DEPARTMENT OF ENERGY (DOE)
OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (EERE)

ENABLING EXTREME REAL-TIME GRID INTEGRATION OF SOLAR ENERGY (ENERGISE)

Funding Opportunity Announcement (FOA) Number: DE-FOA-0001495
FOA Type: Modification 0001
CFDA Number: 81.087

FOA Issue Date:	May 2, 2016
Informational Webinar:	May 19, 2016
Submission Deadline for Concept Papers:	June 17, 2016, 5:00pm ET
Submission Deadline for Full Applications:	August 26, 2016, 5:00pm ET
Expected Submission Deadline for Replies to Reviewer Comments:	October 14, 2016, 5:00pm ET
Expected Date for EERE Selection Notifications:	December 9, 2016
Expected Timeframe for Award Negotiations	60-90 days

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

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

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

MODIFICATIONS

All modifications to the Funding Opportunity Announcement are highlighted in yellow in the body of the FOA.

Mod. No.	Date	Description of Modification
0001	June 22, 2016	• Modified the link in section VI.B.12 to http://www1.eere.energy.gov/financing/resources.html.

TABLE OF CONTENTS

I. FUNDING OPPORTUNITY DESCRIPTION

A. DESCRIPTION/BACKGROUND

BACKGROUND

The U.S. Department of Energy (DOE) has developed this Funding Opportunity Announcement (FOA) as part of the Grid Modernization Initiative (GMI), taking into account the overall interests of both the Office of Energy Efficiency and Renewable Energy (EERE) and the Office of Electricity Delivery and Energy Reliability (OE). This FOA is issued by the EERE, Solar Energy Technologies Office; however it was prepared, and responses will be reviewed, in consultation and coordination with OE. While this FOA was designed to address a future with solar power interconnecting with the grid at scale, DOE recognizes that there may be other distributed generation and load (i.e. electric vehicles) technologies that also interconnect with the grid, and proposed solutions should not create negative consequences that are not addressed or identified.

The DOE SunShot Initiative is a collaborative national effort launched in 2011 that aggressively drives innovation to make solar energy cost competitive, without subsidies, with traditional energy sources before the end of the decade. SunShot supports efforts by private companies, universities, non-profit organizations, state and local governments, and national laboratories to drive down the cost of solar electricity to $0.06 per kilowatt-hour, without incentives, by the year 2020.

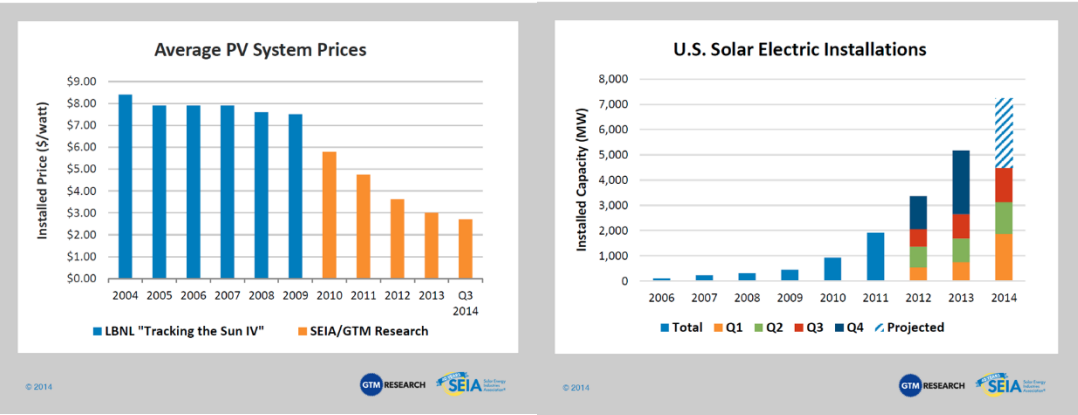

Figure 1. The installed cost of solar energy systems is rapidly decreasing (left). The solar deployment is rapidly increasing (right).

The installed costs of both solar photovoltaics (PV) and concentrating solar power (CSP) have fallen significantly in recent years, spurring significant growth and accelerating deployment of solar energy systems (Figure 1.). Between 2010 and 2015, the average price per kWh of a utility-scale PV project has dropped from about $0.21 to $0.10/kWh and the total cumulative

installed solar power (including PV and CSP) in the U.S. today has grown to approximately 28 gigawatts (GW).[1] A significant portion of the solar capacity is connected to distribution systems. Through the first half of 2015, the solar industry has supplied 40% of all new electric generating capacity.[2] When the price of solar electricity reaches the SunShot target, it will be cost-competitive with other non-renewable forms of electricity. This in turn will enable solar-generated power to grow from approximately 1% of the current electricity supply to about 14% by 2030 and 27% by 2050, as projected in the SunShot Vision Study, which corresponds to hundreds of GW of solar on the grid.[3]

A modern electricity grid is vital to the Nation's security, economy, and modern way of life, providing the foundation for essential services that Americans rely on every day. The nation's power grid, however, is aging, and faces a future for which it was not designed. Efforts are being made to address these issues. The DOE's Grid Modernization Initiative (GMI)[4] represents a comprehensive effort to help shape the future of our nation's grid and solve the challenges of integrating conventional and renewable sources while improving the reliability, resilience, affordability, flexibility, and security of the electric power grid. The GMI targets a transition that ensures the grid is resilient and secure enough to withstand growing cybersecurity and climate challenges. Through the GMI and its Multi-Year Program Plan (MYPP), [5] the DOE will help frame new grid architecture design elements, develop new planning and real-time operations platforms, provide metrics and analytics to improve grid performance, and enhance government and industry capabilities for designing the infrastructure and regulatory models needed for a successful grid modernization. The MYPP builds on concepts and recommendations from DOE's recently released Quadrennial Energy Review (QER) and Quadrennial Technology Review (QTR). [6]

[1] DOE SunShot analysis on PV markets and technologies.
[2] According to the "U.S. Solar Market Insight Report" by Solar Energy Industries Association (SEIA), http://www.seia.org/
[3] SunShot Vision Study, February 2012. Online access: http://energy.gov/eere/sunshot/sunshot-vision-study
[4] http://energy.gov/doe-grid-modernization-laboratory-consortium-gmlc-awards
[5] http://energy.gov/sites/prod/files/2016/01/f28/Grid%20Modernization%20Multi-Year%20Program%20Plan.pdf
[6] http://energy.gov/quadrennial-technology-review-2015

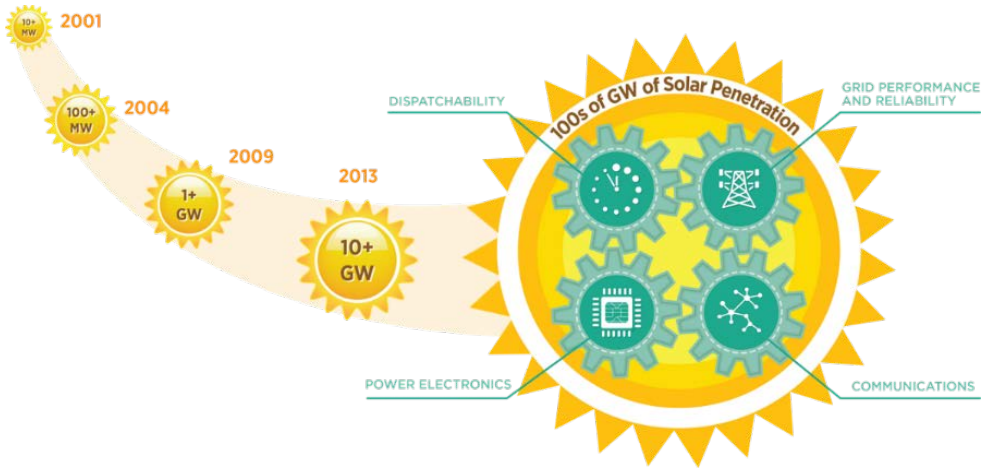

Figure 2. DOE SunShot System Integration Vision

As a part of the GMI, the SunShot Systems Integration (SI) subprogram works in coordination with other technology programs in the Office of Energy Efficiency and Renewable Energy (EERE) and the Office of Electricity Delivery and Energy Reliability (OE). The SI subprogram seeks to enable the widespread deployment of high penetrations of safe, reliable, secure, and cost effective solar energy on the nation's electricity grid by addressing the associated technical and regulatory challenges through targeted technology research, development, and demonstration (RD&D). Specifically, timely and cost-effective interconnections, optimal system planning, integration of solar forecast, real-time monitoring and control of distributed solar systems, and maintaining grid reliability are all challenges that require engineering innovations and technology breakthroughs. To proactively anticipate and address these challenges associated with a scenario in which hundreds (100s) of gigawatts of solar power are interconnected to the electricity grid, the SunShot Systems Integration subprogram has identified four broad, inter-related technical areas, as depicted in Figure 2., and described below.

Grid Performance and Reliability: Maintain and enhance the efficiency and reliability of electricity transmission and distribution grids in a cost-effective, safe manner with hundreds of gigawatts of solar generation deployed onto the nation's electricity grid.

Dispatchability: Ensure that solar power is available on-demand, when and where it is needed, in the desired quantities, and in a manner that is comparable to or better than conventional power plants.

Power Electronics: Develop inverters/converters and other intelligent devices that maximize the power output from solar power plants and interface with the electricity grid (or end use circuits), while ensuring overall system performance, safety, reliability, and controllability at minimum cost.

Communications, Sensing, and Data Analytics: Develop technologies and infrastructure that allow for more effective monitoring and control of solar energy generation, transmission, distribution and consumption under wide spatial and temporal scales.

FUNDING OPPORTUNITY OBJECTIVES

The main objectives of this ENabling Extreme Real-time Grid Integration of Solar Energy (ENERGISE) Funding Opportunity Announcement (FOA) are to:

1. Seek near-term (2020), commercially-ready and *highly scalable* distribution system planning and *real-time* operation solutions that seamlessly interconnect and integrate high penetration (>50% of distribution peak load) solar generation in existing grid architecture (e.g. centralized generation, transmission, and distribution) in a cost-effective, secure, and reliable manner. [7]

2. Seek long-term (2030), transformative and *highly scalable* technologies that plug into distribution system planning and *real-time* operation solutions for advanced grid architectures (e.g. distributed generation, dynamic network topology, microgrid, and potentially distribution level energy market) to enable extremely high penetration (> 100% of distribution peak load) solar generation in a cost-effective, secure, and reliable manner.

The envisioned ENERGISE solutions will require the extensive use of sensor, communication, and data analytics technologies to gather up-to-the-minute measurement and forecast data from diverse sources and perform continuous optimization analysis and active control for existing and new PV installations in real time. The solutions will build upon the PV hosting capacity[8] methods, smart inverters[9], and smart grid technologies[10], and further develop them into practical and scalable distribution system planning and real-time operation tools for day-to-day use by grid operators. The ultimate goal is to transition from static, manual, and cumbersome, experience-based, offline, non-scalable, and costly approaches to dynamic, automated, and streamlined, data-driven, online, highly-scalable, and cost-effective ones that are compatible with a broad set of grid modernization frameworks and solutions.

CHALLENGES TO BE ADDRESSED

Distributed variable generation sources, the present majority of which are distributed PV, are a key driver for the transformation of the electric power grid from today's centralized, static, and rigid system towards a more distributed, dynamic, and flexible system. The following challenges for distribution system planning and operations are fundamentally different from those existing today.

[7] For further description of a modernized grid and its attributes, see GMI's MYPP, p. 5.
[8] http://dpv.epri.com/hosting_capacity_method.html
[9] http://energy.gov/eere/sunshot/solar-energy-grid-integration-systems-advanced-concepts
[10] Smartgrid.gov

Two-Way (Bi-Directional) Power Flow: Historically, the electric power grid has been designed for power flow in one direction—from central generators to high voltage transmission networks to distribution substations to medium voltage distribution feeders and finally through distribution transformers to individual consumer loads. As the penetration of distributed generators such as rooftop PV increases, it is anticipated that during certain hours of the day, the distributed generation (e.g. rooftop solar) will exceed local consumption needs, potentially contributing to the power flows in the "reverse direction," from individual consumers through the feeders back to the distribution substation and possibly into the transmission system. Reverse power flow, as shown conceptually in Figure 3., is already happening in some high PV penetration areas such as Hawaii. [11]

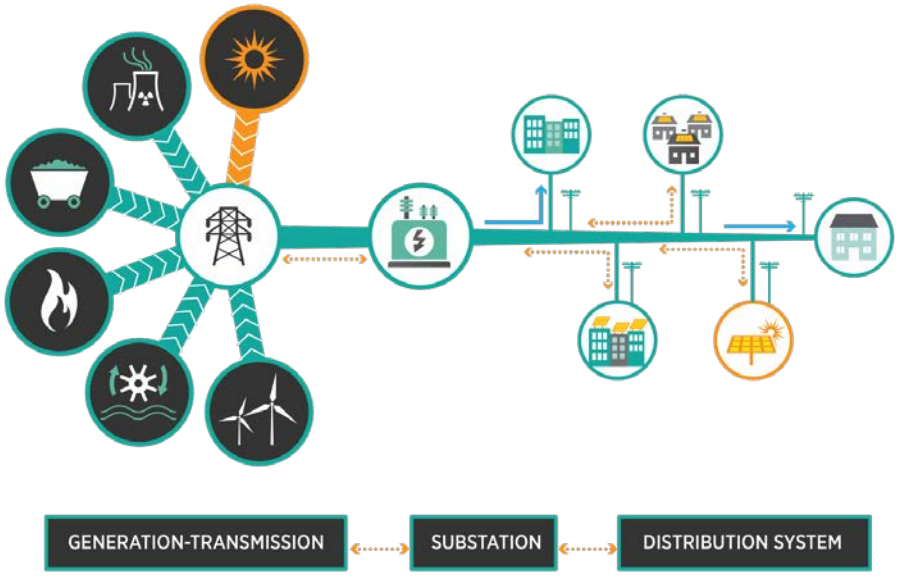

Figure 3. Two-way power flow on the electricity grid due to the integration of solar on the transmission and distribution systems.

