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

Operation and Planning Tools for Inverter-Based Resource Management and Availability for Future Power Systems (OPTIMA)

Funding Opportunity Announcement (FOA) Number: DE-FOA-0003034
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FOA Issue Date: 4/20/2023	
Informational Webinar: 5/4/2023	
Submission Deadline for Concept Papers: 6/12/2023	5:00pm ET
Submission Deadline for Full Applications: 8/22/2023	5:00pm ET
Expected Submission Deadline for Replies to Reviewer Comments: 9/20/2023	5:00pm ET
Expected Date for EERE Selection Notifications: December, 2023	
Expected Timeframe for Award Negotiations: December, 2023 – April, 2024	

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

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

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

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

during which it has an active federal award or an application or plan under consideration by a federal awarding agency. DOE may not make a federal award to an applicant until the applicant has complied with all applicable UEI and SAM requirements and, if an applicant has not fully complied with the requirements by the time DOE is ready to make a federal award, the DOE will determine that the applicant is not qualified to receive a federal award and use that determination as a basis for making a federal award to another applicant.

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

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Modifications

All modifications to the FOA are highlighted in the body of the FOA. Changes from the initial FOA are highlighted in yellow.

Mod. No.	Date	Description of Modification
000001	05/31/2023	The FOA email address was initially not working and has now been fixed. Due to this issue, the Concept Paper Submission Deadline has been extended from 6/5/2023 to 6/12/2023. The FOA timeline on the cover page has been updated to accommodate this change.

I. Funding Opportunity Description

A. Background and Context

i. Background and Purpose

This funding opportunity announcement (FOA) is being issued by the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Solar Energy Technologies Office (SETO). This FOA will advance the Biden Administration's goals to achieve carbon pollution-free electricity by 2035 and to "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050" to the benefit of all Americans. The research, development, and demonstration (RD&D) activities to be funded under this FOA will support the government-wide approach to the climate crisis by driving innovations that can lead to the large-scale deployment of clean energy technologies.

Specifically, projects funded under this FOA will address the emerging challenges and opportunities for grid planning and operation engineers and technicians arising from the power system's transition to variable renewable energy sources and inverter-based power electronic grid interfaces. New state-of-the-art planning and operations tools will enable solar energy to be more optimally and reliably integrated and utilized within the electric power grid, providing Americans with more cheap and secure sources of clean energy.

Grid operations and grid planning refer to the day-to-day and long-term engineering efforts that utilities and Independent System Operators (ISOs) must undertake to maintain a reliable supply of electricity both now and in the future. The variable nature of renewable energy resources, which include solar and wind generation technologies, requires the grid to be operated more flexibly to account for less certain availabilities and flows of energy. Additionally, these renewable sources of generation have different behaviors than the traditional, machine-based generation they are replacing. Grid operators must be able to monitor and react to these changing system dynamics with their tools in the control room. Long-term planning must also account for the impact of extreme weather and other disturbances that may be unique to renewable generation sources. Furthermore, the tools used by grid planners and operators must be updated to adopt new standards and more accurately represent the new technologies being deployed. Updating utility planning and operations tools to address all these changes will be necessary for renewable energy resources to be utilized at their full potential and to be relied upon by grid operators as secure, economic, and clean sources of energy in the future power grid.

ii. Technology Office Objectives

SETO supports solar energy research, development, demonstration, and technical assistance in five areas—photovoltaics (PV), concentrating solar-thermal power (CSP), systems integration, manufacturing and competitiveness, and soft costs—to improve the affordability, reliability, and domestic benefit of solar technologies on the electric grid. In May 2021, SETO released its Multi-Year Program Plan, which describes its activities and specific goals for 2025. In September 2021, DOE released the Solar Futures Study, which examined solar power's role in decarbonizing the grid by 2035 and 2050. Both documents guide SETO's research, development, and demonstration efforts.

Solar energy technologies are essential to achieving a 100% clean electricity system by 2035 and a net-zero energy system by 2050. According to the Solar Futures Study, solar power will need to grow from 5% of the U.S. electricity supply today to 40% by 2035 and 45% by 2050. This will require solar deployment to increase roughly 20% per year for the rest of the decade. With supportive policies, electrification, and aggressive cost reductions, solar technologies could provide 1 terawatt (TW) of generation capacity to the grid by 2035. Preliminary modeling shows that decarbonizing the entire energy system could result in the need for as much as 3 TW of solar capacity due to increased electrification across the energy system.

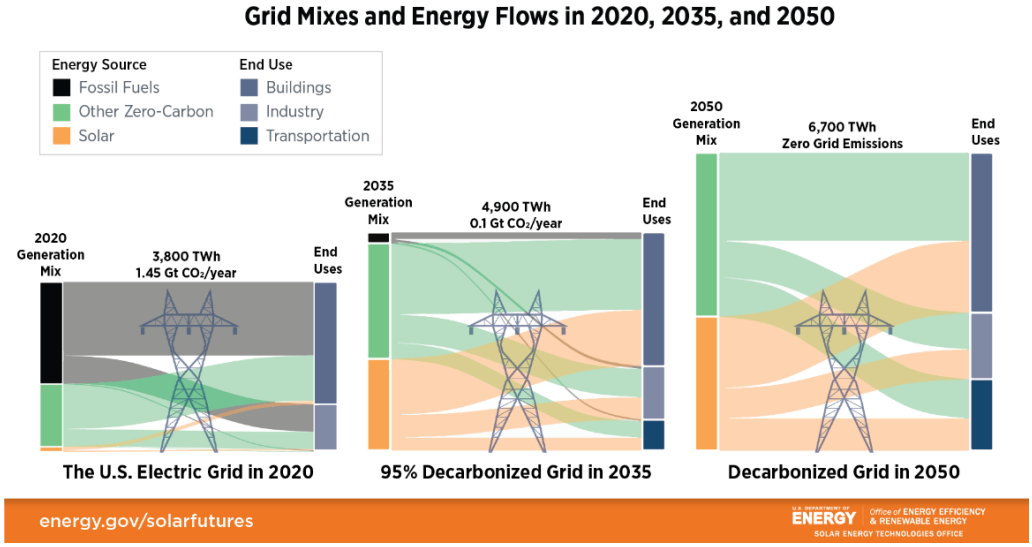

Figure 1: Solar power grew from 3% of the electricity mix in 2020 to 5% in 2022, and to meet net-zero goals is projected to grow to 45% in 2050, serving more building, industry and transportation end uses in the decarbonization + electrification scenario. SOURCE: NREL/DOE Solar Futures Study

Achieving this transition requires that the industry achieve SETO's 2030 cost targets, which would halve the cost of solar power from 2020-2030. In many

parts of the country, solar electricity is already the lowest-cost form of new electricity generation capacity, but solar electricity is not yet cost-effective everywhere. There are multiple pathways to achieve these goals, but all require sustained innovation across solar energy technologies.

Recent policy changes in the Inflation Reduction Act (IRA) created and updated federal tax incentives for solar deployment and domestic solar manufacturing. These changes include an increase and extension of a tax credit that can be claimed for installing solar generation and a new tax credit for solar manufacturing in the U.S. that enables domestic modules and components to be competitive with imports. DOE estimates that these changes will greatly expand the deployment of solar energy and help to reduce carbon emissions to 40% below 2005 levels by 2030.

Further, solar generation must not only be an economically viable resource but must also contribute to the reliability and security of the grid, helping to maintain the quality of service expected by the American people. The RD&D activities to be funded under this FOA will provide grid operators with system risk assessment and control tools to allow renewable resources to better integrate with the grid on hour-by-hour and day-to-day basis, as well as system planning tools to adapt to the changing energy landscape. These RD&D activities will enable solar to become more easily integrated with the electric power system to provide affordable, carbon-free electricity and improve the nation's energy security.

iii. Technology Space and Strategic Goals

Generation technologies that harness energy from renewable sources that vary over time, like solar and wind generation, are collectively referred to as variable renewable energy resources (VRE). As the deployment of solar and wind generation grows, the overall generation capacity of VRE relative to electric demand, or load, grows, as well as the amount of time that system demand is mainly supported by VRE.[1,2,3] For example, on an April day in 2022, California Independent System Operator's (CAISO) solar PV and other renewable electricity met nearly 100% of the system demand for a brief time.[4] In general, the amount

[1] Hawaiian Electric. December 2020. "Power Facts." https://www.hawaiianelectric.com/documents/about_us/company_facts/power_facts.pdf
[2] Southwest Power Pool. 2019. "2019 Annual Report. Integration." https://www.spp.org/documents/62057/2019%20annual%20report%2020200428%20web.pdf
[3] ERCOT. December 2021. "Combined Wind and Solar." https://www.ercot.com/gridmktinfo/dashboards/combinedwindandsolar
[4] CAISO, http://www.caiso.com/Documents/California-ISO-Hits-All-Time-Peak-of-More-Than-97-Percent-Renewables.pdf

of energy available to VRE at any given time and how much can be actively controlled, or dispatched, are less predictable than with traditional generation sources. This makes it more challenging for grid operators to economically plan for adequate energy reserves as the generation fluctuates as well as the electric demand.

An important set of technologies that may aid VRE to become more dispatchable are energy storage systems (ESS). These may be large stand-alone utility scale plants, small distributed systems like residential batteries, or systems co-located with VRE, forming hybrid power plants with a mix of wind, solar, or storage systems. ESS technologies can range from fast responding units with more limited energy reserves, like lithium ion and other battery energy storage systems (BESS), to more long-duration ESS such as flow batteries or pumped storage hydropower. How VRE and ESS coordinate will be an important topic for projects to explore under this FOA.

Another feature of solar and wind generation, along with some ESS, is that these resources are interfaced to the grid through an electronic inverter and are therefore collectively known as inverter-based resources (IBR). The physics of the electronic IBR grid interface are much different than the electromechanical grid interface of traditional generation; the dynamics of IBR are dictated primarily by programming as opposed to the physics of rotating masses and electromagnets. As a result, IBR can operate and react to grid changes much faster than traditional generation, but they do not have the inherent inertia of rotating machines to inhibit grid state changes. These features present new challenges, and opportunities, for grid operators to control IBR to support the grid during disturbances and maintain, and potentially improve, grid reliability and resilience.

While most solar capacity comes from large utility-scale solar systems connected to transmission lines, deployment of smaller solar plants connected at the distribution level and customer-owned, or behind-the-meter (BTM), sites is also increasing. Collectively, these smaller solar (and energy storage) systems are typically referred to as distributed energy resources (DER). Besides distributed generation, controllable loads such as electric vehicles, programmable thermostats, and other smart appliances may also be referred to as DER, and DER along with other sensors, meters, or controllable devices on the distribution network may be broadly referred to as grid-edge technologies.[5,6] Additionally,

[5] NERC. Distributed Energy Resources: Connection Modeling and Reliability Considerations, 2017. https://www.nerc.com/comm/Other/essntlrlbltysrvcstskfrcDL/Distributed_Energy_Resources_Report.pdf

[6] Greentech Media. "What is Grid Edge?". https://www.greentechmedia.com/articles/read/what-is-the-grid-edge

DER aggregators who operate and trade the energy supplied by groups of DER are also expanding across the country.[7]

This FOA will fund research in three (3) Topics Areas that develop technologies to address emerging challenges and enhance the benefits of VRE, IBR, and DER, including long-term planning activities and the daily operation of the grid. The new state-of-the-art planning and operations tools will enable solar energy to be more optimally utilized over time and allow it to be utilized in place of traditional generation, providing Americans with more cheap and secure sources of clean energy.

Figure 2 shows the relation of grid planning to grid operations and some standard activities that are performed under each, which are then mapped to the Topic Area in this FOA to which they most directly correspond. Topic 1 focuses on grid planning and the challenges grid planners face in accounting for VRE in their future studies, while Topics 2 and 3 focus on grid operations and the challenges operators face in short-term scheduling and real time operation of renewable resources. Whereas Topic 2 focuses on optimizing the utilization of VRE in existing grid operations practices, Topic 3 focuses on developing new tools for control room operators and utility engineers to identify and rectify emerging issues related to IBR.

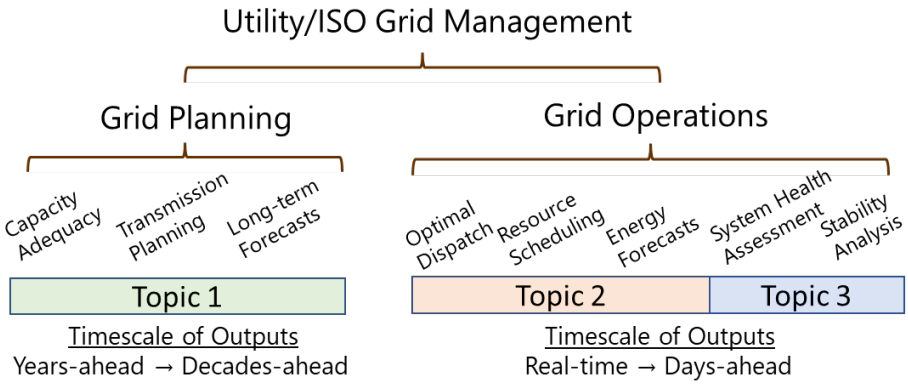

Figure 2. Relationship of grid planning to grid operations and examples of technical work performed within each and how this work maps to Topic Areas' interests. The activities listed here are merely presented to give the applicant an idea as to which topic their field of interest may apply and is not intended to present an exhaustive list of activities of interest.

For the purpose of this FOA, grid planning and grid operations are defined in the following ways:

[7] NREL. "Expanding PV Value: Lessons Learned from Utility-led Distributed Energy Resource Aggregation in the United States," November 2018. https://www.nrel.gov/docs/fy19osti/71984.pdf

- **Grid Planning**: Activities performed by utility companies, Independent System Operators (ISOs), and Regional Transmission Organizations (RTOs) to ensure electric power grid resources, such as generation plants, transmission lines, and substations will meet the anticipated electricity demand over years and decades.[8,9] These planning activities must consider how generation, load, and grid technologies evolve over time, and ensure the long-term system reliability and security to meet service expectations even during worst-case scenarios, such as extreme weather.[10,11] The planning engineers and the stakeholders supporting them are referred to here as **grid planners.** The tools and methodologies currently used by grid planners were developed decades ago for a power system primarily served by conventional generation resources.[12] The rapid transition to clean energy technologies, such as VRE, IBR, and DER, has raised concerns among utilities and regulators that existing planning tools and processes may no longer work adequately for the evolving grid.[13,14] While the fundamental planning goals of reliably and economically meeting the future demand remain the same, the tools and methods used for planning the future power system must be updated to capture the characteristics of these new clean energy technologies.

