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

Solar Energy Technologies Office (SETO) Fiscal Year 2021 Systems Integration and Hardware Incubator Funding Program

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002437
FOA Type: 00003
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FOA Issue Date:	December 16, 2020
Submission Deadline for Letter of Intent:	January 13, 2021, 5:00 p.m. ET
Submission Deadline for Concept Papers:	February 1, 2021, 5:00 p.m. ET
Submission Deadline for Full Applications:	April 5, 2021, 5:00 p.m. ET
Expected Submission Deadline for Replies to Reviewer Comments:	May 5, 2021, 5:00 p.m. ET
Expected Date for EERE Selection Notifications:	June 29, 2021, 5:00 p.m. ET
Expected Timeframe for Award Negotiations:	July 2021 - September 2021

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

- To apply to this FOA, applicants must register with and submit application materials through the 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.

Modifications

All modifications to the FOA are highlighted in the body of the FOA. Changes from modification 000001 are highlighted in yellow. Changes from modification 000002 are highlighted in green. Changes from modification 000003 are highlighted in blue.

Mod. No.	Date	Description of Modification
000001	1/11/2021	Update the Letter of Intent due date to January 13, 2021 at 5:00pm ET.
000002	1/22/2021	Update the due date for Concept Papers, Full Applications, Replies to Reviewer Comments, and the Expected Date for EERE Selection Notifications; see cover page of the FOA. Update the location of the Teaming Partner list and instructions; see page 17. Remove the requirement for Letters of Intent; see pages i, 60, 61, 64, and 66. Update the system for application submissions from EPIC to EERE Exchange. Update the mailbox to submit questions; see footer text. Update maximum file size and clarify naming structure of Application Documents; see Section IV. D., Content and Form of the Concept Paper, and Section IV. E Content and Form of the Full Application. Update Standards for Application Evaluations Update Program Policy Factors; See Section V.C.i., Program Policy Factors Add Section VI.V.xviii., Implementation of Executive Order 13798, Promoting Free Speech and Religious Liberty and VI.V.ixi., Table of Personnel.
000003	2/1/2021	Remove Implementation of Executive Order 13950, Combating Race and Sex Stereotyping.

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I. Funding Opportunity Description

A. Background and Context

i. Background and Purpose

This funding opportunity announcement (FOA) is being issued by the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Solar Energy Technologies Office (SETO). SETO's mission is to accelerate the development and application of technology to advance low-cost, reliable solar energy in the United States. The office supports solar energy research and development (R&D) with the goal of improving the affordability, reliability, and domestic benefit of solar technologies on the electric grid. These efforts support solar energy in becoming a fundamental part of the nation's energy system and economy over the next three decades.

This section describes the overall goals of the Solar Energy Technologies Office Fiscal Year 2021 (FY21) Systems Integration and Hardware Incubator funding program and the types of projects being solicited for funding support through this FOA. The SETO FY21 Systems Integration and Hardware Incubator funding program seeks to invest in innovative research, development, and demonstration (RD&D) projects that enable solar to contribute to the reliability and resilience of the nation's electricity grid and continue to drive down costs, while developing next-generation solar technologies and boosting American solar manufacturing. These projects will support the scalability of solar as deployment increases across the country so that solar is affordable, supports grid reliability, and benefits the U.S. economy.

The U.S. Energy Information Administration (EIA) predicts[1] that in the coming decades, more of America's energy will come from electricity, as buildings, transportation, and industry are increasingly electrified. Solar and other clean energy resources can meet much of this increase in demand. As shown in Figure 1, below, analysts predict that 18% of U.S. electricity will be solar in 2050.[2] Today, solar accounts for just 3% of U.S. electricity,[3] which means that U.S. solar capacity would grow by hundreds of gigawatts (GW) to meet these expectations.[4] If costs fall faster than expected, the contribution of solar energy to the U.S. energy mix could be higher,[5] increasing the urgency of developing solutions that enable solar to contribute reliably to the grid in large quantities.

[1] U.S. Energy Information Administration (EIA), Annual Energy Outlook (AEO) 2020.
[2] EIA AEO 2020, Cole 2019.
[3] EIA, Electricity Data Browser. Accessed August 25, 2020.
[4] EIA AEO 2020.
[5] W. Cole et al. "Envisioning a low-cost solar future: Exploring the potential impact of achieving the SunShot 2030 targets for photovoltaics," Energy 155. 2018.

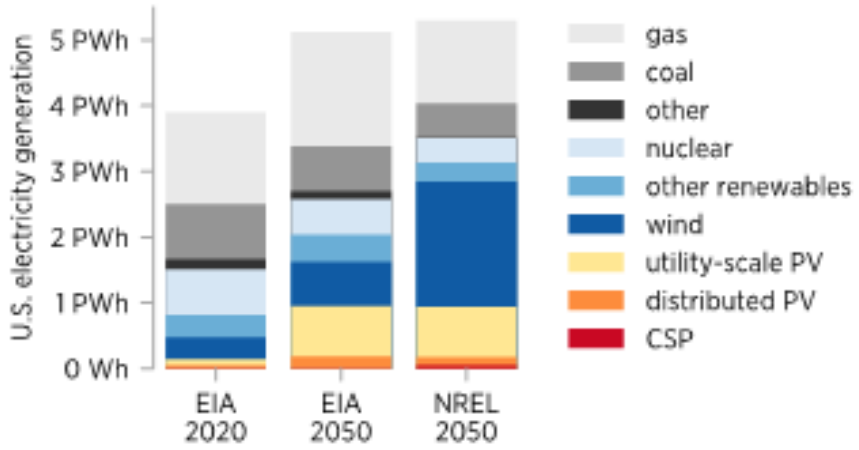

Figure 1. *Projections for the electricity generation mix from the EIA 2020 Annual Energy Outlook and the National Renewable Energy Laboratory 2019 Standard Scenarios show that solar energy is expected to make a major contribution by 2050 [EIA AEO 2020, Cole 2019]. A petawatt-hour (PWh) is a trillion kilowatt-hours (kWh).*

The cost of solar electricity has decreased more than 80% since 2010, driven by global economies of scale, technology innovation, and greater confidence in photovoltaic (PV) technology. Figure 2, below, illustrates the declines in both levelized cost of energy (LCOE) benchmarks and actual power purchase agreement (PPA) prices for utility-scale PV systems. These low costs have driven the deployment of over 75 GW of solar capacity in the United States at of the end of 2019.[6] Costs have more room to decline—through reductions in interconnection costs, streamlining of operations and maintenance, or delivering more energy over the lifetime of a system, for example. In addition, solar can add value to the grid by coupling with energy storage and other technologies to enhance resilience during and after man-made disruptions or natural disasters.

[6] EIA. Electric Power Monthly 2020.

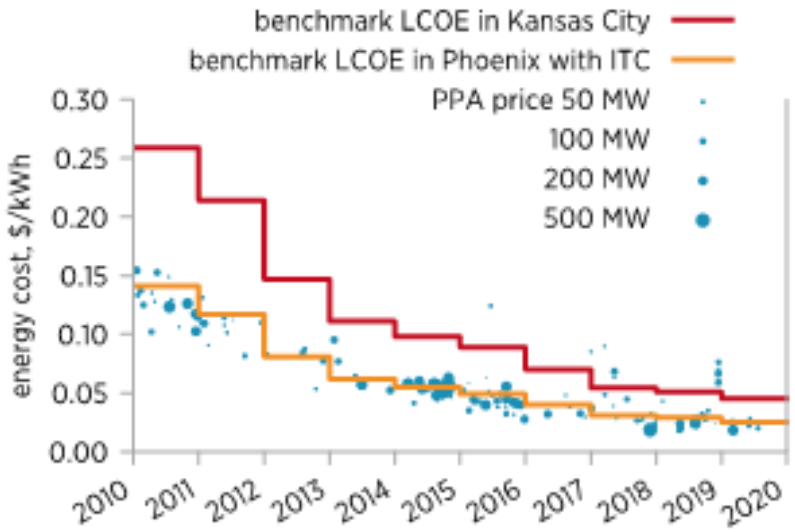

Figure 2. *The modeled cost (lines) and actual contracted energy price in PPA (circles) for utility-scale PV electricity have declined more than 80% since 2010. PPA prices and the orange line include incentives such as the investment tax credit and are often located in sunny areas.*[7] *The red line shows unsubsidized systems with average U.S. climate.*

Operating the power system with high contributions of solar power is increasingly challenging. On the one hand, the power system reacts faster to interruptions than it used to, owing to the power electronics that connect it to wind and solar generation and energy storage.[8] On the other hand, the power system needs larger flexible reserve resources to accommodate the diurnal and uncertain nature of solar generation[9] and the widespread rooftop PV and other distributed energy resources (DER) that are mostly invisible to power system operators. New operational strategies must be developed to tackle these challenges and maximize the value of solar generation beyond just providing energy to the power system.[10] This fundamental need has led to greater interest in combining solar technology with sensing and communication tools, analytics and controls, and energy storage, and in enhancing the capabilities of PV power electronics.

Technology advancements provide opportunities to increase the value of solar energy as deployment grows. Sensing and communication tools have advanced to provide higher temporal resolutions and wider spatial coverage.[11] Analytics and controls have been

[7] M. Bolinger, J. Seel, D. Robson. "Utility-Scale Solar, 2019 Edition," December 2019.
[8] Australian Energy Market Operator. "Maintaining Power System Security with High Penetrations of Wind and Solar Generation: International Insights for Australia," October 2019.
[9] California ISO. "What the Duck Curve Tells Us about Managing a Green Grid," 2016.
[10] A. Mills and R. Wiser. "Changes in the Economic Value of Variable Generation at High Penetration Levels: A Pilot Case Study of California" (June 2012).
[11] North American Synchrophasor Initiative (NASPI). "NASPI PMU Map," March 2017.

improving the fast dynamics of the power-electronics-heavy system[12] and the visibility of DER.[13] More battery storage is being installed alongside PV systems to mitigate the variability of solar energy and provide fast-responding control capabilities.[14] This allows PV systems to better support grid reliability and resilience while delivering affordable energy. Concentrating solar-thermal power (CSP) systems, which use traditional thermal power generators, also have the potential to support power system reliability and provide stored solar energy when it is most needed.

ii. Technology Space and Strategic Goals

American innovation and technology development pioneered the manufacturing and scale-up of solar PV technologies, beginning with the first solar manufacturing line built in 1979, in California.[15] U.S. R&D has helped lower manufacturing costs, increase efficiency and performance, and improve reliability of solar technologies. Over the past 35 years, SETO awardees achieved nearly half of all solar cell efficiency world records[16] and pioneered the development of molten salt in CSP plants, which is used as a blueprint for CSP plants around the world. The solar office supports nearly 400 solar projects across the country.

Since 2011, SETO has been working to make solar electricity price-competitive with conventional utility sources.[17] Those investments have lowered costs across the solar value chain. National Laboratory test capabilities and research on degradation rates have supported longer lifetimes for PV systems, online tools have made it easier for consumers to determine if they can install solar and save money by doing so, and new racking systems have reduced installation times. The office has provided stakeholders the technical information they need to speed permitting and interconnection processes. These investments have helped secure American leadership in solar innovation and increase energy affordability across the country.[18]

In 2017, SETO announced that the industry had achieved the SunShot 2020 utility-scale cost goal of $0.03 per kilowatt-hour (kwh), three years early. Just as solar industry costs declined faster than what was considered ambitious in 2011, SETO expects that costs will continue to fall, as long as we maintain the pace of innovation. SETO has established new, more ambitious goals for 2030, which would cut the levelized cost of solar energy

[12] B. Johnson et al. "Synchronization of Parallel Single-Phase Inverters Using Virtual Oscillator Control," *IEEE Trans. Power Electron.,* November 2014.
[13] 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.
[14] H. Rudnick and L. Barroso. "Flexibility Needed: Challenges for Future Energy Storage Systems," *IEEE Power and Energy Magazine,* September/October 2017.
[15] ARCO Solar built the first manufacturing line in the U.S. in 1979.
[16] Based on SETO analysis of the National Renewable Energy Laboratory's efficiency chart.
[17] SETO. *SunShot Vision Study*, 2012. https://www.energy.gov/sites/prod/files/2014/01/f7/47927.pdf.
[18] SETO. "Connect the Dots: Innovations in Residential Solar." https://www.energy.gov/eere/solar/connect-dots-innovations-residential-solar.

by 50% between 2020 and 2030 while facilitating grid integration. Achieving these targets would make solar one of the most affordable sources of new electricity generation.[19] The targets for the unsubsidized LCOE at the point of grid connection[20] are:

- $0.03/kWh for utility-scale PV;
- $0.04/kWh for commercial rooftop PV;
- $0.05/kWh for residential rooftop PV; and
- $0.05/kWh for CSP with 12 or more hours of thermal energy storage.

Although these targets are aggressive, there are multiple realistic paths to achieve them. All pathways require significant improvements across the office's research areas, and greater progress in one area can allow for more moderate change in others. These interdependencies and trade-offs among cost- and performance-improvement factors create numerous technology-development opportunities.

As a result of the recent cost reductions and the rapid growth in solar deployment, SETO has expanded its focus to include more work to ensure that solar can support the reliability, resilience, and security of the grid. Today, solar contributes energy to the grid, but it doesn't help grid operators maintain system-wide balance or manage electricity transmission. SETO's research has laid the groundwork for solar to contribute to these essential grid reliability services. Over the next 10 years, the office will work to harness the capabilities of connected DER to improve grid reliability. These devices will be able to contribute to power quality, match energy supply and demand, and restart power during an outage.

[19] DOE. *The SunShot Initiative's 2030 Goal: 3¢ per Kilowatt Hour for Solar Electricity,* 2016. https://www.energy.gov/sites/prod/files/2016/12/f34/SunShot%202030%20Fact%20Sheet-12_16.pdf.

[20] SETO. "Goals of the Solar Energy Technologies Office." https://www.energy.gov/eere/solar/goals-solar-energy-technologies-office.

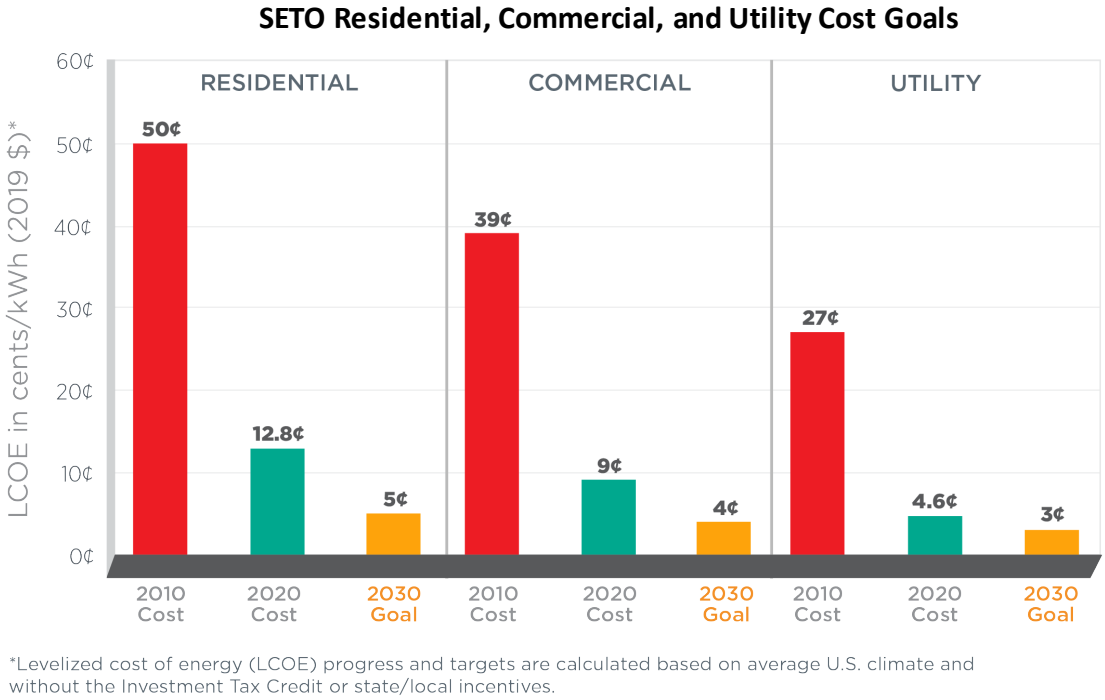

Figure 3. *2030 PV LCOE cost targets across the three solar market segments: residential, commercial, and utility-scale. The 2030 PV LCOE targets are calculated based on average U.S. climate and without the Investment Tax Credit. For example, a $0.03 LCOE for utility-scale would translate to $0.02 to $0.04 LCOE across the continental United States because of differences among locations in the amount of sunlight and in temperature, snow accumulation, and wind speed. The residential and commercial goals have been adjusted for inflation.*

In addition, the office has set a target for developing next-generation CSP power plants, which incorporate thermal energy storage to provide solar energy when the sun is not shining. These next-generation plants raise the temperature of the heat they deliver to the power cycle, thereby increasing the efficiency of the plant. The Generation 3 Concentrating Solar Power Systems[21] (Gen3 CSP) funding program, launched in 2018, provided $85 million for research to advance high-temperature components and develop integrated assembly designs with thermal energy storage that can reach operating temperatures greater than 700° Celsius (1,290° Fahrenheit). If successful, these projects will lower the cost of a CSP system by approximately $0.02/kWh, which is 40% of the way toward the office's 2030 cost goals of $0.05/kWh for baseload configurations.

[21] SETO. "Generation 3 Concentrating Solar Power Systems (Gen3 CSP). https://www.energy.gov/eere/solar/generation-3-concentrating-solar-power-systems-gen3-csp.