Today's distribution grid is not equipped to manage reverse power flows, which poses fundamental challenges to safe and reliable operations. Thus, advanced solid-state transformers, power flow controllers, and fault protection equipment are part of DOE's broader grid research portfolio.[12] One challenge is the reconfiguration of protection equipment to handle bi-directional power flows and still trip for system faults correctly, without nuisance or sympathetic tripping. Reconfiguring protection systems adds cost and technical complexity due to the unpredictable and varying nature of bi-directional power flow from intermittent renewables such as solar power. Another key challenge is voltage regulation under reverse

[11] Dora Nakafuji, et al, "Minimum Day Time Load Calculation and Screening", Distributed Generation Interconnection Collaborative (DGIC) webinar, April 30, 2014. Online access: http://www.nrel.gov/tech_deployment/dgic.html.

[12] http://energy.gov/sites/prod/files/2015/09/f26/QTR2015-3F-Transmission-and-Distribution_1.pdf

power flow conditions. The current distribution system's primary voltage control equipment are voltage regulators (VRs), load tap changers (LTCs), and capacitor banks (CAP banks), which are designed and programmed to manage one-way power flow. The integration of distributed PV may cause excessive (in some cases several times more) operations of these assets compared to baseline operations without PV. Increase in equipment wear and tear results in the reduction of their service life and, in extreme cases, can cause direct damage and premature failure.[13] Another key challenge is the unintentional islanding during fault conditions. Currently, utilities either choose conservative approaches to limit the maximum PV penetration level including generation curtailment, or require costly mitigation methods one interconnection at a time. These are some of the major barriers for large scale solar deployment.

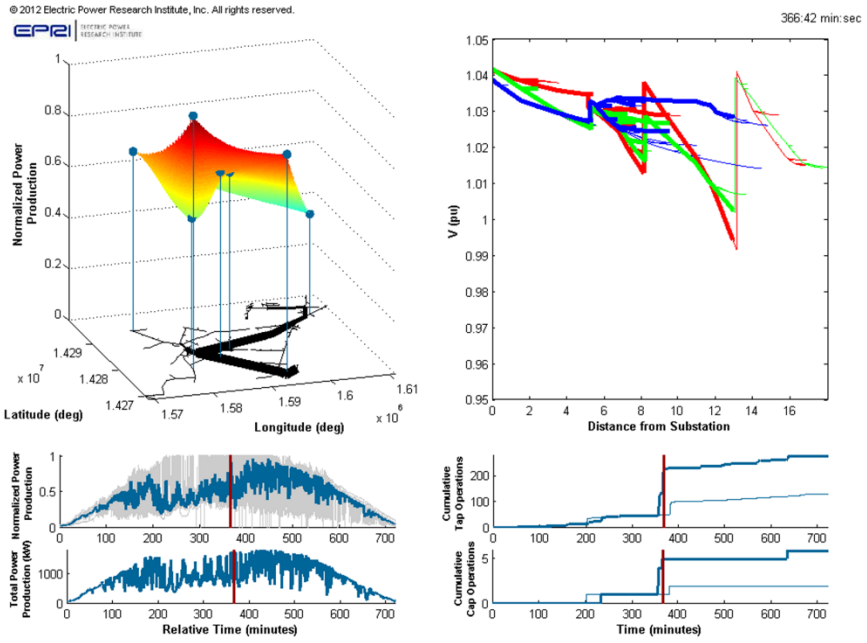

Figure 4. As the distributed solar generation varies minute-by-minute, the feeder voltage profile varies accordingly. The voltage control equipment (e.g. load tap changers and capacitor banks) significantly increase the number of operations in order to keep the voltage within the required limit. [14]

Variable Solar Generation: Traditional distribution system planning and operation has been based on snapshot power flow analysis of the feeder circuit at a limited number of scenarios (typically minimum and maximum load) for a period of one year to determine the potential voltage perturbations and other potential reliability issues. While this approach has been sufficient for the distribution system planning and operation dominated by predictable central

[13] Robert J. Broderick, et al, "Time Series Power Flow Analysis for Distribution Connected PV Generation", Sandia Report, SAND2013-0537, January 2013.

[14] Presentation, "DOE/VT/EPRI Hi-Pen PV Project, Phase II: Hosting Capacity Determinations for Two Feeders", EPRI, May 23, 2012. Online access: http://dpv.epri.com/media/epri_phase_ii_results.pdf.

generation and passive loads, the integration of high penetration distributed solar requires the analysis of fast-changing dynamics of solar generators due to the intermittent nature of cloud cover and weather. Novel techniques such as quasi-static time series (QSTS) and stochastic methods have been used in solar interconnection studies. Using the QSTS method, it has been shown (see Figure 4.) that the variability of solar generation can cause system voltage to fluctuate significantly (usually on a seconds to minutes timescale) and exceed ANSI C84.1 [15] limits at certain times and locations. Solar variability can also create power quality issues such as flickers.

However, QSTS analyses present daunting computational challenges. A one-year QSTS analysis at 1-minute resolution for one solar deployment scenario requires about 500,000 power flow snapshots, representing a number of simulation runs that is several orders of magnitude higher than in the current practice. Furthermore, hundreds and thousands of potential solar deployment scenarios are typically simulated in order to assess the impact of high penetration solar integration. Utilities' existing software tools lack the capability to implement advanced QSTS tools that are interoperable with legacy systems, making real-time decisions based on large volumes of streaming spatial and temporal data impractical. Research in computational algorithms for better modeling and software tools is underway, and may provide a base for significant performance improvement.[16] Currently, the interconnection study and approval time for a large distribution-connected PV system (>100kW) could take anywhere from 60 to 180 days, presenting a major barrier for large scale solar deployment. SunShot is targeting a combined interconnection study and approval time of less than 5 days for such systems by 2020, and less than 1 day by 2030.

Interactions Between Transmission and Distribution Systems: Existing numerical analysis algorithms decouple the transmission and distribution systems—distribution systems are treated as lumped loads for analysis of a transmission system. Likewise, the analysis of a distribution system considers the transmission system to be a constant supply source. With the proliferation of distributed solar generators and other distributed energy resources (DERs) that have the potential to create power flows from the distribution system to the transmission system, advanced numerical analysis paradigms must be created. The paradigm envisioned by ENERGISE includes real-time operations and operational planning algorithms that optimize diverse network configurations, coupling the whole or regional transmission grid with multiple distribution substations and their feeders downstream. Conventional assumptions of decoupled analysis will be inadequate for this. In order to enable the operations and planning of distribution networks with high penetration of solar generation and other DERs, it is imperative to develop numerical analysis algorithms – like distribution state estimation, quasi-static time series load flow analysis, optimal power flow for unbalanced networks, etc. – on seamlessly integrated transmission and distribution grids. Additional advanced power system

[15] http://www.ansi.org/, ANSI C84.1-2011 Electric Power Systems and Equipment - Voltage Ratings (60 Hertz)
[16] http://energy.gov/sites/prod/files/2015/09/f26/QTR2015-3E-Measurements-Communications-and-Controls.pdf; http://energy.gov/sites/prod/files/2015/09/f26/QTR2015-3D-Flexible-and-Distributed-Energy_0.pdf

analysis methods, such as machine learning and stochastic methods, will also be required for scalable, real-time, and robust system planning and operations to address the tremendous challenges in computational and modeling requirements at multiple operating time scales of solar generation variability. [17]

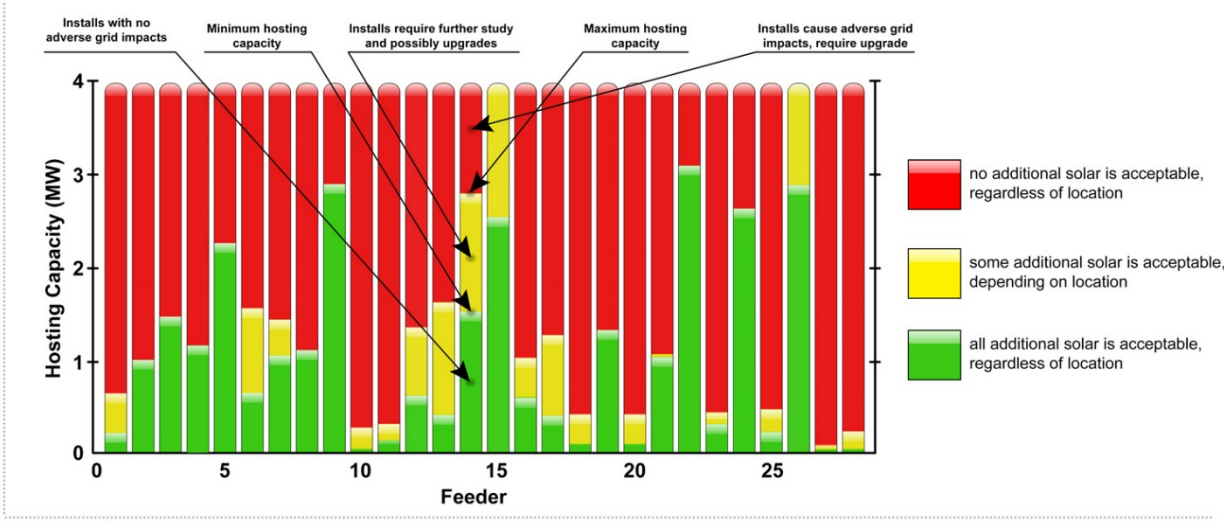

Figure 5. EPRI's distributed PV hosting capacity, ranging from less than 10% of peak load to more than 100%, for 28 feeders across the United States using high-resolution data.[18]

Lack of System Visibility and Control: While today's electric power grid is well monitored and controlled by system operators at the transmission and distribution substation levels, very little visibility and control are available beyond distribution substations. This is particularly true for distributed and behind-the-meter PV systems. The value of this functionality was demonstrated in the Smart Grid Investment Act program.[19] This lack of visibility raises serious concerns about system reliability when integrating solar generation at large scales due to the variability of solar production and reverse power flows. For reliable grid operations, electric power grid operators and planners need timely and accurate information about solar generators and the distribution system itself. For a large PV system with a single interconnection point to the distribution grid, it has been shown that solar generation variability can be predicted from a small number of irradiance sensors and/or single-module measurements based on geographic smoothing effects. [20,21] However, for smaller PV systems that are connected to the distribution grid at

[17] http://energy.gov/doe-grid-modernization-laboratory-consortium-gmlc-awards
[18] G. Hering, "New Tools and Methods Work to Integrate Solar on Local Circuits", EPRI Journal featured article, July 16, 2015. Online access: http://eprijournal.com.
[19] https://www.smartgrid.gov/recovery_act/index.html
[20] Presentation, "DOE/VT/EPRI Hi-Pen PV Project, Phase III: Smart Inverter Modeling Results, Variability Analysis, and Hosting Capacity Beyond Thresholds", EPRI, May 8, 2013. Online access: http://dpv.epri.com/media/epri_phase_iii_results.pdf
[21] M. Lave, et el, "Ota City: Characterizing Output Variability from 553 Homes with Residential PV Systems on a Distribution Feeder", Sandia Report, SAND2011-9011, November 2011

many locations, in some cases clustered to create hot spots, it is necessary to monitor and forecast solar generation at finer spatial and temporal scales.

Figure 5. shows the results of "hosting capacity" analysis using QSTS combined with stochastic modeling. It illustrates the importance of the unique feeder characteristics and the location of the distributed PV systems as well as the need for high resolution measurement data.

Figure 6. further illustrates the challenges as the electric power grid evolves from a centralized network architecture to a more distributed one, with ever increasing numbers of small and variable generators and DERs scattered throughout the grid. Smart PV inverters, smart grid devices, Advanced Metering Infrastructure (AMI) meters, and other DER controllers will all become monitoring and control points (or nodes) in the distribution system. The number of these "active nodes" will grow from today's range of tens for a typical distribution substation area to thousands and even millions in future distribution grids. Today's utility operators and planners lack the capabilities and tools to handle this large number of nodes and corresponding amount of data. For example, a hypothetical feeder circuit having a peak load of 5MW, 50% PV penetration relative to peak load, and average system size of 5kW, will result in 500 active nodes if every PV system is monitored and controlled.

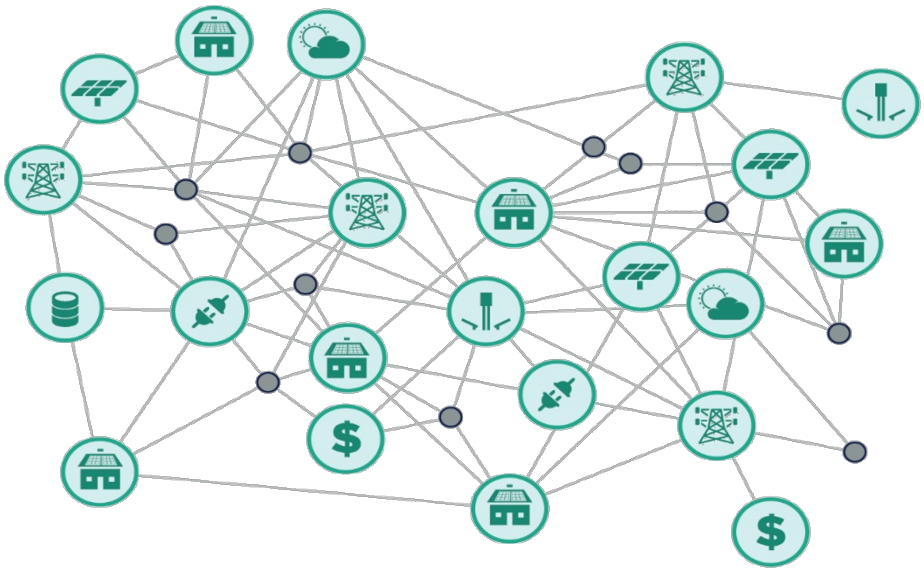

Figure 6. A conceptual diagram illustrating the communication needs and complexity in future electric power systems.