- **Grid Operations:** Activities performed by operators in utility control rooms and ISO markets on a day-to-day basis to ensure safe and reliable electricity supply to meet customer demand. These activities include dispatching generation units, switching transmission lines, and real-time monitoring and control of grid equipment. Grid operations also include day-ahead and hour-ahead scheduling of resources according to supply and demand forecast, clearing the optimal dispatch in wholesale energy market, and preparing sufficient reserves to meet instantaneous and

[8] DOE, "Enhanced Transmission Planning", https://www.energy.gov/gdo/enhanced-transmission-planning
[9] DOE, "National Transmission Planning Study", https://www.energy.gov/gdo/national-transmission-planning-study
[10] California, "New Report on September Heat Wave Details California's Action to Meet Historic Challenges to Power Grid", https://www.gov.ca.gov/2022/11/02/new-report-on-september-heat-wave-details-californias-action-to-meet-historic-challenges-to-power-grid/
[11] ERCOT, "Preliminary Report on Causes of Generator Outages and Derates During the February 2021 Extreme Cold Weather Event", April 27, 2021. https://www.ercot.com/files/docs/2021/04/28/ERCOT_Winter_Storm_Generator_Outages_By_Cause_Updated_Report_4.27.21.pdf
[12] NREL, "Power system planning: Emerging practices suitable for evaluating the impact of high-penetration of photovoltaics," 2018.
[13] NERC, "Long-term reliability assessment", 2022.
[14] NERC, "2022 State of Reliability", https://www.nerc.com/pa/RAPA/PA/Performance Analysis DL/NERC_SOR_2022.pdf

unexpected changes of load or generation, or both. These operators and the engineers supporting them are referred to here as **grid operators.**

To succeed, the projects funded under this FOA will need to bring together diverse teams that include research and development partners, such as universities and national labs, industry partners, such as original equipment manufacturers and software vendors, and electric industry stakeholders, such as transmission and distribution (T&D) utilities and independent system operators. Industry partners should work with researchers in the technology development phases to ensure practical designs and then should work to create prototypes that are as close to commercialization as possible. Project teams should include electric utility and ISO partners to ensure solutions are developed to aid the grid planners and operators who will ultimately be the end users of the technologies.

Technologies developed under this FOA should be field tested in real-world scenarios to be ready for pilot deployments or initial commercial development within 1-3 years after completion of the project. Where possible, teams should test their prototypes in real-world field demonstrations, such as interfacing with their existing operational and planning systems, ingesting real-time field measurement data, or monitoring and controlling field-deployed assets. As such, teams should also include solar facility operators to collect data on plant designs and real-time operations and field test any controls developed.

iv. Cross-Office Coordination

SETO has collaborated with the DOE Office of Electricity (OE) and other EERE offices, including the Wind Energy Technologies Office (WETO), to develop the scope of this funding effort to best fit DOE's existing and ongoing research portfolio. Each Topic Area in Section I.B. describes past and ongoing funding efforts from these other offices and how this funding will augment these programs. Members from these offices also often participate in the competitive selection process to identify projects that best demonstrate the viability of solar and wind resources to rapidly integrate with the nation's electric grid in an affordable and reliable manner to achieve the goal of decarbonizing the electricity sector.

v. Priority Research Areas

The **O**peration and **P**lanning **T**ools for **I**nverter-Based Resources **M**anagement and **A**vailability for Future Power Systems (OPTIMA) FOA focuses on the research, development, and demonstration of innovative technologies and tools for the bulk power system in the following three topic areas:

1. PLANNING TOOLS FOR FUTURE POWER SYSTEMS. This topic area seeks to fund the development of new tools and methodologies for grid planners to incorporate the dynamic features of VRE and inverter-based technologies to improve the long-term planning of the bulk power system. The goal is to increase resource availability and transmission capacity utilization by accounting for resource uncertainty and flexibility in the planning process and by incorporating technologies that can reduce uncertainty and grid congestion, such as energy storage, advanced IBR modeling and grid-supporting controls, and grid-enhancing technologies (GETs), into planning tools. These tools will also address the impact of cascading disturbance events on VRE, such as long-term extreme weather conditions, the stability impact of high amounts of IBR, and the need for accurate modeling and estimation of aggregated DER in system net loads.

2. VARIABILITY MANAGEMENT IN GRID OPERATIONS. This topic seeks to fund the development of tools for grid operators to optimally utilize and control large-scale, transmission connected VRE, as well as large numbers of DER, to achieve a more reliable and predictable operation of the grid. Projects will develop solutions for the bulk power system that improve the scheduling and dispatch of resources and services by incorporating dispatchable renewable resources and the uncertainty of non-dispatchable resources. In addition, projects can also develop solutions at the distribution or aggregator level to improve the flexible real-time dispatch and optimal utilization of many VRE and DER to respond to market or bulk power system needs and to improve local grid conditions. Control systems developed under this topic should incorporate new technologies that address VRE and DER uncertainty, such as short-term probabilistic estimations of available solar resources, aggregated sensing and control of grid-edge technologies, and incorporating new metrics for security constraints, such as the stability of the grid.

3. RAPID SYSTEM HEALTH AND RISK ASSESSMENT TOOLS FOR GRID OPERATORS. This topic seeks to fund development and demonstration of tools for grid operators, and the data and communication systems that support them, to identify and mitigate emerging system risks that are driven by the faster dynamics and uncertain control interactions of IBR. These tools will need to ingest data from multiple data sources, including existing and new sensors, to create wide-area geospatially- and time-correlated data sets. These data sets should be structured to allow for quick analysis to produce improved grid situational awareness through real time system health indicators, recommend mitigation actions, and rapid and automated near-real-time event analysis. Visualization tools developed in this topic

should provide operators accurate estimations of system state, including the amount of real-time DER generation and available stored energy, including BTM. Advanced data analytic techniques should be utilized to provide actionable information about events in real-time or near real-time.

See each topic area's description in Section I.B for more details on the emerging challenges in these spaces, the technologies of interest to address these challenges, and applications not of interest.

Projects funded by SETO are expected to produce high-impact outcomes with a view toward commercialization and wide dissemination, including communication of the results in high-visibility, high-impact, publications.

vi. 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 in the EERE eXCHANGE website. The Teaming Partner List will be regularly updated to reflect new teaming partners who provide their organization's information.

SUBMISSION INSTRUCTIONS: Users will see a new section, "Teaming Partners", within the left-hand navigation in eXCHANGE. This page allows users to view published Teaming Partner Lists and any interested party that would like to be included on this list should submit a request within eXCHANGE to join the teaming partner list. Select the appropriate Teaming Partner List from the dropdown and fill in the following information: Investigator Name, Organization Name, Organization Type, Topic Area, Background and Capabilities, Website, Contact Address, Contact Email, and Contact Phone.

DISCLAIMER: By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of the above-referenced information. By facilitating the Teaming Partner List, DOE is not endorsing, sponsoring, or otherwise evaluating the qualifications of the individuals and organizations that are 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.

B. Topic Areas

i. Topic Area 1: Planning Tools for Future Power Systems

Background and Context

Power system planning is a complex engineering and stakeholder process that determines how the system should grow over time in terms of generation and transmission capacity expansions and investment choices. The primary goal is to ensure the generation capacity meets the system demand reliably and economically during normal and abnormal operating conditions for the planning horizon, typically 5-20 years.[15] The system planning process typically includes:

a) Long-term demand and net-demand projection;
b) Planning for generation needed to serve the projected demand;
c) Planning for the transmission network to deliver generation to the load; and
d) Planning for ancillary services to ensure grid reliability.

System planners use long-term statistical forecasting models to project peak demand and total annual energy based on historical demand data and adjusted for seasonality, demand uncertainty, and other factors.[16] Planners then conduct generation expansion analysis to determine the required addition of generation capacity and technology mix, which also considers the retirement of existing generation facilities. Planners also assess the needs for new transmission networks (or upgrades of existing networks) to ensure that new generation resources have access to the transmission network at the least cost.[17]

Emerging Challenges and Opportunities

In today's system planning process, VRE, IBR, and DER are often not regarded as firm resources compared to the traditional dispatchable generation. The detailed operation parameters and capabilities of these new technologies are not accurately represented in the planning models and tools. When VRE becomes the main generation source in a clean electric grid, major changes in the system planning processes will be needed. While there are some challenges in incorporating the required changes in the existing planning processes for VRE,

[15] ESIG report, "Redefining Resource Adequacy for Modern Power Systems," 2021. https://www.esig.energy/wp-content/uploads/2022/12/ESIG-Redefining-Resource-Adequacy-2021-b.pdf

[16] ERCOT report, "2022 ERCOT System Planning: Long-Term Hourly Peak Demand and Energy Forecast," 2022. https://www.ercot.com/files/docs/2022/02/24/2022_LTLF_Report.pdf

[17] PJM Interconnection report, "Enhanced 15-Year Long-Term Planning (Master Plan) White Paper," 2022. https://www.pjm.com/-/media/committees-groups/committees/pc/2022/20220525-long-term/enhanced-long-term-planning-discussion-document.ashx

these changes will lead to new opportunities for system planners. Here are some examples of the emerging challenges and opportunities:

- Capacity Adequacy measures if the power system has sufficient generation capacity to meet the load at any given time, especially during system peak demand time.[18] VRE generation capacity is non-deterministic and varies with weather, time, and location. The capacity value of wind and solar plants is generally lower than nameplate capacity and decreases as deployment increases. But, when combined with energy storage, it can approach 100% of the nameplate.[19]
- Energy Adequacy measures if the power system has sufficient generation fuel and stored energy to meet the load for the entire year (i.e., 8760 hours). VRE generation has daily and seasonal variation and typically a lower capacity factor than traditional generation. Overbuilding of VRE plants is common, which can lead to transmission network congestion, negative pricing, and under-utilization of the VRE. It is important to explicitly consider resource utilization as a part of system planning.
- Weather-related events can simultaneously affect generation, loads, and the transmission and distribution grids. Weather events may also impact some VRE differently than others. It is necessary to correctly model such correlated events to better estimate the time, frequency, duration, and severity of generation capacity surplus and scarcity.
- System stability will change as the physical properties and control responses of traditional generators are replaced with those of the IBR. In system planning, it is important to consider various IBR control technologies, e.g., grid-following (GFL) and grid-forming (GFM) control functionalities,[20] and analyze their long-term impacts to system reliability and stability.
- Distributed energy resources' impact on the bulk power system will become more prominent as DER are widely deployed. Most utilities today still lack the ability to monitor and control DER or predict net load and its volatility.[21] It is important to bring better visibility of DER at the aggregate-level and incorporate this information into the long-term bulk power system planning.

[18] ESIG report, "Capacity Expansion Modeling for Transmission Planning: Summary of an ESIG Workshop", 2022. https://www.esig.energy/wp-content/uploads/2022/11/ESIG-CEM-workshop-summary-112922.pdf

[19] LBNL report, "Drivers of the Resource Adequacy Contribution of Solar and Storage for Florida Municipal Utilities," 2019. https://eta-publications.lbl.gov/sites/default/files/lbnl-resource_adequacy_for_solar_and_storage-pre-print.pdf

[20] NREL News, "UNIFI: NREL To Lead Grid-Forming Inverter Consortium, Streamlining Renewable Integration at All Scales" 2021. https://www.nrel.gov/news/program/2021/nrel-to-lead-grid-forming-inverter-consortium.html

[21] ESIG report, "The Transition to a High-DER Electricity System: Creating a National Initiative on DER Integration for the United States", 2022. https://www.esig.energy/wp-content/uploads/2022/08/ESIG-DER-integration-US-initiative-report-2022.pdf

Current State of the Art

There are many existing power system planning tools and methods, such as the National Energy Modeling System (NEMS), Regional energy deployment system (ReEDS), Renewable Energy Integration and Optimization (REopt), Aurora, and PLEXOS that researchers, and utility and system planners have used for decades. In addition, several commercially available tools (e.g., GridView, PSSE, PSLF) have also been widely used for system planning. [22,23] While the existing planning models and tools were developed for the planning needs of the traditional power system dominated by dispatchable generators, they cannot address many new features of the future grid. [15,Error! Bookmark not defined.] This section discusses a f ew major system planning functionalities and the shortcomings of the current state of the art.

1) Resource Adequacy is the primary benchmark to assess the electric power system's ability to always supply generation capacity and energy demand. The following table details the major attributes of the existing resource adequacy assessment methods and highlights the potential changes required in a high-IBR power system.

Table 1. Capability gap analysis for resource adequacy assessment.

Description	Existing Approach	Capability Gaps
Planning Criteria	Plan for demand-hours considering peak demand as the worst-case scenario	Insufficient to capture the 8760-hour operation of the VRE and IBR generation[24]
VRE Capacity	VRE is not treated as firm capacity	VRE's equivalent firm capacity estimation needs to be enhanced
Uncertainty Quantification	Uncertainty in system planning has been addressed mainly by robust optimization and stochastic programming[25]	Weather-dependent VRE generation needs to be quantified more rigorously using advanced probabilistic approaches

[22] H. Ringkjob, et. al, "A review of modelling tools for energy and electricity systems with large shares of variable renewables," *Renewable and Sustainable Energy Reviews*, Elsevier, Volume 96, November 2018, Pages 440-459. https://www.sciencedirect.com/science/article/pii/S1364032118305690

[23] M. Emmanuel, et. al., "A review of power system planning and operational models for flexibility assessment in high solar energy penetration scenarios", Elsevier, Solar Energy, Volume 210, 1 November 2020, Pages 169-180. https://www.sciencedirect.com/science/article/abs/pii/S0038092X20307489

[24] PNNL report, "Dynamic contingency analysis tool," 2017. https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-26197.pdf

[25] J. Marmolejo, et al., "A stochastic robust approach to deal with the generation and transmission expansion planning problem embedding renewable sources," Elsevier Book, Uncertainties in Modern Power Systems 2021. https://www.sciencedirect.com/science/article/pii/B9780128204917000037

DER	Does not directly include distribution system level energy resources[Error! Bookmark not defined.]	Need to incorporate distribution system level resources
Reliability Metrics	Standard practice in the industry is to consider a Loss of Load Probability (LOLP) level of 1 day in 10 years as an acceptable target[22,15]	New metrics are needed to address correlation of VRE and IBR generation with weather

2) Contingency planning is one of the most important aspects of power system planning to ensure that the system is capable of transitioning from normal to abnormal operating conditions and vice-versa.[26] The following table highlights gaps within the existing contingency planning.

Table 2. Capability gap analysis of contingency planning.

Description	**Existing Approach**	**Capability Gaps**
Contingency Selection (Source of Contingencies)	Number and type of contingencies are selected by ISOs based on the historical system performance, outage system components, and planners' judgment[Error! Bookmark not defined.]	In addition to contingency from component outages, need to also consider correlated events (e.g., impacts of weather on generation, component failures/outages)
Contingency Evaluation (Impact)	Traditional contingency evaluation does not use dynamic models of IBR to study the impacts of selected contingencies[24]	New contingency evaluation tools should incorporate dynamic behaviors of IBR to ensure system stability in both pre- and post-contingency conditions
Computational Requirements	Require less computational resources as planning only need to evaluate relatively fewer pre-defined numbers of contingencies[24]	Requires computationally efficient contingency planning tools to access many scenarios to account for correlated events and variabilities in generation

3) VRE resource utilization is one measure to assess how well these generation resources are made available to the system operators. To mitigate network congestion, either new T&D buildouts and/or maximizing the existing infrastructure's utilization through deployment of new flexibility technologies,

[26] NERC report, "Reliability Guideline Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018", March 2020. https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Guideline_IEEE_1547-2018_BPS_Perspectives.pdf

e.g., advanced control of IBR,[26] GETs,[27] flexible loads, and energy storage.[21] The table below highlights gaps for the VRE's utilization assessment.

Table 3. Capability gap analysis of VRE Utilization Assessment.

Description	Existing Approach	Capability Gaps
Network Constraints (Thermal, Reliability, Stability)	Mainly consider new transmission buildouts	Need to consider the additional transmission capacity unlocked by new flexibility technologies, e.g., GETs, advanced IBR controls, energy storage, and flexible loads.
Resource Utilization	Mainly evaluate utilization of individual VRE without consideration of any control capabilities	Need to consider resource utilization enabled by advanced control, integrated co-located resources, and the time and locational values of VRE resources.