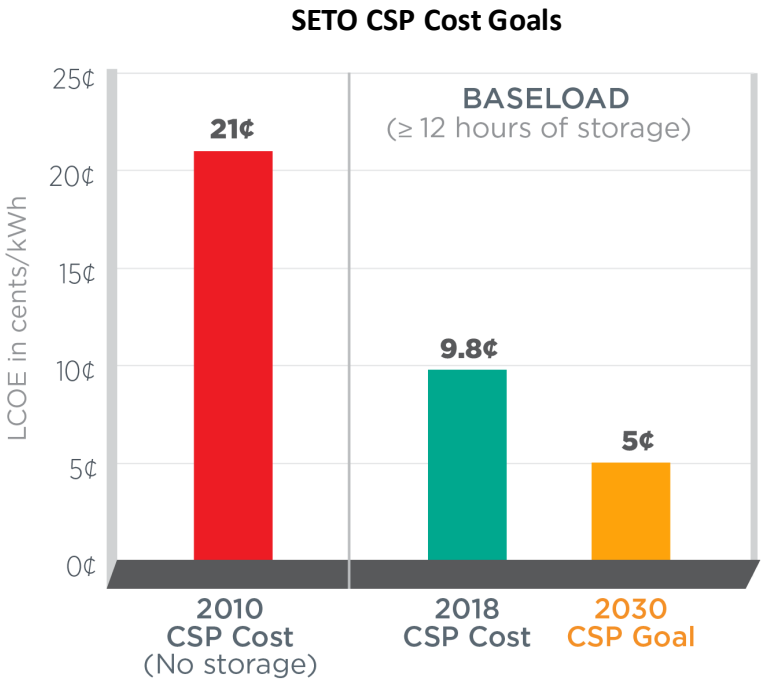

Figure 4. *2030 CSP LCOE cost targets for baseload power plants with 12 or more hours of storage.*

The 2020s are expected to be a decade of strong solar growth, touching every state and expanding solar to new applications, including community resilience. These new areas will require research to tackle complex challenges, whether related to cost, technology, or permitting requirements. For example, communities that want to use solar to increase their resilience may need different cost models than those that want to use solar only for energy production. In the same way, solar that can coordinate seamlessly with other technologies, like wind and storage, may have new technology challenges. The office will continue to provide the knowledge base that enables the solar industry to solve the challenges of the next decade.

SETO is also working to support the growth of solar manufacturing in the United States. A report from the National Renewable Energy Laboratory (NREL) about domestic solar PV manufacturing expansions shows that the country's PV module capacity more than tripled in the past year.[22] While the growth in solar PV module manufacturing is encouraging, SETO is also working to expand the opportunities for manufacturing across the value chain—from manufacturing the capital equipment for making cells to developing the tools used in operations and maintenance (O&M). In last year's FOA, the office solicited hardware innovations that would support a strong U.S. solar

[22] Smith, Brittany L., and Robert Margolis. "Expanding the Photovoltaic Supply Chain in the United States: Opportunities and Challenges," 2019. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-73363. https://www.nrel.gov/docs/fy19osti/73363.pdf.

manufacturing sector and supply chain. SETO continues to support these innovations, enabling the nation to keep pace with the rising domestic and global demand for solar energy products.

As the solar industry enters the next decade, SETO is working to integrate solar into the fabric of the American landscape—to help communities achieve their energy and resiliency goals, explore new applications of solar, drive innovation and entrepreneurship, and lower electricity costs.

iii. Cross-Office Coordination

As part of the DOE's Grid Modernization Initiative,[23] SETO collaborates with other EERE offices and the Offices of Electricity (OE), Fossil Energy, Nuclear Energy, and Cybersecurity, Energy Security, and Emergency Response (CESER) to integrate solar energy into the grid. These efforts are aligned with the technology areas in the Grid Modernization Multi-Year Program Plan,[24] including grid resilience, energy storage, sensors and measurements, and cybersecurity. In addition, SETO works with OE to ensure that solar plays a key role in supporting U.S. critical infrastructure.[25] SETO coordinates cybersecurity research with CESER and is aligned with the EERE cybersecurity vision and multi-year-plan goals.

The solar office collaborates with the Building Technologies Office, the Wind Energy Technologies Office (WETO), and other EERE offices to develop new technologies and analytical tools that support energy resource flexibility and grid services, balancing renewable generation, load, and alternative storage technologies. SETO works with the Offices of Nuclear Energy and Fossil Energy to advance research in the development of the supercritical carbon dioxide (sCO_2) Brayton cycle, as well as the Office of Fossil Energy's 10 megawatt-electric Supercritical Transformational Electric Power (STEP) pilot facility.

iv. Priority Research Areas

Achieving SETO's goals requires sustained, multifaceted innovation. Projects supported by this FOA will advance R&D and RD&D in PV, CSP, and solar grid integration technologies. The majority of the innovations sought here will improve the scalability of solar, whether it is reaching critical manufacturing scale for new materials and processes, or allowing growth while maintaining grid reliability.

Engaging in R&D and RD&D activities with the support of public funds also comes with the responsibility to disseminate the outcomes to the nation's researchers, its industry

[23] DOE Modernization Initiative. https://www.energy.gov/grid-modernization-initiative.
[24] DOE Grid Modernization Multiyear Program Plan. https://energy.gov/downloads/grid-modernization-multi-year-program-plan-mypp.
[25] U.S. Department of Homeland Security. https://www.cisa.gov/critical-infrastructure-sectors.

stakeholders, and the general public. It is a goal of this FOA to encourage, where applicable, broad and lasting access to important datasets and software code that the projects generate.

With this FOA, the office intends to fund ambitious, high-impact research in the following areas:

Topic Area 1: Grid-Forming Technologies Research Consortium
SETO and WETO will support the creation of the Grid-Forming Technologies Research Consortium, which will bring together researchers and stakeholders to advance research on grid-forming solar, wind, and storage inverters, and other grid-forming technologies, and ensure that these technologies enhance power systems operation for years to come. This topic identifies the wide-ranging research areas the consortium will address through RD&D efforts, including voltage and frequency control, hardware design, and standards. It also underlines the required systems integration perspective of the RD&D efforts and provides the programmatic requirements for the consortium to ensure geographic diversity of the solutions, strong stakeholder engagement, and enduring scope of work. The goal is to make this consortium a financially sustainable, world-leading innovation group five years after its launch.

Topic Area 2: Integrating Behind-the-Meter Solar Resources into Utility Data Systems
This topic area seeks to support the development of communication systems that integrate highly distributed sensor measurements, especially those from behind-the-meter (BTM) PV systems, into utility data systems. The goal is to develop more affordable tools to collect data in real time and foster their adoption by utilities. Doing so will lead to increased visibility of distributed PV generation, which will enable more flexible and reliable control and operation of the overall power system. Projects in this topic area will develop innovative sensor, communications, and data collection technologies to enhance the visibility and observability of BTM solar energy resources. Incorporating these measurements into utility real-time monitoring and control systems will lead to improved power system reliability, resilience, and security in areas with large amounts of BTM solar resources.

Topic Area 3: Hardware Incubator
This topic area seeks to accelerate commercialization of innovative product ideas that can substantively increase U.S. domestic manufacturing across the solar industry supply chain and expand private investment in U.S. solar manufacturing. These products and solutions will lower the cost of solar technologies and facilitate the secure integration of solar electricity into the nation's energy grid. This topic area has two sections:

Topic Area 3a: Hardware Incubator – Product Development

The goal of this topic area is to de-risk new technologies and manufacturing processes and bring them to a commercially relevant prototype stage, while developing and validating a realistic pathway to commercial success.

Topic Area 3b: Hardware Incubator – Product Development & Demonstration
The goal of this topic area is to conduct pilot-scale testing and demonstration of products or solutions. This includes high-volume or high-throughput manufacturing processes for solar hardware, the production of a large number of devices sufficient for statistically robust field testing and validation, or the demonstration of a system (for example, a microgrid or an innovative solar system) focused on pilot-testing new hardware.

A major goal of publicly funded applied R&D and RD&D is to mitigate the inherent risk of novel solutions. Satisfying that goal requires applying a systematic, domain-specific evaluation methodology, such as design of experiments, action research, or verification and validation testing. Well-designed test plans examine the expected range of operation and generate statistical confidence in the results.

SETO-funded projects are expected to produce high-impact outcomes with a view toward commercialization and wide dissemination, including publication of the results in high-visibility, high-impact, peer-reviewed journals.

This funding program is authorized under the Energy Policy Act of 2005, Section 931 (a)(2)(A) (42 USC 16231), which states: "The Secretary shall conduct a program of research, development, demonstration, and commercial application for solar energy, including— (i) photovoltaics; … (iii) concentrating solar power; … [and] (v) manufacturability of low cost, high quality solar systems...."

Note: This funding opportunity represents two of SETO's five subprograms. Pending appropriations, an additional solicitation from SETO in FY 2021 may be released to cover topics related to PV, CSP, and balance of systems soft costs. Topics 3a and 3b are expected to be the only Incubator topics in any FOA released by SETO in FY 2021 that are restricted to for-profit entities and focused on product development and demonstration.

v. Teaming Partner List

Teaming arrangements that include multiple stakeholders across academia, industry, National Laboratories (as appropriate), and technical disciplines are strongly encouraged. For example, teams that include multiple partners are preferred over applications that include a single organization. Teams are encouraged to include representation from diverse entities, such as Historically Black Colleges and Universities (HBCU) or Minority Serving Institutions (MSI), or through linkages with Opportunity Zones. To facilitate the formation of teams, SETO is providing a forum where interested

parties can add themselves to a Teaming Partner List, which allows organizations that may wish to apply to the FOA but not as the prime applicant, to express interest to potential partners.

The Teaming Partner List and instructions will be available at https://www.energy.gov/eere/solar/funding-opportunity-announcement-solar-energy-technologies-office-fiscal-year-2021 the FOA application period. The list will be updated at least weekly until the close of the full application period, to reflect new teaming partners who have provided their information.

Disclaimer: By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of its contact information. By enabling and publishing the Teaming Partner List, EERE is not endorsing, sponsoring, or otherwise evaluating the qualifications of the individuals and organizations that are identifying themselves for placement on this Teaming Partner List. EERE 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: Grid-Forming Technologies Research Consortium

SETO and WETO will support the creation of the Grid-Forming Technologies Research Consortium, which will bring together researchers and stakeholders to advance research on grid-forming solar, wind, and storage inverters, and other grid-forming technologies, and ensure that these technologies enhance power systems operation for years to come. This topic identifies the wide-ranging research areas the consortium will address through RD&D efforts, including voltage and frequency control, hardware design, and standards. It also underlines the required systems integration perspective of the RD&D efforts and provides the programmatic requirements for the consortium to ensure geographic diversity of the solutions, strong stakeholder engagement, and enduring scope of work. The goal is to make this consortium a financially sustainable, world-leading innovation group five years after its launch.

Introduction to Solar and Wind on the Grid

SETO systems integration research addresses challenges related to the integration of solar and other energy technologies into the electric power system. The fraction of annual U.S. electricity generation from solar generation has increased rapidly from 0.1% in 2010 to 2.5% in 2020.[26] LCOE benchmarks and actual PPA prices for utility-scale PV systems have decreased more than 80% since 2010.[27] These low costs have enabled the deployment of over 75 GW direct current (GW_{DC}) or 59 GW alternating current (GW_{AC}) of solar capacity in the United States as of the end of 2019.[28] Wind generation has seen similar trends in cost reduction and a 15% annual growth rate over the past decade.[29] With U.S. wind capacity exceeding 107 $GW_{AC,}$[30] wind is the largest renewable energy resource in the nation, generating 7.3% of electricity in 2019.[31] Combined, solar and wind form significant shares of the energy portfolio and present opportunities for increases in the value of wind and solar generation, while simultaneously enhancing power systems operations.

These trends in solar and wind are fundamentally changing the dynamic characteristics of the electric power system: It is experiencing lower mechanical inertia as a result of more inverter-connected solar and wind generation. Reduced inertia makes maintaining

[26] EIA. "Monthly Energy Review," May 2020.
[27] M. Bolinger, J. Seel, D. Robson. "Utility-Scale Solar, 2019 Edition," December 2019.
[28] Wood Mackenzie. "U.S. Solar Market Insight 2019 Year in Review," March 2020.
[29] EIA. https://www.eia.gov/energyexplained/wind/electricity-generation-from-wind.php.
[30] American Wind Energy Association. https://www.awea.org/resources/news/2020/us-wind-industry-delivers-strong-first-quarter.
[31] EIA. "What Is U.S. Electricity Generation by Energy Source?" Feb. 27, 2020. https://www.eia.gov/tools/faqs/faq.php?id=427&t=3.

frequency and voltage within prescribed ranges more challenging, including during failures of important generation or transmission assets and during simultaneous outages of many distributed energy assets. This can affect the reliable operation of power systems as a whole, as observed in recent, large, system-wide events.[32, 33] Figure 5, below, shows the percentage of combined instantaneous power from wind and solar operating in 2019 and the percentage of annual energy supply they provide.[34, 35, 36, 37, 38] Solar can provide instantaneous values at least two to three times higher than annual supply, and wind has three to four times higher values, due to capacity factors and diurnal and seasonal variations. Today, these high instantaneous values occur for a few seconds or minutes at a time, but they will grow in number, frequency, and duration as more wind and solar are connected. The research challenge is to develop strategies to maintain reliability by integrating advanced functionalities into solar and wind plants.

[32] North American Electric Reliability Corporation (NERC), June 2017. https://www.nerc.com/pa/rrm/ea/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_Interruption_Final.pdf.

[33] National Grid ESO. "Technical Report on the Events of 9 August 2019," UK, September 2019. https://www.ofgem.gov.uk/system/files/docs/2019/09/eso_technical_report_-_final.pdf.

[34] Hawaiian Electric. "Power Facts," November 2019. https://www.hawaiianelectric.com/documents/about_us/company_facts/power_facts.pdf.

[35] EirGrid. "System and Renewable Summary Report," 2019. http://www.eirgridgroup.com/how-the-grid-works/renewables/.

[36] California ISO. "Renewables and Emissions Reports," 2019. http://www.caiso.com/market/Pages/ReportsBulletins/RenewablesReporting.aspx.

[37] Southwest Power Pool. "2019 Annual Report," April 2020. https://www.spp.org/documents/62057/2019%20annual%20report%2020200428%20web.pdf.

[38] Electric Reliability Council of Texas. "2019 Fact Sheet," January 2020. http://www.ercot.com/content/wcm/lists/197391/ERCOT_Fact_Sheet_1.15.20.pdf.

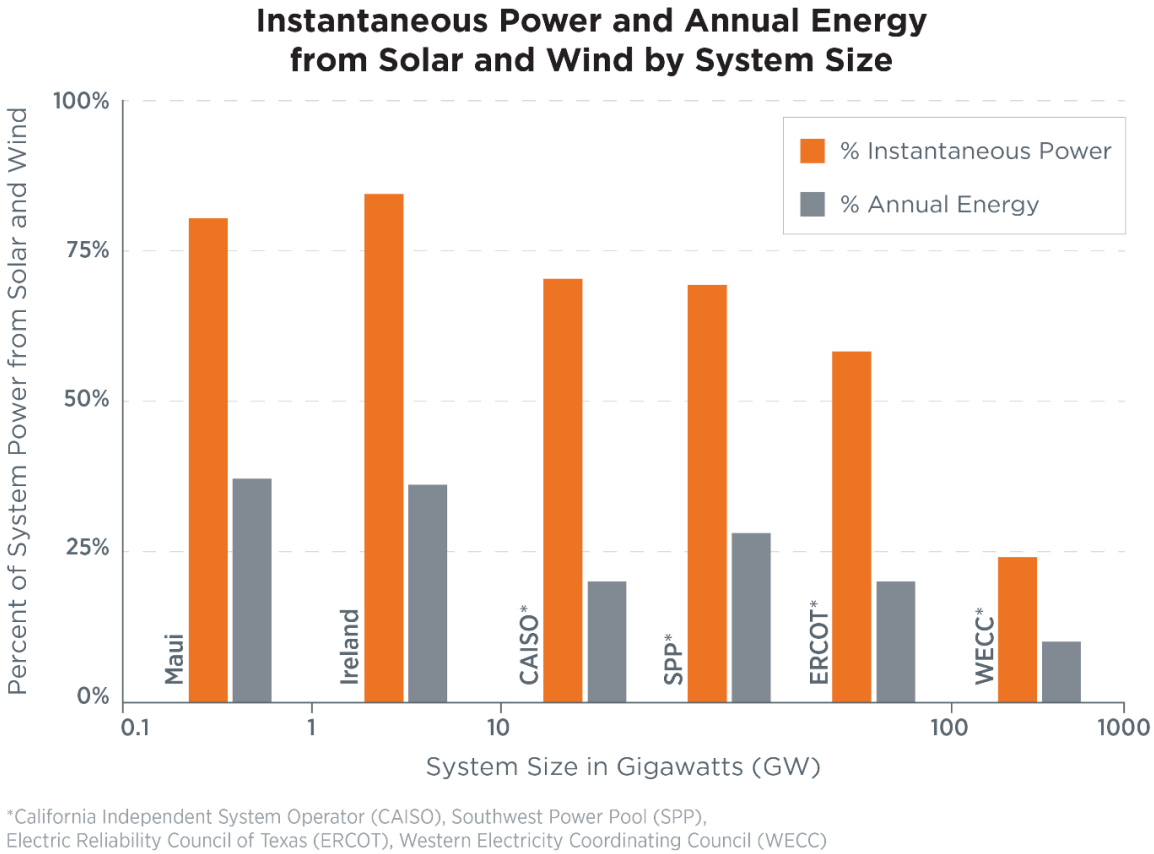

Figure 5. *Instantaneous power and annual energy from solar and wind by system size in 2019.*

The frequency of high instantaneous power supply from wind and solar has been increasing in recent years. Figure 6, below, shows high solar and wind power contributions in California in 2019, which usually occurred during low-electricity demand periods. But the frequency of occurrence is likely to increase and move toward high-demand periods, at which point inverter-based generation will have to actively participate in power systems operations. Developing scalable solutions for overall systems operation that keep up with the increasing instantaneous supply of solar and wind remains a fundamental challenge.