Communications requirements may vary greatly depending on use cases, node locations, and network topologies. In addition, both constituent technologies and the grid architecture are evolving rapidly. Therefore, the capabilities developed today need to be adaptable to address the future challenges while also maintaining compatibility with evolving architectures. Communication network latency, availability, scalability, cost, and cybersecurity are the key issues to be addressed when designing the solutions. Cybersecurity has become a top priority for the nation's electric power system because it is becoming increasingly interconnected and

dependent on the information technology and telecommunications infrastructures. [22] To summarize, the reliable and scalable integration of ubiquitous sensors, communication infrastructures, and big data management, all represent major challenges for large scale solar deployment.

Table 1. summarizes, at a high level, the major challenges to today's transmission and distribution systems resulting from high penetration of solar integration as well as other renewable and/or distributed energy resources. Since this funding opportunity focuses on addressing distribution system challenges, the transmission system challenges are included here for completeness but not discussed in detail.

Table 1. Challenges to the transmission and distribution systems from high penetration solar integration and other renewable and/or distributed energy resources.

Transmission System Challenges of High Penetration of Solar
• *Grid Operations* – increasing need for cycling and ramping of conventional generation, transmission utilization patterns and generation curtailment • *Grid Reliability* – impact on operating reserves and generation flexibility • *Grid Stability* – decreasing system inertia and its impact on frequency response and small signal stability • *Transmission Modeling Tools* – increasing need for dynamic system models in addition to traditional steady state models, transient stability models, and short circuit models • *Grid Operators* – lack of planning and operation tools and experience for managing high penetration PV • *Codes and Standards* – need for harmonizing NERC reliability standards with distribution system standards (e.g. IEEE 1547)
Distribution System Challenges of High Penetration of Solar
• *Voltage Regulation* – more frequent voltage excursions outside the service voltages ranges required by industry standards • *Unintentional Islanding* – safety hazards for line crews and the public due to uncontrolled generation • *Fault Restoration* – out-of-phase reclosing and transient overvoltage causing longer restoration time and lower system reliability • *Power Quality* – concerns that PV may cause more frequent power quality issues such as voltage flicker and harmonic distortion • *Protection Coordination* – potential for new fault current flow patterns impeding the ability of protection devices to detect and isolate faults, on the other hand, increase in system outages due to nuisance tripping • *Distribution Modeling Tools* – need to develop new quasi static time series analysis, interoperability with utility legacy software, model conversion, complex granular data and increase computational time • *Visibility and Control* – need to develop real-time visualization of distribution feeders, big data analytics, low cost sensors, and back-end hardware system • *Codes and Standards* – state interconnection process, IEEE 1547 series, FERC SGIP, UL1741, NEC and stakeholder engagement

[22] http://energy.gov/oe/services/technology-development/energy-delivery-systems-cybersecurity

- *Utilities* – lack of planning and operation tools and experience for managing high penetration PV

PAST RD&D EFFORTS

The DOE has worked with private industry and Federal, state, local, and tribal governments on a variety of initiatives to modernize the electric grid and access a diversity of energy resources. The GMI is one such effort, and reflects the importance of inter-Office coordination. OE has led the DOE's efforts to strengthen, transform, and improve energy infrastructure so that consumers have access to reliable, secure, and clean sources of energy; EERE has accelerated development and deployment of energy efficiency and renewable energy technologies and market-based solutions that strengthen U.S. energy security, environmental quality, and economic vitality.

For example, to address the challenges associated with high penetration of solar onto the electric power grid, the DOE SunShot Initiative has funded several RD&D programs focusing on various technical areas of solar grid integration. The Solar Energy Grid Integration Systems – Advanced Concepts (SEGIS-AC)[23] program funded the development and demonstration of smart inverter technologies that incorporate advanced grid-support functionalities and standard communication protocols. The High Penetration Solar Deployment[24] program funded modeling, testing, and evaluation of solutions to mitigate the impacts of high penetration of PV on distribution systems. The Improving Accuracy of Solar Forecasting[25] program funded the development, validation, and implementation of accurate forecasts of solar energy production across a range of temporal and spatial scales. The Solar Utility Networks: Replicable Innovations in Solar Energy (SUNRISE) [26] program funded projects that help utilities to incorporate solar energy into their long-term strategic planning and power system operations. The Sustainable and Holistic Integration of Energy Storage and Solar PV (SHINES) [27] program funded the development and demonstration of integrated, scalable, and cost-effective technologies that incorporate PV solar, energy storage and DER and work seamlessly to meet the needs of both the consumer and the electricity grid.

SunShot has also funded research programs at the DOE national laboratories[28] over the years to help understand the impact of, and create solutions for, high penetration of solar generation at both the bulk power and the distribution system levels. Most recently, as part of the DOE Grid Modernization Laboratory Consortium (GMLC) lab call, [29] the SunShot National Laboratory Multiyear Partnership (SuNLaMP) funding program was launched to develop a broader set of

[23] http://energy.gov/eere/sunshot/solar-energy-grid-integration-systems-advanced-concepts
[24] http://energy.gov/eere/sunshot/high-penetration-solar-deployment
[25] http://energy.gov/eere/sunshot/solar-forecasting
[26] http://energy.gov/eere/sunshot/solar-utility-networks-replicable-innovations-solar-energy
[27] http://energy.gov/eere/sunshot/sustainable-and-holistic-integration-energy-storage-and-solar-pv-shines
[28] http://energy.gov/eere/sunshot/national-laboratory-research-and-development-funding-opportunities
[29] http://energy.gov/doe-grid-modernization-laboratory-consortium-gmlc-awards

solutions to address the challenges of integrating hundreds of gigawatts (GW) of solar energy into the electric power grid.

As part of the GMI, the SunShot program closely collaborates and coordinates with the Office of Science, the Advanced Research Projects Agency-Energy (ARPA-E), the Office of Electricity Delivery and Energy Reliability (OE), and other technology programs within the Office of Energy Efficiency and Renewable Energy (EERE) to address the problems discussed above. This funding opportunity, ENERGISE, is developed in collaboration with OE and other EERE technology offices, and will also closely leverage the research activities in recent ARPA-E funding programs, NODES [30] and GRID-DATA [31].

DESCRIPTION OF THE SOLUTIONS

A SunShot Solar Energy Grid Integration Workshop [32] was held on October 29, 2015, in Washington, DC with participants from academia, industry, government, electric utilities, national laboratories, and regulatory agencies. These experts reaffirmed the urgent need for highly scalable and real-time solutions to manage high penetration of solar generation as well as the rich opportunities offered by integrating sensors, communications, and predictive data analytics technologies into the electric power grid. In addition, the participants identified the critical needs for a clear definition of research-based grid architecture taxonomy and for a coherent view of data and their utilization in grid management and operations.

The envisioned ENERGISE solutions aim to significantly reduce the time and cost for distribution level PV interconnection and integration through the development and demonstration of highly scalable, real-time operation and planning tools, using up-to-the-minute measurement and forecast data, as well as continuous optimization analysis and active control.

The solutions should consider wide ranges of distribution planning and operation scenarios with careful consideration of timescale (annual, daily, hourly, real-time), solar penetration levels (low to high), scalability (number of nodes), control hierarchies (system and local), network topology (radial, mesh, hybrid), legacy devices (LTCs, VRs, CAP banks, breakers, switches, reclosers), and emerging technologies (energy storage, flexible loads, and smart inverters).

For the near-term (2020) (Topic Area 1) (See Section I.B. for a description of topic areas), the proposed planning and operation solutions should be able to monitor and control in real time a distribution system (or subsystem) consisting of at least ten (10) distribution feeders and ten thousand (10,000) active nodes with 50% or more PV penetration relative to the peak load. In addition, the solutions should be able to dynamically respond to simple feeder switching events under radial network topology to ensure that the system operates in a reliable manner.

[30] http://www.arpa-e.energy.gov/?q=arpa-e-programs/nodes
[31] http://www.arpa-e.energy.gov/?q=news-item/doe-announces-11-million-seven-new-projects-test-new-options-optimal-efficiency-us
[32] http://energy.gov/eere/sunshot/downloads/grid-integration-solar-energy-workshop

For the long-term (2030) (Topic Area 2) (See Section I.B. for a description of topic areas), the proposed planning and operation solutions should be able to monitor and control a coupled sub-transmission and distribution system consisting of at least one thousand (1,000) distribution feeders and one million (1,000,000) active nodes with greater than 100% PV penetration relative to the peak load. In addition, the solutions should be able to dynamically and adaptively respond to complex feeder switching events under radial, mesh, or hybrid network topologies to ensure that the system operates in a reliable manner.

These solar penetration levels should be reached with highly distributed solar installations across the entire distribution system rather than with a few large solar installations connected directly to or near the substations.

The ENERGISE solutions will have the following hierarchical layers, as depicted in Figure 7. The proposed near-term solutions should address issues in all layers. The proposed long-term solutions may focus on a subset of the layers with consideration of the end-to-end system.

- Device and Local Control Layer
- Telecommunications and Data Layer
- Traditional System Layer
- Enhanced System Layer

Note that these layers are only one particular representation of the highly integrated and coupled components of the electric power grid. Other hierarchical representations may be considered as long as they meet the funding objectives. The solutions must have all the attributes described in the DOE Grid Modernization MYPP: reliable, resilient, sustainable, flexible, affordable, and secure. Innovations are sought in software, hardware, and system technologies in each layer, which integrate seamlessly into complete solutions. Some hardware and software building blocks, illustrated in Figure 7. as areas where critical challenges exist for high penetration solar generation, will evolve faster than others by adding new capabilities to address the critical challenges from high penetration of solar generation and other DERs. It is imperative that these new capabilities are developed with a coherent view of the future electric power grid and system information through modular design, interoperable interfaces, and consideration for expandability.

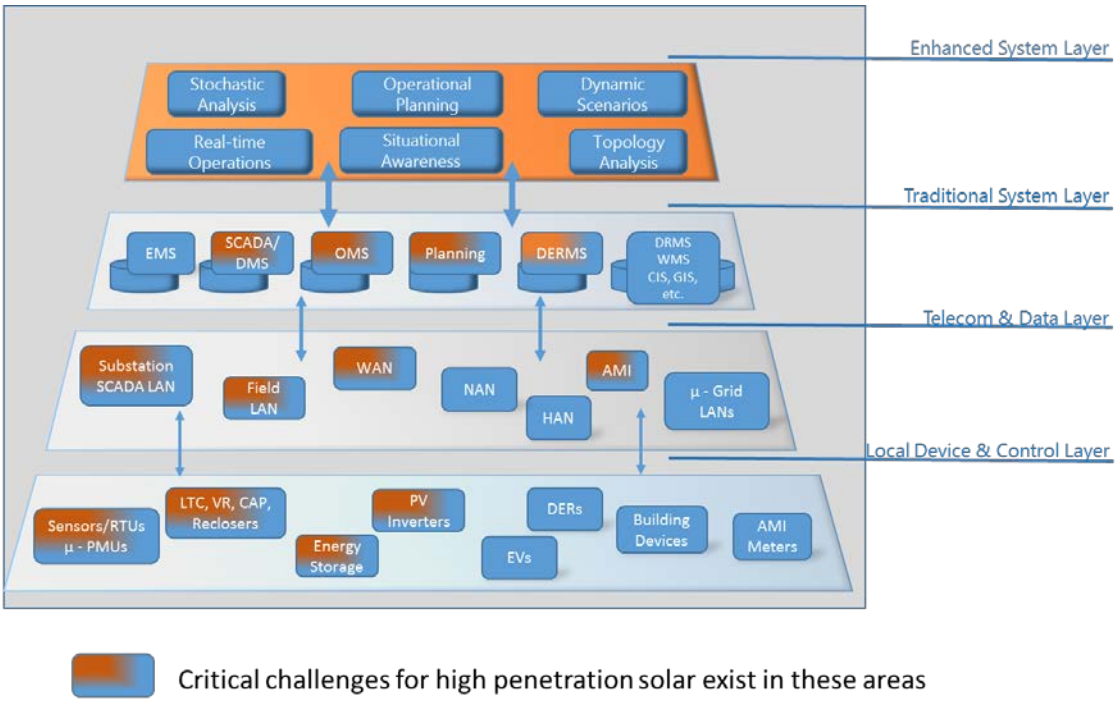

Figure 7. High level concept of the ENERGISE solution.

Device and Local Control Layer

The innovations sought in the Device and Local Control Layer include the development and integration of low-cost, "plug and play" smart sensor and local control devices for day-to-day distribution system operation. These include both legacy devices and emerging technologies that provide timely data acquisition and control, that are necessary to enable high penetration solar generation. It is desirable to integrate multiple functionalities: measurement, edge analytics, communication, and local control, into a single device in order to reduce system cost and integration complexity.

There are significant challenges in large-scale device integration and control coordination as PV and other DER installations become prevalent within the distribution system. The "multi-box" approach as commonly practiced today is not scalable nor cost effective. The diversity of device types, each having different capabilities, also causes major challenges in interoperability and cybersecurity. It is important to establish a common view of the data from all devices so that they can be used and managed consistently in distribution planning and real-time operation. More efforts are needed to harmonize existing standards and further coordinate the development of new standards for full interoperability. A clear delineation of control hierarchy and standardized behaviors of local and system level controls are also critical. Finally, devices from different technology generations should be able to coexist allowing for longer life cycles of grid assets. The set of specific requirements to be considered include, but are not limited to the following:

- Operating environment: indoor, outdoor
- Measurement types, accuracy, and sampling rate
- Data synchronization and location information
- Power schemes: main, battery, energy harvesting
- Cost
- Service life and reliability
- Edge analytics: some raw measurements need to be processed locally before sent, in order to reduce bandwidth requirement; report-by-exception technique should be used whenever possible.
- Local control: automatic or remote control mode, default parameter settings
- Multi-functionality: measurement, control, communication, and power conversion (i.e. PV inverters)
- Interoperability
- Cybersecurity
- Device management and maintenance
- Upgradability

For the near-term (Topic Area 1), the solutions should focus on existing devices and local controllers.

