Project

Provide a brief summary of the project's objectives as related to maturation of the proposed technology.

1.2 Technology Readiness Assessment System

Technology maturation is quantified by a performing a technology readiness assessment (TRA) on the specified technology system.

- Identify the specified "TRA System" and describe all the critical components and/or subsystems that comprise it. See "TRA System" definition under Section 3.1.
- State whether the current project will test: (1) the total, integrated TRA System, or (2) one or more critical subsystems or components of the TRA System. If the latter, identify which critical subsystems and/or components will be tested.

1.3 Commercial Application

Provide a one-paragraph description of the targeted commercial application(s) of the TRA System.

2.0 MATURATION OF THE TRA SYSTEM

2.1 Beginning Technology Readiness Level (TRL) of the TRA System

Briefly summarize the prior research that matured the technology to its current state.

Using the Technology Readiness Levels (TRL) descriptions in Sections 3.2 and 3.3, specify the current (i.e., pre-project) TRL of the TRA System. To attain a certain TRL, all aspects of the associated TRL description must be met.

Justify the specified TRL by explaining how all the required TRL aspects have been achieved.

2.2 Proposed Research to Mature the TRA System

Identify the TRL that the project plans to attain.

- Note that the targeted TRL could be the same as the beginning TRL if the project is aimed at making only incremental progress toward achieving the next TRL.
- If the project proposes to advance the TRL by more than one level, explain if that will be accomplished in stages (i.e., first one TRL, then the next) or by skipping a TRL. If the latter, explain how any increased technical, cost and schedule risks associated with skipping a TRL will be mitigated.

Identify each of the key performance attributes that will be assessed during the research along with the corresponding, quantifiable performance requirements that must be achieved to attain the targeted TRL(s). Explain how the key performance attributes were selected and how the corresponding requirements were determined. Be as specific as practical on any supporting technical/economic assessments (see Section 3.4 for NETL's Systems Analysis Best Practices). As a general principle, all key performance requirements that may be appropriately tested at a particular TRL must be substantially met, thereby supporting the feasibility of commercial success/goal achievement, prior to proceeding to the subsequent TRL.

Briefly summarize the proposed research steps and how they will mature the TRA System to the targeted TRL(s).

2.3 Potential Post-Project Maturation and Commercialization of the TRA System

Assuming the project successfully attains the targeted TRL(s), describe what additional (post-project) work would be required to mature the TRA System to the next TRL. Identify the key performance requirements and goals/measures that would need to be achieved. If possible, provide rough estimates of the cost and duration of the research required to attain the next TRL.

Describe your organization's potential role in a commercialization strategy for the TRA system.

3.0 REFERENCE MATERIAL

3.1 Definition of TRA System

NETL's interpretation (Section 3.2) of the DOE TRL definitions (Section 3.3) is based on a view of technology maturation in which "components" are integrated into a "system" that is being assessed for its technology readiness. To clearly and consistently apply the DOE TRL definitions, one must first precisely identify what "system" is being assessed, defined herein as the "Technology Readiness Assessment (TRA) System." Since most technologies can be viewed as subsystems within larger systems, multiple choices are available for defining the TRA System. However, note that the choice of the "level" of the TRA System affects how TRLs are assessed:

- A TRL 3 is achieved for the specified TRA System when analytical performance predictions for each of the TRA System's critical[67] components have been validated in separate experiments (i.e., without integration across components). Accordingly, the table in Section 3.2 shows the required scope of TRL 3 as "single component" and the required integration of TRL 3 as "none."
- A TRL 4 or 5 is achieved for a given TRA System when the targeted performance requirements for each of its critical, multi-component subsystems (or the entire TRA system) have been validated in a laboratory environment (TRL 4) or relevant environment (TRL 5) with integration of some or all components.
- Achieving TRLs 6 to 9 requires testing of the entire, fully integrated, TRL system.

To further clarify, consider, for example, a fuel cell stack. Its critical components are multiple, identical fuel cells. In turn, the critical components of each fuel cell are an anode, cathode and electrolyte. If one wished to assess the technology readiness of

[67] A component or subsystem of a TRA System is considered critical if it is new, novel, and necessary for the TRA System to meet its anticipated operational performance requirements or poses major cost, schedule, or performance risk during design or demonstration. Note that a component that is fully mature and non-critical for an established application or operational environment may be considered critical if it is incorporated into a new application or operational environment.

the fuel cell stack, the TRA System would be defined as an integrated system of multiple fuel cell subsystems, and a TRL 6 could only be achieved by successfully testing an entire stack of integrated fuel cells. However, if one instead wished to assess the technology readiness of only the fuel cell, the TRA System would be defined as an integrated system of cathode, anode and electrolyte components, and a TRL 6 could be achieved by successfully testing just a single, integrated fuel cell. In both cases, achievement of TRL 6 could be claimed, but only in the context of the properly specified TRA System.