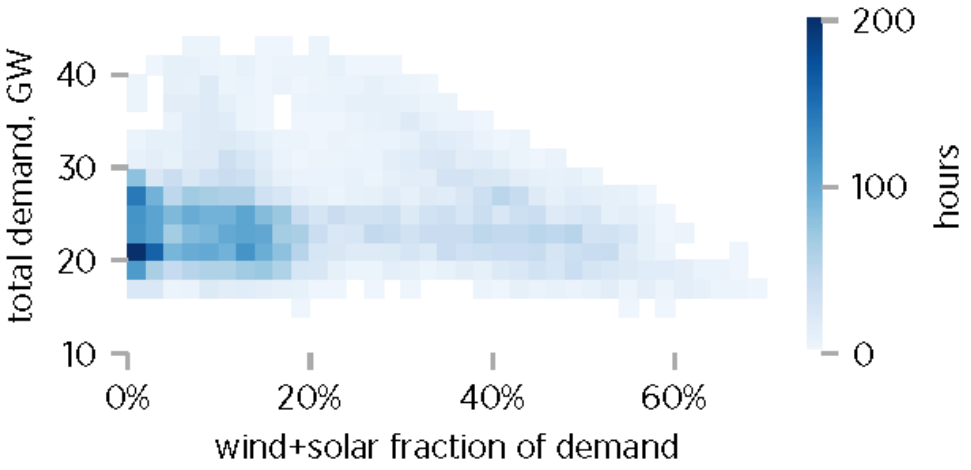

Figure 6. *The frequency of occurrence of solar and wind power contributions at different demand levels in CAISO for 2019. Solar and wind make the maximum contribution when demand is low.*[39]

Background: Grid-Forming Technology

Power electronics provide the primary interface between solar and wind generators and the electric power grid. Most solar, wind, and storage technologies connect to the grid through inverters, power electronics that convert DC power to AC power; they are commonly referred to as inverter-based resources (IBR). IBR rely on conventional generation on the grid to synchronously deliver power—conventional generation "sets the beat" of the grid that IBR then matches. These "grid-following" resources use phase-locked loop (PLL) controls to synchronize to an external voltage signal generated by conventional synchronous generators connected to the grid. As the instantaneous supply of IBR increases and conventional synchronous generation decreases, grid-following resources lose the strong voltage signal to synchronize to, which limits the scalability of IBR. Further, when synchronous generators are not available for frequency and voltage support, it affects the overall reliability of power systems operation.

While grid-following control is the state of the art in commercial IBR, there is a large body of research that has focused on control approaches that do not rely on an external voltage source (i.e., there is no PLL) and that can share load with or without explicit communications. These control approaches are generically referred to as grid-forming controls.[40] Table 1, below, gives a snapshot of the fundamental differences between grid-forming and grid-following controls. With increasing deployment, IBR can become grid-forming resources, which will allow them to provide functionalities traditionally

[39] EIA. Open Data API. June 2020. https://www.eia.gov/opendata/.
[40] National Renewable Energy Laboratory. "Research Roadmap on Grid-Forming Inverters." https://www.nrel.gov/docs/fy21osti/73476.pdf.

provided by synchronous generators and enhance power systems operations at all time scales.

Table 1. *Grid-Following Control versus Grid-Forming Control*[41]

Grid-Following Control	Grid-Forming Control
Assumes grid already formed under normal operations	Assumes it has responsibility to form and maintain healthy grid
Direct-quadrature (dq) vector control of current injected into the grid	Control of voltage magnitude and frequency/phase
Decoupled control of active power (P) and Reactive Power (Q)	Slight coupling between P and Q
Needs PLL	May use PLL control to switch between modes
Needs voltage at the point of common coupling to deliver P and Q	Can black-start a power system
Cannot operate at 100% power electronics penetration; instability thresholds (tipping points) exist	Can *theoretically* operate at 100% power electronics penetration; can coexist with grid-following
Standards exist at device and systems level	Not standardized, inadequate operational experience at a systems perspective

SETO's systems integration research has laid the groundwork for using grid-forming technologies for greater grid resilience and improved reliability with high amounts of solar energy. Most recently, the SETO FY2019 funding program focused on fundamental challenges in grid-forming control and coordination between multiple grid-forming and grid-following resources. Also, in 2019, WETO funded a set of projects focusing on wind control to provide grid services, including enabling grid-forming capability for wind. While grid-forming control theories are being established, it has become apparent that a more system-oriented approach will be needed to apply the technology more broadly in power systems. It is also apparent that a single entity with grid-forming technology cannot solve all grid challenges, and consensus pathways among all entities that have a stake in the broader electric power system are required.

Through this funding opportunity, SETO and WETO will support the creation of a Grid-Forming Technologies Research Consortium, which will bring together researchers, industry partners, utilities, and other stakeholders to form an ecosystem, including an expert network that will adopt a systems-oriented approach to advancing research, development, and commercialization of grid-forming technologies. The consortium will

[41] Adapted from MIGRATE: https://www.h2020-migrate.eu/.

also produce protocols to support the overall enhancement of power systems operation for years to come, while securing America's global leadership in this critical emerging field. The consortium will create, showcase, and demonstrate new capabilities, products, solutions, and processes that can impact the scalable integration of grid-forming resources into a range of electric systems across the United States. The consortium will bring together private and public entities to establish a diverse community, with the tools and expertise to develop and demonstrate next-generation grid-forming technologies and protocols to help advance grid resilience and reliability.

Consortium Programmatic Requirements

The consortium's overall programmatic goals are summarized below:

- Bring together researchers, experts, and stakeholders to form a network and community that will adopt a systems-oriented approach to advance research, development, and commercialization of grid-forming technologies. It is highly encouraged that the consortium ensures diversity of membership through effective partnerships with Historically Black Colleges and Universities (HBCU) and other Minority Serving Institutions (MSI);
- Coordinate with multiple grid-forming research teams to ensure a coherent and comprehensive portfolio of solution sets from the system perspective, encompassing theory; development of modeling capabilities; hardware, software and operational research and development; integration into commercial hardware, software and operational systems; data development and sharing; and training;
- Create, showcase, and demonstrate new capabilities, products, and processes that can impact the scalable integration of grid-forming resources into a range of electric systems representing various configurations and conditions;
- Develop expertise, networks, training, communications, and dissemination strategies to support the growth of a domestic ecosystem that will advance grid-forming technology advancement and implementation to support grid resilience and reliability as new technologies and capabilities become available;
- Bring together private and public entities to co-invest in the development, demonstration, and commercialization of next-generation grid-forming technologies to help advance grid reliability;
- Engage the community at all levels of the supply chain, including large companies, potential end users, researchers, and subject-matter experts involved in critical development work. These stakeholders will support the transition of innovations to commercial applications and ensure efforts are

focused on industry-relevant problems, increasing the likelihood of developing successful solutions; and

- Establish a management and governance structure to support sustained U.S. leadership in the field of grid-forming technologies into the future.

Successful submissions will have the following characteristics:

- Grid-forming technologies applicable to different geographic regions: Grid operations and resources are highly dependent on regional differences, and the inclusion of geographically diverse stakeholders will help address those differences;
- Ability to demonstrate technologies and capabilities at various scales: Industry adoption of grid-forming technologies will also be aided by demonstration of their capabilities at different grid scales and through training opportunities;
- Robust stakeholder engagement: Applicants need to show how the consortium will engage with a wide range of stakeholders and define clear strategies for their participation—in particular, engaging subject-matter experts through outreach and intermediaries. It must also provide sufficient financial and contractual mechanisms for all stakeholders along the supply chain, including end users, to benefit from consortium resources;
- Relevant and enduring scope of work: Submissions must describe their proposed strategy to keep the consortium relevant to industry, list resources that will support consortium operations beyond the award period, and explain how professionals will be recruited and trained to support the consortium;
- Commercialization: Submissions must clearly describe a plan to commercialize the grid-forming technologies developed in the consortium through partnerships with industry. The plan should include a cost analysis of grid-forming technologies and products, as well as system integration and operation; and
- Broad communications and dissemination: Submissions must clearly describe a plan to disseminate research results to the broader industry and a general audience. Submissions should use several dissemination methods to reach out to stakeholders, industries, and the public. Dissemination methods may include industry-focused workshops, websites, product demonstrations, and presentations at domestic and international conferences.

Consortium Governance

Governance of the consortium must be clearly defined with an operational plan that demonstrates experience in managing public-private partnerships, multi-user facilities and information assets, and technical capabilities. This will require a strong management team and organizational director. Consortium leadership must be capable

of leading an industry-wide technology development agenda that strongly leverages industry consortia, regional clusters, and other resources in science, technology, and economic development. A well-managed organization or coalition will be able to efficiently use funds and maintain a limited administrative budget to accomplish its objectives and serve the needs of its members, users, or participants. Applicants must address how decisions will be made and how the direction and vision of the consortium will be executed, given the mix of public and private funding required for the consortium. A dedicated advisory board(s) comprised of relevant stakeholders in both the federal government and private industry will need to be formed. DOE representatives from WETO, SETO, and the Office of Electricity should be on the advisory board.

Leadership is expected to manage projects and monitor their performance within the research focus areas listed in Table 2 through rigorous performance metrics, including but not limited to the system metrics listed in Table 3, impact to U.S. manufacturing, energy productivity goals, management performance, financial performance, industry participation, and education and outreach. Applicants must present a collective intellectual property (IP) management plan that provides an overview of the proposed capabilities for, and collaboration in, open, pre-competitive work among multiple parties in an IP-protected environment. The consortium will be organized to foster an open exchange of pre-competitive best practices and know-how—including design and control methods—while protecting company proprietary IP.

The consortium is expected to be self-sufficient after five years through income-generating activities, which may include, for example, member fees, intellectual property licenses, contract research, or fee-for-service activities. To lay a solid foundation for future industry support, participants may engage and conduct work within the consortium using various contracting and collaboration instruments. Proposals should describe realistic strategies to increase revenue in the later years of the award period to achieve self-sufficiency for a minimum of three years beyond the five-year award period. Income that is generated beyond required cost share may be used to expand research projects relevant to and within the topic areas in this FOA—for example, specific grid-forming product development and commercialization projects or applications of the grid-forming technologies. During the annual review process with the consortium's leadership, stakeholder advisory board, and federal oversight committee, the performance within the research topics will be evaluated for progress and the potential need to redirect efforts. No funding calls or prizes will be run by the consortium. Any additional work will need to be incorporated into the statement of project objectives and approved by the DOE through award modification.

DOE has funded collaborative efforts in other areas that have proved successful. The DOE-funded Power America[42] program brought together research institutions, nonprofit entities, manufacturers, and public regulators to accelerate research in silicon carbide and gallium nitride devices, develop cost-effective manufacturing processes, and promote the application of these devices to a wide range of industries. The program formed an ecosystem of stakeholders that spanned all areas of the wide-band-gap semiconductor manufacturing and supply chain, including 28 industry members, 18 university partners, and 4 National Labs, which resulted in 33 invention disclosures. Applicants are encouraged to look at DOE's and other federally funded centers similar to Power America and the DOE National Science Foundation (NSF) Quantum Energy and Sustainable Solar Technologies (QESST) Engineering Research Center[43] to adopt past successes in consortium models and programmatic structures.

Shared RD&D Infrastructure

An element of the consortium model is the establishment and operation of shared RD&D infrastructure. The consortium born from this FOA will leverage existing infrastructure and establish partnerships with National Laboratories, test facilities, and other centers to supplement the capabilities within it as needed and as practical. Through shared RD&D infrastructure and capabilities at its core, like a testing facility, the consortium will enable demonstration of grid-forming technologies at a scale that can establish technical feasibility and enable business-case development to attract further private investment.

Consortium Research and Training Focus Areas

The consortium will focus on advancing cutting-edge research on systems integration of grid-forming technologies, including grid-forming solar, wind, and storage inverters. The consortium will accelerate progress toward the reliable operation of a power system with 75% power contribution from IBR during medium- and high-demand periods, and demonstrate successful operation at scale in a power system. Sustained power contributions from IBR over several hours vary based on the size of the system, the amount of local standby generation, and the power import/export capacity with external systems. Therefore, the consortium should create scalable goals for a range of system configurations using the baseline 75% power contribution from IBR for a 1 GW system.

Table 2 lists the anticipated research topics the consortium will address, along with brief descriptions and expectations for each topic. The consortium will be expected to have

[42] DOE. https://www.energy.gov/eere/amo/power-america.
[43] DOE-NSF Quantum Energy and Sustainable Solar Technologies Center https://qesst.org/.

the capacity to address all the research topics in Table 2 comprehensively through RD&D.

Table 2. *Grid-Forming Technologies Research Consortium Research Topics*

#	Research Topic	Description
1	Frequency Control	Frequency control refers to actions by grid-forming technologies to maintain the system frequency near the nominal value of 60 hertz (Hz). The consortium should investigate, develop, and validate ways that inverter-based solar and wind generation, with and without storage, can support grid frequency control.
2.	Voltage Control	Voltage control refers to actions by grid-forming technologies to increase or decrease real and reactive power to maintain terminal voltages and power system voltages within an acceptable range. The consortium should identify, research, develop, and validate voltage control methods by grid-forming IBR.
3.	Grid-Forming Technologies Modeling and Simulation	Inverter models for transient stability studies in the bulk grid are highly simplified and lack the details needed for electromagnetic transient programs (EMTP). The consortium should develop a detailed model of grid-forming resources that are agnostic to manufacturer but can be used in large EMTP simulations.
4.	System Modeling and Simulation with Multiple Grid-Forming Resources	The consortium should identify system-wide modeling and simulation challenges that are unique to a grid-forming environment created by IBR, come up with R&D that will inform the power systems operators of these new challenges, and provide tools to address the challenges.
5.	System Protection Using Grid-Forming Technologies	It is possible for fault current contribution by grid-forming resources to be higher than grid-following resources, but the subtransient phenomenon is not well understood. The consortium should focus its research on subtransient behavior of grid-forming resources and how the new grid-forming controls can transform protection coordination, limit transient currents, and provide voltage ride-through.
6.	Black Start Using Grid-Forming Technologies	After a large outage, conventional synchronous generators are used to black-start the grid. The consortium should develop R&D to enable grid-forming IBR to black-start the grid, especially in scenarios where fast recovery is needed after an outage caused by severe weather.
7.	Grid-Forming Hardware Design	Inverter hardware modifications are needed to ensure grid-forming control actions and protection functions are well integrated. The consortium should

		focus its hardware-related efforts on holistic designs of grid-forming inverters optimizing cost, reliability, and functionality.
8.	Standards	Grid-forming IBR display some unique characteristics, in both steady-state and transient performance, which prompts the need to develop tailored standards that build over current 1547 and P2800 standards. The consortium should provide technical and programmatic leadership in grid-forming technologies standards development.

While the research topics in Table 2 must be addressed individually, the consortium should simultaneously build capacity to look at each topic from a broader systems integration perspective. Table 3 lists such system-level requirements.

Table 3. *Grid-Forming Technologies Research Consortium System-Level Metrics*

#	System Requirements	Description
1.	Scalability	Scalability is the ability of grid-forming technologies to scale the instantaneous power contribution from solar and wind for various system demand levels. The consortium should ensure that the newly developed grid-forming controls and hardware are scalable across the transmission, sub-transmission, and distribution networks. The consortium should develop scalability metrics for grid-forming technologies that will help solar and wind contribute to grid reliability at higher percentages of instantaneous penetration for different demands, ranging from 0.1 GW to 10s of GW.
2.	Reliability	Reliability is the ability to meet the electricity needs of end-use customers even when unexpected equipment failures or other factors reduce the amount of available electricity. The consortium should ensure that grid-forming technologies enhance overall system reliability. The consortium will also define appropriate reliability metrics that will be continuously monitored.
3.	Transient Stability	Transient stability is the ability of the power system to restore its synchronism after a major disturbance. This is traditionally supported by synchronous generators. The consortium should focus its research on system-wide transient stability using grid-forming technologies and develop appropriate stability metrics.
4.	Demonstration at Scale	Demonstration will use a physical power system and dynamic test bed simulation. The simulation will include power plants, inverters, energy storage, and the transmission and distribution networks. This demonstration is valid when the power system does not rely on import or export with neighbors so that grid-forming action is mainly from solar, wind, and storage. The consortium will demonstrate on a microgrid with more than 1 megawatt (MW) peak load and on a utility-scale power grid with more than 20 MW peak load.

5.	Human Factors	The consortium should consider human factors in the research and address the need to create the human and operational capacity to use grid-forming technologies and solutions. The consortium should offer programs to train the existing workforce on the different technologies, products, and software tools that result from the consortium's research.

ii. Topic Area 2: Integrating Behind-the-Meter Solar Resources into Utility Data Systems

This topic area seeks to support the development of communication systems that integrate highly distributed sensor measurements, especially those from behind-the-meter (BTM) PV systems, into utility data systems. The goal is to develop more affordable tools to collect data in real time and foster their adoption by utilities. Doing so will lead to increased visibility of distributed PV generation, which will enable more flexible and reliable control and operation of the overall power system. Projects in this topic area will develop innovative sensor, communications, and data collection technologies to enhance the visibility and observability of BTM solar energy resources. Incorporating these measurements into utility real-time monitoring and control systems will lead to improved power system reliability, resilience, and security in areas with large amounts of BTM solar resources.

NOTE: This topic area is intended for applicants who are looking to demonstrate entire data-collection systems that would be deployed throughout a distribution feeder. Applicants who are primarily interested in new innovations or manufacturing processes for products that reside in this technology space, such as sensor components or communication hardware, should read Topic Area 3.

Introduction to Systems Integration

The SETO Systems Integration (SI) team supports RD&D that advances the reliable, resilient, secure, and affordable integration of solar energy onto the U.S. electric grid. For in-depth coverage of the SI team's research areas, please visit the Systems Integration section[44] of SETO's website.

In the past 40 years, solar energy has grown from a niche technology powering satellites in space to a technology that powers homes and businesses in all 50 states. According to the EIA, solar supplied nearly 2.5% of U.S. electricity demand in 2019,[45] and in some states, solar represented over 10% of total annual electricity generation.[46] There are more than 2.4 million solar installations across the United States.[47] Solar generation growth is projected to continue in the near term.