For the long term (Topic Area 2), the solutions should focus on the development and integration of more advanced devices and local controllers that are optimally designed to requirements listed above.

Telecom and Data Layer

The innovations sought in the Telecom and Data Layer include the most efficient and cost effective methods to collect, transport, process, and store the measurement data necessary for real-time system operation and planning analysis in order to manage high penetration of solar generation in the electric power system. These innovations should aim at enabling the transition of distribution control centers from mostly manual operations and data silos, to fully automated operations with an integrated data view of the entire system and without operator intervention.

Management of a high penetration of solar generation requires a large amount of real-time data from PV inverters and other sensors at very short time intervals, and reliable and robust communications. As more smart sensors and DERs are deployed, the available measurement data will increase by many orders of magnitude, creating a "big data"[33] problem that today's system operators are ill-equipped to handle. The electric power grid has a diverse set of data

[33] Gartner provides the following definition: 'Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation.' http://www.gartner.com/it-glossary/big-data/ accessed in January 2016

resources to integrate measurements, and data are provided with varying quality, sampling rate, and latency. For example, micro Phasor Measurement Unit (µPMUs) data are very accurate, time synchronized, sampled at 30 Hz, and collected instantaneously, whereas AMI meters typically provide 15-minute energy measurements collected once every few hours or a day. There may also be some SCADA data from distribution substations and remotely controllable equipment on the distribution feeder, despite the fact that the cost of installing and maintaining remote terminal units (RTUs) has been a deterrent at the distribution level. Data from distribution automation (DA) devices, PV inverters, electric vehicles (EV) and charging stations, weather and load forecasting, and utility information systems (e.g. CIS, GIS) vary significantly in what is measured, where it is measured, and which system is the system of records for them. All these data are potentially useful for real-time operation and system planning, but consistently merging and interfusing them presents significant challenges.

Proliferation of residential and small commercial PV installations poses a significantly challenging set of specific telecom and data requirements whose solutions would broaden to other DER installations within the distribution networks. These include, but are not limited to:

- Level of detail of the data resources: PV systems are being installed all around the distribution networks at the customer meter level
- Frequency of the data
- Locational information: both geographic coordinates and electrical connectivity
- Data being a source for computational analysis at the primary levels, such as state estimation and QSTS; and the secondary levels, such as irradiance forecasting and stochastic analysis, and machine learning
- Synchronization of data at the telecom and system levels
- Scalability
- Availability
- Latency
- Bandwidth
- Interoperability of diverse equipment
- Cybersecurity for the diverse equipment sources

For the near-term (Topic Area 1), solutions should focus on integrating existing information and communication technologies which may include fiber optics, Digital Subscriber Line (DSL), 3G/4G cellular wireless, WiFi, WiMAX, RF radio, satellite, power line communication (PLC), Zigbee, wireless mesh, and other technologies. To ensure interoperability, the solutions should comply with open industry standards and strive to be "plug and play" capable and technology agnostic. At the device level, the solutions should support standard communication protocols such as SunSpec Modbus, Smart Energy Profile (SEP 2), DNP3, and others. At the enterprise level, the solutions should reference the foundational work on DER management system (DERMS) that was initiated through a collaboration between EPRI, DOE, and NIST. [34] FOA

[34] Enterprise Integration Functions for Distributed Energy Resources: Phase 1, EPRI technical report 3002001249, December 2013

responses must include a discussion of the solution's approach to interoperability, and successful awardees will be responsible for creating and adhering to an interoperability plan. For data management, the solutions need to incorporate the modern data science technologies to increase the processing speed and throughput. Focused technical areas include, but are not limited to, the time synchronization of large amounts of data originating from different sources (PV inverters, AMI, OMS, SCADA, CIS, GIS etc.), efficient data transmission and sharing, common data repository, automatic conversion of data formats, and real-time data visualization. The communication and data management platforms need to be scalable, fast, secure, and expandable for future needs. For data interaction, all solutions should be compatible with the relevant industry standard(s). All solutions need to address incompatibility with other DER solutions, if any.

For the long-term (Topic Area 2), solutions should include new communication technologies that are efficient and cost-effective for collecting, manipulating, and visualizing data, for real-time operation at a large scale. More efforts are needed to further develop communication architectures and interfaces that are standardized, open and fully interoperable, and harmonize disparate existing standards. The solutions should include the development of new data technologies tailored for grid management to increase performance and reduce cost. These platforms should be based on a coherent view of the collective data and their utilization in grid management. Common data models and common operating environments should be adopted to break down technology and organizational silos, and open-source approaches should be actively pursued to lower the barrier of entry and integration costs for wide industry adoption. Finally, the communication networks themselves will become larger and more complex, which requires better network management to provide reliable and secure services. All solutions need to address in detail the resolution(s) to incompatibilities with other DER solutions, if any.

Traditional System Layer

The innovations sought in the Traditional System Layer include the creation of interfaces that link the existing planning and operation tools with real-time measurement data and control from the Telecom & Data Layer, and with the advanced power system analysis from the Enhanced System Layer. In particular, the measurement data and the control functions from PV inverters and energy storage should be fully integrated into grid planning and operation. Ultimately, these planning and operation tools will use common models and data sets, and easily share information among themselves. Systems of records must be clearly defined, and system database requirements must be designed to address any bottlenecks that may hinder seamless systems' integration.

The objectives of distribution system planning and operation have always been to maintain a safe operating environment, provide reliable services, maintain acceptable power quality, be reasonably efficient, and protect system and customer assets. Utilities have been using, to varying degrees, tools such as Energy Management System (EMS), substation Supervisory Control and Data Acquisition (SCADA), Distribution Management System (DMS), Outage

Management System (OMS), DER Management System (DERMS), and others to meet these objectives.

However, these tools are not adequate for utilities who pursue more diverse objectives such as integrating a diverse set of large scale distributed and renewable energy resources – including but not limited to rooftop PV, wind, storage, demand response, servicing new loads from large numbers of electric vehicles – improving system efficiency and reliability, and accommodating more demand response and energy efficiency programs. One challenge is that each of these tools has an isolated view of part of the system rather than an integrated view of the entire system. They typically use unique models and data sets that are not easily shared with other tools even though they are all designed for the same electric power grid. These tools have limited capability to handle real-time measurement data that are essential for managing high penetration solar generation and other DERs. Finally, traditional rule-based decision-making methods need to be replaced with or enhanced to more sophisticated data-driven methods that are scalable, autonomous, flexible, and adaptive.

For the near term (Topic Area 1), establishing Distribution Supervisory Control And Data Acquisition (D-SCADA) will allow utilities to implement advanced distribution applications such as Fault Location Isolation and Service Restoration (FLISR) and Volt-VAR Optimization (VVO) in the presence of high penetration solar generation. Through D-SCADA, it should be possible to monitor and control the feeder voltage profile across the distribution system to within permitted range (ANSI C84.1 standards) even when distributed solar generation, as well as generation from other DERs, rapidly fluctuates. Based on the real-time analysis from the Enhanced System Layer, optimal control signals should be automatically sent to load tap changers (LTCs), voltage regulators, and capacitor banks. The grid support functions (e.g. Volt-VAR control) from PV inverters and energy storage (ES) should be fully utilized for dynamic voltage management. D-SCADA, together with the Enhanced System Layer, should have the ability to identify the most suitable distribution controllable equipment (actuator) or combination of actuators, and the set points to control the feeder voltage. Built-in real-time sensitivity analysis is also needed to calculate the impact of a hypothetical action by an actuator on the distribution nodes and branches for various smart-inverter control strategies.

For the long-term (Topic Area 2), existing traditional information systems, such as DMS, OMS, SCADA, DERMS, as well as other relevant systems, should seamlessly interact with each other using industry standards without any telecom and data layer constraints, while enforcing the relevant cybersecurity requirements. Systems of records for each database need to be clearly defined and data duplication needs to be avoided, while enforcing data integrity and providing timely access to data on an as-needed basis. The hierarchical relationships with respect to other information systems within this layer, and also the enhanced system layer, need to be clearly defined and implemented, where necessary. These approaches will enable more efficient and effective integration of high penetration of solar generation and other DERs.

Enhanced System Layer

The innovations sought in the Enhanced System Layer include advanced methods to model, simulate, and predict distribution power system behaviors using large data sets in order to manage high penetration solar generation. These methods include real-time distribution power flow (PF), optimal distribution power flow (OPF), distribution system state estimation (DSSE), stochastic analysis, predictive analysis, dynamic scenario building for "what-if studies", and machine learning techniques. Innovations also include the capability to automatically recognize the changes in network topology due to planned and unplanned switching events. Ultimately, these innovations will enable the electric power system to operate as interconnected subnetworks that can be dynamically combined and separated to achieve optimal power flows and improved reliability. These capabilities should be modular and work seamlessly within the layer and with other layers.

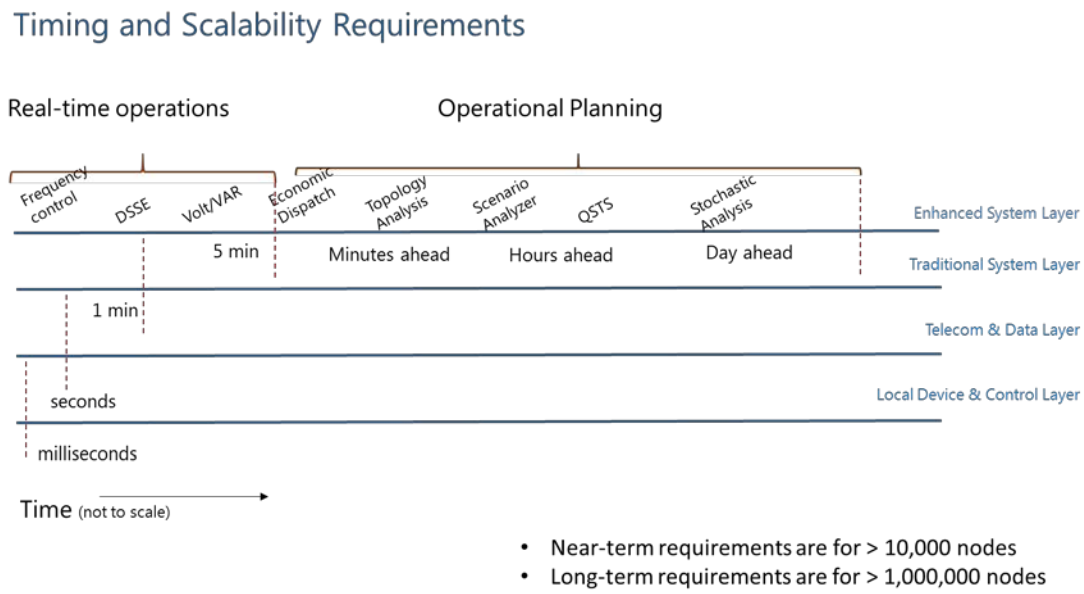

Figure 8. Illustration of time scales of various analysis and control processes included in the real-time operation and planning solutions.

These innovations are organized as real time operation and operation planning applications. Figure 8. illustrates the time scales for these applications and their underlying numerical analysis algorithms.

Real-time Operations: Real-time operations of power systems traditionally refers to the instantaneous balancing of the electric load with generation. It typically covers monitoring and control actions approximately within five-minute time intervals at power system control centers. With the proliferation of DERs, the implementation of smart grid technologies, and especially the projected growth of residential solar power generation, real-time operations need to extend the monitoring and controlling to a more complex and larger grid whose boundaries may be at the customer meter and beyond. Real-time operations may also need to go beyond the reliability of such a network, and may include financial transactions at the distribution customer level.

Situational Awareness: Past outages have proven that knowing the true dynamic and steady states of an electric grid is very important for preventing smaller outages from cascading to larger ones. One of the main goals of recent extensive synchrophasor installations on major power systems across the nation was to provide real-time measurements of the important electrical quantities both for transient and steady-state analysis. Much of this visibility, however, is limited to transmission network voltage levels. With DERs, specifically highly intermittent rooftop PV, gaining exponential footprint on the distribution system, there is a critical need for real time situational awareness at the distribution level.

Operational Planning: Operational planning typically refers to preparation for how weather, load, and generation conditions may change in the next minutes, hours, and days. Electric power generation, transmission, and distribution pose many challenges due to their unique characteristics. These include, but are not limited to: the power flows following well-known physical laws (rather than assigned routes); the inability to store electrical power in large enough quantities for immediate consumption; the difficulties in accurately forecasting the load ahead of time; and now, the difficulties in accurately forecasting the generation profiles from DERs, particularly solar residential and commercial PV.

Dynamic Scenarios: Operators and planners at power grid control centers need to prepare for spontaneous changes in the weather, load and generation fluctuations, and planned, as well as unplanned, contingencies. As such, they need to be able to simulate several different scenarios on the fly. Being able to look at variations both in network topology (including distribution feeders) and forecasted variables, which affect the main variables in power and optimal power flow analysis, can be only achieved by being able to dynamically analyze different scenarios. Security constrained analysis will also have to be extended to include the distribution substations and feeders.

Topology Analysis: One of the main challenges for carrying out advanced numerical analysis for power networks is the accuracy of the network/grid/feeders' topology data such as the true state of switches, accurate branch parameters and impedance values, loads being assigned to correct phases, etc. Accurate results from advanced power flow analysis can be achieved only if these input variables are accurate. Residential and small commercial PVs pose a significant challenge for topology analysis, as single phase PVs may not always be assigned to the correct phase in the network model. In addition, to active switch and branch monitoring, real-time probabilistic feeder topology recognition algorithms are required to determine various grid topology based on limited switching possibilities. Similarly, automatic topology-change recognition algorithms are required for feeder switching optimization.