3.2 NETL Interpretations of DOE Technology Readiness Levels in the Context of Fossil Energy and Carbon Management R&D

<table>
<tr><th rowspan="2">TRL</th><th rowspan="2">DOE Definition</th><th colspan="6">Minimum Simultaneous Requirements to Achieve TRL
based on NETL Interpretation of DOE Definitions & Descriptions</th></tr>
<tr><th>Scope</th><th>Integration</th><th>Fidelity</th><th>Scale</th><th>Environment</th><th>Metrics</th></tr>
<tr><td>1</td><td>Basic principles observed and reported</td><td colspan="5" rowspan="2">Any experimentation is limited to discovery and validation of fundamental scientific principles. Formulation of the technology that applies the fundamental science is initiated in conceptual paper studies but experiments on the applied technology have not begun.</td><td>NA</td></tr>
<tr><td>2</td><td>Technology concept and/or applications formulated</td><td rowspan="9">Project-specific TMPs should define cost and/or performance metrics for relevant TRLs. To attain a given TRL, the technology must achieve the metrics for that TRL (or show a likely potential to do so).</td></tr>
<tr><td>3</td><td>Analytical and experimental critical function and/or characteristic proof of concept</td><td>Single Component</td><td>None</td><td>Low (ad-hoc hardware)</td><td rowspan="3">Lab</td><td>Lab
(simulated conditions)</td></tr>
<tr><td>4</td><td>Component and/or system validation in laboratory environment</td><td rowspan="2">Total system or multi-component subsystem</td><td rowspan="2">Integration of some or all components</td><td rowspan="2">High (nearly a prototype)</td><td rowspan="3">Relevant
(regulated expected conditions)</td></tr>
<tr><td>5</td><td>Laboratory scale, similar system* validation in relevant environment</td></tr>
<tr><td>6</td><td>Engineering/pilot-scale, similar (prototypical) system validation in relevant environment</td><td rowspan="4">Total system

(The total system is equivalent to the "TRA System," which is the system or subsystem for which technology readiness is being assessed)</td><td rowspan="4">All components and subsystems integrated</td><td rowspan="2">Prototype</td><td>Small Pilot**</td></tr>
<tr><td>7</td><td>Full-scale, similar (prototypical) system demonstrated in relevant environment</td><td>Large Pilot or Full**</td></tr>
<tr><td>8</td><td>Actual system completed and qualified through test and demonstration. Technology has been proven to work in its final form and under expected conditions.</td><td>Actual system in final form</td><td rowspan="2">Full</td><td rowspan="2">Operational
(unregulated actual conditions)</td></tr>
<tr><td>9</td><td>Actual operation of the technology in its final form, under the full range of conditions.</td><td>Commercially warranted</td><td>NA</td></tr>
<tr><td colspan="8">* The DOE TRL 5 description states that the "similar system" matches the final application in "almost all respects" and is "almost prototypical." This table interprets the similar, but not fully prototypical, system as being either: a) the total system for which readiness is being evaluated, or b) a multi-component subsystem of the total system. This interpretation is supported by the DOE TRL 6 description which states that "TRL 6 begins true engineering development of the technology as an operational system."
** DOE defines TRL 6 as a pilot-scale prototype and TRL 7 as a full-scale prototype. DOE defines TRLs 8 and 9 as involving "actual" systems at full scale. This table assumes that the scale of the TRL 7 full-scale prototype could be less than or equal to the scale of the TRL 8 full-scale actual system. At a minimum, the scale of the TRL 7 prototype must be sufficiently large to support subsequent testing of a TRL 8 full-scale actual system without the need for testing at an intervening scale.</td></tr>
</table>

3.3 Description of DOE Technology Readiness Levels

Source: U.S. Department of Energy, "Technology Readiness Assessment Guide". Office of Management. 2011.