4) Distribution systems have traditionally been treated as passive loads in bulk power system planning. With rapid growth of DER, it becomes essential to have a robust and accurate model representation of aggregated DER capacity in bulk power system planning.

Table 4. Capability gap analysis of DER Integration.

Description	Existing Approach	Capability Gaps
DER Modeling /Forecasting	Primarily modeled as passive loads	Need more accurate models of DER at aggregate-level, including active controls
Reserve Margin	Static operating envelopes accounting for "worst case scenario"[28], and do not consider DER	Operational reserve margin that can vary over time and location and must consider DER.
Phase Representation	Positive sequence that assumes 3-phased balanced network	Individual phase representation to capture unbalanced loading conditions.
T&D Coordination	Not considered	Must be considered

Past Funding Efforts

DOE has funded many projects in the past to conduct research and development on various power system planning tools and methodologies. SETO-funded planning projects cover topics such as a) investigating the optimal placement of

[27] ESIG article, "The Role for Grid-Enhancing Technologies'" 2022. https://www.esig.energy/the-role-for-grid-enhancing-technologies/

[28] ESIG article, "A Distribution System Architecture of the Future," 2022. https://www.esig.energy/a-distributed-system-architecture-of-the-future/

system components, such as solar photovoltaics and energy storage, b) developing modeling and simulation methodologies for long-term system planning under various constraints, and c) developing software tools to help grid operators manage the grid. Specific programs are:

- SETO FY2022-24 Lab Call[29] focuses on the improvement of transient and dynamic models for solar grid integration, simulation of large-scale power systems, and integration of the required models into planning tools for studying the system's dynamic behavior during the planning phase to ensure system stability.
- Solar Forecasting 2 FOA, launched in 2018, aimed to improve the management of solar power's variability and uncertainty, enabling more reliable and cost-effective integration onto the grid planning.
- SETO FY2019-21 Lab Call[30] funded multiple projects to provide foundational analysis and evaluation of solar integration challenges, as well as strategies for advancing power system planning.
- SETO's Universal Interoperability for Grid-Forming Inverters (UNIFI) Consortium launched in 2021,[31] aims to better integrate IBR into electric grid planning and operation at any scale.
- The North American Renewable Integration Study (NARIS)[32] released in 2021 provides analytical results to grid planners and utilities about opportunities for a coordinated, continental-wide grid planning with a high share of VRE.

In 2022, DOE's Grid Deployment Office (GDO) launched "Building a Better Grid Initiative" that aims to catalyze the nationwide development of new and upgraded high-capacity electric transmission lines and support investments to modernize the flexibility and resilience of the distribution system. The transmission planning R&D efforts have focused on 1) National Transmission Needs Study to identify areas of greatest need with the expectation to relieve future constraints and congestion; 2) National Transmission Planning for developing and reducing the costs of technologies that enable the transmission system to be used more efficiently.

To improve the transmission capacity utilization of existing infrastructure without only relying on the traditional upgrades, the DOE's Office of Electricity

[29] SETO, FY22-24 Lab Call. https://www.energy.gov/eere/solar/solar-energy-technologies-office-lab-call-fy2022-24
[30] SETO, FY19-21 Lab Call. https://www.energy.gov/eere/solar/solar-energy-technologies-office-lab-call-fy2019-21
[31] SETO, FY2021 System integration and hardware incubator funding program. https://www.energy.gov/eere/solar/solar-energy-technologies-office-fiscal-year-2021-systems-integration-and-hardware
[32] NREL report, "North American Renewable Integration Study," 2021. https://www.nrel.gov/analysis/naris.html

(OE) released reports on "Dynamic Line Rating" in 2019,[33] and "Grid-Enhancing Technologies (GETs): A Case Study on Ratepayer Impact" in 2022.

Over the past years, DOE has also been driving numerous efforts to accelerate energy storage technology development. The Long Duration Storage Shot™, announced in July 2021, aims to reduce the cost of grid-scale energy storage by 90% for systems that deliver 10+ hours of duration within the decade.[34]

Topic Objectives

This topic area seeks to fund the development of new tools and methodologies for grid planners to incorporate the dynamic features of VRE, IBR, and DER to improve long-term planning of the bulk power system. The goal is to increase resource availability and transmission capacity utilization by accounting for resource uncertainty and flexibility in the planning process and by incorporating technologies that can reduce uncertainty and grid congestion, such as energy storage, advanced IBR modeling and grid-supporting controls, and GETs, into planning tools. These tools will also address the impact of cascading disturbance events on VRE, such as long-term extreme weather conditions, the stability impact of high amounts of IBR, and the need for accurate modeling and estimation of aggregated DER in system net loads. These tools and methods will be more accurate and efficient to address near-term deployment issues and long-term planning scenarios, analyze the impacts of VRE, IBR, and DER technologies in the power system, increase resource availability and transmission capacity, and enable optimal system design solutions.

The proposed new system planning tools and methodologies are expected to support the following specific topic area objectives:

1) To improve system reliability by accounting for resource uncertainty of VRE,
2) To improve the utilization of VRE and reduce grid congestion,
3) To better integrate DER in bulk power system planning,
4) To incorporate grid flexibility technologies into planning process,
5) To address the impact of cascading disturbance events and system stabilities.

Project Requirements

Successful projects are expected to include, but not be limited to, the following research activities:

[33] DOE, "Dynamic Line Rating - Report to Congress," 2019. https://www.energy.gov/sites/prod/files/2019/08/f66/Congressional_DLR_Report_June2019_final_508_0.pdf

[34] DOE announcement, Long Duration Storage Shot ™, 2021. https://www.energy.gov/eere/long-duration-storage-shot

- Develop accurate models that can capture the uncertainty of VRE and integrate them into the planning tools.
- Develop new reliability metrics and improve existing ones by considering extreme weather and other correlated events.
- Develop and improve probabilistic approaches and tools for resource adequacy assessments that can estimate uncertainty of VRE and assess load shed risks; evaluate hour-by-hour system operations with VRE for 8760 hours each planning year instead of only for peak-demand hours.
- Develop new methods and tools for contingency planning that consider correlated events and IBR dynamics.
- Develop new methods and tools for the integration of distribution level resources in the bulk power system planning process, requiring more accurate representations of DER.
- Develop new planning methods and tools that consider a comprehensive set of grid flexibility technologies (e.g., advanced IBR controls, active VRE plant-level optimization, energy storage, GETs, and demand-side flexibilities).
- Validate and demonstrate the new planning tools and approaches in simulation using ISOs' or utilities' planning platform. The validation process should establish a clear baseline of planning scenarios and compare the results from using existing tools and new planning tools.

Project teams are encouraged to form an industry advisory board comprising utilities, ISOs, regulatory entities, or other pertinent industry representatives to provide technical challenges and needs of the industry.

Proposals should consider including the project features listed in Table 5. The metrics describe project features of interest to DOE and what would be considered an impactful and scientifically meritorious project proposal. Applicants are encouraged to develop their own ambitious performance metrics that go beyond the metrics defined for each of these features. Projects do not need to meet all the metrics listed in Table 5 to apply, but projects that meet or exceed most or all of the listed metrics will be considered higher for selection.

Table 5. Topic Area 1 Project Requirements

Project Features	Qualitative and Quantitative Technical Metrics
Team Partners	• Active participation from utilities and/or ISOs, and software vendors as project partners including budget and associated tasks
Scalability of Studies (Simulations)	• Preferred system size for planning studies > 10 GW • Must be a representative U.S. power system

	• Include a diversity of generation types, including VRE, large traditional generation plants, and DER, with significant contribution from solar generation and ESS, including energy limited resources, such as BESS • Able to run scenarios for systems with VRE and ESS penetration >80% annual energy, >100% instantaneous power • Able to study extreme weather scenarios resulting in significant reduction VRE generation over long periods of time
Field Demonstration	• N/A
Capabilities of Developed Technologies	• Planning horizon of 5-20 years • Planning tools capable of studying multiple scenarios and chronology of operation over a year, not just peak and/or worst-case hours • Ability to integrate with existing commercial software or utility/ISO platforms • Ability to be utilized by either vertically integrated or deregulated utilities • Ability to estimate true load and DER contribution at the aggregated level
Target System Performance	Provide quantitative target performance metrics with sufficient justifications comparing with selected benchmark criteria, including, but not limited to, the following: • Increased VRE utilization • Accuracy of probabilistic tools in capturing capacity shortfall and surplus • System reliability indicators such as Loss of load events (LOLE), and loss of load hours (LOLH) • Accuracy of estimation of DER aggregation at transmission node • Increased computational speed for given system size and complexity
Cybersecurity	• Workplan describes how cybersecurity is considered in the developed planning tools and methodologies
Technoeconomic Analysis	• Workplan describes how benefits of the technology will be evaluated
Commercialization	• Workplan describes how the technology will become more broadly used by industry or developed/integrated into a commercial product in the short term after project completion • Describe how software developed under this FOA will be distributed (e.g., open source, as part of an existing commercial software package)
Stakeholder Engagement	• Workplan describes how project results will be disseminated to the industry and how industry feedback will be collected and utilized in the project execution

Applications Not of Interest for Topic 1

- Projects that primarily focus on electricity market design, including incentives and regulation frameworks.

- Projects that focus primarily on the development and demonstration of new grid enhancing technologies (GETs) hardware equipment, e.g., dynamic line rating (DLR) as opposed to their integration into planning software and tools.
- Projects that focus on transmission expansion planning.
- Projects that primarily focus on the forecasting of weather and climate.
- Projects that primarily focus on generation interconnection issues.
- Projects that focus on the design of distribution system operations.

ii. Topic Area 2: Variability Management in Grid Operations

Background and Context

The North American electricity grid operates extremely well with a high degree of overall reliability,[35] which is the result of the regional transmission operation structure and advances in technologies. Electricity supply and demand must be balanced in real-time, e.g., hour-by-hour and minute-to-minute. Typically, based on the day-ahead load forecast, utilities and ISOs make resource scheduling (unit commitment) decisions to have available generation facilities ready to start up the next day and produce electricity.[36] Utilities and ISOs will continuously monitor in real-time the changing load demand, the performance of the generators, and the transmission network conditions. A process, known as security-constrained economic dispatch, will optimize power flow every 5 minutes (or 15 minutes), and then issue dispatch orders to online generation facilities, setting specific output levels for each facility so that least-cost electricity is delivered reliably across the system.[37]

Emerging Challenges and Opportunities

With VRE becoming the main generation resources in a clean electric grid, many challenges will need to be addressed to achieve reliable and economic grid operations. Deployment of large amounts of flexible resources such as energy storage and transmission expansion will enable more flexible operation of the grid and optimal utilization of VRE. Below are some examples:

- Flexible Operation: The presence of VRE requires an increase in the flexibility of power systems to provide enough ramping capacity and accommodate more frequent cycling between maximum and minimum

[35] Anjan Bose, Thomas J. Overbye, "Electricity Transmission System Research and Development: Grid Operations", DOE, Transmission Innovation Symposium: Modernizing the U.S. Electric Grid, 2021. (Link)
[36] Jeremy Lin, Fernando H. Magnago, "Electricity Markets: Theories and Application", 2017, ISBN:9781119179351.

capacity of other generators to compensate for the VRE uncertainty and variability. This operational flexibility can come from energy storage, transmission system expansion, enhanced system utilization through GETs, and better VRE and load forecasting.

- Economic Operation: The locational marginal price at a specific location in the grid – whether it is zonal or nodal – reflects the cost of delivering electricity to that location.[36] Concentrated VRE deployment in some areas can result in over-generation from time to time, resulting in suboptimal curtailment or negative pricing. Better pricing structures are needed to optimize VRE utilization.
- DER Integration: As more DER are deployed at the distribution level, their impact is increasingly seen at the transmission level, increasing the need to incorporate monitoring and control information about these resources into the transmission control center. This coordination between transmission and distribution operations will allow DER to be integral parts of bulk power grid operations.[38]
- Grid Strength: As traditional synchronous generators are replaced with IBR, the change in system strength needs to be considered as new security and stability constraints for resource allocation and dispatch.[39,40] (Innovations to address specific challenges in system strength or system inertia are discussed in Topic 3.)
- Grid Control and Information Architecture: The presence of VRE and IBR also requires faster and more automated grid control and information architectures to quickly identify system security constraints and support unit commitment and economic dispatch.[41]

Current State of the Art

Transmission utilities and ISOs/RTOs have typically relied on supervisory control and data acquisition (SCADA) and energy management systems (EMS) for bulk power system operations.[42] Distribution utilities typically deploy advanced distribution management system (ADMS) and distributed energy resource

[38] Chen-Ching Liu, Emma M. Stewart, "Electricity Transmission System Research and Development: Distribution Integrated with Transmission Operations," DOE, Transmission Innovation Symposium: Modernizing the U.S. Electric Grid, 2021. (Link)

[39] AMEO, "2020 System Strength and Inertia Report", December 2020. (Link)

[40] National Grid ESO, "Outline new approach to stability services in significant step forwards towards a zero-carbon electricity system", (Link)

[41] Jeff Dagle, Dave Schoenwald, "Electricity Transmission System Research and Development: Automatic Control Systems," DOE, Transmission Innovation Symposium: Modernizing the U.S. Electric Grid, 2021. https://www.energy.gov/sites/default/files/2021-05/Automatic Controls Dagle Schoenwald_0.pdf

[42] Idaho National Laboratory, "Review of Supervisory Control and Data Acquisition (SCADA) Systems". https://inldigitallibrary.inl.gov/sites/STI/STI/3310858.pdf#search=Supervisory%20control%20and%20data%20acquisition

management system (DERMS) for grid operations.[38] In general, these tools reside in the transmission and distribution control centers to support operational planning, real-time decision-making and control processes, and visualization of the state of the grid and process results to the operators.

There have been many research efforts to improve power system operation tools to manage the variability of VRE.[43,44] These approaches include stochastic approaches for unit commitment, solar and wind generation forecasting, probabilistic scenario analysis, network topology update, dynamic hosting capacity analysis. [45,46] However, significant gaps remain to holistically incorporate VRE, IBR, and DER variability management into grid operations tools.

Unit Commitment (UC) involves the optimal scheduling of generation units to meet electricity demand from day-ahead forecast.

Table 6: Capability gap analysis for Unit Commitment.

Description	Existing Approach	Capability Gaps
Type of Generation	Detailed operation models for fossil fuel, nuclear, and hydro units.[36]	Need similar detailed operation models for VRE, energy storage, and aggregated DER.
Uncertainty Management	Only demand's variation is considered with worst-case uncertainty leading to conservative reserve allocations. [47]	Need to consider both generation and load and co-optimize supply/demand balance dynamically.

Economic Dispatch (ED) refers to activities by system operators to optimally balance electricity supply and demand in real time. They do this by issuing dispatch orders to online generation units every 5 (or 15) minutes, up to 1 hour in advance. The dispatch (and redispatch) must respect the physical constraints of the power system including transmission lines and generation units.

[43] IRENA, "Planning the operability of power systems – Overcoming technical and operational bottlenecks". https://www.irena.org/-/media/Files/IRENA/Agency/Events/2017/Jan/17/IRENA-WFES-Scaling-up-VRE---Operation-Planning---Final.pdf?la=en&hash=DA778DAF2644A2D6DBC70665B109E6B3AACA6673

[44] Debabrata Chattopadhyay, "Operational Planning of Power System: An Integrated Approach", *Energy Sources*, 16:1, 59-73, DOI: 10.1080/00908319408909062, 1994.