Stochastic Analysis: Stochastic analysis has been used in long-term planning and day-ahead markets for operational and risk management in transmission networks. The random variables in this type of analysis typically include variations in fuel prices, system level load forecasts, bidding patterns in the energy markets, and contingencies defined as important by the operators. Clearly, with the proliferation of DERs, and especially with large numbers of small,

distributed and intermittent PV generation, such analysis needs to be extended to include distribution networks. A new generation of probabilistic modeling approaches is required to deal with multiple random processes, reflecting the true nature of the challenges that frame load and generation forecasting at the level of detail of distribution customer level.

For the near-term (Topic Area 1), the proposed solutions should implement distribution system state estimation (DSSE) which is critical to monitor and control large numbers of active nodes such as PV inverters. DSSE will focus on establishing true three-phase unbalanced network models, overcoming the lack of real-time measurement and limited data quality, and improving estimation accuracy and computation time.

Operational planning and real-time operations for distribution networks will also require significant innovation in power flow (PF) models. This includes the capability to handle different types of measurement data from conventional RTU/SCADA, μ-PMUs, as well as the latest generation smart inverters, line sensors, and smart meters. In addition, modeling enhancements to multiple-phase unbalanced power flow algorithms need to be incorporated.

QSTS analysis offers crucial advantages over the standard snap-shot approach. It provides important information to the operators and planning on the time-dependent real-time conditions and states of the distribution networks. In addition, what-if scenarios with potentially bi-directional (two-way power flow) due to the presence of intermittent DERs under certain generation/load conditions within the distribution networks can be built and studied by manipulating certain variables in the QSTS analyses. By streamlining PV interconnection studies and distributed energy resources planning, such methods should be incorporated into real-time operations and operational planning. Therefore auto-conversion capability from utility legacy feeder models to the QSTS modeling platform with the capability of scaling up thousands of feeders will be required, presenting significant and unprecedented computational challenges.

Innovations in optimal power flow (OPF) algorithms will also be needed to resolve the challenges presented by high penetration of DERs, in particular distributed residential PVs. These include robust algorithms for multi-objective functions such as Volt/VAR, loss minimization, minimum control actions, control actions to minimize voltage violations, and optimal placement of sensors for improved visibility unbalanced multi-phase distribution network models.

For the long-term (Topic Area 2), in addition to the near-term requirements, solutions should include DSSE-based reliability/security assessment to analyze contingencies and determine necessary corrective actions against possible failures in power systems, similar to transmission networks.[35] The PF models should include capabilities to analyze all feeders off of multiple sub-transmission or distribution substations - including the sub-transmission network and

[35] Y.-F. Huang, S. Werner, J. Huang, N. Kashyap, and V. Gupta, "State estimation in electric power grids: Meeting new challenges presented by the requirements of the future grid", Signal Processing Magazine, IEEE, vol. 29, no. 5, p. 33–43, 2012.

capabilities to handle the merging of multi-phase networks - including microgrids. QSTS should include innovative circuit topology modification algorithms – with circuit combining and/or dividing, and reduction capabilities while retaining key circuit parameters – to be designed and implemented for fast and accurate modeling. OPF algorithms should include economic dispatch with DERs, security constrained contingency analysis, and optimal circuit reconfiguration or switching. Predictive data analytics such as machine learning will also be required to augment OPF approaches, especially when performance requirements and/or accurate network data are obstacles to reliable and robust solutions for real-time and operational planning decisions. Such applications include, but are not limited to, real-time evaluation of circuit node voltages, predictive estimation of flexible loads and PV generation, energy storage dispatch, and other DER controls.

These predictive data analysis algorithms should be robust and dependable under different operation conditions to support prescriptive algorithms that will outline a set of controls to mitigate the system violations that are predicted. Prescriptive analysis algorithms should be fast enough to be run for long-term planning (typically months to years) and operational planning studies.

TECHNICAL PERFORMANCE TARGETS

The high level system requirements and detailed technical performance metrics for the ENERGISE solutions are listed below in Table 2. and 3., respectively.

Table 2. High Level System Requirements

Requirements	Baseline (2015)	Near Term (2020)	Long Term (2030)
Distribution level solar penetration[36, 37] 1) relative to peak load, 2) relative to day time minimum load (DML), 3) by annual energy production	<15% except for few cases	>50%	>100%
	<100% except for few cases	>125%	>250%
	<5% except for few cases	>20%	40-80%
Interconnection Review and Approval Time	10-60 days (<50kW) >10-90 days (50kW to 2MW) [38]	< 1 day (residential) < 5 days (commercial/utility)	in real time (residential) < 1 day (commercial/utility)
Reliability	SAIDI/SAIFI ANSI 84.1 IEEE, NERC	SAIDI/SAIFI ANSI 84.1 IEEE, NERC	SAIDI/SAIFI ANSI 84.1 IEEE, NERC
Distribution Network Scalability	~10s active nodes	~10,000s active nodes	~1,000,000s active nodes
Observability, Predictability & Visualization	Almost none	>80% coverage, Real-time visualization, Day-ahead, hour-ahead forecast	>99% coverage, Real-time visualization, Day-ahead, hour-ahead forecast, 5-minute forecast
Controllability & Optimization	Limited to legacy devices (LTC, CAP, VR) Non-optimal	Coordinated hierarchical control of legacy devices, PV inverters, ES and other DER controllers Optimized for operation	Coordinated hierarchical control of legacy devices, PV inverters, ES, other DER controllers, and emerging smart controllers Optimized for operation and emerging distribution energy market

[36] Assumptions: Annual peak-to-average electricity demand ratio, or the inverse of load factor, is 2. Solar generation capacity factor is 20% for the near term, 20-40% for the long term depending on the DC/AC ratio of solar power plants and the amount of integrated energy storage. The ratio of peak load and day time minimum load is 2.5. Capacity factor is defined as the ratio of the average load on (or power output of) an electricity-generating unit or system to the capacity rating of the unit or system over a specified period of time.

[37] These solar penetration levels should be reached with highly distributed solar installations across the entire distribution system rather than with a few large solar installations connected directly to or near the substations.

[38] A State-Level Comparison of Processes and Timelines for Distributed Photovoltaic Interconnection in the United States," NREL technical report, NREL/TP-7A40-63556, January 2015

Table 3. Detailed Technical Requirements and Performance Metrics

Requirements			Performance Metrics	
			Near-term	**Long-term**
Platform	Openness	Support application development and implementation by different 3rd parties without the need for any legacy system and database translators or transformations	Desired	Required
	Security	Secure API	Required	Required
	Interoperability	Device level - IEC 61850	Required	Required
		Enterprise level - IEC 61968 (CIM)	Required	Required
	Scalability	Network size by substations	>3	>10
		Network size by microgrids	>3	>10
		Network size by feeders	10	1,000
		Network size by active nodes	> 10,000	> 1 million
	Database	Synchronization of data among systems-of-records' databases	Up to 3 systems	> 10 systems
		Availability	Scheduled	On-demand
	Computation cycle	Real-time operation	< 1 minute	< 1 minute
		Operational planning	< 5 minutes	< 5 minutes
Device	Measurement and metadata	Locational Information	Required	Required
		Timestamps	Required	Required
		Time resolution for planning	1 minute	1 minute
		Time resolution for operation and control	1 second	1 second
Communication	Performance	Availability	Support real-time operation	
		Latency	Support real-time operation	
		Scalability	Support 1 million nodes	
Control	Response time	Local level	< 10 seconds	< 10 seconds
		Network level	< 30 seconds	< 30 seconds
		System level	< 1 minutes	< 1 minutes
		Enterprise level	< 5 minutes	< 5 minutes

Analytics	Distribution system state estimation (DSSE)	Observability (using both available sensors and SW techniques)	> 75%	> 99%
	Feeder topology recognition	Switch and branch status	> 10	> 100
		Real-time probabilistic feeder topology recognition	Desired solution time < 60 sec	Required solution time < 60 sec
	Distribution power flow (PF)	True multi-phase models	Capability to analyze all feeders off a single substation	Capability to analyze all feeders off multiple substations
	QSTS	Circuit reduction by size and simulation time	90%	90%
	Distribution optimal power flow (OPF)	Multi- objective optimization	Technical objectives such as Volt/Var	Techno-economic objectives including economic dispatch
	Stochastics Analysis	Predictive controls	Required for operational planning	Required for real-time operational planning
		Prescriptive controls	for long-term planning	for operational planning

Note: Proposals that present solutions to address only a subset of the metrics table must demonstrate clear linkages to other components of a system solution, such that the integrated system meets the overall target metrics.

B. Topic Areas/Technical Areas of Interest

Applicants to the FOA may submit applications in response to one or both topic areas below. However, a separate application needs to be submitted for each topic area.

For Topic Area 1, the proposed distribution planning and real time operation solutions should aim to address the near-term (2020) objectives as described in Section A, and meet all the respective technical metrics in Tables 2. and 3., as well as the requirements in Table 4., and activities below. Specifically, the near-term solutions should be commercially-ready and scalable, and seamlessly interconnect and integrate high penetration (>50% of distribution peak load) solar generation in existing grid architecture (e.g. centralized generation, transmission, and distribution) in a cost-effective, secure, and reliable manner.

For Topic Area 2, the proposed planning and real time operation solutions should aim to address the long-term (2030) objectives as described in Section A, and meet all the respective technical metrics in Tables 2. and 3., as well as the requirements in Table 4., and activities below. Specifically, these include transformative and highly scalable technologies that plug into distribution system planning and real-time operation solutions for advanced grid architectures, (e.g. distributed generation, dynamic network topology, microgrid, and potentially distribution level energy market) to enable extremely high penetration (> 100% of distribution peak load) solar generation in a cost-effective, secure, and reliable manner.

Table 4 General requirements for Topic Areas 1 and 2 proposals.

Note: A node is defined as a (or a set of) monitoring and control equipment connected to the distribution system at a point of common coupling. A virtual node is a logical representation of the physical node in computer simulations.

	Topic Area 1 Requirements Near-Term (2020)	Topic Area 2 Requirements Long-Term (2030)
Solution components	Require all layers in an end-to-end system solution	May focus on a subset of the layers with consideration of the end-to-end solution
Demonstration	Require at least one-year field demonstration	Strongly encourage field demonstration; may substitute with lab and/or virtual demonstration
Validation	Require at least 100 physical nodes monitored and controlled in field demonstration and 10,000 virtual nodes monitored and controlled in hardware-in-the-loop simulation.	Require at least 100 physical nodes monitored and controlled in hardware-in-the-loop simulation and 1,000,000 virtual nodes monitored and controlled in computer simulation.
Technology Readiness or Maturity Level	mid- to high-level, commercial-ready actual system	early- to mid-level, engineering prototypes
Utility partner(s)	Require at least one utility partner	Strongly encourage utility partners
Cost share required of awardee	50%	20%
Size of award	$500k - $4M	$500k - $2M

All applicants are required to perform all activities in their entirety as given below, as part of the overall project:

1. Design: Create an ENERGISE conceptual prototype that includes part (only if applying to Topic 2) or all (both topics) of the following solution components, and meets the respective performance metrics:

- Device and Local Control Layer
- Telecommunication and Data Layer
- Traditional System Layer
- Enhanced System Layer

Each proposing team is required (Topic 1) or encouraged (Topic 2) to include at least one utility partner (or an equivalent electricity service provider) as an integral and active member, and for Topic 1, the proposed ENERGISE solution should be accepted by the utility to be deployed at scale. DOE expects the utility partner in the project team to be integrally involved in the fundamental design and development of the ENERGISE solution, and provide specific guidance on the desired operation of the solution with the utility grid.

2. Development and Validation Testing: Perform detailed development, implementation, and validation testing of the proposed ENERGISE solution prototypes. The applicant should provide a detailed testing plan to demonstrate the effectiveness of the proposed technology in achieving the program objectives and technical performance targets. Testing should include real hardware and software in addition to computer simulations. Testing and validation should use real world measurement data or high-fidelity synthesized data with a sufficient level of detail and duration. Wherever possible, large scale hardware-in-the-loop testing is strongly desired to mimic the real world operation scenarios. Test results should show that all of the performance targets of the proposed ENERGISE solution can be met or exceeded, and as such form a critical milestone in this project.

3. Deployment and Demonstration: Field deployment and demonstration are required for Topic Area 1, and optional but strongly encouraged for Topic Area 2. In the case of Topic Area 2, if applicants choose not to propose field deployment and demonstration, a medium to large scale hardware-in-the-loop lab demonstration is required.

It is DOE's expectation that the field deployment will occur in a distribution system that is representative of those widely prevalent across the country, in either rural settings or densely populated urban environments, and anything in between. All equipment and components proposed as part of the ENERGISE solution, or proposed to be interacting with the developed ENERGISE solution, should be actual equipment operating in real-world conditions without a proxy or a simulator in place of the actual equipment. This is to ensure that the developed ENERGISE solution is installed and tested under the most commonly occurring conditions, and therefore provides a pathway to facilitate large-scale deployment.

Once the ENERGISE solution is installed, varying levels of continuous and dynamic visualization, control, and optimization should be verified to show that all of the performance targets can be met or exceeded after deployment of the ENERGISE solution, using actual performance data for at least 1 year.

Considerable interaction with both the utility and the consumer is expected of the ENERGISE solution, and should be studied as part of the deployment. The operational objectives for the proposed solution should include maximizing cost-effective utilization of installed solar systems, sensors, communication, and data infrastructures, and should further consist of a well-defined set of value metrics that will appeal to a broad range of potential stakeholders.

3. **Value Analysis:** Applicants should perform in-depth value analysis to show that there will be net benefits, that these benefits will be sustained if the ENERGISE solution is deployed at scale, and to show the pathway for deployment of the ENERGISE solution for levels of penetration of solar greater than 100% of peak load. The sustainability of benefits at varying penetration levels of solar can be shown through a blend of results from deployment, and from detailed modeling of deployment under very high solar penetration scenarios. A clear and credible pathway should be shown to be achievable with a very high degree of confidence toward meeting the SunShot LCOE target of 6 cents/kWh at wholesale level and reaching grid parity at the retail level. The assumptions, methodology, and calculations will be independently validated by DOE.