Relative Level of Technology Development	TRL	TRL Definition	Description
System Operations	9	Actual system operated over the full range of expected mission conditions.	The technology is in its final form and operated under the full range of operating mission conditions. Examples include using the actual system with the full range of wastes in hot operations.
System Commissioning	8	Actual system completed and qualified through test and demonstration.	The technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental testing and evaluation of the system with actual waste in hot commissioning. Supporting information includes operational procedures that are virtually complete. An Operational Readiness Review (ORR) has been successfully completed prior to the start of hot testing.
	7	Full-scale, similar (prototypical) system demonstrated in relevant environment	This represents a major step up from TRL 6, requiring demonstration of an actual system prototype in a relevant environment. Examples include testing full-scale prototype in the field with a range of simulants in cold commissioning (1). Supporting information includes results from the full-scale testing and analysis of the differences between the test environment, and analysis of what the experimental results mean for the eventual operating system/environment. Final design is virtually complete.

Relative Level of Technology Development	TRL	TRL Definition	Description
Technology Demonstration	6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	Engineering-scale models or prototypes are tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing an engineering scale prototypical system with a range of simulants.(1) Supporting information includes results from the engineering scale testing and analysis of the differences between the engineering scale, prototypical system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. TRL 6 begins true engineering development of the technology as an operational system. The major difference between TRL 5 and 6 is the step up from laboratory scale to engineering scale and the determination of scaling factors that will enable design of the operating system. The prototype should be capable of performing all the functions that will be required of the operational system. The operating environment for the testing should closely represent the actual operating environment.
Technology Development	5	Laboratory scale, similar system validation in relevant environment	The basic technological components are integrated so that the system configuration is similar to (matches) the final application in almost all respects. Examples include testing a high-fidelity, laboratory scale system in a simulated environment with a range of simulants (1) and actual waste (2). Supporting information includes results from the laboratory scale testing, analysis of the differences between the laboratory and eventual operating system/environment, and analysis of what the experimental results mean for the eventual operating system/environment. The major difference between TRL 4 and 5 is the increase in the fidelity of the system and environment to the actual application. The system tested is almost prototypical.

Technology Development	4	Component and/or system validation in laboratory environment	The basic technological components are integrated to establish that the pieces will work together. This is relatively "low fidelity" compared with the eventual system. Examples include integration of ad hoc hardware in a laboratory and testing with a range of simulants and small scale tests on actual waste (2). Supporting information includes the results of the integrated experiments and estimates of how the experimental components and experimental test results differ from the expected system performance goals. TRL 4-6 represent the bridge from scientific research to engineering. TRL 4 is the first step in determining whether the individual components will work together as a system. The laboratory system will probably be a mix of on hand equipment and a few special purpose components that may require special handling, calibration, or alignment to get them to function.

Relative Level of Technology Development	TRL	TRL Definition	Description
Research to Prove Feasibility	3	Analytical and experimental critical function and/or characteristic proof of concept	Active research and development (R&D) is initiated. This includes analytical studies and laboratory-scale studies to physically validate the analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative tested with simulants.(1) Supporting information includes results of laboratory tests performed to measure parameters of interest and comparison to analytical predictions for critical subsystems. At TRL 3 the work has moved beyond the paper phase to experimental work that verifies that the concept works as expected on simulants. Components of the technology are validated, but there is no attempt to integrate the components into a complete system. Modeling and simulation may be used to complement physical experiments.
Basic Technology Research	2	Technology concept and/or application formulated	Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are still limited to analytic studies. Supporting information includes publications or other references that outline the application being considered and that provide analysis to support the concept. The step up from TRL 1 to TRL 2 moves the ideas from pure to applied research. Most of the work is analytical or paper studies with the emphasis on understanding the science better. Experimental work is designed to corroborate the basic scientific observations made during TRL 1 work.
	1	Basic principles observed and reported	This is the lowest level of technology readiness. Scientific research begins to be translated into applied R&D. Examples might include paper studies of a technology's basic properties or experimental work that consists mainly of observations of the physical world. Supporting Information includes published research or other references that identify the principles that underlie the technology.

[1] Simulants should match relevant chemical and physical properties.
[2] Testing with as wide a range of actual waste as practicable and consistent with waste availability, safety, ALARA, cost and project risk is highly desirable.

3.4 NETL Systems Analysis Best Practices

NETL has developed Systems Analysis Best Practices (SABP) as an accompaniment to the DOE Technology Readiness Level (TRL) definitions. The SABP serve as a guide for

the Principal Investigator/researcher to inform on the level of systems and economic analysis rigor appropriate at each TRL.