The electric power grid has changed dramatically in recent years, incorporating a new mix of generating resources and advanced network and consumer technologies. Grid-connected solar, wind, and other renewable energy resources have significantly

[44] SETO. https://www.energy.gov/eere/solar/systems-integration.
[45] EIA.
[46] Solar Energy Industries Association. "Solar State by State." https://www.seia.org/states-map.
[47] Wood Mackenzie/SEIA. "Solar Market Insight Report," May 2020.

increased over the past decade.[48] Solar energy resources can be broken down further into solar-thermal applications, large utility-scale solar CSP and PV plants, and more distributed residential or commercial BTM PV systems in homes and businesses that are measured by the utility's power meter. BTM PV is growing and has unique integration challenges,[49] including billing, interconnection, and monitoring the impacts and operation of millions of dispersed PV generators across the grid.

The grid's network infrastructure has also evolved, becoming more digital and complex with different types of sensors and more reliable communications. It has been augmented with new hardware technologies, such as DC power lines, flexible AC transmission systems, and solid-state transformers.[50,51] At the same time, the electrification of vehicles[52] and buildings, as well as the growth of grid-connected storage devices,[53] have transformed load types and profiles. Additionally, studies show that electric power grids are being operated closer to their thermal and stability limits.[54] As a result of these changes, grids are experiencing lower inertia, more uncertainties, and interactive participation from DER. These changes are driven by economic development, environmental sustainability, and extensive electrification requirements, which are precipitating fundamental changes in electric power grid planning and operations.

Topic Area Introduction and Main Objectives

The growing adoption of BTM distributed solar resources installed on utility distribution feeders increases the impacts of these systems on both the local and bulk power grids in aggregate. Despite this trend, distribution utilities do not generally monitor BTM resources in real time. While smart meters or feeder-level measurements may collect or ascertain BTM solar generation data, this data is typically insufficient to be useful in making real-time operation and control decisions that may impact the reliability, quality, or resilience of power delivery. This topic area seeks to fund technologies that would enable real-time measurements on distribution feeders to be incorporated into utility

[48] REN21 Renewables Now. "Renewables 2019 – Global Status Report," May 2019. https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf.
[49] CAISO reported instantaneous electricity generation of an estimated 7.7 GW by behind-the-meter solar on April 13, 2019. https://pv-magazine-usa.com/2019/04/15/californias-solar-power-record-setting-season-is-here/.
[50] NREL/PNNL/ANL/ORNL/Iowa State University/SPP/MISO/WAPA. "Interconnection Seams Studies." Department of Energy Grid Modernization Laboratory Consortium. 2020. https://www.nrel.gov/analysis/seams.html.
[51] Klaehn Burkes, Joe Cordaro, Tom Keister, and Kerry Cheung. "Solid State Power Substation Roadmap," U.S. Department of Energy Office of Electricity, December 2017. https://www.energy.gov/sites/prod/files/2018/03/f49/SSPS%20Roadmap%20Draft%20-%20Public.pdf.
[52] EIA. "Annual Energy Outlook 2020 with Projections to 2050," January 2020. https://www.eia.gov/outlooks/aeo/pdf/aeo2020.pdf.
[53] H Rudnick and L Barroso. "Flexibility Needed: Challenges for Future Energy Storage Systems," *IEEE Power and Energy Magazine*, September/October 2017.
[54] North American Electric Reliability Corporation. 2018 Summer Reliability Assessment. https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_SRA_05252018_Final.pdf.

data systems so they can improve feeder situational awareness and realize the potential value of coordinating high-penetration BTM solar energy resources and other DER.

Historically, the wide adoption of such data measurement, communication, and collection systems has been hindered by costs. Despite the wide adoption of smart meters and other sensing technologies, real-time measurements of BTM generation and load are generally not integrated into grid management tools. In general, distribution systems still lack the real-time monitoring capabilities that provide robust visibility to the transmission grid despite being more diverse, variable, and prone to disturbances.[55] Many utilities find that it is simply not practical or affordable to install the infrastructure to collect data from remote sensors across their distribution networks.[56] Therefore, this topic area seeks to fund projects that develop affordable sensing and communication strategies, as well as data collection and management systems and their data processing and analytics capabilities. The funded projects will also demonstrate the practicality of designs to be installed and operated on real distribution feeders. Drastically reducing the costs of such real-time monitoring systems promotes their widespread use, which will lead to greater overall grid visibility and situational awareness, especially in systems with high penetration of BTM PV.

Research Background and State-of-the-Art

The lack of BTM situational awareness has led to grid operation challenges in existing applications, such as net-load forecasting and protection planning. For example, system operators were unable to predict how much BTM generation would disconnect during the 2018 Angeles Forest event, so when approximately 130 MW of DER tripped offline at the same time as a loss of 860 MW of utility-scale PV, the severity of the event increased (see Figure 7, below). However, the amount of DER disconnected is only an estimate, owing to the lack of sensing. This will continue to be a growing issue as long as more distributed PV is installed without providing real-time visibility to the transmission grid.

[55] Kuhar, U., et. al. *Observability of Power-Distribution Systems: State-Estimation Techniques and Approaches*. Springer Nature, 2020.
[56] Kirker, Ron. "Situational Awareness Offers Grid Benefits." *T&D World*. December 20, 2016. https://www.tdworld.com/grid-innovations/distribution/article/20967535/situational-awareness-offers-grid-benefits.

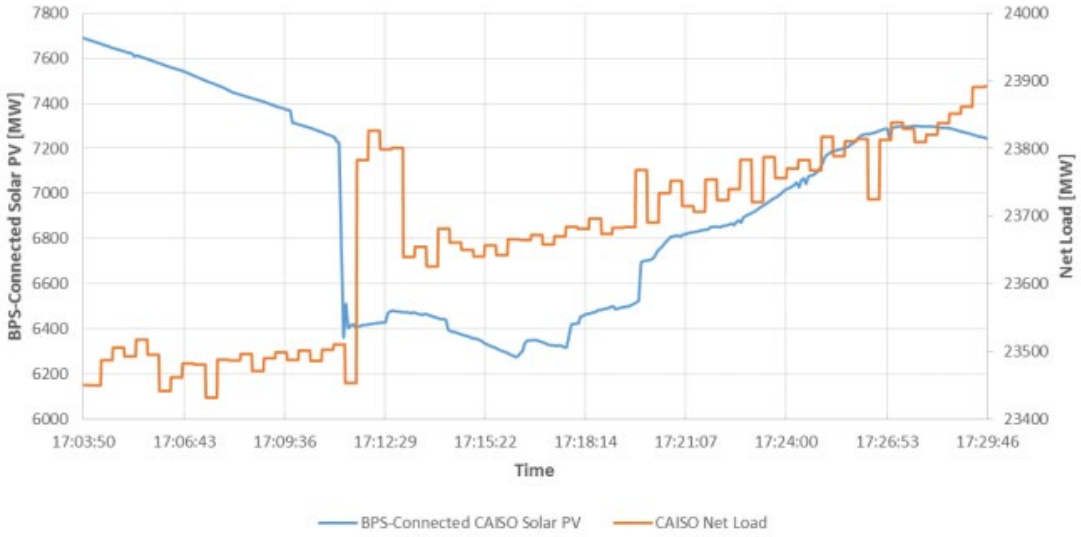

***Figure 7**. Fault scenario in which large, metered solar generating plants cease production during a disturbance, and distributed PV generation simultaneously stops producing, which contributes to a sudden increase in net load.*[57]

Furthermore, there is a general lack of understanding of the dynamic behavior of distributed PV during disturbances.[58] How lower system inertia caused by increased inverter-based resources may impact the bulk power grid or how protective relays may respond to fast switching transients from inverters need further research.[59] More observability of inverter-based resources, including BTM PV, is necessary to develop control strategies to mitigate these issues. These controls and other new distribution automation and control applications, such as automated service restoration, BTM-provided grid services, and improved fault ride-through behavior, may also be stymied without more network observability. Successful projects in this topic area will enable future development of advanced network controls and algorithms that improve interconnection, coordination, and grid reliability, quality, and resilience by integrating distributed data sources and improving overall distribution network visibility.

In addition to the large-scale issues at the transmission level, there are situational awareness issues at the local distribution level that may benefit from distributed sensors. Historically, downed conductors causing high-impedance faults have been a safety hazard to the public and utility line crews.[60] These types of faults are also potential catalysts of wildfires and, lacking visibility into the state of their distribution

[57] NERC. "April and May 2018 Fault Induced Solar Photovoltaic Resource Interruption Disturbances Report," 2019.
[58] NERC. "Recommended Disturbance Monitoring for Inverter-Based Resources," 2020.
[59] IEEE Power & Energy Society. "Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance," 2018.
[60] Short, Tom. "Can We Detect Live Downed Conductors on Distribution Lines?" *T&D World.* March 11, 2020. https://www.tdworld.com/test-and-measurement/article/21125863/can-we-detect-live-downed-conductors-on-distribution-lines.

networks, could lead utilities to preemptively curtail power for safety.[61] As large amounts of inverter-based generation on distribution networks come online, such problems could become more complex.[62] A lack of real-time knowledge of the state of distribution networks, such as network voltage profile, line loading, or fault current contributions, may also lead to more conservative estimations of their distributed PV hosting capacity,[63] leading to fewer potential PV installations.[64] Monitoring the real-time measurements of PV inverters could not only mitigate these potential complexities of the future grid but also unlock new opportunities to improve the safe and reliable operation of the distribution grid.

Adding the capabilities of fast-acting, responsive solar inverters to grid operations may enable more flexible and adaptive grid controls that make the grid more reliable, resilient, and secure against cyberattack and physical disturbances. However, being able to monitor and communicate with these resources is a necessary first step. Faster controls also require more frequent measurements. This requirement translates to higher-bandwidth communication networks, which are typically costlier. Thus, unlocking the dynamic capabilities of modern inverters by making sensing and communication more affordable and accessible to utilities is one of the primary goals of this topic area.

SETO has previously supported research into technologies that advance the level of measurement and control of DER and their supporting utility equipment. In 2016, the Enabling Extreme Real-Time Grid Integration of Solar Energy (ENERGISE)[65] program funded an array of projects to improve the scalability of integrating large amounts of distributed PV to the grid. These projects simulated electric networks of over 1 million nodes and developed control architectures for integrating high penetrations of DER. This program, as well as other DOE programs that have funded improvements in distribution automation, have shown that costs of a sensor network must be reduced to achieve large-scale deployment of those sensors.[66]

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[61] Powell, Debbie. "2020 Wildfire Mitigation Plan Overview." PG&E. https://www.pge.com/pge_global/common/pdfs/safety/emergency-preparedness/natural-disaster/wildfires/PGE_2020_CWSP_Update.pdf.

[62] Baran, M. E., et. al. "Impact of High Penetration Residential PV Systems on Distribution Systems." 2011 IEEE Power and Energy Society General Meeting. 2011.

[63] Interstate Renewable Energy Council. "Optimizing the Grid: Regulator's Guide to Hosting Capacity Analyses for Distributed Energy Resources." https://irecusa.org/publications/optimizing-the-grid-regulators-guide-to-hosting-capacity-analyses-for-distributed-energy-resources/.

[64] Reno, Matthew J. "Advanced Inverter Planning: Voltage and Protection." https://www.osti.gov/servlets/purl/1524267.

[65] SETO. https://www.energy.gov/eere/solar/funding-opportunity-announcement-enabling-extreme-real-time-grid-integration-solar-energy.

[66] DOE. "Results from the Smart Grid Investment Grant Program," September 2016. https://www.energy.gov/sites/prod/files/2016/11/f34/Distribution%20Automation%20Summary%20Report_09-29-16.pdf.

Past research has also indicated that grid services, such as voltage optimization, could increase PV hosting capacity while also providing energy and cost savings if smart inverters were integrated into utility systems efficiently.[67] In 2018, through the Advanced SystemS Integration for Solar Technologies (ASSIST)[68] program, SETO funded projects that developed tools and models to improve situational awareness and enhance resilience in power systems. In these efforts, modeling, simulation, and controls and algorithm development were key areas of focus.

With this topic area, SETO seeks to add sensor and measurement hardware and software development to the grid-sensing portfolio. Ongoing DOE efforts to understand sensing and measurement technology gaps are occurring through working groups that develop such mechanisms as the Grid Modernization Laboratory Consortium (GMLC) Sensing and Measurement Technology Roadmap.[69] These working groups have identified gaps in sensing and communications technologies that may require further research or improved commercialization to advance. In addition to hardware limitations, data management or standardization issues may be restricting deployment. SETO seeks to fund research that closes the hardware and software technology gaps, with an explicit focus on integrating measurements from distributed BTM inverters.

The distribution networks with robust communication and sensing capabilities are typically those that have invested in enhanced distribution network control applications.[70] These systems can provide real-time situational awareness and control but come at a steep cost.[71] Additionally, these systems have not been designed to collect real-time data from many thousands of distributed sensors, such as PV inverters. These systems also typically provide only local situational awareness to the distribution utility and do not provide aggregate real-time data to transmission-level entities. Sensing and communication systems have been more widely deployed with smart meter rollouts, but these systems are typically not designed for the data bandwidth and latency requirements of real-time sensing and control applications.

The communication networks deployed in most advanced distribution automation applications use either fiber-optic networks or meshed wireless radio networks. Fiber-optic networks provide high-bandwidth, low-latency data transfer but are expensive to

[67] DOE. "Smart Grid System Report," November 2018. https://www.energy.gov/sites/prod/files/2019/02/f59/Smart%20Grid%20System%20Report%20November%202018_1.pdf.

[68] SETO. https://www.energy.gov/eere/solar/advanced-systems-integration-solar-technologies-assist-situational-awareness-and.

[69] Rizy, T. D., & Ohodnicki, P. "Sensing and Measurement Technology Roadmap: Devices Including Communications and Data Analytics Requirements." GMLC. 2019.

[70] Shadle, David. "Is There a Gold Standard for Electric Distribution Grids?" *T&D World.* April 19, 2018. https://www.tdworld.com/grid-innovations/distribution/article/20971171/is-there-a-gold-standard-for-electric-distribution-grids.

[71] National Renewable Energy Laboratory. "Distribution Grid Integration Unit Cost Database." https://www.nrel.gov/solar/distribution-grid-integration-unit-cost-database.html.

install, especially as a solution for a large number of BTM resources. Solutions that use physical communication lines, such as fiber optics, are susceptible to the same outages that affect power lines in an emergency. Radio networks require fewer installed components but typically rely on a multitude of repeaters to transfer the data over long distances. These repeaters can be costly and typically require batteries to operate in the event of an outage, which presents an ongoing maintenance cost to the utility that grows with the number of communicating devices connected.[72] Communication networks that use cellular technology have seen limited adoption due to concerns over data rates, availability, cybersecurity, and costs if licensed bands are used. Similar concerns have limited the use of Wi-Fi and internet-based communications in real-time operations.

Topic Description and Goals

SETO seeks to support the development of utility sensing and communication networks that enhance the visibility of BTM resources, such as solar generation, in distribution grids. The main objective of this topic is to design, develop, and field-validate data-collection hardware and software that measure and integrate real-time data from distributed BTM PV inverters and other sensors from across distribution feeder networks into utility information systems, either directly or via an intermediary interface. Projects should include data-collection systems for a large number of sensors as individual direct measurements, aggregate measurements, or both, as suited for the intended end-use application. The architecture of the data-collection system may be a wholly new design or incorporate third-party systems, such as data cloud systems or non-utility-owned data systems. Successful projects will focus on the development of new low-cost sensors, strategies for low-cost transmission of real-time data, and efficient data-collection and management algorithms and software systems to improve system scalability. Projects will work to integrate this data into utility information technology and operational technology systems in a dynamic, synchronized manner to enhance the situational awareness of utility real-time operating systems. Successful solutions will also be capable of retrofitting networks with a significant amount of existing BTM PV and utility systems. Those systems could include Supervisory Control and Data Acquisition (SCADA) systems, energy and distribution management systems, advanced metering infrastructure, distributed energy resource management systems (DERMS), forecasting tools, or inverter measurements.

Each proposing team is required to include at least one utility partner as an integral and active member, and the utility should agree to deploy the proposed solution at scale. Further, the conceptual solution should demonstrate sustainable potential value to both utility and BTM PV owners and customers through economic analysis to estimate the benefits obtained if the proposed solution is deployed. DOE expects the utility partner

[72] National Renewable Energy Laboratory. "Distribution Grid Integration Unit Cost Database." https://www.nrel.gov/solar/distribution-grid-integration-unit-cost-database.html.

on the project team to be integrally involved in the fundamental design and development of the solution, and to provide specific guidance on the desired operation of the solution with the utility grid. DOE expects the rest of the project team to demonstrate buy-in from the utility partner.

While SETO is primarily focused on the integration of sensors that capture BTM PV data, other distributed sensors installed at customer load sites and across the distribution grid may also be incorporated to add value to the grid operator and potentially the customer. Successful applications may include sensors that provide measurements about PV inverters, EV chargers, battery energy storage systems, smart meters, line current and voltage sensors, grid-edge devices, internet of things (IoT) devices, digital relays, and other digital protection devices.

The measurements or data of interest in this topic area are the real-time signals from physical sensors that are transmitted automatically via a sufficiently robust communication network. However, SETO considers several factors as part of an effective data-collection system:

- The design of the communication medium, such as fiber-optic lines or meshed radio networks, which is a key factor in its practicality and affordability;
- Data collection and management software, as well as the hardware or cloud services that run these applications;
- The costs to deploy and install the sensor and communication hardware; and
- The secure interface, such as a server or website, that makes the data available to a variety of utility real-time operations and control applications, such as power system state estimation tools or net load forecasting algorithms.

Successful applications will focus on the integration of PV inverter measurement data into distribution utility real-time operations software tools, either directly or through an intermediary system that would interface with the utility software. To this end, applicants must allocate significant effort and funding toward sensor hardware development, data gathering and processing, or integration into utility operational technologies systems. Successful applications must also make data available to future end-use applications. Future end-use applications of interest include those that provide accurate calculation and estimation of real-time BTM solar generation and customer load, improve grid resiliency, advance power system situational awareness and model validation, and enable the future integration of advanced control schemes. Proposals must therefore also make clear the requirements of the data resolution and the communication network for the data to be collected. Proposed projects must also address the interoperability of PV data and other BTM sensors within utility systems.

Well-defined metrics are necessary for SETO to assess a project's success.[73] Table 4 lists the capabilities of interest for prospective projects in this topic area. Proposals should provide quantifiable metrics that satisfy the capabilities listed. The example performance metrics in the table below are intended to clarify the capabilities and which metrics may be of interest, but applicants are encouraged to develop their own ambitious performance metrics for each of these capabilities.