All pre- and post-deployment benefit analyses should be performed for two cases: a) to estimate benefits at the proposed location as baseline, and b) to estimate benefits when the ENERGISE solution is deployed at a scale for high penetration of solar. The assumptions for these analyses should be clearly stated, justified, and buy-in should be demonstrated by stakeholders including the customer and the utility. The economic analysis should be done with actual grid, market, and component, performance data as applicable, for a continuous period of at least 1 year. Economic modeling should be performed using stakeholder accepted methodologies and assumptions for both the year in which actual data is available, and future years' projections of net benefits under multiple scenarios. The pre-deployment analysis as indicated in the Design activity above will estimate the benefits that will be obtained upon implementation of the proposed solution whereas the post-deployment analysis in the Demonstration activity will calculate the benefits obtained using actual data obtained from the installation(s).

Applicants should also identify additional value propositions (such as synergies between PV, EV, and building load management) resulting from real time control and operation of the system, by using a multi-stakeholder team approach that includes the utilities, regulators, PV manufacturers, other equipment manufacturers, and consumers in the design and development stage.

5. Cybersecurity and Interoperability: Applicants should describe their strategies and plans for establishing and maintaining interoperability, and the utilization of open standards wherever

possible. Applicants should consider interoperability within their solution (among devices and/or subsystems) and at the external interfaces with other utility and customer systems. Applicants shall indicate where they have chosen to utilize proprietary standards.

Applicants should also describe their approach to establishing and maintaining cybersecurity throughout their solution, and at the interfaces to external components and systems. In accordance with the cybersecurity technique of defense-in-depth, applicants shall not cede responsibility for cybersecurity to the external boundaries of their proposed solution, nor shall they propose that it be added on at some later stage. Discussion should include a defense-in-depth approach with respect to the layers depicted in Figure 7 and within the layers relevant to the proposed solution, as well as appropriate and available standards.

Post award, Recipients will be required to submit an Interoperability Plan and a Cybersecurity Plan, detailing how they propose to implement and maintain these aspects of their solution. (See Appendix F & G for additional information).

All work under EERE funding agreements must be performed in the United States. See Section IV.J.3 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.B of the FOA,
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Applications with a focus on basic research in energy storage materials or the field deployment of energy storage systems

D. Authorizing Statutes

The programmatic authorizing statute is EPAct 2005 931(2)(A).

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

II. Award Information

A. Award Overview

1. *Estimated Funding*

EERE expects to make approximately $25 million of Federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 10-15 awards under this FOA. EERE may issue one, multiple, or no awards.

Individual awards may vary between $500k and $4 million for Topic Area 1, and between $500k and $2 million for Topic Area 2.

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.

2. *Period of Performance*

EERE anticipates making awards that will run up to 36 months in length. Project continuation will be contingent upon satisfactory performance and go/no-go decision 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 program goals and objectives. As a result of this evaluation, EERE will make a determination to continue the project, re-direct the project, or discontinue funding the project.

3. *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.

1. *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.9 of the FOA for more information on what substantial involvement may involve.

2. FUNDING AGREEMENTS WITH FFRDCS

The value of the Federally Funded Research and Development Centers (FFRDC) portion of an award will be included in the award to the Prime Recipient. The Awardee must then initiate an agreement (e.g. Work for Others, Cooperative Research and Development Agreements (CRADA), or Technology Services Agreement (TSA)) with any FFRDC Project Team members to arrange work structure, project execution, and any other matters.

3. GRANTS

Although EERE has the authority to provide financial support to Prime Recipients through Grants, EERE generally does not fund projects through Grants. EERE may fund a limited number of projects through Grants, as appropriate.

4. TECHNOLOGY INVESTMENT AGREEMENTS

In rare cases and if determined appropriate, EERE will consider awarding a Technology Investment Agreement (TIA) to a non-FFRDC applicant. TIAs, governed by 10 CFR Part 603, are assistance instruments used to increase the involvement of commercial entities in the Department's research, development, and demonstration programs. A TIA may be either a type of cooperative agreement or an assistance transaction other than a cooperative agreement, depending on the intellectual property provisions. In both cases, TIAs are not necessarily subject to all of the requirements of 2 CFR Part 200 as amended by 2 CFR Part 910.

In a TIA, EERE may modify the standard Government terms and conditions, including but not limited to:

- Intellectual Property Provisions: EERE may negotiate special arrangements with recipients to avoid the encumbrance of existing intellectual property rights or to facilitate the commercial deployment of inventions conceived or first actually reduced to practice under the EERE funding agreement.
- Accounting Provisions: EERE may authorize the use of generally accepted accounting principles (GAAP) where recipients do not have accounting systems that comply with Government recordkeeping and reporting requirements.

EERE will be more amenable to awarding a TIA in support of an application from a consortium or a team arrangement that includes cost sharing with the private sector, as opposed to an application from a single organization. Such a consortium or teaming arrangement could include a FFRDC. If a DOE/NNSA FFRDC is a part of the consortium or teaming arrangement, the value of, and funding for the DOE/NNSA FFRDC portion of the work will be authorized and

funded under the DOE field work authorization system and performed under the laboratory's Management and Operating contract. Funding for a non-DOE/NNSA FFRDC would be through an interagency agreement under the Economy Act or other statutory authority. Other appropriate contractual accommodations, such as those involving intellectual property, may be made through a "funds in" agreement to facilitate the FFRDCs participation in the consortium or teaming arrangement. If a TIA is awarded, certain types of information described in 10 CFR 603.420(b) are exempt from disclosure under the Freedom of Information Act for five years after DOE receives the information.

An applicant may request a TIA if it believes that using a TIA could benefit the RD&D objectives of the program (see section 603.225) and can document these benefits. If an applicant is seeking to negotiate a TIA, the applicant must include an explicit request in its Full Application. After an applicant is selected for award negotiation, the Contracting Officer will determine if awarding a TIA would benefit the RD&D objectives of the program in ways that likely would not happen if another type of assistance agreement (e.g., cooperative agreement subject to the requirements of 2 CFR Part 200 as amended by 2 CFR Part 910). The Contracting Officer will use the criteria in 10 CFR 603, Subpart B, to make this determination.

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 initial requirements, it will be considered non-responsive, removed from further evaluation, and ineligible for any award.

A. ELIGIBLE APPLICANTS

1. INDIVIDUALS

U.S. citizens and lawful permanent residents are eligible to apply for funding as a Prime Recipient or Subrecipient.

2. 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 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 Federally Funded Research and Development Centers (FFRDCs) are eligible to apply for funding as a Prime Recipient or Subrecipient.

Non-DOE/NNSA FFRDCs are eligible to apply for funding as a Subrecipient, but are not eligible to apply as a Prime Recipient.

Federal agencies and instrumentalities (other than DOE) are eligible to apply for funding as a Subrecipient, but are not eligible to apply as a Prime Recipient.

3. 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. 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.

4. 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.

5. *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

The cost share requirements are 50% for Topic Area 1 and 20% for Topic Area 2, respectively. 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.

1. *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. The Prime Recipient's cost share obligation is expressed in the Assistance Agreement as a static amount in U.S. dollars (cost share amount) and as a percentage of the Total Project Cost (cost share percentage). If the funding agreement is terminated prior to the end of the project period, the Prime Recipient is required to contribute at least the cost share percentage of total expenditures incurred through the date of termination.

The Prime Recipient is solely responsible for managing cost share contributions by the Project Team and enforcing cost share obligation assumed by Project Team members in subawards or related agreements.

1. *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.

2. COST SHARE TYPES AND ALLOWABILITY

Every cost share contribution must be allowable under the applicable Federal cost principles, as described in Section IV.N.1 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. Cash contributions may be provided by the Prime Recipient or Subrecipients. Allowable in-kind contributions include, but are not limited to: personnel costs, indirect costs, facilities and administrative costs, rental value of buildings or equipment, and the value of a service, other resource, or third party in-kind contribution.

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

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

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

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

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

Applicants are encouraged to refer to 2 CFR 200.306 as amended by 2 CFR 910.130 & 10 CFR 603.525-555 for additional guidance on cost sharing.

3. 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.

4. 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.

5. 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).

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

C. COMPLIANCE CRITERIA

Concept Papers and Full Applications must meet all Compliance criteria listed below or they will be considered noncompliant. EERE will not review or consider noncompliant submissions, including 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 due to server/connection congestion.

1. COMPLIANCE CRITERIA

i. Concept Papers

Concept Papers are deemed compliant if:

- The Concept Paper complies with the content and form requirements in Section IV.C 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.

ii. Full Applications

Full Applications are deemed compliant if:

- The applicant submitted a compliant Concept Paper;
- The Full Application 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 the FOA.

iii. Replies to Reviewer Comments

Replies to Reviewer Comments are deemed compliant if:

- The Reply to Reviewer Comments complies with the content and form requirements in Section IV.E 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

1. REQUIREMENTS FOR DOE/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. 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.

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.

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

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

i. Authorization for non-DOE/NNSA FFRDCs

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

ii. Authorization for DOE/NNSA FFRDCs

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

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

iii. Value/Funding

The value of and funding for the FFRDC portion of the work will be included in the award to a successful applicant. The Prime Recipient and FFRDC must execute a separate agreement (CRADA, work for others, TSA, etc.).

iv. Cost Share

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

v. Responsibility

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

vi. Limit on FFRDC Effort

The scope of work to be performed by the FFRDC may not be more significant than the scope of work to be performed by the applicant.

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

Applicants may only submit one Full Application for each topic area of this FOA. If an applicant submits more than one Full Application to the same topic area, EERE will only consider the last timely submission for evaluation. Any other submissions received listing the same applicant for the same topic area will be considered noncompliant and not eligible for further consideration. This limitation does not prohibit an applicant from collaborating on other applications (e.g., as a potential Subrecipient or partner) so long as the entity is only listed as the prime applicant on one Full Application submitted under this FOA.

G. Questions Regarding Eligibility

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

IV. Application and Submission Information

A. Application Process

The application process will include two phases: a Concept Paper phase and a Full Application phase. **Only applicants who have submitted an eligible Concept Paper will be eligible to submit a Full Application**. 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, and 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 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 Times New Roman 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.
- 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 Concept Papers and Full Applications at least 48 hours in advance of the submission deadline**. Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), applicants should allow at least 1 hour to submit a Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE Exchange, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline.

EERE urges applicants to carefully review their Concept Papers, and Full Applications and to allow sufficient time for the submission of required information and documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V.A.2 of the FOA.

1. Additional Information on EERE Exchange

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

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

Applicants that experience issue with submissions that result in late submissions: In the event that an applicant experiences technical difficulties so severe that they are unable to submit their application by the deadline, the applicant should contact the Exchange helpdesk for assistance (EERE-ExchangeSupport@hq.doe.gov). The Exchange helpdesk and/or the EERE Exchange system administrators will assist the applicant in resolving all issues (including finalizing submission on behalf of and with the applicant's concurrence). PLEASE NOTE, however, those applicants who are unable to submit their application on time due to their waiting until the last minute when network traffic is at its heaviest to submit their materials will not be able to use this process.

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:
ControlNumber_LeadOrganization_Project_Part_1
ControlNumber_LeadOrganization_Project_Part_2, etc.

C. CONTENT AND FORM OF THE CONCEPT PAPER

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

1. 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 and is limited to 5 pages at the maximum:

SECTION	DESCRIPTION
Cover Page	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
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.

EERE makes an independent assessment of each Concept Paper based on the criteria in Section V.A.1 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 sent to applicants at the close of that phase.

D. 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.

Applicants will have approximately 30 days from receipt of the Concept Paper Encourage/Discourage notification 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 submission of their Concept Paper, and should include that control number in the file name of their Full Application submission (i.e., Control number_Applicant Name_Full Application).

1. 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:

SUBMISSION	COMPONENTS	FILE NAME
Full Application (PDF, unless stated otherwise)	Technical Volume (See Chart in Section IV.D.2)	ControlNumber_LeadOrganization_Technical Volume
	Statement of Project Objectives (Microsoft Word format) (10 page limit)	ControlNumber_LeadOrganization_SOPO
	SF-424 Application for Federal Assistance	ControlNumber_LeadOrganization_App424

	Budget Justification (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Budget_Justification
	Summary for Public Release (1 page limit)	ControlNumber_LeadOrganization_Summary
	Summary Slide (1 page limit, Microsoft PowerPoint format)	ControlNumber_LeadOrganization_Slide
	Subaward Budget Justification (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Subawardee_Budget_Justification
	Budget for FFRDC, if applicable	ControlNumber_LeadOrganization_FWP
	Authorization from cognizant Contracting Officer for FFRDC, if applicable	ControlNumber_LeadOrganization_FFRDCAuth
	SF-LLL Disclosure of Lobbying Activities	ControlNumber_LeadOrganization_SF-LLL
	Foreign Entity and Performance of Work in the United States waiver requests, if applicable	ControlNumber_LeadOrganization_Waiver

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:

ControlNumber_LeadOrganization_TechnicalVolume_Part_1
ControlNumber_LeadOrganization_TechnicalVolume_Part_2, etc.

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

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

2. TECHNICAL VOLUME

The Technical Volume must be submitted in Adobe 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.2 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 20 pages, including the cover page, table of contents, and all citations, charts, graphs, maps, photos, or other graphics,

and must include all of the information in the table below. The applicant should consider the weighting of each of the evaluation criteria (see Section V.A.2 of the FOA) when preparing the Technical Volume.

SECTION/PAGE LIMIT	DESCRIPTION
Cover Page	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Project Overview (This section should constitute 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 (This section should constitute approximately 30% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state of the art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state of the art/technical baseline if the project is successful.
Workplan and Market Transformation Plan (This section should constitute	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure, Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed Statement of Project Objectives (SOPO) is separately requested. The Workplan should contain the following information:

approximately 40% of the Technical Volume)	• 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. • Work Breakdown Structure (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 work breakdown structure (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, where success is defined as technical achievement rather than simply completing a task. To ensure that milestones are relevant, applicants should follow the SMART rule of thumb, which is that all milestones should be **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely. 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 (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. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one project-wide go/no-go decision point for each budget period (12 to 18-month period) of the project. The Applicant should also provide the specific technical criteria to be used to

	make the go/no-go decision. 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, and product distribution
Technical Qualifications and Resources (Approximately 20% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • Describe the Project Team's unique qualifications and expertise, including those of key Subrecipients. • Describe the Project Team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project.