[45] Alireza Mansoori, Alireza Sheikhi Fini, Mohsen Parsa Moghaddam, "Power System Robust Day-ahead Scheduling with the Presence of Fast-Response Resources Both on Generation and Demand Sides under High Penetration of Wind Generation Units", *International Journal of Electrical Power & Energy Systems*, Volume 131, 2021.

[46] Joakim Widén, Nicole Carpman, Valeria Castellucci, David Lingfors, Jon Olauson, Flore Remouit, Mikael Bergkvist, Mårten Grabbe, Rafael Waters, "Variability assessment and forecasting of renewables: A review for solar, wind, wave and tidal resources", *Renewable and Sustainable Energy Reviews*, Volume 44, 2015, Pages 356-375.

[47] Hong, Y.-Y.; Apolinario, G.F.D., "Uncertainty in Unit Commitment in Power Systems: A Review of Models, Methods, and Applications", *Energies*, 2021, v14, p6658. https://doi.org/10.3390/en14206658

Table 7. Capability gap analysis for Economic Dispatch.

Description	Existing Approach	Capability Gaps
Cost Functions	Only traditional generation units are modeled in detail, including input-output; fuel-cost; heat-rate and incremental cost curves.	Need to model VRE and aggregated DER cost functions in more detail.
Merit Order	Operators select the traditional resources that offer the lowest cost for the marginal megawatt. [48]	Need to incorporate new economic characteristics relevant to VRE.
Constraints	Thermal limit of transmission lines is considered as the main security constraint.	Need to incorporate system strength and inertia as additional system security constraints.

Optimal Power Flow Analysis (OPF) refers to the mathematical modeling techniques to solve the optimization problem of matching electricity supply and demand at the lowest cost, subject to the security constraints of the physical power system.[49]

Table 8: Capability gap analysis for Optimal Power Flow Analysis.

Description	Existing Approach	Capability Gaps
OPF Solver	Simplified model of DC OPF; operational constraints violation can occur with oversimplistic assumptions, e.g., unity power factor, 3-phase balanced, etc.	Need to incorporate VRE's uncertainties, chronological operations; and enable optimal real/reactive power dispatch
Topology	Static network topology.	Need to incorporate dynamic network topology and its parameters.
Mathematical Methods	Formulated as constrained static optimization problem requiring to collect all information at the dispatch center.	Need to consider both centralized and distributed approaches for decision-making.

Scenario analysis presents system operators with options, or what-ifs, to decide on next actions given the uncertainty evaluation of power systems.[50]

Table 9: Capability gap analysis for Scenario Analysis

Description	Existing Approach	Capability Gaps
Scenario Generation	Temporal correlation has been negligible, and single states can be applied in the optimization.	Need to incorporate stochastic methods that reflect uncertainties

[48] Southwest Power Pool (SPP), "Operating Instructions and Out Of Merit Energy Reference Guide". https://spp.org/documents/66213/oome oi reference guide v4.pdf

[49] Obio, E., Ali, S., Oyebanjo, I., Abara, D., Suleiman, F., Ohiero, P., Oku, D. and Ogar, V., "Comparison of Economic Dispatch, OPF and Security Constrained-OPF in Power System Studies", *Journal of Power and Energy Engineering*, 2022, v10, p54-74. https://doi.org/10.4236/jpee.2022.108005

[50] Hui Li, Zhouyang Ren, Miao Fan, Wenyuan Li, Yan Xu, Yunpeng Jiang, Weiyi Xia, "A review of scenario analysis methods in planning and operation of modern power systems: methodologies, applications, and challenges", *Elsevier*, *Electric Power Systems Research*, Volume 205, April 2022.

		in VRE and loads, and chronology in operation.
Mitigation Action	Perform switching actions and generation dispatch.	Need to incorporate additional attributes to describe VRE capabilities.
Scenario Ranking	Scenario analysis is time-consuming, and often cannot satisfy the requirement of real-time decision-making.	Need to develop new methodologies and indices to evaluate and rank the scenarios.

DER Integration: Recent research has shown that aggregated DER can help supplement services offered by utilities and independent system operators while providing resource diversity and resilience for the bulk power system.[51,52] However, DER have not been integrated into grid operations tools.[53]

Table 10: Capability gap analysis for DER Integration

Description	Existing Approach	Capability Gaps
Model Representation	Each distribution system is treated as a "load point"; DER are considered as negative loads; balanced 3-phase is assumed	Need more accurate models of DER at aggregate-level
Reserve Support	Static operating envelopes accounting for "worst case scenario", and typically do not consider DER	Need to track dynamic operational reserve margin available from aggregated-DER by time and location.

System strength is the ability of the power system to withstand abrupt changes due to disturbances. With increasing VRE and IBR deployment, it becomes important to consider the changing system strength as additional security constraints when solving OPF problems.[54,55] **Note: applicants should consider submitting to Topic 3 (Section B.iii.) if they are interested in proposing new methodologies for evaluating system strength and system inertia.**

Table 11: Capability gap analysis for system strength and inertia as Security Constraints

Description	Existing Approach	Capability Gaps

[51] C. Loutan et al., "Demonstration of Essential Reliability Services by a 300-MW Solar Photovoltaic Power Plant", NREL technical report, March 2017. https://www.nrel.gov/docs/fy17osti/67799.pdf

[52] C. Loutan et al. "Demonstration of Capability to Provide Essential Grid Services", CAISO, March 2020. https://www.caiso.com/Documents/WindPowerPlantTestResults.pdf

[53] R. Quint et al. "Transformation of the Grid: The Impact of Distributed Energy Resources on Bulk Power Systems," IEEE Power and Energy Magazine, November/December 2019.

[54] AEMO, "System Strength in the NEM Explained", March 2020. https://aemo.com.au/-/media/files/electricity/nem/system-strength-explained.pdf

[55] Bendong Tan, Junbo Zhao, Marcos Netto, Venkat Krishnan, Vladimir Terzija, Yingchen Zhang, "Power system inertia estimation: Review of methods and the impacts of converter-interfaced generations", *Elsevier*, *International Journal of Electrical Power & Energy Systems*, Volume 134, January 2022.

System Strength	The required fault current level to maintain secure operation is typically characterized in the design phase; and start experiencing shortfalls with increasing VRE	Incorporate system strength and inertia as new security constraints into resource rescheduling model.
System Inertia	The resistance to speed change of rotating masses is essential for system stability in a synchronous generator dominated system; but not easily replicated in IBR.	

Past Funding Efforts

DOE SETO has funded many RD&D projects to address challenges in VRE and DER interconnections, optimal system operations, integration of solar forecast, real-time monitoring and control of solar systems, and maintaining grid reliability.

- In 2016, the Enabling Extreme Real-Time Grid Integration of Solar Energy [56] (ENERGISE) program funded projects to improve the scalability of integrating large amounts of distributed PV to the grid via simulating electric networks of over 1 million nodes and developing associated control architectures.
- In 2017, SETO announced the Solar Forecasting 2 [57] funding opportunity to support projects that generate tools to enable grid operators to better forecast solar energy, and to improve the management of solar power's variability and uncertainty. As one of the program's outcomes, the Solar Forecast Arbiter platform has been used as a benchmark model to support the Solar Forecasting Prize [58] and the Net Load Forecasting Prize.[59]
- In 2022, SETO announced the Bipartisan Infrastructure Law (BIL) Solar and Wind Grid Services and Reliability Demonstration funding program to support demonstration projects that integrate variable renewable generation with other large-scale or aggregated distributed energy resource (DER) technologies to provide critical grid-supporting services.

Topic Objectives

This topic seeks to fund the development of tools for grid operators to optimally utilize and control large-scale, transmission connected VRE, as well as large numbers of DER, to achieve a more reliable and predictable operation of the

[56] SETO. ENERGISE FOA, 2016. https://www.energy.gov/eere/solar/funding-opportunity-announcement-enabling-extreme-real-time-grid-integration-solar-energy

[57] SETO, Solar Foresting 2 FOA, 2017. https://www.energy.gov/eere/solar/funding-opportunity-announcement-solar-forecasting-2

[58] SETO, American-Made Solar Forecasting Prize, 2021. https://www.energy.gov/eere/solar/american-made-solar-forecasting-prize

[59] SETO, American-Made Net Load Forecasting Prize, 2023. https://www.energy.gov/eere/solar/american-made-net-load-forecasting-prize

grid. Projects will develop solutions for the bulk power system that improve the scheduling and dispatch of resources and services by incorporating dispatchable renewable resources and the uncertainty of non-dispatchable resources. In addition, projects can also develop solutions at the distribution or aggregator level to improve the flexible real-time dispatch and optimal utilization of many VRE and DER to respond to market or bulk power system needs and to improve local grid conditions. Control systems developed under this topic should incorporate new technologies that address VRE and DER uncertainty, such as short-term probabilistic estimations of available solar resources, aggregated sensing and control of grid-edge devices, and incorporating new metrics for security constraints, such as grid strength.

Project Requirements

Successful projects are expected to include, but not be limited to, the following research activities:

- Develop new coordinated decision-making and controls for Operational planning and economic dispatch by incorporating:
    1. advanced probabilistic forecasting for VRE and loads to enable what-if analysis into day-ahead and hour-ahead operational planning procedures,
    2. new flexibility technologies (e.g., energy storage, GETs, and power flow controllers),
    3. sufficient information about aggregate-level DER and load in distribution systems for better resource utilization, and
    4. new security and stability constraints into the optimal resource scheduling model.
- Develop new analytic and computational approaches and tools to support:
    1. stochastic scenario and topology analysis,
    2. advanced optimal power flow analysis that captures chronological operations and enables collaborative real and reactive power dispatch,
    3. state estimation capturing the uncertainties and variability of VRE and DER, and
    4. data interface with multiple data sources, e.g., phasor measurement units, advanced metering infrastructure, inverters, other new sensors/monitoring devices.
- Develop new visualization tools to improve operator situational awareness with the increasing number and rate of measurements, and display intuitive actionable information about VRE and DER.
- Demonstrate the target system performance by integrating these new functionalities with the actual utility/ISO's EMS and using real-time field measurements for operation of actual generation units and other

controllable assets, or, with the emulated power system in a utility/ISO's operation training console with near real-time response.

The developed operational tools should be able to be utilized by either vertically integrated utilities or deregulated market participants. Project teams are encouraged to form an industry advisory board comprising of utilities, ISOs, regulatory entities, or other pertinent industry representatives to provide feedback on technical challenges and the needs of the industry.

Proposals should consider including the project features listed in Table 12. The metrics describe project features of interest to DOE and what would be considered an impactful and scientifically meritorious project proposal. Applicants are encouraged to develop their own ambitious performance metrics that go beyond the metrics defined for each of these features. Projects do not need to meet all the metrics listed in Table 12 to apply, but projects that meet or exceed most or all of the listed metrics will be considered higher for selection.

Table 12. Topic Area 2 Project Requirements.

Features	Qualitative and Quantitative Technical Metrics
Team Partners	• Active participation from utilities and/or ISOs, and software vendors as project partners including budget and associated tasks.
Scalability of Studies (Simulations, HIL emulations)	• Preferred system size ≥ 10 GW or > 2 GW for islanded networks. • Must be a representative U.S. power system. • Include a diversity of generation types, including VRE, large traditional generation plants, DER, with significant contribution from solar generation and ESS, including energy limited resources, such as BESS. • Able to run simulations with VRE and ESS penetration >80% annual energy, >100% instantaneous power. • Able to study weather scenarios with significant daily and seasonal fluctuations in VRE generation.
Field Demonstration	• Power system includes a diversity of generation types and significant contributions from VRE, ESS, and DER. • Demonstrate new functionalities and tools in actual utility/ISO's operations or operation training environment. • Evaluation period, ≥ 1 months, required; ≥ 3 months, recommended
Capabilities of Developed Technologies	• Operational planning and economic dispatch approaches that incorporate VRE's variability and uncertainties, new flexibility technologies, and economic characteristics. • Security-constrained optimization with new security and stability constraints.
Target System Performance	Quantitative target performance metrics, including their sufficient justification, in project milestones including, but not limited to, the following:

	• Increased VRE and DER utilization above baseline. • Increased operational reliability measured by stability and operating reserves. • Accuracy of estimating VRE and DER capacity. • Computational speed and complexity feasible for deployment in control centers
Cybersecurity	• Workplan describes how cybersecurity is considered in the developed operations tools and methodologies.
Technoeconomic Analysis	• Workplan describes how benefits of the technology will be evaluated
Commercialization	• Workplan describes how the technology will become more broadly used by industry or developed into a commercial product in the short term after project completion. • Describe how software developed under this FOA will be distributed (e.g., open source, as part of an existing commercial software package)
Stakeholder Engagement	• Workplan describes how project results will be disseminated to the industry and how industry feedback will be collected and utilized in the project execution.

Applications Not of Interest for Topic 2

- Applications that focus on developing grid stability, and system strength and inertia estimation algorithms. **Relevant efforts should consider Topic 3.**
- Applications that focus primarily on the development of flexibility technologies, e.g., energy storage, GETs, and power flow controllers, as opposed to their integration into operations software and tools.
- Applications that primarily focus on generation interconnection issues.
- Applications that focus on solutions for distribution system operations.
- Applications that focus on electricity market designs.

iii. Topic Area 3: Rapid System Health and Risk Assessment Tools for Grid Operators

Background and Context

Impacts to the electricity grid due to the rapid growth of IBR connecting to the distribution system are not fully understood. Some reports have collected information about recent events that have caused major disturbances impacting

grid performance and triggering IBR abnormal behavior.[60,61,62] While data collection and analysis helps to understand the root cause of IBR abnormal behaviors, these activities can take days or even months after the occurrence of the events. Grid operators need new tools to anticipate these disturbance events before they happen, and the capabilities to mitigate their impacts.[63] Due to the faster dynamics and more distributed nature of IBR, these new tools need to integrate higher resolution sensing data and analytics to increase system visibility and improve reliability compared to existing utility operation tools.

Emerging Challenges and Opportunities

Issues of stability in power flow can be placed into broad categories of event-triggered instabilities and the often-slower onset of oscillations from interactions of control systems. Event-triggered instabilities include those initiated by transmission short-circuit faults and sudden loss of significant generation or load. Control-driven oscillations may build slowly to become a major threat to overall stability of the electric grid. These interactions between control systems, and between controls and the passive elements of the grid, are generally of low frequency, leading to Sub-Synchronous Oscillations (SSO). For decades, SSO disturbances have been observed in electric grids, particularly the bulk power system, and grid operators have developed mitigation plans for traditional systems. But the growing penetration of IBR, combined with their dispersion, variety, and fast control capability, have indicated that SSO issues will become much more common and develop much faster – perhaps beyond human comprehension and manual intervention.[64,65]

IBR abnormal behavior may include undesired disconnection of IBR plants in response to routine grid disturbances such as line fault or inter-area oscillations. Table 13 provides some examples of events relevant to solar generation, including information about event type, impacts to IBR connected to the electric grid, and main causes of IBR output reduction. As reported, widespread power reduction occurred at multiple solar PV facilities located hundreds of miles from

[60] OFGEM, "9 August 2019 power outage report". https://www.ofgem.gov.uk/sites/default/files/docs/2020/01/9_august_2019_power_outage_report.pdf

[61] NERC, Major Event Analysis Reports. https://www.nerc.com/pa/rrm/ea/Pages/Major-Event-Reports.aspx

[62] NERC, "2019 ERO Reliability risk Priorities Report". https://www.nerc.com/comm/RISC/Documents/RISC ERO Priorities Report_Third_Draft_September_2019_CLEAN.pdf

[63] Innocent Kamwa, "Dynamic Wide Area Situational Awareness: propelling future Decentralized, Decarbonized, Digitized, and Democratized Electric Grids". https://ieeexplore.ieee.org/document/10007664

[64] Yunzhi Cheng, et al, "Real-World Subsynchronous Oscillation Events in Power Grids with High Penetrations of Inverter-Based Resources". https://ieeexplore.ieee.org/document/9740416

[65] ORNL, "FNET/GridEye: A Tool for Situational Awareness of Large Power Interconnection Grids". https://www.osti.gov/servlets/purl/1771877

the location of the disturbance event. These reductions were related to inverter-level or plant-level tripping incorrectly in response to the fault itself.