Table 4. *Capabilities of Interest for Prospective Projects*

Capability	Example Performance Metric
Affordability	• Reduces overall installation cost of sensing and data aggregation system by 20%, compared with commercially available systems • Development of a sensor that can transmit synchrophasor measurements at half the cost of existing devices
Sensor Utilization (Number of Inverters, Sensors)	• Demonstrates the integration of hundreds of sensors • Demonstrates the integration of heterogeneous sensor types, such as inverter power output, line current sensors, and advanced metering infrastructure load sensors
Scalability	• Demonstrates ability to increase visibility into 1 million nodes • Demonstrates plug-and-play ability of new sensors into the system with minimal or no configuration required
Data Quality and Usability	• Sufficient real-time power measurements to perform five-minute net load estimation • Recorded transient waveforms sampled to provide visibility up to the 50th harmonic
Retrofittable	• Has method to measure 100% of existing BTM PV power generation • Has method to infer all existing BTM PV power generation within 5% error
Database	• Synchronization of data among information and operations technologies databases
Interoperability	• Implements International Electrotechnical Commission (IEC) 61850 or equivalent for devices, IEC 61968 or equivalent for utility enterprise • Integrates a multitude of sensor types from various vendors
Hierarchical Data Sharing	• Implements hierarchical data aggregation and sharing, such as between transmission and distribution interfaces

[73] https://gridlab.org/wp-content/uploads/2020/05/Grid-Modernization-Playbook-report-1.pdf.

Integration	• Integrates with existing utility information technology and operational technology systems and extendable for future applications
Computation Cycle	• Refreshes data fast enough to support operational planning (steady-state) to real-time operations (dynamic) applications
Communications Availability and Latency	• Measured probability of communication error and latency exceeds the requirements for real-time protection commands or control set-point changes
Resiliency	• Maintains data availability in the event of one or more device failures, or loss of communication paths
Privacy	• Supports customer confidentiality; follows personally identifying information (PII) and critical energy/electric infrastructure requirements
Security	• Application programming interface (API) is compliant with latest security standards
Geographic Identification	• Provides geographic information of sensors for interoperability
Verification and Metadata	• Data calibration and integration across systems, data verification, anomaly detection, and time stamps required

Applications of Interest

- New innovative sensor hardware or system designs that drastically reduce sensor network installed system costs;
- Innovative communication network strategies to collect highly distributed sensor data in an interoperable and affordable manner to facilitate data collection across entire distribution systems;
- Approaches that are scalable to affordably deploy on a range of feeders, from a small number of BTM PV up to very high PV penetration levels at thousands of customer sites;
- Interfaces that make synchronized, time-stamped data available to both distribution and transmission real-time operations and control software;
- Data gathering, filtering, and management software that detects anomalies and errors in data and ensures only useful and relevant data is made available;
- Incorporating existing inverter and other BTM sensors into utility control and planning systems;
- Monitoring hardware degradation, both utility and customer-owned equipment;
- Capturing high-fidelity waveform measurements for modeling fast power electronics behaviors and characterizing low-current, high-impedance, or incipient faults, and malicious attacks; and
- Demonstrations of prototype data collection systems on medium-voltage utility distribution feeders.

Questions about this FOA? Email SETO.FOA@ee.doe.gov. Problems with EERE Exchange? Email EERE-ExchangeSupport@hq.doe.gov. Include FOA name and number in subject line.

Applications Specifically Not of Interest

- Applications from companies seeking the incremental development or cost-reduction of an existing product, or seeking to demonstrate a singular product, device, or component (these applications may be appropriate for Topic Area 3);
- Applications that focus on the development of advanced inverter or grid controls;
- Applications that primarily focus on advancements in control software platforms, such as DERMS or advanced distribution management systems (ADMS);
- Projects focused on theoretical state estimation and controls algorithm development;
- Applications that do not include PV system data, especially converter or inverter data;
- Applications focused on the deployment of existing commercial sensors, measurement, and communications systems;
- Applications focused on standards development;
- Applications focused on solar or load forecasting algorithms and tools; and
- Applications focused on cybersecurity.

iii. Topic Area 3: Hardware Incubator

This topic area seeks to accelerate commercialization of innovative product ideas that can substantively increase U.S. domestic manufacturing across the solar industry supply chain and expand private investment in U.S. solar manufacturing. These products and solutions will lower the cost of solar technologies and facilitate the secure integration of solar electricity into the nation's energy grid.

This topic area has two subtopic areas:

- The goal of Topic Area 3a is to de-risk new technologies and manufacturing processes and bring them to a commercially relevant prototype stage, while developing and validating a realistic pathway to a commercial success.
- The goal of Topic Area 3b is to conduct pilot-scale testing and demonstration of products or solutions. This includes high-volume or high-throughput manufacturing processes for solar hardware, the production of a large number of devices sufficient for statistically robust field testing and validation, or the demonstration of a system (for example, a microgrid or an innovative solar system) primarily focused on pilot-testing new hardware.

In both subtopic areas, SETO funding should help retire technical, business, and market risks of solar hardware to validate pathways to commercial success through customer engagement and trials. Additional outputs include attracting follow-on private investment, securing patents, and producing technical publications (white papers) that lead to business growth, revenue, and job creation.

Notes to Applicants:

- Topic Areas 3a and 3b aim to accelerate the transition of innovative technologies to the market. Applicants must be domestic for-profit entities with the intent to develop (Topic Area 3a) or demonstrate (Topic Area 3b) their technology's viability with potential customers. Research organizations or for-profit entities that are proposing research and development efforts to advance the public knowledge or the state-of-the-art within the academic community should apply to Topic Area 1 of this FOA.
- Applications that fall under Topic Area 2: Integrating Behind-the-Meter Solar Resources into Utility Data Systems are not of interest under Topic Area 3. Applicants with innovations in this area should apply under Topic Area 2.
- This will be the only Incubator topic in any FOA released by SETO in FY2021, and it is restricted to for-profit entities and focused on product development and demonstration.
- SETO reserves the right to select Topic Area 3b applicants under Topic Area 3a with a reduced scope if that is determined to be the more appropriate topic area

for the work proposed. SETO also reserves the right to move applications from Topic Area 3a to Topic Area 3b if deemed appropriate.

SETO aims to support U.S. leadership across the solar value chain. Within Topic Areas 3a and 3b, solar hardware includes but is not limited to PV cells and modules; structural balance of system components, like racking; electrical balance of system components, including inverters and combiners; hardware tools for inline metrology, operations and maintenance (O&M), and quality control; CSP technologies, including components for industrial process heat; hardware components needed for the integration of the solar generation into the electric grid; and new manufacturing tools and methods to produce these products or components.

Motivations and Goals

Manufacturing is vital to the U.S. economy. The manufacturing sector generates roughly 11.4% of U.S. gross domestic product (GDP)[74] and employs more than 12.8 million Americans.[75] In 2019, about $9 billion were spent on PV hardware in the United States.[76] About $4 billion of this was spent on domestic content, with the balance on imported content.[77] DOE is committed to increasing the portion of value that is kept in the U.S. economy and promote domestic manufacturing of taxpayer-funded technology developments.

Domestic manufacturing of solar hardware creates jobs, produces ancillary economic activity, and promotes energy security. Reducing reliance on imported goods also reduces cost uncertainty and reduces sensitivity to international supply chain disruptions. Emerging concerns about cybersecurity may also be resolved by using U.S.-made or assembled hardware.

America's innovators have the potential to develop new value streams and products that can supply both domestic and global markets. These investments will help accelerate the growth of the solar industry, identify emerging opportunities, and drive down manufacturing costs for our domestic energy market, positioning the U.S. on the leading edge of solar industry advances.

SETO's Manufacturing and Competitiveness team supports the transformation of research and development results into products that can be manufactured in the United

[74] Bureau of Economic Analysis, Value Added by Private Industries: Manufacturing as a Percentage of GDP [VAPGDPMA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/VAPGDPMA, March 8, 2019.

[75] U.S. Bureau of Labor Statistics, All Employees: Manufacturing [MANEMP], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/MANEMP, March 8, 2019.

[76] Hardware spending calculated using Wood Mackenzie "2019 Year in Review Solar Market Insight" and NREL "2020 PV System Benchmark."

[77] Domestic content calculated in forthcoming NREL report on domestic content of solar systems.

States. This program addresses key barriers to bringing commercial solutions closer to the market. Addressing these barriers, which are too risky for the private sector to support on its own, will allow solar companies to attract private investment to bring solutions to market commercialization. Due to the commercial and proprietary nature of these projects, only for-profit entities and teams led by for-profit entities may apply.

Application Guidelines

A responsive application to this topic should:

- Include a summary of the milestones expected to be achieved by the end of the period of performance. Each application should include technical milestones as well as milestones related to engagement with potential customers to collect feedback on the technology being developed and the business value proposition. Milestones must be associated with quantifiable, measurable, verifiable, aggressive yet realistic success metrics and definitions of how completion of an objective will be assessed. Milestones should not be activity-based; they should represent achievement of a specific mission-related outcome, as opposed to completion of task. Although reports are required as part of the cooperative agreement, they cannot be used as milestones. Reports summarize activities; milestones validate functionality and engagement with potential customers.
- Include a preliminary cost analysis and milestones with appropriate cost targets with projections for price and performance improvements that identify assumptions and data showing a path to becoming cost-competitive with the evolving state of the art.[78]
- Assess the state of the art, including products or solutions already commercially available or that could be considered competitors when the proposed product enters the market, and thoroughly differentiate the proposed innovation with respect to the expected state of the art for products and solutions that will be on the market by the time the proposed innovation is commercialized.
- Discuss a credible and reasonable path and timeline to U.S. manufacturing of the proposed technology.
- Justify all performance claims with theoretical predictions or relevant experimental data.
- Describe how addressing the technical risks identified in the application will increase the likelihood of securing private investment following the award period.
- Provide a thorough explanation of why federal funds are needed to develop the solution, why all proposed tasks warrant federal funding, and why private-sector funding is not appropriate for this work.

[78] Applicants should follow the proper procedures to mark any specific business-sensitive information as protected from public release. Applicants should not mark the entire technical volume as protected but only specific data and/or description of specific technical specifications.

This topic area seeks to help businesses that plan to identify a profitable, self-sustaining business opportunity based on their innovation. It is not intended to support creating a product, organization, service, or other entity or item that requires continued government support or that relies solely on a licensing model.

Topic Area 3a: Product Development

Successful applicants for this topic area will be companies domestically incorporated at the time of submission of the full application with an existing technology at the proof-of-concept stage. This means that the application should include a feasibility study that proves the technical and business viability of the technology. In addition, the application should demonstrate critical functionality of the proof of concept in a controlled, lab-scale environment and why it provides advantages compared to the state of the art. However, there must be significant technical and business risks that need to be retired for which private funding is unlikely, owing to the early-stage nature of the proposed product or solution. Through this award, the awardee will advance their technology to a manufacturing-relevant prototype made in a lab environment.

A minimum 20% recipient cost share is required for projects in this topic area, with the expectation that most, if not all, of the activities proposed can be classified as research and development tasks.

Areas of Interest

SETO will support solutions that can advance domestic manufacturing of solar energy technologies, including materials and tools to develop a robust domestic supply chain, while facilitating the integration of solar energy into the nation's grid. Applications must fall within one of these areas:

- Advanced solar system integration technologies that enhance the ability of solar energy systems to contribute to grid reliability, resiliency, and security;
- CSP and solar-thermal industrial process heat;
- PV technologies, including manufacturing innovations; or
- Hardware technologies that reduce the balance of system costs of a PV system.

In addition, SETO seeks solutions related to floating solar-powered aeration systems. Aeration is the introduction of air into aquatic systems to support the growth of aerobic bacteria and aquatic life. Facilitating the oxidative decomposition of biological materials, aeration can also remove the gaseous products of decomposition, including ammonia, hydrogen sulfide, methane, and carbon dioxide. Many natural systems depend upon aeration to maintain a diversity of animal and plant species, as well as overall health. However, a surplus of nutrients, restricted mixing and flow, or significant depth can

deplete dissolved oxygen in aqueous systems. Artificial aeration can address this issue. As a technology, aeration is generally applied to establish, maintain, or restore sufficient dissolved oxygen to ensure successful remediation and protection of water resources, including natural bodies of water (e.g., rivers, lakes) and artificial ones (e.g., fish farms, lagoons). Recently, self-powered, autonomous units that combine floating photovoltaics and aeration have been implemented to help restore natural water resources. SETO seeks innovations that can advance the application of floating solar-powered aeration systems (FSAS) to improve water quality. Applications should fall within one of the following three broad areas for ecosystem management on water systems:

- FSAS for environmental restoration and protection of natural water systems;
- FSAS for sustainable water systems for aquaculture; or
- FSAS for sustainable waste bio-processing water systems.

Applicants must verify that their project is not included in the areas specifically not of interest listed below. SETO encourages applicants to explore and leverage strong partnerships with established or adjacent industries that would speed the development and domestic manufacture of products.

Applications Specifically Not of Interest

Applications to Topic Areas 3a and 3b will be considered nonresponsive and declined without external merit review if they:

- Fall under Topic Area 2: Integrating Behind-the-Meter Solar Resources into Utility Data Systems;
- Focus exclusively on HVAC or water heating applications;
- Propose development of concentrated PV or solar spectrum splitting technologies;
- Propose development of technologies with very low possibility of being manufactured domestically at a competitive cost (e.g., PV modules based on copper indium gallium selenide (CIGS), copper zinc tin sulfide (CZTS), or amorphous silicon thin films; technologies assuming incorporation of functional materials such as quantum dots or luminescent solar concentrators; etc.);
- Propose technologies to improve the shade tolerance of PV modules;
- Involve perovskite photovoltaics;
- Propose software-only solutions, including but not limited to software that facilitates system design or system monitoring, and any software solution to improve customer acquisition processes. Note that hardware technologies that also require software innovation and integrated hardware/software solutions *will* be considered responsive to this topic area;
- Are not based on sound scientific principles (e.g., violate the laws of thermodynamics);

- Discuss business plans without clear validation of market assumptions; Competitive approaches in the same market segment should be discussed in the application;
- Propose to develop undifferentiated products, incremental advances, or duplicative products;
- Propose projects lacking substantial impact from federal funds. Federal funds are intended to enable projects in this topic area to sufficiently retire risk for follow-on investment or catalyze development. Projects that have sufficient monies and resources to be executed without federal funds are not of interest;
- Propose development of ideas or technologies that have already received federal support for the same technology at the same technology readiness level.[79]

Topic Area 3b: Product Development & Demonstration

Successful applicants for this topic area will be established companies or startups incorporated in the United States with an existing prototype whose technical functionalities have already been fully demonstrated and verified on a small scale and in a controlled environment. Through this award, a successful application will pursue one or more of the following objectives:

- Development of high-volume or high-throughput manufacturing processes for solar hardware that can be manufactured competitively in the United States;
- Production of a sufficiently large number of devices for statistically robust field testing and validation; or
- Demonstration of new hardware component(s) or novel system architectures in robust, commercially relevant pilot tests (e.g., an innovative solar system or microgrid system architecture developed in collaboration with relevant partners, like energy service companies and utilities).

Applications must include the identification and pursuit of domestic manufacturing pathways.

A minimum 50% recipient cost share is required for projects in this topic area, with the expectation that all activities can be classified as RD&D tasks. Generally, tasks that consist of empirical or physical validation of technical feasibility and economic potential of a technology at a commercially relevant scale are considered demonstration tasks and require 50% cost share. For details about cost share requirements, please see section III.B.

[79] U.S. Department of Energy. "DOE G 413.3-4A Chg 1 (Admin Chg), Technology Readiness Assessment Guide." https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04-admchg1.

Areas of Interest

This topic area is open to any application that falls within one of these areas:

- Advanced solar system integration technologies that enhance the ability of solar energy systems to contribute to grid reliability, resiliency, and security. Applications including storage elements are acceptable if the storage hardware component is part of a larger solution enabling high-penetration solar scenarios;
- CSP and solar-thermal industrial process heat technologies;
- PV technologies, including manufacturing innovations; and
- Hardware technologies that reduce the balance of system costs of a PV system.

Any technology in these areas will be considered as long as the applicant shows a clear path to commercialization, manufacturing, or both in the United States. This topic is intended to support technology development from component or system validation in a laboratory to engineering on a pilot-scale or similar prototypical system validation in a relevant environment.[80]

Applications Specifically Not of Interest

Applications to both subtopic areas will be considered nonresponsive and declined without external merit review if they:

- Fall under Topic Area 2: Integrating Behind-the-Meter Solar Resources into Utility Data Systems;
- Focus exclusively on HVAC or water heating applications;
- Propose development of concentrated PV or solar spectrum splitting technologies;
- Propose development of technologies with very low possibility of being manufactured domestically at scale at a competitive cost (e.g., PV modules based on copper indium gallium selenide (CIGS), copper zinc tin sulfide (CZTS), or amorphous silicon thin films; technologies assuming incorporation of functional materials such as quantum dots or luminescent solar concentrators; etc.)
- Propose technologies to improve the shade tolerance of PV modules;
- Involve perovskite photovoltaics;
- Propose software-only solutions, including but not limited to software that facilitates system design or system monitoring, and any software solution to improve customer acquisition processes. Note that hardware technologies that also require software innovation and integrated hardware/software solutions *will* be considered responsive to this topic area;

[80] DOE Office of Environmental Management. "Standard Review Plan: Technology Readiness Assessment Report." 2010. https://www.energy.gov/sites/prod/files/em/Volume_I/O_SRP.pdf

- Are not based on sound scientific principles (e.g., violate the laws of thermodynamics);
- Discuss business plans without clear validation of market assumptions. Competitive approaches in the same market segment should be discussed in the application;
- Propose to develop undifferentiated products, incremental advances, or duplicative products;
- Propose projects lacking substantial impact from federal funds. Federal funds are intended to enable projects in this topic area to sufficiently retire risk for follow-on investment or catalyze development. Projects that have sufficient monies and resources to be executed without federal funds are not of interest;
- Propose development of ideas or technologies that have already received federal support for the same technology at the same technology readiness level.[81]

Other SETO Commercialization Programs

SETO has supported the commercialization of solar innovations through funding programs that support entrepreneurs at various stages of commercialization.[82] Specifically:

- The American-Made Solar Prize[83] is a competition designed to support entrepreneurs as they develop transformative technology ideas into concepts and then into early-stage prototypes ready for industry testing. It is composed of three progressive phases that happen over the course of a year and are structured to provide the resources and environment necessary to create new solutions and develop them into early-stage prototypes. Along the way, competitors can receive prizes totaling up to $800,000 of a $3.9 million prize pool, based on performance at demonstration days and a streamlined review process. This program has the fastest timeline among SETO's small-business programs, but only semifinalists, finalists, and grand-prize winners receive a monetary prize.
- The two-phase Small Business Innovation Research and Small Business Technology Transfer programs[84] provide financial assistance to early-stage research and development efforts at small businesses for a specific scope of work with clear objectives. The first phase is focused on proving the feasibility of

[81] https://www.directives.doe.gov/directives-documents/400-series/0413.3-EGuide-04-admchg1

[82] Please read the relative FOA to learn more about eligibility criteria and cost share requirements of each program. Please note that these programs may or may not be announced, based on Congressional appropriation, programmatic decision, and office priorities.