System and economic analyses are an essential component of research and development (R&D). They are used to determine appropriate experimental conditions, inform R&D targets and technology maturation plans, assess R&D progress, and estimate the benefits of successful technology development in commercial applications.

Systems analysis is the analytic process used to evaluate the behavior and performance of processes, equipment, subsystems, and systems. Such analyses serve to characterize the relationships between independent (e.g., design parameters and configurations, material properties, etc.) and dependent variables (e.g., thermodynamic state points, output, etc.) through the creation of models representative of the envisioned process, equipment, subsystem, or system. These analyses are used to determine the important variables (i.e., performance attributes) and the associated targets (i.e., performance requirements) that must be achieved through R&D and testing to realize commercial and/or program goals.

The performance requirements are selected such that the equipment, subsystem, or system meets the envisioned objectives in the target commercial application. The target commercial application refers to one specific use for the advanced technology, at full commercial scale. A project may include more than one target commercial application. For example:

1. Technologies that reduce the cost of gasification may be useful for both liquid fuels and power production.
2. Technologies that may be useful to monitor CO_2 storage in more than one type of storage site.

The modeling and simulation effort may use one or more of a variety of tools, such as Excel, MATLAB, Aspen Plus, Aspen Plus Dynamics, Thermoflow, CHEMCAD, etc., depending upon suitability to the specific processes, the scope of the development effort, and the stage of development.

An integral part of systems analysis is economic analysis - the process of estimating and assigning costs to equipment, subsystems, and systems corresponding to models of and specifications for the commercial embodiment of the technology. Such analyses include the estimation of capital costs, as well as operating and maintenance costs. Component service life and corresponding replacement costs are often a crucial aspect of these analyses. See Performing a Techno-economic

Analysis for Power Generation Plants, DOE/NETL-2015/1726, July 2015, for further guidance.

As a technology matures, the systems analyses are frequently updated, and are expected to increase in fidelity and complexity commensurate with the available technical understanding, experimental data, and overall level of effort (cost of R&D). The results are used to inform the next stage of development and provide specific experimental and analysis success criteria (the performance requirements).

As a general principle, the performance requirements that may be appropriately tested at a particular TRL must be substantially met, thereby supporting the feasibility of commercial success/goal achievement, prior to proceeding to the subsequent TRL. Note that, as with the TRL descriptions, these SABP are "gate-in;" that is, prerequisites to achieving the associated TRL.

NETL supports a wide range of RD&D projects, from small, short-duration materials development and property characterization projects up to large-scale power plant demonstrations. The nature and complexity of the technology under development and the scope of the project must be taken into account when applying the SABP – they may not be strictly applicable as written to every project. For example, it is an unreasonable expectation for a project developing a sensor, or fuel cell cathode, or thermal boundary coating for a turbine airfoil to perform a full-scale power plant simulation to determine the performance requirements of the specific technology in the course of pursuing TRL 4. However, the project must explicitly tie the quantitative goals/objectives for the technology to referenced system studies as well as relevant industry and/or market requirements in such a manner that their pedigree is readily traceable. On the other hand, a project endeavoring to develop a full system concept incorporating novel components and process integration is expected to perform more robust, extensive analyses.

Descriptions of the SABP associated with each TRL are provided in the table below.

TRL	DOE Definition	Systems Analysis Best Practices
1	Basic principles observed and reported	Assessment: Perform an assessment of the core technology resulting in (qualitative) projected benefits of the technology, a summary of necessary R&D needed to develop it into the actual technology, and principles that support of the viability of the technology to achieve the projected benefits.