Table 13. Reported examples of undesired or potential solar IBR tripping induced by BPS disturbance events.[66,67,68]

Event Type	Impact to Grid-connected IBR	Main Causes of Generation Reduction
EVENT-TRIGGERED OSCILLATIONS		
Line-to-Ground or Phase-to-Phase Fault	Grid-fault caused voltage drop in the areas of solar PV facilities further causing PV output reduction. The impacted solar PV facilities were located hundreds of miles away from the location of the event.	• Phase-Locked Loop loss of synchronism • Inverter tripping - facilities with legacy inverters unable to ride through overvoltage or undervoltage conditions • Momentary cessation - facilities with legacy inverters unable to provide active and reactive power support during fault • Slow active power recovery
CONTROL-DRIVEN OSCILLATIONS		
8Hz-22Hz Intra-Area Oscillations	observed between substations and PV systems or after line or capacitor switching	• Apparent control interactions between IBR plants and a "weak" (relatively high impedance) grid

Current State of the Art

Organizations like NERC, Texas RE, and ISOs use situational awareness tools, techniques, and processes to analyze disruption events in BPS.[69,70] These tools are used for offline root cause analysis to identify the source and type of disturbance involving IBR and the overall system impact.

To understand and maintain reliability and stability of power grids with high IBR penetration new tools should be able to collect real-time or near real-time data from multiple data sources. In addition, to autonomously perform correlation analysis of abnormal IBR and grid control interactions. These tools should provide information on data collection strategies (e.g., resolution, type, and processing requirements).

[66] NERC report, "Odessa Disturbance". https://www.nerc.com/pa/rrm/ea/Documents/Odessa_Disturbance_Report.pdf

[67] NERC report, "Multiple Solar PV Disturbances in CAISO". https://www.nerc.com/pa/rrm/ea/Documents/NERC_2021_California_Solar_PV_Disturbances_Report.pdf

[68] NERC report, "San Fernando Disturbance". https://www.nerc.com/pa/rrm/ea/Documents/San_Fernando_Disturbance_Report.pdf

[69] TEXAS RE, Reliability Services. https://www.texasre.org/reliabilityservices

[70] Electric Power Group, Real Time Dynamics Monitoring System. https://www.electricpowergroup.com/rtdms.html

Today, software-based tools exist to operate transmission and distribution power grids with limited exposure to IBR technologies.[71] Such systems are used for traditional grid operations and do not offer methods or processes for real- and near-time wide-area system monitoring of abnormal IBR behaviors induced by a disturbance in the system BPS. Data inputs do not include information of IBR conditions that can be used to identify and analyze the source and type of system faults.

For example, as a part of Advanced Distribution Management System (ADMS) functionalities, the fault location, isolation, and service restoration (FLISR) application can improve coordination of protection systems switching devices but may fail to characterize faults with high penetration of IBR. Transmission-level operation tools such as SCADA-EMS offer limited IBR situational awareness and generally lack knowledge of DER. Though EMS are robust against degradation or loss of traditional grid elements,[72] they are not presently capable of representing IBR generation widely dispersed across the BPS or representing the aggregated DER capacity at every distribution substation. Further, these tools generally lack the capability of performing analytics and reporting to provide for full understanding of system status before and after disturbance events involving IBR.

Past Funding Efforts

Over the years, the DOE has funded projects to conduct research and development on technologies to optimize operations of power grids. These efforts have advanced technologies in topics such as sensors and communications, systems integration for operations and situational awareness, data analytics and the development of multiple test beds to validate the integration of multiple components before they are subjected to an operational environment. Past funding opportunities and other research initiatives in this area have focused on the following topics:

- SETO FY2021 Systems Integration and Hardware Incubator funding program focuses on the development of novel communication systems that will integrate highly distributed sensors measurements from behind-the-meter PV systems into utility data systems.
- SETO FY2017 Enabling Extreme Real-Time Grid Integration of Solar Energy (ENERGISE) funding program developed solutions to enable distribution

[71] T&D World article, "SCADA Systems for Renewable energy, ADMS for Utilities". https://www.tdworld.com/renewables/article/21167604/scada-systems-for-renewables-energy-industry-advanced-distribution-management-systems-for-utilities

[72] NERC report, "Energy Management System Performance Special Assessement (2018-2019)". https://www.nerc.com/pa/rrm/ea/PapersDocumentsAssessmentsDL/EMS_Special_Assessment_March2021.pdf

grid operators to gather up-to-the-minute measurement and forecast data from distributed energy sources and optimize system performance using sensor, communications, and data analytics technologies.

- To provide grid owners and operators with more detailed data about grid conditions:
- Office of Electricity (OE) FY2019 Big Data Synchrophasor Analysis funding program explored the use of artificial intelligence (AI) and machine-learning (ML) technologies on phasor measurement unit data to gain insights and develop new tools to improve understanding or grid operations and management.[73,74]
- Through the Grid Modernization Initiative (GMI) and other efforts, the National Laboratories have developed capabilities for the integration of sensors, communications, and visualization interfaces to understand operational challenges associated with the deployment of IBR.[75,76]

Topic Objectives

This topic seeks to fund development and demonstration of tools for grid operators, and the data and communication systems that support them, that will identify and mitigate emerging system risks that are driven by the faster dynamics and uncertain control interactions of IBR. These tools will need to ingest data from multiple data sources, including existing and new sensors, to create wide-area geospatially- and time-correlated data sets. These data sets should be structured to allow for quick analysis to produce improved grid situational awareness through real time system health indicators, recommend mitigation actions, and rapid and automated near-real-time event analysis. Visualization tools developed in this topic should provide operators accurate estimations of system state, including the amount of real-time DER generation and available stored energy, including BTM. Advanced data analytic techniques should be utilized to provide actionable information about events in real-time or near real-time.

These real-time monitoring and analysis tools will enable grid operators to assess system health and mitigate system instabilities, which include SSO due to IBR

[73] DOE, Big Data Synchrophasor Analysis. https://www.energy.gov/oe/big-data-synchrophasor-analysis
[74] SmartGrid.gov, Recovery Act: Synchrophasor Applications in Transmission System. https://www.smartgrid.gov/recovery_act/program_impacts/applications_synchrophasor_technology.html
[75] DOE Grid Modernization Initiative, Advanced Distribution Management System Testbed Development. https://gridmodernization.labworks.org/projects/advanced-distribution-management-system-testbed-development
[76] Pacific Northwest National Laboratory, Electricity Infrastructure Operations Center – Capabilities. https://www.pnnl.gov/projects/eioc/capabilities

control interactions and disturbances that can cause wide-spread reduction of solar PV output. These tools will provide visualization and event alerts in the operator control room and will be validated through field demonstration.

Project Requirements

The proposed tools will need to have the following functions:

1) Data gathering capabilities to provide situational awareness of IBR,
2) Advanced data analytics for real-time system health assessment,
3) Historic labeled and synchronized disturbance data sets for post-event forensic analysis, and
4) Mitigation recommendations for operator or autonomous control actions.

Successful projects will develop new tools which are able to detect grid and IBR anomalies at milliseconds to minutes timescale, using information from multiple monitoring points and data sources from existing sensors and/or new high-resolution sensors (e.g., Continuous Point on Wave (CPoW), Point on Wave (PoW). The tools will include event correlation algorithms through automated processing of multiple data sources. Analytical methods can include, but are not limited to, feature extraction, threshold-based anomaly triggering, AI/ML, and other techniques. Monitoring points should include both transmission and distribution system levels, and distribution monitoring should include an approximation of aggregated BTM PV generation and other DER capacity.

Assessment of overall system inertia and relevant impedance ("grid strength") should also be included. Furthermore, information about abnormal control interactions between DER and electric grid systems should be processed and displayed into utility or ISO/RTO control rooms. The tools will have a visualization interface to provide real-time information about the system health (e.g., alarms/indicators, detection, disturbance type, topology) and generate reports for event root cause analysis. The tools will include procedures for operators to work through abnormal scenarios (e.g., grid or IBR instabilities), or an automated remediation platform if analysis shows potential for rapid onset of instabilities.

Proposals should consider including the project features listed in Table 14. The metrics describe project features of interest to DOE and what would be considered an impactful and scientifically meritorious project proposal. Applicants are encouraged to develop their own ambitious performance metrics that go beyond the metrics defined for each of these features. Projects do not need to meet all the metrics listed in Table 14 to apply, but projects that meet or exceed most or all the listed metrics will be considered higher for selection.

Table 14. Topic Area 3 Project Requirements.

Features	Qualitative and Quantitative Technical Merits
Team Partners	• Active participation from utilities, ISOs, and software vendors as project partners including budget and associated tasks
Scalability of Studies	• Power system size > 10 GW or > 2 GW for islanded networks. • System must be a representative U.S. electric grid • Solar PV facilities in aggregate contributing ≥ 75 MVA/MW[77] • Include a diversity of generation types, including VRE, large traditional generation plants, and DER
Field Demonstration	• Data processing system incorporated with real-time utility sensor data and field measurements in a representative section(s) of the grid • Evaluation period, ≥ 1 months, required; ≥ 3 months, recommended
Capabilities of Developed Technologies	• Ability to detect and monitor disturbances from milliseconds to minutes. This will include identification of SSO origination in real-time • Collect wide area (≥ 200 miles) disturbance event data and build analytics to identify IBR mis-operation. Correlate multiple data sources to identify nuisance tripping. • Demonstration of technology should include connecting to live utility data streams. • Visualization interface providing easy access to data including rapid and actionable information to operators. The tool should be able to collect data from multiple sources, enable multimodal analytics (e.g., device, plant and system level), label each data source, provide disturbance report, and keep a historian for offline and root cause analysis. Establish a methodology to help users label and ingest data into the tool.

Target System Performance	• Description of system performance including the following:
	  ○ Integration of software and/or hardware tools
	  ○ Deployment of algorithms to detect, locate and increase visibility of plants or faulty equipment.
	  ○ Easy to understand dashboard display of system's health alarms for operators.
	• System alerts should be generated in near- or real-time. Automated root cause analysis report can be performed offline.

Cybersecurity	• Workplan describes how cybersecurity is considered in the developed operations tools and methodologies.
Technoeconomic Analysis	• Workplan describes how benefit of technology will be evaluated

[77] NERC standard, "PRC-004-3 — Protection System Misoperation Identification and Correction". https://www.nerc.com/pa/Stand/Reliability Standards/PRC-004-4.pdf

Commercialization	• Workplan describes how the technology will become more broadly used by industry or developed into a commercial product in the short term after project completion • Describe how software developed under this FOA will be distributed (e.g., open source, as part of an existing commercial software package)
Stakeholder Engagement	• Workplan clearly describes how project results will be disseminated to the industry and how industry feedback will be collected and utilized in the project execution

Applications Not of Interest for Topic 3

- Applications that do not include impacts of IBR.
- Applications that primarily focus on sensor development.
- Application that only focus on cybersecurity.

All work for projects selected under this FOA must be performed in the United States. See Section IV.J.iii. and Appendix C.

C. Applications Specifically Not of Interest

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

- Applications that fall outside the technical parameters specified in Sections I.A. and I.B. of the FOA.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Applications that are described as not of interest in the topic area description in Section I.B. of the topic area to which they are applying.

D. Community Benefits Plan

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

To support the goal of building a clean and equitable energy economy, projects funded under this FOA are expected to (1) advance diversity, equity, inclusion and accessibility (DEIA); (2) contribute to energy equity; and (3) invest in America's workforce. To ensure these objectives are met, applications must include a Community Benefits Plan that addresses the three objectives stated above. See

Section IV.D.xiv. and Appendix F for the more information on the Community Benefits Plan content requirements.

E. Authorizing Statutes

The programmatic authorizing statute is Energy Act of 2020 Division Z Sec. 3004(b)(2)(B).

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

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make a total of approximately $30,000,000 of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 9-13 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $2,000,000 and $4,000,000.

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

Topic Area Number	Topic Area Title	Anticipated Number of Awards	Anticipated Minimum Award Size for Any One Individual Award (Fed Share)	Anticipated Maximum Award Size for Any One Individual Award (Fed Share)	Approximate Total Federal Funding Available for All Awards	Anticipated Period of Performance (months)
1	Planning Tools for Future Power Systems	3-4	$2,000,000	$2,500,000	$8,000,000	36 months
2	Variability Management in Grid Operations	3-4	$2,500,000	$3,500,000	$10,000,000	36 months
3	Rapid System Health and Risk Assessment Tools for Grid Operators	3-5	$2,500,000	$4,000,000	$12,000,000	36 months

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

ii. Period of Performance

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

iii. New Applications Only

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

B. EERE Funding Agreements

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

i. Cooperative Agreements

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

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

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

ii. Funding Agreements with Federally Funded Research and Development Center (FFRDCs)[78]

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

III. Eligibility Information

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

A. 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; and
4. State and local governmental entities, and Indian tribes.

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

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

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

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

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

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.

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

ii. Foreign Entities

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

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

B. Cost Sharing

Applicants are bound by the cost share proposed in their Full Applications if selected for award negotiations. The cost share must be at least 20% of the total project costs[79] for research and development projects and 50% of the total project costs for demonstration and commercial application projects.[80] The cost share must come from non-federal sources unless otherwise allowed by law.

The topic area requirements by topic area are as follows:

Topic Area	Cost Share Requirement
1	20%
2	20% and 50%
3	20% and 50%

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

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

Examples of activities that would be considered demonstrations under Topics 2 and 3 include upgrading fielded controllers, such as IBR firmware or hardware, installing new sensors and communication equipment in solar facilities or on the electric grid, operating and monitoring fielded equipment during a pilot test phase, or testing how software responds to real-time data from field measurements.

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

i. Legal Responsibility

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

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

ii. Cost Share Allocation

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

iii. Cost Share Types and Allowability

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

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

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

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

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

The 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.
- Costs of software licenses. Costs for the purchase of off-the-shelf software offered commercially to the general public will be considered on a case-by-case basis. Third party donation of off-the-shelf software will be considered on a case-by-case basis. Software licenses for software owned by prime or sub-recipients will not be considered allowable as cost share.

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 Grants Officer and incorporated into the project budget before the expenditures are incurred.

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

iv. Cost Share Contributions by FFRDCs

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

v. Cost Share Verification

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

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

vi. Cost Share Payment

DOE requires prime recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the prime recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a minimum, the cost sharing percentage negotiated). As FFRDC funding will be provided directly to the FFRDC(s) by DOE, prime recipients will be required to provide project cost share at a percentage commensurate with the FFRDC costs, on a budget period basis, resulting in a higher interim invoicing cost share ratio than the total award ratio.