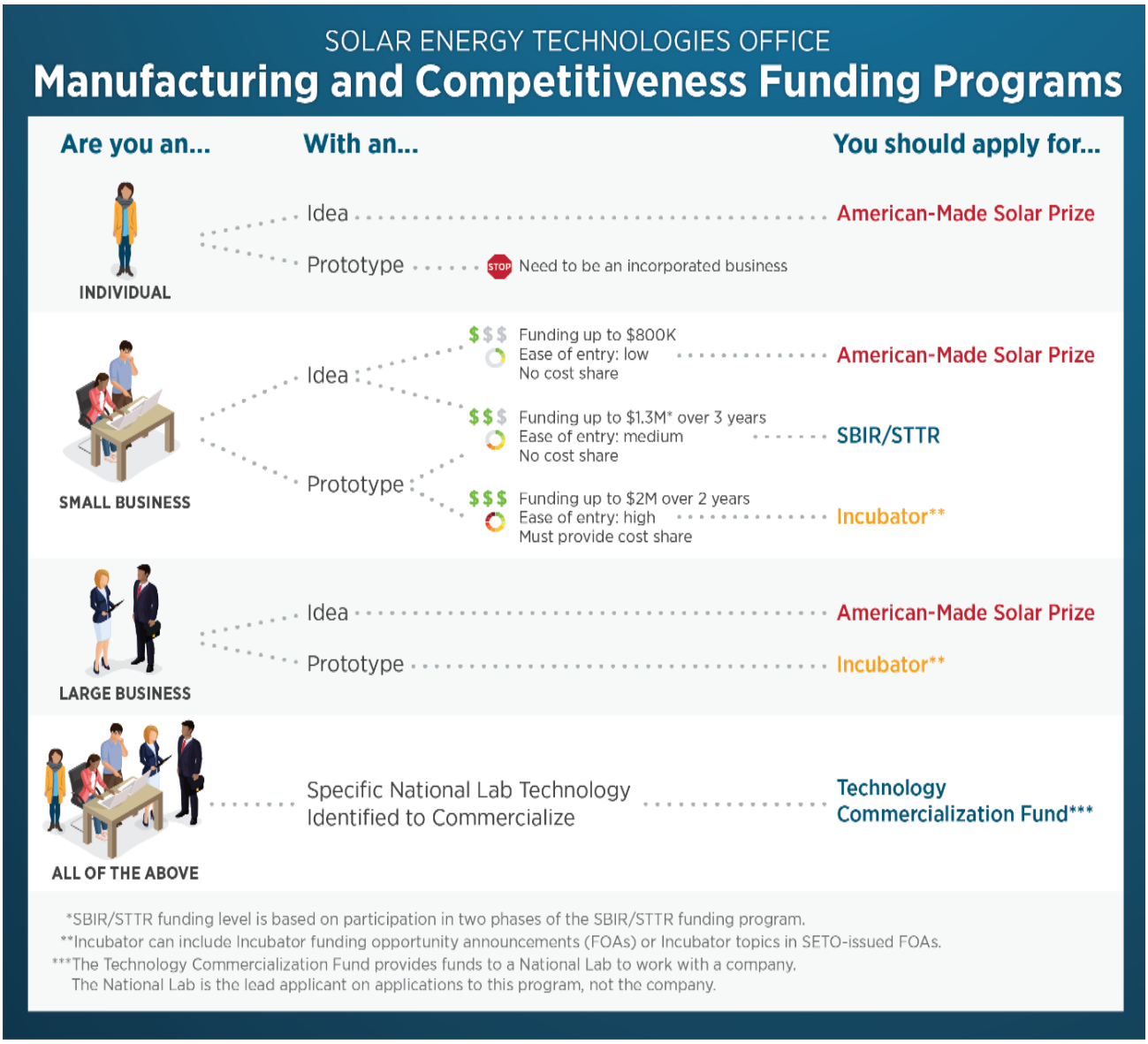
[83] https://americanmadechallenges.org/solarprize/index.html

[84] SETO. https://energy.gov/solar-office/sbir.

an idea (awarding up to $200,000); the second is focused on prototype development (awarding up to $1.1 million).

- The Technology Commercialization Fund[85] promotes federal research and development investments in technology with commercial potential where DOE National Laboratories are the lead applicants and require a commercial, private-sector partner to commit a 50% project cost share and be involved in project formation and execution with the goal of transferring the lab developed technology to the commercial project partner.

Figure 8, below, can help you decide where to submit an application.



[85] SETO. https://energy.gov/eere/solar/funding-opportunities
Questions about this FOA? Email SETO.FOA@ee.doe.gov. Problems with EERE Exchange? Email EERE-ExchangeSupport@hq.doe.gov. Include FOA name and number in subject line.

Figure 8. *SETO funding programs that support commercialization.*

All work under EERE funding agreements must be performed in the United States. See Section IV.K.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 Section I.A. and I.B. of the FOA.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).

D. Authorizing Statutes

The programmatic authorizing statute is the programmatic authorizing statute is EPACT 2005, Section 931 931(a)(2)(B).

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

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make a total of approximately $45,000,000 of federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 11 to 15 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $300,000 and $25,000,000.

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	Grid-Forming Technologies Research Consortium	1	$25,000,000	$25,000,000	$25,000,000	60
2	Integrating Behind-the-Meter Solar Resources into Utility Data Systems	2-3	$2,000,000	$3,000,000	$6,000,000	24-36
3a	Hardware Incubator – Product Development	6-12	$500,000	$1,500,000	$6,000,000	18-24
3b	Hardware Incubator – Product Development & Demonstration	1-4	$1,500,000	$3,000,000	$8,000,000	18-36

EERE may establish more than one budget period for each award and fund only the initial budget period(s). Funding for all budget periods, including the initial budget period, is not guaranteed. Before the expiration of the initial budget period(s), EERE may perform a down-select among different recipients and provide additional funding only to a subset of recipients.

ii. Period of Performance

EERE anticipates making awards that will run from 12 months up to 60 months, comprised of one or more budget periods. Project continuation will be

contingent upon several elements, including satisfactory performance and Go/No-Go decision review. For a complete list, see Section VI.B.xiv. At the Go/No-Go decision points, EERE 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. As a result of this evaluation, EERE 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.

Topic Area Number	Topic Area Title	Estimated Duration of Award (months)
1	Grid-Forming Technologies Research Consortium	60
2	Integrating Behind-the-Meter Solar Resources into Utility Data Systems	24-36
3a	Hardware Incubator – Product Development	18-24
3b	Hardware Incubator – Product Development & Demonstration	18-36

iii. New Applications Only

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

B. EERE Funding Agreements

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

i. Cooperative Agreements

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

Through cooperative agreements, EERE provides financial or other support to accomplish a public purpose of support or stimulation authorized by federal

statute. Under cooperative agreements, the government and prime recipients share responsibility for the direction of projects.

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

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

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

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. Individuals

U.S. citizens and lawful permanent residents are eligible to apply for funding as a prime recipient or subrecipient.

ii. Domestic Entities

For-profit entities, educational institutions, and nonprofits that are incorporated (or otherwise formed) under the laws of a particular state or territory of the United States and have a physical location for business operations in the United States are eligible to apply for funding as a prime recipient or subrecipient. Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995 are not eligible to apply for funding.

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

DOE/NNSA FFRDCs are eligible to apply for funding as a subrecipient in all topic areas and are eligible to apply as a prime recipient for Topics 1 and 2 only.

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

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

Eligibility Restriction:
Topic Areas 3a and 3b: Eligibility to Topic areas 3a and 3b is restricted. Prime recipients must be for-profit businesses. The scope of work performed by the prime recipient must represent the majority of the work performed (51% or more), as measured by the total project costs. All other entities described here may be subrecipients.

iii. Foreign Entities

Foreign entities, whether for-profit or otherwise, are eligible to apply for funding under this FOA. Other than as provided in the "Individuals" or "Domestic Entities" sections above, all prime recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a state or territory of the United States and have a physical location for business operations in the United States. If a foreign entity applies for funding as a prime recipient, it must designate in the Full Application a subsidiary or affiliate incorporated (or otherwise formed) under the laws of a state or territory of the United States to be the prime recipient. The Full Application must state the nature of the corporate relationship between the foreign entity and domestic subsidiary or affiliate.

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

In the waiver request, the applicant must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to have a foreign entity serve as the prime recipient. EERE may require additional information before considering the waiver request.

A foreign entity may receive funding as a subrecipient with an approved waiver to the performance of work in the United States requirement. Please see Appendix C.

iv. Incorporated Consortia

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

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

v. Unincorporated Consortia

Unincorporated consortia, which may include domestic and foreign entities, must designate one member of the consortium to serve as the prime recipient/consortium representative. The prime recipient/consortium representative must be incorporated (or otherwise formed) under the laws of a state or territory of the United States. The eligibility of the consortium will be determined by the eligibility of the prime recipient/consortium representative under Section III.A. of the FOA.

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

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

B. Cost Sharing

Topic Areas 1 and 2: The cost share must be at least 20% of the total allowable costs (i.e., the sum of the government share, including FFRDC costs if applicable, and the recipient share of allowable costs equals the total allowable cost of the

project) for research and development projects and education and outreach (or project activities) and 50% of the total allowable costs for demonstration projects (or project activities) and must come from non-federal sources unless otherwise allowed by law. (See 2 CFR 200.306 and 2 CFR 910.130 for the applicable cost sharing requirements.)

Topic Area 3a: The cost share must be at least 20% of the total allowable costs for research and development projects (i.e., the sum of the government share, including FFRDC costs if applicable, and the recipient share of allowable costs equals the total allowable cost of the project) and must come from non-federal sources unless otherwise allowed by law. (See 2 CFR 200.306 and 2 CFR 910.130 for the applicable cost sharing requirements.)

Topic Area 3b: The cost share must be at least 50% of the total allowable costs for demonstration projects (i.e., the sum of the government share, including FFRDC costs if applicable, and the recipient share of allowable costs equals the total allowable cost of the project) and must come from non-federal sources unless otherwise allowed by law. (See 2 CFR 200.306 and 2 CFR 910.130 for the applicable cost sharing requirements.)

Topic Area Number	Topic Area Title	Cost Share Requirement
1	Grid-Forming Technologies Research Consortium	20%, 50%
2	Integrating Behind-the-Meter Solar Resources into Utility Data Systems	20%, 50%
3a	Hardware Incubator – Product Development	20%
3b	Hardware Incubator – Product Development & Demonstration	50%

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

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

- Expenditures that were reimbursed under a separate federal program.
- 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 Contracting Officer and incorporated into the project budget before the expenditures are incurred.

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

iv. Cost Share Contributions by FFRDCs

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

v. Cost Share Verification

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

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

vi. Cost Share Payment

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

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

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

C. Compliance Criteria

Letters of Intent, Concept Papers, Full Applications, and Replies to Reviewer Comments (encouraged for Topic Areas 1, 2, 3a, and 3b) must meet all compliance criteria listed below or they will be considered noncompliant. EERE will not review or consider noncompliant submissions, including Letters of Intent, Concept Papers, Full Applications, and Replies to Reviewer Comments that were: submitted through means other than EERE Exchange; submitted after the applicable deadline; and/or submitted incomplete. EERE will not extend the submission deadline for applicants that fail to submit required information by the applicable deadline due to server/connection congestion.

Topic Area Number	Topic Area Title	Is Letter of Intent applicable?	Is Letter of Intent required?	Is Concept Paper applicable?	Are Replies to Reviewer comments applicable?
1	Grid-Forming Technologies Research Consortium	Yes	No	Yes	Yes
2	Integrating Behind-the-Meter Solar Resources into Utility Data Systems	Yes	No	Yes	Yes
3a	Hardware Incubator – Product Development	Yes	No	Yes	Yes

3b	Hardware Incubator – Product Development & Demonstration	Yes	No	Yes	Yes

i. Compliance Criteria

1. *Letters of Intent (optional for Topic Areas 1, 2, 3a, and 3b)*
   Letters of Intent are deemed compliant if:
   - The applicant entered all required information and clicked the "Submit" button in EERE Exchange by the deadline stated in the FOA.

2. *Concept Papers (required for Topic Areas 1, 2, 3a, and 3b)*
   Concept Papers are deemed compliant if:
   - The Concept Paper complies with the content and form requirements in Section IV.D. of the FOA; and
   - The applicant successfully uploaded all required documents and clicked the "Submit" button in EERE Exchange by the deadline stated in this FOA.

3. *Full Applications*
   Full Applications are deemed compliant if:
   - The applicant submitted a compliant Concept Paper *(required for Topic Areas 1, 2, 3a, and 3b)*;
   - The Full Application complies with the content and form requirements in Section IV.E. of the FOA; and
   - The applicant successfully uploaded all required documents and clicked the "Submit" button in EERE Exchange by the deadline stated in the FOA.

4. *Replies to Reviewer Comments (encouraged for Topic Areas 1, 2, 3a, and 3b)*
   Replies to Reviewer Comments are deemed compliant if:
   - The Reply to Reviewer Comments complies with the content and form requirements in Section IV.F. of the FOA; and
   - The applicant successfully uploaded all required documents to EERE Exchange by the deadline stated in the FOA.

D. Responsiveness Criteria

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

E. Other Eligibility Requirements

i. Requirements for DOE/National Nuclear Security Agency (NNSA) Federally Funded Research and Development Centers (FFRDC) Listed as the applicant

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

The following wording is acceptable for the authorization:

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

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

ii. Requirements for DOE/NNSA and non-DOE/NNSA Federally Funded Research and Development Centers Included as a Subrecipient

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

5. *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.

6. *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.

   In addition to obtaining authorization from the cognizant Contracting Officer, Office of Science Laboratories are required to provide written authorization from the Director of Laboratory Policy (SC-32) with the application.

The following wording is acceptable for this authorization:
Authorization is granted for the [Enter Laboratory Name] 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.

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

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

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

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

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

Topic Areas 1, 2, 3a, and 3b: An entity may submit more than one Concept Paper and Full Application to this FOA, provided that each application describes a unique, scientifically distinct project and provided that an eligible Concept Paper was submitted for each Full Application.

G. Questions Regarding Eligibility

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

IV. Application and Submission Information

A. Application Process

For Topic Areas 1, 2, 3a, and 3b, the application process will include three phases: a Letter of Intent phase, 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**.

Topic Area(s)	Phase 1: Letter of Intent	Phase 2: Concept Paper	Phase 3: Full Application
Topic Areas 1, 2, 3a, and 3b	Yes	Yes	Yes

At each phase, EERE performs an initial eligibility review of the applicant submissions to determine whether they meet the eligibility requirements of Section III of the FOA. EERE will not review or consider submissions that do not meet the eligibility requirements of Section III. All submissions must conform to the following form and content requirements, including maximum page lengths (described below) and must be submitted via EERE Exchange at https://eere-Exchange.energy.gov, unless specifically stated otherwise. **EERE will not review or consider submissions submitted through means other than EERE Exchange, submissions submitted after the applicable deadline, or incomplete submissions**. EERE will not extend deadlines for applicants who fail to submit required information and documents due to server/connection congestion.

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

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

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

size of 12 point or larger (except in figures or tables, which may be 10-point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies. References must be included as footnotes or endnotes in a font size of 10 or larger. Footnotes and endnotes are counted toward the maximum page requirement;

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

Applicants are responsible for meeting each submission deadline. **Applicants are strongly encouraged to submit their Letters of Intent, 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 Letter of Intent, Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Letter of Intent, 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 Letter of Intent, Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline.

EERE urges applicants to carefully review their Letters of Intent, Concept Papers, Full Applications, and Replies to Reviewer Comments to allow sufficient time for the submission of required information and documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V.A.ii. of the FOA.

B. Application Forms

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

Note: The maximum file size that can be uploaded to the EERE Exchange website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page

limit specified in the FOA, it must be broken into parts and denoted to that effect. For example:
TechnicalVolume_Part_1
TechnicalVolume_Part_2

C. Content and Form of the Letter of Intent

Letters of Intent will be used by EERE to plan for the merit review process. The letters should not contain any proprietary or sensitive business information. The letters will not be used for down-selection purposes, and do not commit an applicant to submit an application.

EERE will not review or consider ineligible Letters of Intent (see Section III of the FOA).

Each applicant must provide the following information as part of the Letter of Intent:

All Topic Areas:

- Project Title;
- Lead Organization;
- Organization Type (Business < 500 Employees; Business > 1000 Employees; Business 500-1000 Employees; FFRDC; Government-Owned, Government Operated; Non-Profit; University);
- Whether the application has been previously submitted to EERE;
- % of effort contributed by the Lead Organization;
- The Project Team, including:
  - The Principal Investigator for the prime recipient;
  - Team Members (i.e., subrecipients); and
  - Key Participants (i.e., individuals who contribute in a substantive, measurable way to the execution of the proposed project);
- Technical Topic or Area; and
- Abstract – The abstract provided should be not more than 200 words in length, and should provide a truncated explanation of the proposed project.