TRL	DOE Definition	Systems Analysis Best Practices
2	Technology concept and/or applications formulated	White Paper: A white paper describing the intended commercial application, the anticipated environment the actual technology will operate in, and the results from the initiation of a detailed analysis (that will at least qualitatively justify expenditure of resources versus the expected benefits and identify initial performance attributes).
3	Analytical and experimental critical function and/or characteristic proof of concept	Performance Model and Initial Cost Assessment: This performance model is a basic model of the technology concept, incorporating relevant process boundary conditions, that provides insight into critical performance attributes and serves to establish initial performance requirements. These may be empirically- or theoretically-based models represented in Excel or other suitable platforms. In addition, an initial assessment and determination of performance requirements related to cost is completed.
4	Component and/or system validation in laboratory environment	System Simulation and Economic Analysis: These models incorporate a performance model of the technology (may be a simple model as developed for TRL 3, or something more detailed – either should be validated against empirical data gathered in the laboratory) into a model of the intended commercial system (e.g., power plant). In addition, an economic analysis (e.g., cost-of-electricity) of the technology is performed, assessing the impact of capital costs, operating and maintenance costs, and life on the impact of the technology and its contributions to the viability of the overall system in a commercial environment. These analyses serve to assess the relative impact of known performance attributes (through sensitivity analyses) and refine performance requirements in the context of established higher-level technical and economic goals (e.g., programmatic or DOE R&D goals). These models are typically created in process simulation software (e.g., ASPEN Plus) or other suitable platforms. DOE maintains guidance on the execution of techno-economic analyses [1].
5	Laboratory scale, similar system* validation in relevant environment	System Simulation and Economic Analysis Refinement: A more detailed process model for the technology, validated against empirical data gathered in the laboratory, will be developed and incorporated into system simulations. This provides greater fidelity in the performance and cost estimation for the technology, facilitating updates to performance attributes and requirements (including updates to the economic analysis). This also allows greater evaluation of other process synergy claims (e.g., state-of-the-art technology is improved by the use of the new technology). Cost estimation should be either vendor-based or bottom-up costing approaches for novel equipment.

TRL	DOE Definition	Systems Analysis Best Practices
6	Engineering/pilot-scale, similar (prototypical) system validation in relevant environment	System Simulation and Economic Analysis Refinement: Performance and cost models are refined based upon relevant environment laboratory results, leading to updated performance attributes and requirements. Preliminary steady-state and dynamic (if appropriate for the technology) modeling of all critical process parameters (i.e., upper and lower operating limits) of the system prototype is completed. Cost estimation should be either vendor-based or bottom-up costing approaches for novel equipment. Key process equipment should be specified to the extent that allows for bottom-up estimating to support a feasibility study of the integrated system.
7	Full-scale, similar (prototypical) system demonstrated in relevant environment	System Simulation and Economic Analysis Refinement: Performance and cost models are refined based upon relevant environment and system prototype R&D results. The refined process, system and cost models are used to project updated system performance and cost to determine if the technology has the potential to meet the project goals. Performance attributes and requirements are updated as necessary. Steady-state and dynamic modeling all critical process parameters of the system prototype covering the anticipated full operation envelope (i.e., upper and lower operating limits) is completed. Cost models should be based on vendor quotes and traditional equipment estimates should be minimal.
8	Actual system completed and qualified through test and demonstration. Technology has been proven to work in its final form and under expected conditions.	System Simulation and Economic Analysis Validation: The technology/system process models are validated by operational data from the demonstration. Economic models are updated accordingly.
9	Actual operation of the technology in its final form, under the full range of conditions.	Commercial Use: Models are used for commercial scaling parameters.

Appendix I – Workforce Readiness Plan Template

Recipient Name:
PI Name:
Award Number:
Project Title:
Technology:

Availability and accessibility of training programs: Describe the necessary skillset and training required to prepare the workforce needed to commercialize/deploy the technology. Discuss availability of training and educational programs to fill current or projected activity/commercialization need.

Ongoing or planned collaborations with education and training providers: Describe plans and approaches to access the necessary training for the workforce needed to commercialize/deploy the technology. This includes coordination with educational institutions such as community colleges, technical schools, and universities, company-led in-house training, union training, etc. Please identify any institutions with which working relationships exist.

Identify any necessary certificates, certifications or other educational attainment involved in this technology/activity. Examples include apprenticeships, certificates, certifications, academic training or other programs available through in-house training or in coordination with education institutions such as community colleges, technical schools, universities, unions or other professional associations.

Identify any Economically Distressed Communities or state or federal designated Opportunity Zones or other geographically defined empowerment zones where this activity may occur *(example: Appalachian region distressed or defined counties).*

Appendix J – Economic Revitalization and Job Creation Questionnaire Template for FECM R&D Projects

Economic Revitalization and Job Creation Questionnaire

1. Apart from job creation, how will the project and/or the associated technology development and deployment support economic revitalization?

2. How many jobs could potentially be created by the project and/or associated technology development and deployment? As applicable, please quantify in terms of number of jobs created per unit of product, number of jobs created per unit of waste remediated, number of jobs created per unit of emissions mitigated, and/or another appropriate metric.