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

C. Compliance Criteria

All applicant submissions must:

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

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

Applicants are strongly encouraged to submit their Concept Papers, Full Applications, and Replies to Reviewer Comments at least 48 hours in advance of the submission deadline. Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), applicants should allow at least 1 hour to submit a Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE eXCHANGE, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made to any of these documents, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline. EERE will not extend the submission deadline for applicants that fail to submit required information by the applicable deadline due to server/connection congestion.

D. Responsiveness Criteria

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

E. Other Eligibility Requirements

i. Requirements for DOE/NNSA and non-DOE/NNSA FFRDCs Included as a Subrecipient

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

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

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

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

c. Funding, Cost Share and Subaward with FFRDCs
The value of and funding for the FFRDC portion of the work will not normally be included in the award. DOE/NNSA FFRDCs participating as a subrecipient on a project will be funded directly through the DOE field work proposal (WP) process. Non-DOE/NNSA FFRDCs participating as a subrecipient will be funded through an interagency agreement with the sponsoring agency. Although the FFRDC portion of the work is excluded from the award, the applicant's cost share requirement will be based on the total cost of the project, including the applicant's, the subrecipient's, and the FFRDC's portions of the project.

Unless instructed otherwise by the DOE CO for the DOE award, all FFRDCs are required to enter into a Cooperative Research and Development Agreement[81] (CRADA) or, if the role of the DOE/NNSA FFRDC is limited to technical assistance and intellectual property is not anticipated to be generated from the DOE/NNSA FFRDC's work, a Technical Assistance Agreement (TAA), with at least the prime recipient before any project work begins. Any questions regarding the use of a CRADA or TAA should be directed to the cognizant DOE field intellectual property (IP) counsel.

The CRADA or TAA is used to ensure accountability for project work and provide the appropriate management of intellectual property (IP), e.g., data protection and background IP. The CRADA or TAA must be agreed upon by all parties and submitted to DOE or other sponsoring agency, when applicable, for approval, or submitted to DOE for notice under the Master Scope of Work process, when applicable, using any DOE or other sponsoring agency

[81] A cooperative research and development agreement is a contractual agreement between a national laboratory contractor and a private company or university to work together on research and development. For more information, see https://www.energy.gov/gc/downloads/doe-cooperative-research-and-development-agreements

approved CRADA or TAA template without substantive changes by the time the award is made to the prime recipient.

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

An entity may submit more than one Full Application to this FOA, provided that each application describes a unique, scientifically distinct project.

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. Application Process

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

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

- Each must be submitted in Adobe PDF format unless stated otherwise;
- Each must be written in English;
- All pages must be formatted to fit on 8.5" x 11" paper with margins not less than one inch on every side. Use Calibri typeface, a black font color, and a font size of 12-point or larger (except in figures or tables, which may be 10-point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies. References must be included as footnotes or endnotes in a font size of 10 or larger. Footnotes and endnotes are counted toward the maximum page requirement;
- A **control number** will be issued when an applicant begins the EERE eXCHANGE application process. The control number must be included with all application documents. Specifically, the control number must be prominently displayed on the upper right corner of the header of every page and included in the file name (i.e., *Control Number_Applicant Name_Full Application*);
- Page numbers must be included in the footer of every page; and

- Each submission must not exceed the specified maximum page limit, including cover page, charts, graphs, maps, and photographs when printed using the formatting requirements set forth above and single spaced. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages.

i. Additional Information on EERE eXCHANGE

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

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

B. Application Forms

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

Note: The maximum file size that can be uploaded to the EERE eXCHANGE website is 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

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

C. Content and Form of the Concept Paper

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

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

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

D. Content and Form of the Full Application

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

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

All Full Application documents must be marked with the control number issued to the applicant.

i. Full Application Content Requirements

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

Component	File Format	Page Limit	File Name
Technical Volume	PDF	15	ControlNumber_LeadOrganization_TechnicalVolume
Resumes	PDF	3 pages each	ControlNumber_LeadOrganization_Resumes
Letters of Commitment	PDF	1 page each	ControlNumber_LeadOrganization_LOCs
Statement of Project Objectives	MS Word	10	ControlNumber_LeadOrganization_SOPO
SF-424: Application for Federal Assistance	PDF	n/a	ControlNumber_LeadOrganization_App424
Budget Justification Workbook	MS Excel	n/a	ControlNumber_LeadOrganization_Budget_Justification
Summary/Abstract for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary

Summary Slide	MS Power-Point	1	ControlNumber_LeadOrganization_Slide
Subrecipient Budget Justification	MS Excel	n/a	ControlNumber_LeadOrganization_Subrecipient_Budget_Justification
DOE Work Proposal for FFRDC, if applicable (see DOE O 412.1A, Attachment 2)	PDF	n/a	ControlNumber_LeadOrganization_WP
Authorization from cognizant Contracting Officer for FFRDC	PDF	n/a	ControlNumber_LeadOrganization_FFRDCAuth
SF-LLL Disclosure of Lobbying Activities (prime and subrecipients)	PDF	n/a	ControlNumber_LeadOrganization_SF-LLL
Foreign Entity Waiver Requests and Foreign Work Waiver Requests	PDF	n/a	ControlNumber_LeadOrganization_Waiver
Community Benefits Plan	PDF	5	ControlNumber_LeadOrganization_CBP
Current and Pending Support	PDF	n/a	ControlNumber_LeadOrganization_CPS
Transparency of Foreign Connections	PDF	n/a	ControlNumber_LeadOrganization_TFC
Potentially Duplicative Funding Notice	PDF	n/a	ControlNumber_LeadOrganization_PDFN

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

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

ii. Technical Volume

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

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

Applicants must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical Volume. However, EERE and reviewers are under no obligation to review cited sources.

The Technical Volume to the Full Application may not be more than 15 pages, including the cover page, table of contents, and all citations, charts, graphs, maps, photos, or other graphics, and must include all of the information in the

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

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

Technical Volume Content Requirements	
SECTION/PAGE LIMIT	**DESCRIPTION**
Cover Page	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, names of project managers, senior/key personnel and their organizations, the project location(s), and any statements regarding confidentiality.
Project Overview (Approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact (Approximately 30% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology or focus area, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving

	the anticipated performance targets, including a description of previous work done and prior results. This section should also address the project's access to necessary infrastructure (e.g., transportation, water, electricity transmission), including any use of existing infrastructure, as well as to a skilled workforce. • Innovation and Impacts: The applicant should describe the current state-of-the-art in the applicable field, the specific innovation of the proposed technology or focus area, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state-of-the-art/technical baseline if the project is successful.
Workplan (Approximately 40% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go decision points, and Project Schedule. A detailed SOPO is separately requested. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes. • Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on Go/No-Go decision points). The applicant should describe the specific expected end result of each performance period, including milestones in the Community Benefits Plan. • WBS and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard WBS for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this FOA. The summary provided should be consistent with the SOPO. The SOPO will contain a more detailed description of the WBS and tasks. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can

	be activity based) or a SMART technical milestone. SMART milestones should be Specific, Measurable, Achievable, Relevant, and Timely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO.
	• Go/No-Go Decision Points (See Section VI.B.xiv. for more information on the Go/No-Go Review): The applicant should provide a summary of project-wide Go/No-Go decision points at appropriate points in the Workplan. At a minimum, each project must have at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of the project. See Section VI.B.xiv. The applicant should also provide the specific technical and community benefits plan criteria to be used to evaluate the project at the Go/No-Go decision point. The summary provided should be consistent with the SOPO. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone.
	• End of Project Goal: The applicant should provide a summary of the end of project goal(s). At a minimum, each project must have one SMART end of project goal. The summary provided should be consistent with the SOPO.
	• Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points.
	• Buy America Requirements for Infrastructure Projects: Within the first 2 pages of the Workplan, include a short statement on whether the project will involve the construction, alteration, and/or repair of infrastructure in the United States. See Appendix D for applicable definitions and other information to inform this statement.
	• Project Management: The applicant should discuss the team's proposed management plan, including the following:
	  ○ The overall approach to and organization for managing the work.
	  ○ The roles of each project team member.
	  ○ Any critical handoffs/interdependencies among project team members.

	○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices. ○ The approach to project risk management, including a plan for securing a qualified workforce and mitigating risks to project performance including but not limited to community or labor disputes. ○ A description of how project changes will be handled. ○ If applicable, the approach to Quality Assurance/Control. ○ How communications will be maintained among project team members. • Market Transformation Plan: The applicant should provide a market transformation plan, including the following: ○ Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan. ○ Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, and product distribution.
Technical Qualifications and Resources (Approximately 20% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • Describe the project team's unique qualifications and expertise, including those of key subrecipients. • Describe the project team's existing equipment and facilities, or equipment or facilities already in place on the proposed project site, that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. • Describe the skills, certifications, or other credentials of the construction and ongoing operations workforce.

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

iii. Resumes

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

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

iv. Statement of Project Objectives (SOPO)

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

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

v. SF-424: Application for Federal Assistance

Applicants must complete the SF-424 Application for Federal Assistance which is available at: EERE Funding Application and Management Forms. Complete all required fields in accordance with the instructions on the form. The list of certifications and assurances in Field 21 can be found at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms, under Certifications and Assurances. Note: The dates and dollar amounts on the SF-424 are for the complete project period and not just the first project year, first phase or other subset of the project period.

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

vi. Budget Justification Workbook

Applicants must complete the Budget Justification Workbook which is available at: EERE Funding Application and Management Forms. Applicants must complete each tab of the Budget Justification Workbook for the project as a whole, including all work to be performed by the prime recipient and its subrecipients and contractors. Applicants should include costs associated with required annual

audits and incurred cost proposals in their proposed budget documents. The "Instructions and Summary" included with the Budget Justification Workbook will auto-populate as the applicant enters information into the Workbook. Applicants must carefully read the "Instructions and Summary" tab provided within the Budget Justification Workbook.

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

vii. Summary for Public Release

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

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

viii. Summary Slide

Applicants must provide a single slide summarizing the proposed project. The Summary Slide template must include the following information:

- A technology summary;
- A description of the technology's impact;
- Proposed project goals;
- Any key graphics (illustrations, charts and/or tables);
- The project's key idea/takeaway;
- Topline community benefits;
- Project title, prime recipient, Principal Investigator, and senior/key personnel information; and
- Requested EERE funds and proposed applicant cost share.

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

ix. Subrecipient Budget Justification (if applicable)

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

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

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

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

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

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

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

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

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

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

Recipients and subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities"

(https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-federal funds have not been paid and will not be paid to any person for influencing or attempting to influence any of the following in connection with the application:

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

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

xiii. Waiver Requests (if applicable)

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

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

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

xiv. Community Benefits Plan

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

The applicant's Community Benefits Plan must include at least one Specific, Measurable, Assignable, Relevant, and Timely (SMART) milestone per budget

period to measure progress on the proposed actions. The Community Benefits Plan will be evaluated as part of the technical review process. If EERE selects a project, EERE will incorporate the Community Benefits Plan into the award and the recipient must implement its Community Benefits Plan as part of carrying out its project. During the life of the EERE award, EERE will evaluate the recipient's progress, including as part of the Go/No-Go review process.

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

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

The applicant's Community Benefits Plan must address the following three sections:

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

2) **Energy Equity:**
   This section must articulate the applicant's consideration of long-term equity implications of the research. It must identify how the specific project integrates equity considerations into the project design to support equitable

outcomes should the innovation be successful. Like cost reductions and commercialization plans, the Community Benefits Plan requires description of the equity implications of the innovation if successful.

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

See Appendix F for more guidance.

xv. Current and Pending Support

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

The information may be provided in the format approved by the National Science Foundation (NSF), which may be generated by the Science Experts Network Curriculum Vita (SciENcv), a cooperative venture maintained at https://www.ncbi.nlm.nih.gov/sciencv/, and is also available at https://www.nsf.gov/bfa/dias/policy/nsfapprovedformats/cps.pdf. The use of a format required by another agency is intended to reduce the administrative burden to researchers by promoting the use of common formats. If the NSF format is used, the individual must still include a signature, date, and a certification statement using the language included in the paragraph above.

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

Definitions:

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

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

Senior/key personnel – an individual who contributes in a substantive, meaningful way to the scientific development or execution of a research,

development and demonstration (RD&D) project proposed to be carried out with DOE award.[82]

xvi. Transparency of Foreign Connections

Applicants must provide the following information 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 physical address;
2. The identity of all owners, principal investigators, project managers, and senior/key personnel who are a party to any *Foreign Government-Sponsored Talent Recruitment Program* of a foreign country of risk (i.e., China, Iran, North Korea, and Russia);
3. The existence of any joint venture or subsidiary that is based in, funded by, or has a foreign affiliation with any foreign country of risk, including the People's Republic of China;
4. Any current or pending contractual or financial obligation or other agreement specific to a business arrangement, or joint venture-like arrangement with an enterprise owned by a foreign state or any foreign entity;
5. Percentage, if any, that the proposed recipient or subrecipient has foreign ownership or control;
6. Percentage, if any, that the proposed recipient or subrecipient is wholly or partially owned 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;

[82] 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.

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 five percent;
12. A summary table identifying all rounds of financing, the purchase dates, the investors for each round, and all the associated governance and information rights obtained by investors during each round of financing; and
13. An organization chart to illustrate the relationship between your entity and the immediate parent, ultimate parent, and any intermediate parent, as well as any subsidiary or affiliates. Identify where each entity is incorporated.

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

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

xvii. Potentially Duplicative Funding Notice

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

recipient must promptly notify the DOE Contracting Officer in writing of the potential duplication and eliminate any inappropriate duplication of funding.

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

E. Content and Form of Replies to Reviewer Comments

EERE will provide applicants with reviewer comments following the evaluation of all eligible Full Applications. Applicants have a brief opportunity to prepare a short Reply to Reviewer Comments (Reply). The Reply must not exceed three (3) pages. If a Reply is more than three (3) pages in length, EERE will review only the first three (3) pages and disregard any additional pages. Applicants may use the Reply to respond to one or more comments or to supplement their Full Application. The Reply may include text, graphs, charts, or data.

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

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

F. Post Selection Information Requests

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

- Personnel proposed to work on the project and collaborating organizations (See Section VI.B.xix. Participants and Collaborating Organizations);
- Current and Pending Support (See Sections IV.D.xv. and VI.B.xx. Current and Pending Support);
- Indirect cost information;
- Other budget information;

- Letters of Commitment from third parties contributing to cost share, if applicable;
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5);
- Information for the DOE Office of Civil Rights to process assurance reviews under 10 CFR 1040;
- Representation of Limited Rights Data and Restricted Software, if applicable; and
- Environmental Questionnaire.

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

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

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.

H. Submission Dates and Times

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

I. Intergovernmental Review

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

J. Funding Restrictions

i. Allowable Costs

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

ii. Pre-Award Costs

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

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

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

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

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

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

1. Requirement

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

2. Failure to Comply

If the prime recipient fails to comply with the Performance of Work in the United States requirement, EERE may deny reimbursement for the work conducted outside the United States and such costs may not be recognized as allowable recipient cost share. The prime recipient is responsible should any work under this award be performed outside the United States, absent a waiver, regardless of whether the work is performed by the prime recipient, subrecipients, contractors or other project partners.

3. Waiver

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

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

iv. Construction

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

v. Foreign Travel

Foreign travel costs are not allowable under this FOA.

vi. 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.

vii. Buy America Requirements for Infrastructure Projects

Pursuant to the Build America Buy America Act, subtitle IX of the 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 BIL, and whether the infrastructure in question is publicly owned or serves a public function.