D. Content and Form of the Concept Paper

To be eligible to submit a Full Application, applicants must submit a Concept Paper by the specified due date and time. Applicants must submit a Concept Paper for Topic Areas 1, 2, 3a and 3b. To be eligible to submit a Full Application, applicants for those topics' areas must submit a Concept Paper by the specified due date and time.

i. Concept Paper Content Requirements

EERE will not review or consider ineligible Concept Papers (see Section III of the FOA).

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

The Concept Paper must conform to the following content requirements:

Section	Page Limit	Description
Cover Page Section	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, and any statements regarding confidentiality.
Technology Description and Addendum	4 pages maximum	Technology Description -- Applicants are required to describe succinctly: • The proposed technology, including its basic operating principles and how it is unique and innovative; • The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target could be met); • The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; • The potential impact that the proposed project would have on the relevant field and application; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project. Addendum -- Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: • Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan;

		• Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has worked together with its teaming partners on prior projects or programs; and • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities. • Applicants may provide graphs, charts, or other data to supplement their Technology Description.
Concept Slide	1 page maximum	Applicants are required to provide a single PowerPoint slide summarizing the proposed project. The slide must be submitted in Microsoft PowerPoint format. This slide is used during the evaluation process and should be legible when viewed on a screen in a conference room. The content of this Summary Slide must not include any proprietary or sensitive business information as DOE may make it available to the public after selections are made. The Summary Slide requires the following information: • The project's key idea/takeaway • A description of the project's impact • Proposed project goals • Any key graphics (illustrations, charts, and/or tables) • Project title, Prime Recipient, Principal Investigator, and Subrecipients • Requested SETO funds and proposed applicant cost share (if applicable)

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. An applicant who receives a "discouraged" notification may still submit a Full Application. EERE will review all eligible Full Applications. However, by discouraging the submission of a Full Application, EERE intends to convey its lack of programmatic interest in the proposed project in an effort to save the applicant the time and expense of preparing an application that is unlikely to be selected for award negotiations.

EERE may include general comments provided from reviewers on an applicant's Concept Paper in the encourage/discourage notification posted on EERE Exchange at the close of that phase.

E. Content and Form of the Full Application

Applicants must submit a Full Application by the specified due date and time to be considered for funding under this FOA. Applicants must complete the following application forms found on the EERE Exchange website at https://eere-Exchange.energy.gov/, in accordance with the instructions.

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

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

i. Full Application Content Requirements

EERE will not review or consider ineligible Full Applications (see Section III. of the FOA).

Each Full Application shall be limited to a single concept or technology. Unrelated concepts and technologies shall not be consolidated in a single Full Application. Full Applications must conform to the following requirements:
Topic Area 1:

Component	File Format	Page Limit	Required Template
Technical Volume	PDF	30	
Resumes	PDF	1	
Letters of Commitment	PDF	1	
SF-424			https://www.grants.gov/web/grants/forms/sf-424-family.html
Budget Justification Workbook			
Summary/Abstract for Public Release	PDF	1	
Summary Slide	MS PowerPoint	1	
Subrecipient Budget Justification			
DOE Work Proposal for FFRDC, if applicable (see DOE O 412.1A, Attachment 3)	PDF		

Authorization from cognizant Contracting Officer for FFRDC	PDF		
SF-LLL Disclosure of Lobbying Activities	PDF		
Foreign Entities and Foreign Work	PDF		
U.S. Manufacturing Plan	PDF		
Open Source Software Distribution Plan	PDF		
Data Management Plan	PDF		

Topic Areas 2, 3a, and 3b:

Component	File Format	Page Limit	Required Template
Technical Volume	PDF	15	
Resumes	PDF	1	
Letters of Commitment	PDF	1	
SF-424			https://www.grants.gov/web/grants/forms/sf-424-family.html
Budget Justification Workbook			
Summary/Abstract for Public Release	PDF	1	
Summary Slide	MS PowerPoint	1	
Subrecipient Budget Justification			
DOE Work Proposal for FFRDC, if applicable (see DOE O 412.1A, Attachment 3)	PDF		
Authorization from cognizant Contracting Officer for FFRDC	PDF		
SF-LLL Disclosure of Lobbying Activities	PDF		
Foreign Entities and Foreign Work	PDF		
U.S. Manufacturing Plan	PDF		

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

TechnicalVolume_Part_1
TechnicalVolume_Part_2

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

Questions about this FOA? Email SETO.FOA@ee.doe.gov. Problems with EERE Exchange? Email EERE-ExchangeSupport@hq.doe.gov. Include FOA name and number in subject line.

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

ii. Technical Volume

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

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

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

Topic Area Number	Topic Area Title	Page Limit
1	Grid-Forming Technologies Research Consortium	30
2	Integrating Behind-the-Meter Solar Resources into Utility Data Systems	15
3a	Hardware Incubator - Product Development	15
3b	Hardware Incubator - Product Development & Demonstration	15

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

SECTION/PAGE LIMIT	DESCRIPTION

Cover Page (1)	The cover page should include the project title, the specific FOA Topic Area being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Project Overview (Approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact (Approximately 30% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state of the art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state of the art/technical baseline if the project is successful.
Summary Statement of Project Objectives (Approximately 40% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed SOPO is separately requested. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes.

	• Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on Go/No-Go decision points). The applicant should describe the specific expected end result of each performance period. • WBS and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard WBS for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this FOA. The summary provided should be consistent with the SOPO. The SOPO will contain a more detailed description of the WBS and tasks. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be Specific, Measurable, Achievable, Relevant, and Timely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO. • Go/No-Go Decision Points: The applicant should provide a summary of project-wide Go/No-Go decision points at appropriate points in the Workplan. A Go/No-Go decision point 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 a minimum, each project must have at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of

	the project. See Section VI.B.xiv. The applicant should also provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. The summary provided should be consistent with the SOPO. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone. • End of Project Goal: The applicant should provide a summary of the end of project goal(s). At a minimum, each project must have one SMART end of project goal. The summary provided should be consistent with the SOPO. • Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points. • Project Management: The applicant should discuss the team's proposed management plan, including the following: o The overall approach to and organization for managing the work o The roles of each project team member o Any critical handoffs/interdependencies among project team members o The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices o The approach to project risk management o A description of how project changes will be handled o If applicable, the approach to Quality Assurance/Control o How communications will be maintained among project team members • Market Transformation Plan: The applicant should provide a market transformation plan, including the following: o Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan o Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. Manufacturing Plan, and product distribution.
Team Qualifications and Resources	The Technical Qualifications and Resources should contain the following information:

(Approximately 20% of the Technical Volume)	• Describe the project team's unique qualifications and expertise, including those of key subrecipients.
	• Describe the project team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project.
	• This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives.
	• Describe the time commitment of the key team members to support the project.
	• Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable.
	• For multi-organizational or multi-investigator projects, describe succinctly:
	  ○ The roles and the work to be performed by each PI and Key Participant;
	  ○ Business agreements between the applicant and each PI and Key Participant;
	  ○ How the various efforts will be integrated and managed;
	  ○ Process for making decisions on scientific/technical direction;
	  ○ Publication arrangements;
	  ○ Intellectual Property issues; and
	  ○ Communication plans

iii. Resumes

Applicants are required to submit 1 page resumes for key participating team members. Multi-page resumes are not allowed. Save the resumes in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Resumes".

iv. Letters of Commitment

Submit letters of commitment from all subrecipient and third-party cost share providers. If applicable, also include any letters of commitment from partners/end users (1-page maximum per letter). Save the letters of commitment in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_LOCs".

v. SF-424: Application for Federal Assistance

Complete all required fields in the EERE Exchange system 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-242 in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_424".

vi. Budget Justification Workbook

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

vii. Summary/Abstract for Public Release

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

viii. Summary Slide

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

The Summary Slide template requires the following information:

- A technology summary;
- A description of the technology's impact;
- Proposed project goals;
- Any key graphics (illustrations, charts and/or tables);
- The project's key idea/takeaway;
- Project title, prime recipient, Principal Investigator, and Key Participant 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. 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".

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

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

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

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

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

xii. Waiver Requests: Foreign Entities and Foreign Work (if applicable)

1. **Foreign Entity Participation:**
   As set forth in Section III.A.iii., all prime recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. Appendix C lists the necessary information that must be included in a request to waive this requirement.

2. **Performance of Work in the United States (Foreign Work Waiver)**
   As set forth in Section IV.K.iii., all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the prime recipient should make every effort to purchase supplies and equipment within the United States. Appendix C lists the necessary information that must be included in a foreign work waiver request.

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

xiii. U.S. Manufacturing Commitments

Pursuant to the DOE Determination of Exceptional Circumstances (DEC) dated September 9, 2013, each applicant under each topic area is required to submit a U.S. Manufacturing Plan as part of its application. The U.S. Manufacturing Plan

represents the applicant's measurable commitment to support U.S. manufacturing as a result of its award.

Each U.S. Manufacturing Plan must include a commitment that any products embodying any subject invention or produced through the use of any subject invention will be manufactured substantially in the United States, unless the applicant can show to the satisfaction of DOE that it is not commercially feasible to do so (referred to hereinafter as "the U.S. Competitiveness Provision"). The applicant further agrees to make the U.S. Competitiveness Provision binding on any subawardee and any assignee or licensee or any entity otherwise acquiring rights to any subject invention, including subsequent assignees or licensees. A subject invention is any invention conceived of or first actually reduced to practice under an award.

DOE does not expect the U.S. Manufacturing Plans to be tied to a specific product or technology. However, in lieu of the U.S. Competitiveness Provision, an applicant may propose a U.S. Manufacturing Plan with more specific commitments that would be beneficial to the U.S. economy and competitiveness. For example, an applicant may commit specific products to be manufactured in the U.S., commit to a specific investment in a new or existing U.S. manufacturing facility, keep certain activities based in the U.S. or support a certain number of jobs in the U.S. related to the technology. An applicant which is likely to license the technology to others, especially universities for which licensing may be the exclusive means of commercialization the technology, the U.S. Manufacturing Plan may indicate the applicant's plan and commitment to use a specific licensing strategy that would likely support U.S. manufacturing.

If DOE determines, at its sole discretion, that the more specific commitments would provide a sufficient benefit to the U.S. economy and industrial competitiveness, the specific commitments will be part of the terms and conditions of the award. For all other awards, the U.S. Competitiveness Provision shall be incorporated as part of the terms and conditions of the award as the U.S. Manufacturing Plan for that award.

The U.S. Competitiveness Provision is also a requirement for the Class Patent Waiver that applies to domestic large business under this FOA (see Section VIII.J. Title to Subject Inventions).

Save the U.S. Manufacturing Plan in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_USMP".

xiv. Data Management Plan (DMP)

Topic Area 1: Applicants are required to submit a DMP with their Full Application.

Topic Areas 2, 3a, and 3b: Applicants whose Full Applications are selected for award negotiations will be required to submit a DMP during the award negotiations phase.

An applicant may select one of the template Data Management Plans (DMP) listed below. Alternatively, instead of selecting one of the template DMPs below, an applicant may submit another DMP provided that the DMP, at a minimum, (1) describes how data sharing and preservation will enable validation of the results from the proposed work, how the results could be validated if data are not shared or preserved and (2) has a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publications. DOE Public Access Plan dated July 24, 2014 provides additional guidance and information on DMPs.

Option 1 (when protected data is allowed): For the deliverables under the award, the recipient does not plan on making the underlying research data supporting the findings in the deliverables publicly-available for up to five (5) years after the data were first produced because such data will be considered protected under the award. The results from the DOE deliverables can be validated by DOE who will have access, upon request, to the research data. Other than providing deliverables as specified in the award, the recipient does not intend to publish the results from the project. However, in an instance where a publication includes results of the project, the underlying research data will be made available according to the policies of the publishing media. Where no such policy exists, the recipient must indicate on the publication a means for requesting and digitally obtaining the underlying research data. This includes the research data necessary to validate any results, conclusions, charts, figures, images in the publications.

Option 2: For any publication that includes results of the project, the underlying research data will be made available according to the policies of the publishing media. Where no such policy exists, the recipient must indicate on the publication a means for requesting and digitally obtaining the underlying research data. This includes the research data necessary to validate any results, conclusions, charts, figures, images in the publications.

Save the DMP in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_DMP".

xv. Open Source Software Distribution Plan

Applicants for Topic 1 are required to submit an Open Source Software Distribution Plan as part of their Full Application. Open Source Software Distribution Plans are optional for Topic 2 &3. This plan describes how software produced under this FOA will be distributed. Submission of an Open Source Software Distribution Plan is required; failure to submit a complete Plan may result in a determination of non-compliance for your Full Application. Guidance for preparing an Open Source Software Distribution Plan is included in Appendix D of the FOA. Save the Open Source Software Distribution Plan in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_OSSDP".

F. Content and Form of Replies to Reviewer Comments

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

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

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

Topic Areas 1, 2, 3a, and 3b:

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

G. Post Selection Information Requests

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

- Indirect cost information;
- Other budget information;
- Commitment Letters from Third Parties Contributing to Cost Share, if applicable;
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5);
- Representation of Limited Rights Data and Restricted Software, if applicable; and
- Environmental Questionnaire.

H. Dun and Bradstreet Universal Numbering System (DUNS) Number 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 DUNS 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 DUNS 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.

I. Submission Dates and Times

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

J. Intergovernmental Review

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

K. Funding Restrictions

i. Allowable Costs

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

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

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

ii. Pre-Award Costs

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

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

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

made; or (3) if an award is made for a lesser amount than the selectee anticipated.

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

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

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

1. **Requirement**
   All work performed under EERE awards must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment; however, the prime recipient should make every effort to purchase supplies and equipment within 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

There may be limited circumstances where it is in the interest of the project to perform a portion of the work outside the United States. To seek a foreign work waiver, the applicant must submit a written waiver request to EERE. Appendix C lists the necessary information that must be included in a request for a foreign work waiver.

The applicant must demonstrate to the satisfaction of EERE that a waiver would further the purposes of the FOA and is in the economic interests of the United States. EERE may require additional information before considering a waiver request. Save the waiver request(s) in a single PDF file. The applicant does not have the right to appeal EERE's decision concerning a waiver request.

iv. Construction

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

v. Foreign Travel

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

vi. Equipment and Supplies

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

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

vii. Domestic Preference – Infrastructure Projects

As appropriate and to the extent consistent with law, Applicants shall ensure that, to the greatest extent practicable, iron and aluminum as well as steel, cement, and other manufactured products (items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber) used in the proposed project shall be produced in the United States. This requirement shall flow down to all sub-awards including all contracts, subcontracts and purchase orders for work performed under the proposed project.

viii. Lobbying

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

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

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

ix. Risk Assessment

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

In addition, DOE evaluates the risk(s) posed by applicants before they receive federal awards. This evaluation may consider: results of the evaluation of the applicant's eligibility; the quality of the application; financial stability; quality of management systems and ability to meet the management standards prescribed in this part; history of performance; reports and findings from audits; and the applicant's ability to effectively implement statutory, regulatory, or other requirements imposed on non-federal entities.
In addition to this review, DOE must comply with the guidelines on government-wide suspension and debarment in 2 CFR 180, and must require non-federal entities to comply with these provisions. These provisions restrict federal awards, subawards and contracts with certain parties that are debarred, suspended or otherwise excluded from or ineligible for participation in federal programs or activities.

x. Invoice Review and Approval

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

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

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.

Topic Areas 1, 2, 3a, and 3b:

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

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

ii. Full Applications

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

Topic Areas 1, 3a, and 3b:

Criterion 1: Innovation and Impact (40%)
The project is innovative and impactful, assuming the stated outcomes can be achieved as written. The project is differentiated with respect to existing commercial products, solutions, or technologies. If successful, the project is scalable to have a broader impact and maintained at a sufficiently large scale after project completion. If and as applicable, the project offers wide and open access to its data and software code deliverables.

Criterion 2: Quality and Likelihood of Completion of Stated Goals (30%)
The application demonstrates an understanding and appreciation of project risks and challenges the proposed work will face and incorporates reasonable assumptions related to the execution of the project (i.e. market size, customer participation, costs, speed of proposed scale-up or adoption). The information included for the project is validated through customer trials, data from prior work, report references, technical baselines established, etc. The stated goals of the project are SMART (Specific, Measurable, Achievable, Relevant, and Timely) and likely to be accomplished within the scope of this project. The proposed budget is reasonable to achieve the objectives proposed. For Topic Area 1 only: The application includes a clearly defined operational plan that supports a coherent system-oriented approach for proposed RD&D activities as well as management of relevant partnerships, facilities, and information assets.

A plan credible is in place to show the path to becoming self-sufficient after the award period.

Criterion 3: Capability and Resources of the Applicant/Project Team (20%)
The team is well qualified and has the capability and resources necessary to successfully complete the project. The team (including proposed subrecipients) have the training and experience to achieve the final results on time and to specification. The project team is fully assembled and committed to the project (verified through letters of support) and has a demonstrated record of successful past performance. For Topic Area 1 only: The Consortium director and management team have demonstrated strong leadership and stakeholder engagement capabilities from past experience in similar programs.

Criterion 4: Contribution to U.S. Manufacturing (10%)
The likelihood that the project will strengthen the competitiveness of domestic manufacturing and translate into increased long-term manufacturing and employment in the United States based on the resulting commercial products and technologies and commitments made in the U.S. Manufacturing Plan.

Topic Areas 2:

Criterion 1: Innovation and Impact (50%)
The project is innovative and impactful, assuming the stated outcomes can be achieved as written. The project is differentiated with respect to existing commercial products, solutions, or technologies. If successful, the project is scalable to have a broader impact and maintained at a sufficiently large scale after project completion. If and as applicable, the project offers broad and open access to its major data and software code products.

Criterion 2: Quality and Likelihood of Completion of Stated Goals (30%)
The application demonstrates an understanding and appreciation of project risks and challenges the proposed work will face and incorporates reasonable assumptions related to the execution of the project (i.e., market size, customer participation, costs, speed of proposed scale-up or adoption). The information included for the project is validated through customer trials, data from prior work, report references, technical baselines established, etc. The stated goals of the project are SMART (Specific, Measurable, Achievable, Relevant, and Timely) and likely to be accomplished within the scope of this project. The proposed budget is reasonable to achieve the objectives proposed.