	• Attach one-page resumes for key participating team members as an appendix. Resumes do not count towards the page limit. Multi-page resumes are not allowed. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. • Attach letters of commitment from all Subrecipient/third party cost share providers as an appendix. Letters of commitment do not count towards the page limit. • Attach any letters of support from partners/end users as an appendix (1 page maximum per letter). Letters of support do not count towards the page limit. • For multi-organizational or multi-investigator projects, describe succinctly: o The roles and the work to be performed by each PI and Key Participant; o Business agreements between the applicant and each PI and Key Participant; o How the various efforts will be integrated and managed; o Process for making decisions on scientific/technical direction; o Publication arrangements; o Intellectual Property issues; and o Communication plans
FOA-Specific Requirements	In addition, • Topic 1 requires at least one utility partner; for Topic 2, utility partners are strongly encouraged. • Describe the strategies for the assurance of cybersecurity and interoperability of the proposed solutions • Identification of the potential for open source software distribution or alternative software distribution methods.

3. STATEMENT OF PROJECT OBJECTIVES

Applicants are required to complete a Statement of Project Objectives (SOPO). A SOPO template is available on EERE Exchange at https://eere-Exchange.energy.gov/. The SOPO, including the Milestone Table, must not exceed 10 pages when printed using standard 8.5 x 11 paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point. Save the SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_SOPO".

4. SF-424: APPLICATION FOR FEDERAL ASSISTANCE

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

project period. Save the SF-424 in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_App424".

5. *Budget Justification Workbook (EERE 335)*

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, and provide all requested documentation (e.g., a Federally-approved rate agreement, vendor quotes). 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".

6. *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".

7. *Summary Slide*

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

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.

8. SUBAWARD BUDGET JUSTIFICATION (EERE 335)

Applicants must provide a separate budget justification, EERE 335 (i.e., budget justification for each budget year and a cumulative budget) for each subawardee 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 subaward budget justification in a Microsoft Excel file using the following convention for the title "ControlNumber_LeadOrganization_Subawardee_Budget_Justification".

9. BUDGET FOR DOE/NNSA FFRDC (IF APPLICABLE)

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE Field Work Proposal (FWP) in accordance with the requirements in DOE Order 412.1, Work Authorization System. DOE Order 412.1 and DOE O 412.1 (Field Work Proposal form) area available at the following link, under "DOE Budget Forms": https://www.directives.doe.gov/directives/0412.1-BOrder-a/view. Save the FWP in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_FWP".

10. 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".

11. SF-LLL: DISCLOSURE OF LOBBYING ACTIVITIES

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" (http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf) if any non-Federal funds have been paid or will be paid to any person for influencing or attempting to influence any of the following in connection with your 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".

12. Waiver Requests: Foreign Entities and Performance of Work in the United States

i. Foreign Entity Participation:

As set forth in Section III.A.3, 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.

ii. Performance of Work in the United States

As set forth in Section IV.J.3, 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 request to waive the Performance of Work in the United States requirement.

13. U.S. Manufacturing Commitments

EERE requires subject inventions (i.e., inventions conceived or first actually reduced to practice under EERE awards) to be substantially manufactured in the United States by Project Teams and their licensees, as described below. The applicant may request a modification or waiver of the U.S. Manufacturing Requirement.

a. Domestic Small Businesses, Educational Institutions and Nonprofits

Domestic Small businesses (including Small Business concerns), domestic educational institutions, and nonprofits that are Recipients or Subrecipients under EERE funding agreements must require their exclusive licensees to substantially manufacture the following products in the United States for any use or sale in the United States: (1) articles embodying subject inventions, and (2) articles produced through the use of subject inventions. This requirement does not apply to articles that are manufactured for use or sale overseas.

Domestic small businesses, domestic educational institutions and nonprofits must require their assignees to apply the same U.S. Manufacturing requirements to their exclusive licensees.

These U.S. Manufacturing requirements do not apply to nonexclusive licensees.

b. Large Businesses, Foreign Entities, and State and Local Government Entities

Large businesses and foreign entities that are Recipients or Subrecipients under EERE funding agreements that take title to subject inventions through a patent waiver are required to substantially manufacture the following products in the United States: (1) products embodying subject inventions, and (2) products produced through the use of subject invention(s). This requirement applies to products that are manufactured for use or sale in the United States or overseas.

Large businesses and foreign entities must apply the same U.S. Manufacturing requirements to their assignees, licensees, and entities acquiring a controlling interest in the large business or foreign entity. Large businesses and foreign entities must require their assignees and entities acquiring a controlling interest in the large business or foreign entity to apply the same U.S. Manufacturing requirements to their licensees.

c. FFRDCs

DOE FFRDCs are subject to the U.S. Manufacturing requirements set forth in their Management and Operating Contracts. All other FFRDCs are subject to the U.S. Manufacturing requirements as set forth above, based on their size and for-profit status.

E. Content and Form of Replies to Reviewer Comments

EERE will provide applicants with reviewer comments following 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 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 notify applicants via email when the Reviewer Comments are available for reply. The expected submission deadline is on the cover page of the FOA; however, it is the applicant's responsibility to monitor email 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 email 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 pages in length, EERE will review only the first three (3) pages and disregard any additional pages.

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

F. Post-Award Information Requests

If selected for award, EERE reserves the right to request additional or clarifying information for any reason deemed necessary, including but not limited to:

- 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
- Environmental Questionnaire

G. Dun and Bradstreet Universal Numbering System Number and System for Award Management

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: (i) Be registered in the System for Award Management (SAM) at https://www.sam.gov before submitting its application; (ii) provide a valid Dun and Bradstreet Universal Numbering System (DUNS) number in its application; and (iii) 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 may determine that the applicant is not qualified to receive a Federal

award and use that determination as a basis for making a Federal award to another applicant.

H. SUBMISSION DATES AND TIMES

Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted in EERE Exchange no later than 5 p.m. Eastern on the dates provided on the cover page of this FOA.

I. DATA MANAGEMENT PLAN

An applicant whose Full Application is selected for award will be required to submit a Data Management Plan within 3 months of the award notification. The Data Management Plan is a document that outlines the proposed plan for data sharing or preservation. Submission of this plan is required by the due date identified in your award notification, and failure to submit the plan may result in the termination of award. Guidance for preparing a Data Management Plan is provided in Appendix D of the FOA.

J. OPEN SOURCE SOFTWARE DISTRIBUTION PLAN

An applicant whose Full Application is selected for award will be required to submit an Open Source Software Distribution Plan (or an alternative software distribution plan that encourages wide adoption of the research findings) within 3 months of the award notification. This plan describes how software produced under this FOA will be distributed and must be consistent with the market transformation plan submitted with the application. Submission of an Open Source Software Distribution Plan (or an alternative software distribution plan) is required by the due date identified in your award notification, and failure to submit the plan may result in the termination of award. Guidance for preparing an Open Source Software Distribution Plan is included in Appendix E of the FOA.

K. INTEROPERABILITY PLAN

An applicant whose Full Application is selected for award will be required to submit an Interoperability Plan within 3 months of the award notification. The Interoperability Plan is a document that outlines the proposed plan for achieving and maintaining interoperability within and between components and systems utilizing open standards and other interoperability best practices. The Interoperability Plan is subject to review, acceptance, and periodic audit by DOE. Submission of this plan is required by the due date identified in your award notification, and failure to submit the plan may result in the termination of award. Guidance for preparing an Interoperability Plan is provided in Appendix F of the FOA.

L. CYBERSECURITY PLAN

An applicant whose Full Application is selected for award will be required to submit a Cybersecurity Plan within 3 months of the award notification. The Cybersecurity Plan is a document that outlines the proposed plan for achieving and maintaining cybersecurity

throughout components and systems utilizing open standards and other cybersecurity best practices. The Cybersecurity Plan is subject to review, acceptance, and periodic audit by DOE. Submission of this plan is required by the due date identified in your award notification, and failure to submit the plan may result in the termination of award. Guidance for preparing a Cybersecurity Plan is provided in Appendix G of the FOA.

M. INTERGOVERNMENTAL REVIEW

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

N. FUNDING RESTRICTIONS

1. 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:

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

2. 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 costs can only be incurred if such costs would be reimbursable under the agreement if incurred after award.

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.

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

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 costs where the Prime Recipient incurred the costs prior to receiving written authorization from the Contracting Officer. If the applicant elects to undertake activities that 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 and such costs may not be recognized as allowable cost share. Likewise, if a project is selected for negotiation of award, and the Prime Recipient elects to undertake activities that are not authorized for Federal funding by the Contracting Officer in advance of 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. 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.

3. PERFORMANCE OF WORK IN THE UNITED STATES

a. 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.

b. 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 if the work is performed by the Prime Recipient, Subrecipients, contractors or other project partners.

c. 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 waiver of the Performance of Work in the United States requirement, the applicant must submit a written waiver request to EERE.

Appendix C lists the necessary information that must be included in a request to waive the Performance of Work in the United States requirement.

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

4. CONSTRUCTION

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

5. FOREIGN TRAVEL

Foreign travel costs are not allowable under this FOA.

6. 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. The rules for property disposition are set forth in 2 CFR 200.310 – 200.316 as amended by 2 CFR 910.360.

7. 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" (http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf) if any non-Federal funds have been paid or will be paid to any person for influencing or attempting to influence any of the following in connection with your 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.

8. *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 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.

V. Application Review Information

A. Technical Review Criteria

1. *Concept Papers*

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

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

- 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.

2. *Full Applications*

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

Criterion 1: Technical Merit, Innovation, and Impact (50%)

Technical Merit and Innovation

- Extent to which the proposed technology or process is innovative;
- Degree to which the current state of the technology and the proposed advancement are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state-of-the art to the proposed advancement;
- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work; and
- Extent to which the proposed technologies and solutions address all the attributes described in the DOE Grid Modernization MYPP: reliable, resilient, sustainable, flexible, affordable, and secure.

Impact of Technology Advancement

- How the project supports the topic area objectives and target specifications and metrics; and
- The potential impact of the project on advancing the state-of-the-art.

Criterion 2: Project Research and Market Transformation Plan (30%)

Research Approach, Workplan and SOPO

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

Identification of Technical Risks

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

Baseline, Metrics, and Deliverables

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

Market Transformation Plan

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

Criterion 3: Team and Resources (20%)

- The capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. The qualifications, relevant expertise, and time commitment of the individuals on the team;
- The sufficiency of the facilities to support the work;
- The degree to which the proposed consortia/team demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies;
- The level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan;
- The reasonableness of the budget and spend plan for the proposed project and objectives; and
- Topic 1 requires at least one utility partner; for Topic 2, utility partners are strongly encouraged.

3. 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 "Department of Energy Merit Review Guide for Financial Assistance," which is available at: http://energy.gov/sites/prod/files/meritrev.pdf.

C. OTHER SELECTION FACTORS

1. 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 commercialize energy or related technologies;
- Technical, market, organizational, and environmental risks associated with the project;
- Whether the proposed project is likely to lead to increased employment and manufacturing in the United States;
- Whether the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty; and
- Whether the proposed project will advance the goals of the Climate Action Champion initiative, as committed to by the designated Champion pursuant to its designation agreement. The Climate Action Champion initiative goals include improving climate resilience and reducing greenhouse gas emissions.

Note: The Climate Action Champion initiative program policy factor is only applicable to (1) projects proposed by Climate Action Champions[39] as designated under DOE's Request for Applications DE-FOA-0001189; (2) projects proposed by a member of a regional collaboration or consortium designated as a Champion; and (3) projects proposed in a Climate Action Champion community where the applicant submits a letter from the Champion confirming the proposed project would further the Champion's goals under the Climate Action Champion initiative. If an applicant is seeking to receive consideration under (3), the applicant must contact the applicable Champion to obtain a letter of support.

D. Evaluation and Selection Process

1. 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

[39] In recognition of the importance of the dual policy goals of reducing greenhouse gas emissions and enhancing climate resilience, the U.S. Department of Energy (DOE) – in close collaboration with other Federal agencies – launched the Climate Action Champion initiative to identify and showcase U.S. local and tribal governments that have proven to be climate leaders through pursuing opportunities to advance both of these goals in their communities. Recently, DOE selected sixteen (16) U.S. local governments and tribal governments – or regional collaborations or consortia thereof – that demonstrated a strong and ongoing commitment to implementing strategies that both reduce greenhouse gas emissions and enhance climate resilience, with a particular emphasis on strategies that further both goals. http://www.whitehouse.gov/blog/2014/12/03/announcing-first-class-climate-action-champions

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

2. 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.3 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.

3. 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.

4. 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.

5. 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 DATES

EERE anticipates notifying applicants selected for negotiation of award by September 2016 and making awards by November 2016.

VI. AWARD ADMINISTRATION INFORMATION

A. AWARD NOTICES

1. INELIGIBLE SUBMISSIONS

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

2. CONCEPT PAPER NOTIFICATIONS

EERE will notify applicants of its determination to encourage or discourage the submission of a Full Application. EERE will send a notification letter by email or EERE Exchange to the technical and administrative points of contact designated by the applicant in 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 letter encouraging the submission of a Full Application does not authorize the applicant to commence performance of the project. Please refer to Section IV.J.2 of the FOA for guidance on pre-award costs.

3. 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.

4. Successful Applicants

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

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

Please refer to Section IV.J.2 of the FOA for guidance on pre-award costs.

5. 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.