3. What will be the nature of the created jobs, including the extent to which they will include clean energy jobs?

4. To what extent will the created jobs be at the prevailing wage?

5. To what extent will the created jobs be located in power plant and coal communities that are economically distressed and/or have been harmed by the adverse environmental impacts of the energy industry?

6. What recruitment strategies will be used for: a) workers from the local community, and b) individuals who belong to groups that are historically underserved or underrepresented?

7. Will the skills possessed by the existing labor force be adequate for the created jobs, or will training be required for those workers?

Appendix K – Environmental Justice Questionnaire Template for FECM R&D Projects

Environmental Justice Questionnaire

1. How does the developmental technology rely on limited resources such as coal, biomass, freshwater, land, and/or low-carbon energy? What is the relationship between the amount of resources used versus the amount of product formed?

2. How does the developmental technology remediate legacy environmental impacts of the energy industry, including environmental impacts associated with the use of coal?

3. To what extent does the developmental technology provide ancillary environmental benefits, such as reductions in NO_x and SO_x emissions, particulate matter, or hazardous pollutants?

4. If coal is used as a feedstock, where will it be mined and what are the associated near-term and legacy environmental impacts of the coal mining, including methane leakage?

5. If coal (or other) wastes are being remediated, what is the relationship between the amount of coal wastes used versus the amount of product formed?

6. What is the project's waste management strategy and what are the anticipated impacts of residual waste on local residents?

Appendix L – Carbon Ore to Carbon Manufacturing Precursor Materials (CMPM) State Point Data Table

Carbon Manufacturing Precursor Materials (CMPM)			
	Units	**Performance Target**	**Actual Measured Result**
Particle Size	Micron		
% Carbon	%		
% Ash	%		
Sulfur (S)			
Nitrogen (N)			
[68]PC 1:			
PC 2:			
PC 3:			
PC 4:			
PC 5:			
PC 6:			
PC 7:			
PC 8:			
PC 9:			
PC 10:			
PC 11:			
PC 12:			
PC 13:			
PC 14:			
Projected Finished Products			
	Units	**Commercial CMPM**	**Coal-Derived CMPM**

[68] PC = performance characteristic. List the performance characteristics used to validate the experimental CMPM and compare to commercial analogues. There is no requirement to fill all PC rows. If more rows are needed, users can attach a supplementary sheet.

Target CMPM Application	-		
U.S. Market Value	$		
U.S. Market Size	(Tonne)		
U.S. Estimated Required Selling Prices	$/kg		
U.S. Continuous Annual Growth Rate (CAGR)	%		
Coal Source			
Description			
Location			
Sourcing Partner (if applicable)			
Rank			
Volume Available (Tonne)			

Appendix M – Guidance for Development of Techno-Economic Analyses for DOE/NETL'S Critical Minerals and Materials Program

The intent of the TEA is to demonstrate economic feasibility and identify economic and design hurdles that can be addressed with future research development and demonstration. The TEA should include a description of how the proposed process would fit within the overall Critical Minerals and Materials supply chain and what additional processes or processing steps would need to be developed to produce individual high-purity rare earth elements (REEs) and/or rare earth oxides (REOs) and other critical minerals and materials (CMM).

The TEA should include a paper study to determine the technical, economic, and environmental aspects of resources required for commercial-scale operation. As applicable, the TEA should evaluate:

1. Available quantity and quality of feedstock to support long-term commercial operation.
2. Commercial availability of the required process equipment. The TEA should be based on vendor quotes where available but, if relevant quotes are not available, the TEA may be based on appropriate scaling factors.
3. Commercial availability of reagents (i.e., lixiviants, acids/bases, solvents, etc.), and/or alternate reagents/additives. The TEA should consider the following factors for reagents and/or alternate reagents/additives required for commercial-scale operation:
    a. Current and proposed sources of reagents with geographic location of domestic and global reagent manufacturing facilities (if available, include the current and future production capacity of those facilities).
    b. Market availability, relative purity, and price for quantities of reagent required to initially fill and periodically supplement the initial system fill (system make-up/re-charging), and the risk of supply becoming unavailable. If supply and /or price of commercial reagents are constraints, the TEA should consider the technical and economic feasibility (including capital and operating costs) of producing reagents on-site at the rare earth recovery system commercial-scale site.
    c. Technical factors such as reagent purity requirements, reagent performance, reagent degradation, and the techno-economic impact of those factors.