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

Please note that, based on 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 non-profit organization. Subawards

should conform to the terms of the prime award from which they flow; in other words, for-profit prime recipients are not required to flow down these Buy America requirements to subrecipients, even if those subrecipients are non-Federal entities as defined above. Conversely, prime recipients which are non-Federal entities must flow the Buy America requirements down to all subrecipients, even if those subrecipients are for-profit entities. Finally, for all applicants—both non-Federal entities and for-profit entities—DOE is including a program policy factor that the Selection Official may consider in determining which Full Applications to select for award negotiations that considers whether the applicant has made a commitment to procure U.S. iron, steel, manufactured products, and construction materials in its project.

The DOE financial assistance agreement will require each recipient: (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 Appendix D and the terms and conditions of an award.

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

viii. Lobbying

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

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

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

ix. Risk Assessment

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

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

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

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

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

Further, as DOE invests in critical infrastructure and funds critical and emerging technology areas, DOE also considers possible vectors of undue foreign influence in evaluating risk. If high risks are identified and cannot be sufficiently mitigated, DOE may elect to not fund the applicant.

x. Invoice Review and Approval

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

- Summary of costs by cost categories;
- Timesheets or personnel hours report;
- Invoices/receipts for all travel, equipment, supplies, contractual, and other costs;

- UCC filing proof for equipment acquired with project funds by for-profit recipients and subrecipients;
- Explanation of cost share for invoicing period;
- Analogous information for some subrecipients; and
- Other items as required by DOE.

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

a. Prohibition

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

b. Definitions

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

to disclose their participation to U.S. entities. Compensation could take many forms including cash, research funding, complimentary foreign travel, honorific titles, career advancement opportunities, promised future compensation, or other types of remuneration or consideration, including in-kind compensation.

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

xii. Affirmative Action and Pay Transparency Requirements

All 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.

The Department of Labor's (DOL) Office of Federal Contractor Compliance Programs (OFCCP) uses a neutral process to schedule compliance evaluations. OFCCP's Technical Assistance Guide[83] should be consulted to gain an understanding of the requirements and possible actions the recipients, subrecipients, contractors and subcontractors must take. Additional guidance may also be found in the National Policy Assurances, produced by DOE.

xiii. Foreign Collaboration Considerations

a. Consideration of new collaborations with foreign entities and governments. The recipient will be required to provide DOE with advanced written notification of

[83] 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

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 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 polies and procedures.

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

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

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

This criterion involves consideration of the following factors:

- The applicant clearly describes the proposed technology, how the technology is unique and innovative, and how the technology will advance the current state-of-the-art;

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

ii. Full Applications

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

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

Technical Merit and Innovation

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

Impact of Technology Advancement

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

Project Management

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

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

Research Approach, Workplan and SOPO

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

Identification of Technical Risks

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

Baseline, Metrics, and Deliverables

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

Market Transformation Plan

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

Industry Adoption Plan

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

Criterion 3: Team and Resources (10%)
This criterion involves consideration of the following factors:

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

- Reasonableness of the budget and spend plan for the proposed project and objectives.

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

Diversity, Equity, Inclusion and Accessibility (DEIA)

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

Energy Equity

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

Workforce Implications

- Clear and comprehensive workplan tasks, staffing, research, and timeline for engaging workforce stakeholders and/or evaluating the possible near- and long-term implications of the project for the U.S. workforce;
- Approach to document the knowledge, skills, and abilities of the workforce required for successful commercial deployment of innovations resulting from this research; and

- Likelihood that the plan will result in improved understanding of the workforce implications related to the innovation if successful.

iii. Criteria for Replies to Reviewer Comments

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

B. Standards for Application Evaluation

Applications that are determined to be eligible will be evaluated in accordance with this FOA, by the standards set forth in EERE's Notice of Objective Merit Review Procedure (76 Fed. Reg. 17846, March 31, 2011) and the guidance provided in the "DOE Merit Review Guide for Financial Assistance," effective September 2020, which is available at: https://energy.gov/management/downloads/merit-review-guide-financial-assistance-and-unsolicited-proposals-current.

C. Other Selection Factors

i. Program Policy Factors

In addition to the above criteria, the Selection Official may consider the following program policy factors in determining which Full Applications to select for award negotiations:

- The degree to which the proposed project exhibits technological diversity when compared to the existing DOE project portfolio and other projects selected from the subject FOA;
- The degree to which the proposed project, including proposed cost share, optimizes the use of available EERE funding to achieve programmatic objectives;
- The level of industry involvement and demonstrated ability to accelerate demonstration and commercialization and overcome key market barriers;
- The degree to which the proposed project is likely to lead to increased high-quality employment and manufacturing in the United States;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty;
- The degree to which the proposed project, or group of projects, represent a desired geographic distribution (considering past awards and current applications);

- The degree to which the proposed project incorporates applicant or team members from Minority Serving Institutions (e.g., Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs)); and partnerships with Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or Indian tribes;
- The degree to which the proposed project, when compared to the existing DOE project portfolio and other projects to be selected from the subject FOA, contributes to the total portfolio meeting the goals reflected in the Community Benefits Plan criteria; and
- The degree to which the proposed project will employ procurement of U.S. iron, steel, manufactured products, and construction materials.

D. Evaluation and Selection Process

i. Overview

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

ii. Pre-Selection Interviews

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

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

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

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

iii. Pre-Selection Clarification

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

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

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

iv. Recipient Responsibility and Qualifications

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

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

DOE will consider any written comments by the applicant, in addition to the other information in the entity information domain in SAM.gov, in making a judgment about the applicant's integrity, business ethics, and record of

performance under federal awards when completing the review of risk posed by applicants as described in 2 CFR 200.206.

v. Selection

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

E. Anticipated Notice of Selection and Award Negotiation Dates

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

VI. Award Administration Information

A. Award Notices

i. Ineligible Submissions

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

ii. Concept Paper Notifications

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

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

iii. Full Application Notifications

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

iv. Applicants Selected for Award Negotiations

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

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

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

v. Alternate Selection Determinations

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

vi. Unsuccessful Applicants

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

B. Administrative and National Policy Requirements

i. Registration Requirements

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

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

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

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

2. **System for Award Management**
   Register in SAM (https://www.sam.gov). Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called a

Marketing Partner ID Number (MPIN) are important steps in SAM registration. Please update your SAM registration annually.

3. **FedConnect**
   Register in FedConnect (https://www.fedconnect.net). To create an organization account, your organization's SAM MPIN is required. For more information about the SAM MPIN or other registration requirements, review the FedConnect Ready, Set, Go! Guide at https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf.

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

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

ii. Award Administrative Requirements

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

iii. Foreign National Participation

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

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

iv. Subaward and Executive Reporting

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

v. National Policy Requirements

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

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

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

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

vii. Flood Resilience

Applications should indicate whether the proposed project location(s) is within a floodplain, how the floodplain was defined, and how future flooding will factor into the project's design. The base floodplain long used for planning has been the 100-year floodplain, that is, a floodplain with a 1.0 percent chance of flooding in any given year. As directed by Executive Order 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input (2015), Federal agencies, including DOE, continue to avoid development in a floodplain to the extent possible. When doing so is not possible, Federal agencies are directed to "expand management

from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended." The higher flood elevation is based on one of three approaches: climate-informed science (preferred), freeboard value, or 0.2 percent annual flood change (500-year floodplain). EO 13690 and related information is available at: https://www.energy.gov/nepa/articles/eo-13690-establishing-federal-flood-risk-management-standard-and-process-further.

viii. Applicant Representations and Certifications

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

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

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

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

   For purposes of these representations the following definitions apply:

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

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

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

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

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

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

(3) Notwithstanding the provision listed in paragraph (a), a nondisclosure or confidentiality policy form or agreement that is to be executed by a person connected with the conduct of an intelligence or intelligence-related activity, other than an employee or officer of the United States government, may contain provisions appropriate to the particular activity for which such document is to be used. Such form or agreement shall, at a minimum, require that the person will not disclose any classified information received in the course of such activity unless specifically authorized to do so by the United States government. Such nondisclosure or confidentiality forms shall also

make it clear that they do not bar disclosures to Congress, or to an authorized official of an executive agency or the Department of Justice, that are essential to reporting a substantial violation of law.

ix. Statement of Federal Stewardship

EERE will exercise normal federal stewardship in overseeing the project activities performed under EERE awards. Stewardship Activities include, but are not limited to, conducting site visits; reviewing performance and financial reports; providing assistance and/or temporary intervention in unusual circumstances to correct deficiencies that develop during the project; assuring compliance with terms and conditions; and reviewing technical performance after project completion to ensure that the project objectives have been accomplished.

x. Statement of Substantial Involvement

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

1. EERE shares responsibility with the recipient for the management, control, direction, and performance of the project.

2. EERE may intervene in the conduct or performance of work under this award for programmatic reasons. Intervention includes the interruption or modification of the conduct or performance of project activities.

3. EERE may redirect or discontinue funding the project based on the outcome of EERE's evaluation of the project at the Go/No-Go decision point(s).

4. EERE participates in major project decision-making processes.

xi. Subject Invention Utilization Reporting

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

first commercial sale or use, gross royalties received by the prime recipient, and such other data and information as EERE may specify.

xii. Intellectual Property Provisions

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

xiii. Reporting

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

xiv. Go/No-Go Review

Each project selected under this FOA will be subject to a periodic project evaluation referred to as a Go/No-Go Review. A Go/No-Go Review is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. At the Go/No-Go decision points, DOE will evaluate project performance, project schedule adherence, the extent milestone objectives are met, compliance with reporting requirements, and overall contribution to the program goals and objectives. Federal funding beyond the Go/No-Go decision point (continuation funding) is contingent upon (1) availability of federal funds appropriated by Congress for the purpose of this program; (2) the availability of future-year budget authority; (3) recipient's technical progress compared to the Milestone Summary Table stated in Attachment 1 of the award; (4) recipient's submittal of required reports; (5) recipient's compliance with the terms and conditions of the award; (6) DOE's Go/No-Go decision; (7) the recipient's submission of a continuation application[84]; and (8) written approval of the continuation application by the Grants Officer.

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

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

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.

xv. Conference Spending

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

xvi. Uniform Commercial Code (UCC) Financing Statements

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

Properly record, and consent to the Department's ability to properly record if the recipient fails to do so, UCC financing statement(s) for all equipment in excess of $5,000 purchased with project funds. These financing statement(s) must be approved in writing by the Grants 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 Grants 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 Grants Officer may direct.

xvii. Real Property and Equipment

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

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

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

xix. Participants and Collaborating Organizations

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

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

xx. Current and Pending Support

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

xxi. U.S. Manufacturing Commitments

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

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

As noted in the U.S. Competitiveness Provision, if an entity cannot meet the requirements of the U.S. Competitiveness Provision, the entity may request a modification or waiver of the U.S. Competitiveness Provision. For example, the entity may propose modifying the language of the U.S. Competitiveness Provision in order to change the scope of the requirements or to provide more specifics on the application of the requirements for a particular technology. As another example, the entity may request that the U.S. Competitiveness Provision be waived in lieu of a net benefits statement or United States manufacturing

plan. The statement or plan would contain specific and enforceable commitments that would be beneficial to the United States economy and competitiveness. Examples of such commitments could include manufacturing specific products in the United States, making a specific investment in a new or existing United States manufacturing facility, keeping certain activities based in the United States or supporting a certain number of jobs in the United States related to the technology. DOE may, in its sole discretion, determine that the proposed modification or waiver promotes commercialization and provides substantial United States economic benefits, and grant the request. If granted, DOE will modify the award terms and conditions for the requesting entity accordingly.

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

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

xxii. Interim Conflict of Interest Policy for Financial Assistance

The DOE interim Conflict of Interest Policy for Financial Assistance (COI Policy)[85] 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.

[85] 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.

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

xxiii. Data Management Plan (DMP)

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

xxiv. Fraud, Waste and Abuse

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

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

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

> The non-Federal entity or applicant for a Federal award must disclose, in a timely manner, in writing to the Federal awarding agency or pass-through entity all violations of Federal criminal law involving fraud, bribery, or gratuity violations potentially affecting

the Federal award. Non-Federal entities that have received a Federal award including the term and condition outlined in appendix XII of 2 CFR Part 200 are required to report certain civil, criminal, or administrative proceedings to SAM.gov. Failure to make required disclosures can result in any of the remedies described in 2 CFR 200.339. (See also 2 CFR part 180, 31 U.S.C. § 3321, and 41 U.S.C. § 2313.) [85 FR 49539, Aug. 13, 2020]

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

xxv. Human Subjects Research

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

VII. Questions/Agency Contacts

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

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

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

VIII. Other Information

A. FOA Modifications

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

B. Government Right to Reject or Negotiate

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

C. Commitment of Public Funds

The Grants 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 Grants Officer, either express or implied, is invalid.

D. Treatment of Application Information

Applicants should not include business sensitive (e.g., commercial or financial information that is privileged or confidential), trade secrets, proprietary, or otherwise confidential information in their application unless such information is necessary to convey an understanding of the proposed project or to comply with a requirement in the FOA. Applicants are advised to not include any critically sensitive proprietary detail.

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

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., Concept Paper, Full Application). The first copy should be marked, "non-confidential" with the information believed to be confidential deleted. The second copy should be marked "confidential" and must clearly and conspicuously identify the 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 containing 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 agreement between the submitter and the government. The government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.
> [End of Notice]

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

E. Evaluation and Administration by Non-Federal Personnel

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

and non-disclosure acknowledgements (NDA) prior to reviewing an application. Non-federal personnel conducting administrative activities must sign an NDA.

F. Notice Regarding Eligible/Ineligible Activities

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

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

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

H. Requirement for Full and Complete Disclosure

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

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

I. Retention of Submissions

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

J. Title to Subject Inventions

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

- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions;

- All other parties: The Federal Non-Nuclear Energy Act of 1974, 42. U.S.C. § 5908, provides that the government obtains title to new inventions unless a waiver is granted (see below);
- Class Patent Waiver: DOE has issued a class waiver that applies to this FOA. Under this class waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class waiver, a domestic large business must agree that any products embodying or produced through the use of a subject invention first created or reduced to practice under this program will be substantially manufactured in the United States.
- Advance and Identified Waivers: For an applicant not covered by a Class Patent Waiver or the Bayh-Dole Act, the applicant may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property data terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.

- DEC: On June 07, 2021, DOE approved a DETERMINATION OF EXCEPTIONAL CIRCUMSTANCES (DEC) UNDER THE BAYH-DOLE ACT TO FURTHER PROMOTE DOMESTIC MANUFACTURE OF DOE SCIENCE AND ENERGY TECHNOLOGIES. In accordance with this DEC, all awards, including sub-awards, under this FOA shall include the U.S. Competitiveness Provision in accordance with the U.S. Manufacturing Commitments section 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 non-profit 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.

K. Government Rights in Subject Inventions

Where prime recipients and subrecipients 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 contractors doing work on behalf of the government.

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.

L. Rights in Technical Data

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

"Limited Rights Data": The 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 EERE awards may be protected from public disclosure for up to five years after the data is generated ("Protected Data"). For awards permitting Protected Data, the protected data must be marked as set forth in the award's intellectual property terms and conditions and a listing of unlimited rights data (i.e., non-protected data) must be inserted into the data clause in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

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

M. Copyright

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

N. Export Control

The United States government regulates the transfer of information, commodities, technology, and software considered to be strategically important to the United States to protect national security, foreign policy, and economic interests without imposing undue regulatory burdens on legitimate international trade. There is a network of federal agencies and regulations that govern exports that are collectively referred to as "Export Controls". All recipients and subrecipients are responsible for ensuring compliance with all applicable United States Export Control laws and regulations relating to any work performed under a resulting award.