Criterion 3: Capability and Resources of the Applicant/Project Team (20%)
The team is well qualified and has the capability and resources necessary to successfully complete the project. The team (including proposed subrecipients)

have the training and experience to achieve the final results on time and to specification. The project team is fully assembled and committed to the project (verified through letters of support) and has a demonstrated record of successful past performance

iii. Criteria for Replies to Reviewer Comments

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

B. Standards for Application Evaluation

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

C. Other Selection Factors

i. Program Policy Factors

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

- The degree to which the proposed project, including proposed cost share, optimizes the use of available EERE funding to achieve programmatic objectives;
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty;
- The degree to which the proposed project, or group of projects, represent a desired geographic distribution (considering past awards and current applications);

- The degree to which the proposed project exhibits technological or programmatic diversity when compared to the existing DOE project portfolio and other projects selected from the subject FOA;
- Based on the commitments made in the U.S. Manufacturing Plan, the degree to which the proposed project is likely to lead to increased employment and manufacturing in the United States or provide other economic benefit to U.S. taxpayers (Topic Area 2 Only); and
- The degree to which the project improves resilience of critical infrastructure;

Diversity (other than technological)

- The degree to which the proposed project exhibits team member diversity, with participants including but not limited to HBCUs/OMIs or members within Qualified Opportunity Zones.

Optimize Funding

- The degree to which the proposed project avoids duplication/overlap with other publicly or privately funded work.

Complementary Efforts

- The degree to which the proposed project supports complementary efforts or projects, which, when taken together, will best achieve the research goals and objectives.

Market Impact

- The degree to which the proposed project enables new and expanding market segments.

EE/Deployment

- The degree to which the project's solution or strategy will maximize deployment or replication.

Tech Transfer

- The degree to which the project promotes increased coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer.

D. Evaluation and Selection Process

i. Overview

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

matter of the FOA. Ultimately, the Selection Official considers the recommendations of the reviewers, along with other considerations such as program policy factors, in determining which applications to select.

ii. Pre-Selection Interviews

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

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

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

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

iii. Pre-Selection Clarification

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

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

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

iv. Recipient Integrity and Performance Matters

DOE, prior to making a federal award with a total amount of federal share greater than the simplified acquisition threshold, is required to review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313).

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

DOE will consider any written comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under federal awards when completing the review of risk posed by applicants as described in 2 C.F.R. § 200.205.

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

ii. Concept Paper Notifications

For topic areas that require applicants to submit a Concept Paper, EERE will notify applicants of its determination to encourage or discourage the submission of a Full Application. EERE will post these notifications to EERE Exchange.

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

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

iii. Full Application Notifications

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

iv. Successful Applicants

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

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

Please refer to Section IV.K.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 Exchange**
   Register and create an account on EERE Exchange at https://eereExchange.energy.gov. This account will then allow the user to register for any open EERE FOAs that are currently in EERE 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 EERE 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. **DUNS Number**
   Obtain a DUNS number (including the plus 4 extension, if applicable) at http://fedgov.dnb.com/webform.

3. **System for Award Management**
   Register with the SAM at https://www.sam.gov. Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called a Marketing Partner ID Number (MPIN) are important steps in SAM registration. Please update your SAM registration annually.

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

5. **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 Letters of Intent, Concept Papers, and Full Applications will not be accepted through Grants.gov.

6. **Electronic Authorization of Applications and Award Documents**
   Submission of an application and supplemental information under this FOA through electronic systems used by the DOE, including EERE Exchange and

FedConnect.net, constitutes the authorized representative's approval and electronic signature.

ii. Award Administrative Requirements

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

iii. Foreign National Access Under DOE Order 142.3A, "Unclassified Foreign Visits and Assignments Program"

All applicants selected for an award under this FOA may be required to provide information to DOE in order to satisfy requirements for foreign nationals' access to DOE sites, information, technologies, equipment, programs or personnel. A foreign national is defined as any person who is not a U.S. citizen by birth or naturalization. If a selected applicant (including any of its subrecipients, contractors or vendors) anticipates involving foreign nationals in the performance of its award, the selected applicant may be required to provide DOE with specific information about each foreign national to ensure compliance with the requirements for access approval. National laboratory personnel already cleared for site access may be excluded. Access approval for foreign nationals from countries identified on the U.S. Department of State's list of State Sponsors of Terrorism must receive final approval authority from the Secretary of Energy or the Secretary's assignee before they commence any work under the award.

iv. Subaward and Executive Reporting

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

v. National Policy Requirements

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

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

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

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

vii. Applicant Representations and Certifications

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

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

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

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

   For purposes of these representations the following definitions apply:

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

3. Nondisclosure and Confidentiality Agreements Representations

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

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

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

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

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

(3) Notwithstanding the provision listed in paragraph (a), a nondisclosure or confidentiality policy form or agreement that is to be executed by

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

viii. Statement of Federal Stewardship

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

ix. Statement of Substantial Involvement

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

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

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

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

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

x. Intellectual Property Management Plan (IPMP)

Topic Area 1: Within 30 days of selection, applicants must submit an executed IPMP between the members of the consortia or team.
Topic Areas 2, 3a, and 3b: An IPMP is not required.

The award will set forth the treatment of and obligations related to intellectual property rights between EERE and the individual members. The IPMP should describe how the members will handle intellectual property rights and issues between themselves while ensuring compliance with federal intellectual property laws, regulations, and policies (see Sections VIII.K.-VIII.N. of this FOA for more details on applicable federal intellectual property laws and regulations). Guidance regarding the contents of IPMP is available from EERE upon request.

The following is a non-exhaustive list of examples of items that the IPMP may cover:

- The treatment of confidential information between members (e.g., the use of NDAs);
- The treatment of background intellectual property (e.g., any requirements for identifying it or making it available);
- The treatment of inventions made under the award (e.g., any requirements for disclosing to the other members on an application, filing patent applications, paying for patent prosecution, and cross-licensing or other licensing arrangements between the members);
- The treatment of data produced, including software, under the award (e.g., any publication process or other dissemination strategies, copyrighting strategy or arrangement between members);
- Any technology transfer and commercialization requirements or arrangements between the members;
- The treatment of any intellectual property issues that may arise due to a change in membership of the consortia or team; and
- The handling of disputes related to intellectual property between the members.

xi. Subject Invention Utilization Reporting

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

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

xii. Intellectual Property Provisions

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

xiii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement. This helpful EERE checklist can be accessed at https://www.energy.gov/eere/funding/eere-funding-application-and-management-forms. See Attachment 2 Federal Assistance Reporting Checklist, after clicking on "Model Cooperative Agreement" under the Award Package section.

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. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the EERE program goals and objectives. Federal funding beyond the Go/No-Go decision point (continuation funding) is contingent upon (1) availability of federal funds appropriated by Congress for the purpose of this program; (2) the availability of future-year budget authority; (3) recipient's technical progress compared to the Milestone Summary Table stated in Attachment 1 of the award; (4) recipient's submittal of required reports; (5) recipient's compliance with the terms and conditions of the award; (6) EERE's Go/No-Go decision; (7) the recipient's submission of a continuation application; and (8) written approval of the continuation application by the Contracting Officer.

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

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

xv. Conference Spending

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

xvi. Uniform Commercial Code (UCC) Financing Statements

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

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

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

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

xviii. Table of Personnel

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. The table should include the individuals' names, job titles, role in the project and their organization. Recipients will have an ongoing responsibility to notify DOE of changes to the personnel and submit an updated list during the life of the life of the award as there are changes to the personnel working on the project.

VII. Questions/Agency Contacts

Upon the issuance of a FOA, EERE personnel are prohibited from communicating (in writing or otherwise) with applicants regarding the FOA except through the established question and answer process as described below. Specifically, questions regarding the content of this FOA must be submitted to SETO.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. **Please note that you must first select this specific FOA Number in order to view the questions and answers specific to this FOA**. EERE will attempt to respond to a question within 3 business days, unless a similar question and answer has already been posted on the website.

Questions related to the registration process and use of the EERE Exchange website should be submitted to: https://eere-Exchange.energy.gov.

VIII. Other Information

A. FOA Modifications

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

B. Government Right to Reject or Negotiate

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

C. Commitment of Public Funds

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

D. Treatment of Application Information

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

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

Concept Papers, Full Applications, Replies to Reviewer Comments, or other submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking

requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

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

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

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

E. Evaluation and Administration by Non-Federal Personnel

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

F. Notice Regarding Eligible/Ineligible Activities

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

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

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

H. Requirement for Full and Complete Disclosure

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

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

I. Retention of Submissions

EERE expects to retain copies of all Letters of Intent, Concept Papers, Full Applications, and Replies to Reviewer Comments 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;
- Large businesses, foreign entities and 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, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan are sufficient.
- Advance and Identified Waivers: For an applicant not covered by the Class Patent Waiver or the Bayh-Dole Act, the applicant may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784; and
- DEC: Each applicant is required to submit a U.S. Manufacturing Plan as part of its application. If selected, the U.S. Manufacturing Plan shall be incorporated into the award terms and conditions for domestic small businesses and nonprofit organizations. DOE has determined that exceptional circumstances exist that warrants the modification of the standard patent rights clause for small businesses and non-profit awardees under Bayh-Dole to the extent necessary to implement and enforce the U.S. Manufacturing Plan. Any Bayh-Dole entity (domestic small business or nonprofit organization) affected by this DEC has the right to appeal it.

K. Government Rights in Subject Inventions

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

1. Government Use License

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

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

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

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

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

L. Rights in Technical Data

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

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

Government Rights in Technical Data Produced Under Awards: The U.S. government normally retains unlimited rights in technical data produced under

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

M. Copyright

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

N. Export Control

The U.S. government regulates the transfer of information, commodities, technology, and software considered to be strategically important to the U.S. 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". To ensure compliance with Export Controls, it is the prime recipient's responsibility to determine when its project activities trigger Export Controls and to ensure compliance.

Export Controls may apply to individual projects, depending on the nature of the tasks. When Export Controls apply, the recipient must take the appropriate steps to obtain any required governmental licenses, monitor and control access to restricted information, and safeguard all controlled materials. Under no circumstances may foreign entities (organizations, companies or persons) receive access to export controlled information unless proper export procedures have been satisfied and such access is authorized pursuant to law or regulation.

Applicants are advised that some of the results of the research conducted under this FOA are expected to be restricted for proprietary reasons and not published or shared broadly within the scientific community.

O. 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-07-16 dated May 22, 2007, found at: https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/memoranda/2007/m07-16.pdf

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).

P. Annual Independent Audits

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

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 C.F.R. § 200.501 and Subpart F.

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

APPENDIX A – COST SHARE INFORMATION

Cost Sharing or Cost Matching

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

How Cost Sharing Is Calculated

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

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

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

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

What Qualifies For Cost Sharing

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

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

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

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

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

General Cost Sharing Rules on a DOE Award

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

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

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

1. Waiver for Foreign Entity Participation as the Prime Recipient

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

Overall, the applicant must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to have a foreign entity serve as the prime recipient. A request to waive the *Foreign Entity Participation as the prime recipient* requirement must include the following:

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

EERE may require additional information before considering the waiver request.

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

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

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

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

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

EERE may require additional information before considering the waiver request.

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

APPENDIX D – OPEN SOURCE SOFTWARE

Open Source Software Distribution Plan.

Applicants that are applying to one or more Topic Areas for which open source software distribution is required must submit a plan describing how software produced under this FOA will be distributed. For a DOE National Laboratory or a FFRDC, the data rights clause, including rights and requirements pertaining to computer software, in its M&O Contract shall apply and shall take precedence over any requirement set forth in this Appendix. The plan must include the following elements:

1. A complete description of any existing software that will be modified or incorporated into software produced under this FOA, including a description of the license rights. The license rights must allow the modified or incorporated software to be distributed as open source.

2. A discussion of the open source license that the applicant plans to use for the software it plans to produce under the FOA, and how that choice furthers the goals of this FOA. The discussion must also address how the license conforms to the conditions listed below.

3. A method for depositing the software in a source code repository.

4. A method for sharing and disseminating the software and other information to team members or others when multiple parties will contribute to the development of the software or the FOA requires that the software or other information be shared or disseminated to others.

Open Source Definition: Open source licenses must conform to all of the following conditions:

Free Redistribution
The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale. The rights attached to the software must apply to all to whom the software is redistributed without the need for execution of an additional license by those parties.

Source Code
The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, i.e., downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program.

Deliberately obfuscated source code and intermediate forms such as the output of a preprocessor or translator are not allowed.

Derived Works
The license must allow modifications and derived works, and permit the option of distributing the modifications and derived works under the same terms as the license of the original software.

Integrity of the Author's Source Code
The license may restrict source-code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.

No Restriction Against Fields of Endeavor
The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.

License Must Not Be Specific to a Product or Technology
The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution. No provision of the license may be predicated on any individual technology or style of interface.

License Must Not Restrict Other Software
The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.

Examples of Acceptable Licenses
Apache License, 2.0
http://www.apache.org/licenses

The 2.0 version of the Apache License was approved by the Apache Software Foundation (ASF) in 2004. The goals of this license revision were to reduce the number of frequently asked questions, to allow the license to be reusable without modification by any project (including non-ASF projects), to allow the license to be included by reference instead of listed in every file, to clarify the license on submission of contributions, to require a patent license on

contributions that necessarily infringe the contributor's own patents, and to move comments regarding Apache and other inherited attribution notices to a location outside the license terms

The result is a license that is compatible with other open source licenses, while remaining true to and supportive of collaborative development across both nonprofit and commercial organizations.
All packages produced by the ASF are implicitly licensed under the Apache License, Version 2.0, unless otherwise explicitly stated.

GNU General or Public License (GPLv3)
http://www.gnu.org/licenses/gpl.html

The GNU General Public License (GNU GPL or simply GPL) is the most widely used free software license, originally written by Richard Stallman for the GNU Project.

The GPL is the first copyleft license for general use, which means that derived works must be distributed under the same license terms. Under this philosophy, the GPL grants the recipients of a computer program the rights of the free software definition and uses copyleft to ensure the freedoms are preserved, even when the work is changed or additions are made. This aspect distinguishes the GPL from permissive free software licenses, including the BSD licenses.
The license's copyright disallows modification of the license. Copying and distributing the license is allowed because the GPL requires recipients to get "a copy of this License along with the Program". According to the GPL FAQ, anyone can make a new license using a modified version of the GPL as long as he or she uses a different name for the license, does not mention "GNU", and removes the preamble, though the preamble can be used in a modified license if permission to use it is obtained from the Free Software Foundation (FSF).

GNU Library or “Lesser” General Public License (LGPLv3) http://www.gnu.org/licenses/lgpl.html

The GNU Lesser General Public License (formerly the GNU Library General Public License) or LGPL is a free software license published by the Free Software Foundation (FSF). It was designed as a compromise between the strong-copyleft GNU General Public License or GPL and permissive licenses such as the BSD licenses and the MIT License. The GNU Library General Public License (as the LGPL was originally named) was published in 1991, and adopted the version number 2 for parity with GPL version 2. The LGPL was revised in minor ways in the 2.1 point release, published in 1999, when it was renamed the GNU Lesser General Public License to reflect the FSF's position that not all libraries should use it. Version 3 of the LGPL was published in 2007 as a list of additional permissions applied to GPL version 3.

The LGPL places copyleft restrictions on the program governed under it but does not apply these restrictions to other software that merely link with the program. There are, however, certain other restrictions on this software.

The LGPL is primarily used for software libraries, although it is also used by some stand-alone applications, most notably Mozilla and OpenOffice.org.

The MIT License (MIT)
http://opensource.org/licenses/MIT

The MIT License is a free software license originating at the Massachusetts Institute of Technology (MIT). It is a permissive license, meaning that it permits reuse within proprietary software provided all copies of the licensed software include a copy of the MIT License terms. Such proprietary software retains its proprietary nature even though it incorporates software under the MIT License. The license is also GPL-compatible, meaning that the GPL permits combination and redistribution with software that uses the MIT License.

Software packages that use one of the versions of the MIT License include Expat, PuTTY, the Mono development platform class libraries, Ruby on Rails, Lua (from version 5.0 onwards), and the X Window System, for which the license was written.

Mozilla Public License 2.0 (MPL-2.0)
http://www.mozilla.org/MPL/2.0/

The Mozilla Public License (MPL) is a free and open source software license. Version 1.0 was developed by Mitchell Baker when she worked as a lawyer at Netscape Communications Corporation and version 1.1 at the Mozilla Foundation. Version 2.0 was developed in the open, overseen by Baker and led by Louis Villa. The MPL is characterized as a hybridization of the modified BSD license and GNU General Public License.

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APPENDIX E – GLOSSARY

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

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

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

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

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

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

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

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

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

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

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

APPENDIX F – DEFINITION OF TECHNOLOGY READINESS LEVELS

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

APPENDIX G – LIST OF ACRONYMS

Insert other acronyms applicable to this FOA (e.g., technology office name, technical terms or metrics)

COI	Conflict of Interest
DEC	Determination of Exceptional Circumstances
DMP	Data Management Plan
DOE	Department of Energy
DOI	Digital Object Identifier
EERE	Energy Efficiency and Renewable Energy
FAR	Federal Acquisition Regulation
FFATA	Federal Funding and Transparency Act of 2006
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
FFRDC	Federally Funded Research and Development Center
GAAP	Generally Accepted Accounting Principles
IPMP	Intellectual Property Management Plan
M&O	Management and Operating
MPIN	Marketing Partner ID Number
MYPP	Multi-Year Program Plan
NDA	Non-Disclosure Acknowledgement
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Agency
OMB	Office of Management and Budget
OSTI	Office of Scientific and Technical Information
PII	Personal Identifiable Information
R&D	Research and Development
RFI	Request for Information
RFP	Request for Proposal
SAM	System for Award Management
SOPO	Statement of Project Objectives
SPOC	Single Point of Contact
TIA	Technology Investment Agreement
TRL	Technology Readiness Level
UCC	Uniform Commercial Code
WBS	Work Breakdown Structure
WP	Work Proposal