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

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

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

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

P. Personally Identifiable Information (PII)

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

By way of example, applicants must screen resumes to ensure that they do not contain PII such as personal addresses, personal landline/cell phone numbers, and personal emails. **Under no circumstances should Social Security Numbers (SSNs) be included in the application**. Federal agencies are prohibited from the collecting, using, and displaying unnecessary SSNs. (See the Federal Information Security Modernization Act of 2014 (Pub. L. No. 113-283, Dec 18, 2014; 44 U.S.C. § 3551).

Q. Annual Independent Audits

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

If an educational institution, non-profit organization, or state/local government is a prime recipient or subrecipient and has expended $750,000 or more of federal awards during the non-federal entity's fiscal year, then a Single or Program-Specific

Audit is required. For additional information, please refer to 2 CFR 200.501 and Subpart F.

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

R. Informational Webinar

EERE will conduct one informational webinar during the FOA process. It will be held after the initial FOA release but before the due date for Concept Papers.

Attendance is not mandatory and will not positively or negatively impact the overall review of any applicant submissions. As the webinar will be open to all applicants who wish to participate, applicants should refrain from asking questions or communicating information that would reveal confidential and/or proprietary information specific to their project. Specific dates for the webinar can be found on the cover page of the FOA.

APPENDIX A – COST SHARE INFORMATION

Cost Sharing or Cost Matching

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

How Cost Sharing Is Calculated

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

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

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

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

What Qualifies for Cost Sharing

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

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

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

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

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

General Cost Sharing Rules on a DOE Award

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

2. In-Kind Cost Share – encompasses all contributions to the project made by the recipient or subrecipient(s) that do not involve a payment or reimbursement and represent donated items or services. In-Kind cost share items include 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

2 CFR 200.306 Cost Sharing or Matching

(a) Under Federal research proposals, voluntary committed cost sharing is not expected. It cannot be used as a factor during the merit review of applications or proposals, but may be considered if it is both in accordance with Federal awarding agency regulations and specified in a notice of funding opportunity. Criteria for considering voluntary committed cost sharing and any other program policy factors that may be used to determine who may receive a Federal award must be explicitly described in the notice of funding opportunity. See also §§200.414 Indirect (F&A) costs, 200.203 Notices of funding opportunities, and Appendix I to Part 200—Full Text of Notice of Funding Opportunity.

(b) For all Federal awards, any shared costs or matching funds and all contributions, including cash and third party in-kind contributions, must be accepted as part of the non-Federal entity's cost sharing or matching when such contributions meet all of the following criteria:

(1) Are verifiable from the non-Federal entity's records;

(2) Are not included as contributions for any other Federal award;

(3) Are necessary and reasonable for accomplishment of project or program objectives;

(4) Are allowable under Subpart E—Cost Principles of this part;

(5) Are not paid by the Federal Government under another Federal award, except where the Federal statute authorizing a program specifically provides that Federal funds made available for such program can be applied to matching or cost sharing requirements of other Federal programs;

(6) Are provided for in the approved budget when required by the Federal awarding agency; and

(7) Conform to other provisions of this part, as applicable.

(c) Unrecovered indirect costs, including indirect costs on cost sharing or matching may be included as part of cost sharing or matching only with the prior approval of the Federal awarding agency. Unrecovered indirect cost means the difference between the amount

charged to the Federal award and the amount which could have been charged to the Federal award under the non-Federal entity's approved negotiated indirect cost rate.

(d) Values for non-Federal entity contributions of services and property must be established in accordance with the cost principles in Subpart E—Cost Principles. If a Federal awarding agency authorizes the non-Federal entity to donate buildings or land for construction/facilities acquisition projects or long-term use, the value of the donated property for cost sharing or matching must be the lesser of paragraphs (d)(1) or (2) of this section.

(1) The value of the remaining life of the property recorded in the non-Federal entity's accounting records at the time of donation.

(2) The current fair market value. However, when there is sufficient justification, the Federal awarding agency may approve the use of the current fair market value of the donated property, even if it exceeds the value described in (1) above at the time of donation.

(e) Volunteer services furnished by third-party 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 third-party volunteer services must be consistent with those paid for similar work by the non-Federal entity. In those instances in which the required skills are not found in the non-Federal entity, rates must be consistent with those paid for similar work in the labor market in which the non-Federal entity competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, necessary, allocable, and otherwise allowable may be included in the valuation.

(f) When a third-party organization furnishes the services of an employee, these services must be valued at the employee's regular rate of pay plus an amount of fringe benefits that is reasonable, necessary, allocable, and otherwise allowable, and indirect costs at either the third-party organization's approved federally negotiated indirect cost rate or, a rate in accordance with §200.414 Indirect (F&A) costs, paragraph (d), provided these services employ the same skill(s) for which the employee is normally paid. Where donated services are treated as indirect costs, indirect cost rates will separate the value of the donated services so that reimbursement for the donated services will not be made.

(g) Donated property from third parties may include such items as equipment, office supplies, laboratory supplies, or workshop and classroom supplies. Value assessed to donated property included in the cost sharing or matching share must not exceed the fair market value of the property at the time of the donation.

(h) The method used for determining cost sharing or matching for third-party-donated equipment, buildings and land for which title passes to the non-Federal entity may differ according to the purpose of the Federal award, if paragraph (h)(1) or (2) of this section applies.

(1) If the purpose of the Federal award is to assist the non-Federal entity in the acquisition of equipment, buildings or land, the aggregate value of the donated property may be claimed as cost sharing or matching.

(2) If the purpose of the Federal award is to support activities that require the use of equipment, buildings or land, normally only depreciation charges for equipment and buildings may be made. However, the fair market value of equipment or other capital assets and fair rental charges for land may be allowed, provided that the Federal awarding agency has approved the charges. See also §200.420 Considerations for selected items of cost.

(i) The value of donated property must be determined in accordance with the usual accounting policies of the non-Federal entity, with the following qualifications:

(1) The value of donated land and buildings must not exceed its fair market value at the time of donation to the non-Federal entity as established by an independent appraiser (e.g., certified real property appraiser or General Services Administration representative) and certified by a responsible official of the non-Federal entity as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, (42 U.S.C. 4601-4655) (Uniform Act) except as provided in the implementing regulations at 49 CFR part 24.

(2) The value of donated equipment must not exceed the fair market value of equipment of the same age and condition at the time of donation.

(3) 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.

(4) The value of loaned equipment must not exceed its fair rental value.

(j) For third-party in-kind contributions, the fair market value of goods and services must be documented and to the extent feasible supported by the same methods used internally by the non-Federal entity.

(k) For IHEs, see also OMB memorandum M-01-06, dated January 5, 2001, Clarification of OMB A-21 Treatment of Voluntary Uncommitted Cost Sharing and Tuition Remission Costs

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

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

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

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

Each task must be calculated individually as follows:

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

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

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

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

The calculation may then be completed as follows:

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

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

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

1. Waiver for Foreign Entity Participation

Many of the technology areas DOE funds fall in the category of critical and emerging technologies (CETs). CETs are a subset of advanced technologies that are potentially significant to United States national and economy security.[86] For projects selected under this FOA, all recipients and subrecipients must be organized, chartered or incorporated (or otherwise formed) under the laws of a state or territory of the United States; have majority domestic ownership and control; and have a physical location for business operations in the United States. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

Waiver Criteria

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

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

Content for Waiver Request

A Foreign Entity waiver request must include the following:

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

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

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

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

DOE may also require:

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

DOE may require additional information before considering the waiver request.

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

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

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

Overall, a waiver request must demonstrate to the satisfaction of DOE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to perform work outside of the United States. A request for a foreign work waiver must include the following:

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

DOE may require additional information before considering the waiver request.

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

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

A. Definitions

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

Construction materials includes an article, material, or supply—other than an item of primarily iron or steel; a manufactured product; cement and cementitious materials; aggregates such as stone, sand, or gravel; or aggregate binding agents or additives[87] —that is or consists primarily of:

- non-ferrous metals;
- plastic and polymer-based products (including polyvinylchloride, composite building materials, and polymers used in fiber optic cables);
- glass (including optic glass);
- lumber; or
- drywall.

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

Moreover, according to the OMB guidance document:

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

[87] BIL, § 70917(c)(1).

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

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

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

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

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

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

(3) all construction materials[88] are manufactured in the United States—this means that all manufacturing processes for the construction material occurred in the United States.

The Buy America requirements only 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.

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

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

For additional information related to the application and implementation of these Buy America requirements, please see OMB Memorandum M-22-11, issued April 18, 2022: 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 reasonably available quantities or of a satisfactory quality at the time of award negotiation.

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

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

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

(3) the inclusion of iron, steel, manufactured products, or construction materials produced in the United States will increase the cost of the overall project by more than 25 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 PSC and NAICS code for each;
- Waiver justification including due diligence performed (e.g., market research, industry outreach) by the applicant or recipient; and
- Anticipated impact if no waiver is issued

DOE may require additional information before considering the waiver request.

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

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

APPENDIX E – LIST OF ACRONYMS

ACE	Area Control Error
AGC	Automatic Generator Control
BA	Balancing Authority
BIL	Bipartisan Infrastructure Law
BPS	Bulk Power System
CAISO	California Independent System Operator
CETs	Critical and Emerging Technologies
COI	Conflict of Interest
CNN	Convolutional Neural Network
CSP	Concentrating Solar-Thermal Power
DEC	Determination of Exceptional Circumstances
DEIA	Diversity, Equity, Inclusion, and Accessibility
DER	Distributed Energy Resource
DMP	Data Management Plan
DMS	Demand-Side Management
DOE	Department of Energy
DOI	Digital Object Identifier
EERE	Energy Efficiency and Renewable Energy
EMT	Electromagnetic Transient
EQ	Environmental Questionnaire
ERCOT	Electric Reliability Council of Texas
ESGC	Energy Storage Grand Challenge
FAR	Federal Acquisition Regulation
FDR	Fault Data Recorder
FERC	Federal Energy Regulatory Commission
FCOI	Financial Conflicts of Interest
FFATA	Federal Funding and Transparency Act of 2006
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
FFRDC	Federally Funded Research and Development Center
GFL	Grid Following
GFM	Grid Firming
GAAP	Generally Accepted Accounting Principles
GDO	Grid Deployment Office
GETs	Grid Enhancing Technologies
GMLC	Grid Modernization Laboratory Consortium
GW_{ac}	Gigawatt
HBCUs	Historically Black Colleges and Universities
HIL	Hardware-in-the-Loop
IBR	Inverter-Based Resources
IIJA	Infrastructure Investment and Jobs Act
IPMP	Intellectual Property Management Plan
IRB	Institutional Review Board

ISO	Independent System Operator
kV	Kilovolt
M&O	Management and Operating
MFA	Multi-Factor Authentication
MPIN	Marketing Partner ID Number
MSI	Minority-Serving institution
MYPP	Multi-Year Program Plan
MW	Megawatt
NDA	Non-Disclosure Acknowledgement
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Corporation
NETL	National Energy Technology Laboratory
NNSA	National Nuclear Security Agency
NSF	National Science Foundation
OCED	Office of Clean Energy Demonstrations
OE	Office of Electricity
OIG	Office of Inspector General
OMB	Office of Management and Budget
OSTI	Office of Scientific and Technical Information
OTA	Other Transactions Authority
PII	Personal Identifiable Information
PMU	Phasor Measurement Unit
PV	Photovoltaic
RDD&D	Research, Development, Demonstration, and Deployment
R&D	Research and Development
RFI	Request for Information
RFP	Request for Proposal
RTO	Regional Transmission Organization
SAM	System for Award Management
SciENcv	Science Experts Network Curriculum Vita
SMART	Specific, Measurable, Achievable, Relevant, and Timely
SETO	Solar Energy Technologies Office
SOPO	Statement of Project Objectives
SPOC	Single Point of Contact
STEM	Science, Technology, Engineering, and Mathematics
TIA	Technology Investment Agreement
TW_{ac}	Terawatt
UCC	Uniform Commercial Code
UEI	Unique Entity Identifier
VRE	Variable Renewable Energy
WBS	Work Breakdown Structure
WETO	Wind Energy Technologies Office
WP	Work Proposal

APPENDIX F – COMMUNITY BENEFITS PLAN GUIDANCE

The DOE is committed to pushing the frontiers of science and engineering; catalyzing high-quality domestic clean energy jobs through research, development, demonstration, and deployment; and ensuring energy equity and energy justice[89] for disadvantaged communities. Therefore, and in accordance with the Administration's priority to empower workers and harness opportunities to create good union jobs as stated in EO 14008 (Executive Order on Tackling the Climate Crisis at Home and Abroad),[90] it is important to consider the impacts of the successful commercial deployment of any innovations resulting from this FOA on current and future workforce.

The goal of the three-section Community Benefits Plan is to allow the application to illustrate engagement in critical thought about implications of how the proposed work will benefit the broadest swaths of American people and lead to broadly shared prosperity, including for workers and disadvantaged communities[91]. The sections of the Community Benefits Plans are considered together because there may be significant overlap between audiences considered in workforce and disadvantaged communities.

Example DEIA, Energy Equity, and Workforce Plan Elements

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

DEIA

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

Equity extends beyond diversity to equitable treatment. Equitable access to

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

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

[91] See footnote 2 for guidance on the definition and tools to locate and identify disadvantaged communities.

opportunity for members of the project team is paramount. This includes ensuring that all members of the team, including students, are paid a living wage, provided appropriate working conditions, and provided appropriate benefits. In the execution of their project plan, applicants are asked to describe efforts in diversity, equity, inclusion, and accessibility. In this context, efforts toward DEIA are defined as:[92]

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

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

DOE strongly encourages applicants to consider partnerships as a means of promoting diversity, equity, inclusion, accessibility, justice, and workforce participation. Minority Serving Institutions, Minority Business Enterprises, Minority Owned Businesses, Disability Owned Business, Women Owned Businesses, Native American-owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to lead these partnerships as the prime applicant or participate on an application as a proposed partner to the prime applicant.

When crafting the DEIA section of the Plan, applicants should describe the

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

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

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

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

Specific examples include:

- Building collaborations and partnerships with researchers and staff at Minority Serving Institutions

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

Energy Equity

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

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

existing equity research available to use and citation in this description or the applicant could describe milestone-based efforts toward developing that understanding through this innovation. These near and long term outcomes may include, but are not limited to: a decrease in the percent of income a household spends on energy costs (energy burden[93]); an increase in access to low-cost capital; a decrease in environmental exposure and burdens; increases in clean energy enterprise creation and contracting (e.g., women or minority-owned business enterprises); increased parity in clean energy technology access and adoption; increases in energy democracy, including community ownership; and an increase in energy resilience.

Specific examples include:

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

Workforce

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

[93] Energy burden is defined as the percentage of gross household income spent on energy costs: https://www.energy.gov/eere/slsc/low-income-community-energy-solutions

that could result in changes to regional or national labor markets.

For additional support with developing the Workforce section of a Community Benefits Plan, please refer to the DOE's Community Benefits Plan Frequently Asked Questions (FAQs) webpage (https://www.energy.gov/bil/community-benefits-plan-frequently-asked-questions-faqs). This new resource, though created primarily for projects funded by the Bipartisan Infrastructure Law (BIL), may be useful for non-BIL-funded R&D projects which are the main subject of this FOA template.

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

Specific examples include:

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

Inclusion of SMART milestones

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

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

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