6. 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

1. 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:

i. EERE Exchange

Register and create an account on EERE Exchange at https://eere-Exchange.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**.

ii. DUNS Number

Obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number (including the plus 4 extension, if applicable) at http://fedgov.dnb.com/webform.

iii. System for Award Management

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

iv. 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 http://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf.

v. Grants.gov

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

vi. Electronic Authorization of Applications and Award Documents

Submission of an application and supplemental information under this FOA through electronic systems used by the Department of Energy, including EERE Exchange and FedConnect.net, constitutes the authorized representative's approval and electronic signature.

2. 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.

3. FOREIGN NATIONAL ACCESS TO DOE SITES

All applicants that ultimately enter into an award resulting from this FOA will be subject to the following requirement concerning foreign national involvement. Upon DOE's request, Prime Recipients must provide information to facilitate DOE's responsibilities associated with foreign national access to DOE sites, information, technologies, and equipment. A foreign national is defined as any person who was born outside the jurisdiction of the United States, is a citizen of a foreign government, and has not been naturalized under U.S. law. If the Prime Recipient or Subrecipients, contractors or vendors under the award, anticipate utilizing a foreign national person in the performance of an award, the Prime Recipient is responsible for providing to the Contracting Officer specific information of the foreign national(s) to satisfy compliance with all of the requirements for access approval.

4. 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.

5. *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.

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

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

7. *Applicant Representations and Certifications*

i. *Lobbying Restrictions*

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

ii. *Corporate Felony Conviction and Federal Tax Liability Representations*

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

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

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

For purposes of these representations the following 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.

iii. Nondisclosure and Confidentiality Agreements Representations

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

(1) 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.

(2) 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:

a. *''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.''*

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

c. 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.

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

9. 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 that the Go/No Go decision point(s).

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

10. 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 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.

11. 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.

12. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, DOE F 4600.2, attached to the award agreement. The checklist can be accessed at http://www1.eere.energy.gov/financing/resources.html.

13. 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. Federal funding beyond the Go/No Go decision point (continuation funding), is contingent on (1) the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority; (2) meeting the objectives, milestones, deliverables, and decision point criteria of recipient's approved project and obtaining approval from EERE to continue work on the project; and (3) the submittal of required reports in accordance with the Statement of Project Objectives.

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.

14. 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.

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: Energise@ee.doe.gov. Questions must be submitted not later than 3 business days prior to the application due date and time.

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

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

VIII. OTHER INFORMATION

A. FOA MODIFICATIONS

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

B. INFORMATIONAL WEBINAR

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

Attendance is not mandatory and will not positively or negatively impact the overall review of any applicant submissions. As the webinar will be open to all applicants who wish to participate, applicants should refrain from asking questions or communicating information that

would reveal confidential and/or proprietary information specific to their project. Specific dates for the webinar can be found on the cover page of the FOA.

C. 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.

D. 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.

E. TREATMENT OF APPLICATION INFORMATION

In general, EERE will only use data and other information contained in applications for evaluation purposes, unless such information is generally available to the public or is already the property of the Government.

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. Applications containing trade secrets or commercial or financial information that is privileged or confidential, which the applicant does not want disclosed to the public or used by the Government for any purpose other than application evaluation, must be marked as described in this section.

The cover sheet of the application must be marked as follows and identify the specific pages containing trade secrets or commercial or financial information that is privileged or confidential:

> Notice of Restriction on Disclosure and Use of Data:
> Pages [list applicable pages] of this document may contain trade secrets or commercial or financial information that is privileged or confidential, and 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 trade secrets or commercial or financial information that is privileged must be marked as follows: "May contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure."

In addition, each line or paragraph containing trade secrets or commercial or financial information that is privileged or confidential must be enclosed in brackets.

The above markings enable EERE to follow the provisions of 10 CFR 1004.11(d) in the event a Freedom of Information Act (FOIA) request is received for information submitted with an application. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under a FOIA request 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.

Subject to the specific FOIA exemptions identified in 5 U.S.C. 552(b), all information submitted to EERE by a FOA applicant is subject to public release under the Freedom of Information Act, 5 U.S.C. §552, as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175. It is the applicant's responsibility to review FOIA and its exemptions to understand (1) what information may be subject to public disclosure and (2) what information applicants submit to the Government that are protected by law. In some cases, DOE may be unable to make an independent determination regarding which information submitted by an applicant is releasable and which is protected by an exemption. In such cases, DOE will consult with the applicant, in accordance with 10 C.F.R. §1004.11, to solicit the applicant's views on how the information should be treated.

F. Evaluation and Administration by Non-Federal Personnel

In conducting the merit review evaluation, the Go/No-Go Review and Peer Review, the Government may seek the advice of qualified non Federal personnel as reviewers. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The applicant, by submitting its application, consents to the use of non-Federal reviewers/administrators. Non-Federal reviewers must sign conflict of interest and non-disclosure agreements prior to reviewing an application. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

G. 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.

H. 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).

I. NOTICE OF POTENTIAL DISCLOSURE UNDER FREEDOM OF INFORMATION ACT

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

J. 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.

K. RETENTION OF SUBMISSIONS

EERE expects to retain copies of all Concept Papers, Full Applications, 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.

L. TITLE TO SUBJECT INVENTIONS

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

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

- All other parties: The Federal Non-Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (see below).

- Class Patent Waiver:

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

- Advance and Identified Waivers: For Applicants not covered by the Class Patent Waiver or unable to agree to the terms of the Class Patent Waiver, Applicants 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.

M. 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.

N. RIGHTS IN TECHNICAL DATA

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

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

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

O. 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. In addition, for those awards requiring distribution of software as

Open-Source Software (OSS), the additional information in Appendix E must be addressed in the application.

P. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION

All information provided by the Applicant must to the greatest extent possible exclude Personally Identifiable Information (PII). The term "personally identifiable information" refers to information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, etc. 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, etc. (See OMB Memordum M-07-16 dated May 22, 2007, found at:
https://www.whitehouse.gov/sites/default/files/omb/memoranda/fy2007/m07-16.pdf

By way of example, Applicants must screen resumes to ensure that they do not contain PII such as personal addresses, phone/cell numbers, personal emails and/or SSNs. In short, if the PII is not essential to the application, it should not be in the application.

Q. ANNUAL COMPLIANCE AUDITS

If a for-profit entity is a Prime Recipient or Subrecipient and has expended $750,000 or more of DOE funds, including cost share, during the entity's fiscal year, an annual compliance audit performed by an independent auditor is be 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 funds during the non-Federal entity's fiscal year, then a single or program-specific audit is required. For additional information, please refer to 2 C.F.R. § 200.501 and Subpart F.

Applicants and sub-recipients (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. 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.

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

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

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

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

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

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

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

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

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

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

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

(B) Valuing and documenting contributions

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

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

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

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

(4) Valuing property donated by third parties.

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

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

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

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

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

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

APPENDIX B – 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: FOREIGN ENTITY PARTICIPATION AS THE PRIME RECIPIENT AND PERFORMANCE OF WORK IN THE UNITED STATES

1. WAIVER FOR FOREIGN ENTITY PARTICIPATION AS THE PRIME RECIPIENT

As set forth in Section III.A.3, all Prime Recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

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

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

As set forth in Section IV.J.3, 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 - DATA MANAGEMENT PLAN

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

DMP Requirements

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

At a minimum, the DMP must describe how data sharing and preservation will enable validation of the results from the proposed work, or how results could be validated if data are not shared or preserved.

The DMP must provide a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publication. This includes data that are displayed in charts, figures, images, etc. In addition, the underlying digital research data used to generate the displayed data should be made as accessible as possible in accordance with the principles stated above. This requirement could be met by including the data as supplementary information to the published article, or through other means. The published article should indicate how these data can be accessed.

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

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

Data Determination for a DMP

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

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

Suggested Elements for a DMP

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

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

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

Sharing and Preservation: A description of the plans for data sharing and preservation. This should include, when appropriate: the anticipated means for sharing and the rationale for any restrictions on who may access the data and under what conditions; a timeline for sharing and preservation that addresses both the minimum length of time the data will be available and any anticipated delay to data access after research findings are published; any special requirements for data sharing, for example, proprietary software needed to access or interpret data, applicable policies, provisions, and licenses for re-use and re-distribution, and for the production of derivatives, including guidance for how data and data products should be cited; any resources and capabilities (equipment, connections, systems, software, expertise, etc.) requested in the research proposal that are needed to meet the stated goals for sharing and preservation (this could reference the relevant section of the associated research proposal and budget request); and

whether/where the data will be preserved after direct project funding ends and any plans for the transfer of responsibilities for sharing and preservation.

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

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

Additional Guidance

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

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

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

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

Definitions

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

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

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

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

> (A) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published, or similar information which is protected under law; and
>
> (B) Personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study."

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

APPENDIX E – 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 Management and Operating (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.

The MPL is the license for the Mozilla Application Suite, Mozilla Firefox, Mozilla Thunderbird and other Mozilla software. The MPL has been adapted by others as a license for their software, most notably Sun Microsystems, as the Common Development and Distribution License for OpenSolaris, the open source version of the Solaris 10 operating system, and by Adobe, as the license for its Flex product line.

APPENDIX F - INTEROPERABILITY PLAN

An Interoperability Plan explains how the award recipient will ensure that information can flow and be used across a complex system. It should demonstrate the Recipient's understanding of interoperability issues within its proposed solution, as well as what issues exist at the external interfaces at the solution boundaries. This plan is subject to DOE review and acceptance, and the recipient is expected to comply with this plan throughout the life of the project.

The de facto gold standard of interoperability is "plug-and-play". As attractive as this concept is, achieving plug-and-play is not easy and in many complex situations and technology readiness levels, it is not practical to specify standard interfaces to this level of detail. Therefore, a progression of interoperability techniques, from most desirable to least desirable is as follows:

- Plug-and-play with a full testing and certification program (e.g. USB)
- Interfaces use a common, published model (e.g. CIM between open standards)
- Interfaces can be transformed or mapped (e.g. published protocol translation)
- No standard exists, completely custom integration.

Interoperability Plan Requirements

In order for the plan to be considered acceptable, it must address the following:

At a minimum, the Interoperability Plan must describe how the award Recipient plans to establish interoperability between networks, systems, devices, application or components within the proposed solution, and at the necessary external interfaces at the solution boundaries. Recipients are directed to maximize the use of open standards wherever possible and adhere to the hierarchy of desirable interoperability techniques listed above, and document deviation from open standards and the utilization of proprietary standards where the Recipient deems necessary.

The Interoperability Plan should reference open public standards and their respective organizations where appropriate. Additional resources regarding interoperability are available through the GridWise Architecture Council (www.gridwiseac.org), the Smart Grid Interoperability Panel (www.sgip.org), and the Buildings Technology Office of EERE (http://energy.gov/eere/buildings/downloads/buildings-interoperability-landscape).

Suggested Elements for an Interoperability Plan

The following list of elements for an Interoperability Plan provides suggestions regarding the interoperability assessment process and the structure of the plan:

Assessment of Scope: A discussion of the scope of the solution as interpreted through the layers depicted in Figure 7 of the FOA should be made, as well as the anticipated challenges, such as where interoperability is low or decisions among standards must be made. Recipients should document all the interfaces (where information is exchanged between networks, systems, devices, applications or components) in their proposed solution as a method for assessing the full scope of the plan. It should be noted that an assessment of all interfaces is also required for a Cybersecurity Plan, and both plans can utilize the same assessment.

Content and Format: A statement of plan for achieving interoperability, and plans for sustaining interoperability and improving it over time. Where existing practice or open standards fall short, Recipients should propose remedies through open public mechanisms to alleviate them over time. Existing, accepted community standards should be used where possible. Where community standards are missing or inadequate, the DMP could propose alternate strategies, and should advise the sponsoring program of any need to develop or generalize standards.

Additional Guidance

Plans should reflect relevant standards and community best practices and make use of community accepted resources whenever practicable.

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

APPENDIX G - CYBERSECURITY PLAN

A Cybersecurity Plan explains how the award recipient will demonstrate their awareness of cybersecurity in the context of the project, and establish a plan for ensuring and maintaining cybersecurity throughout the life of the proposed solution. It should demonstrate the Recipient's understanding of cybersecurity issues within its proposed solution, as well as what issues exist at the external interfaces at the solution boundaries. This plan is subject to DOE review and acceptance, and the recipient is expected to comply with this plan throughout the life of the project.

A Cybersecurity Plan must address not only deliberate attacks launched by disgruntled employees, agents of industrial espionage, terrorists, and other adversaries, but also inadvertent compromises of the information infrastructure due to user errors, equipment failures, and natural disasters. Security must be included in all phases of the system development life cycle, from design phase through implementation, maintenance, and disposition. Systems for critical applications need to withstand cybersecurity events with no loss of critical function.

Cybersecurity Plan Requirements

In order for the plan to be considered acceptable, it must address the following:

> **At a minimum, the Cybersecurity Plan must describe how the award Recipient plans to establish cybersecurity between networks, systems, devices, application or components within the proposed solution, and at the necessary external interfaces at the solution boundaries. Recipients are directed to maximize the use of open standards wherever possible and adhere to the hierarchy of desirable cybersecurity techniques listed above, and document deviation from open standards and the utilization of proprietary standards where the Recipient deems necessary.**

The approach to cyber security should include:

- A summary of the cyber security risks and how they will be mitigated at each stage of the lifecycle (focusing on vulnerabilities and impact).
- A summary of the cyber security criteria utilized for vendor and device selection.
- A summary of the relevant cyber security standards and/or best practices that will be followed.
- A summary of how the project will support emerging smart grid cyber security standards.
- Plans should also address the adequacy of their approach for addressing
    - Ensuring confidentiality, integrity, availability
    - Secure logging, monitoring, alarming, and notification

Suggested Elements for a Cybersecurity Plan

The following list of elements for a Cybersecurity Plan provides suggestions regarding the cybersecurity assessment process and the structure of the plan:

Assessment of Scope: A discussion of the scope of the solution as interpreted through the layers depicted in Figure 7. of the FOA should be made, as well as the anticipated challenges (such as confidentiality, integrity or availability is high, but systems or component resources are low). Recipients should document all the interfaces (where information is exchanged between networks, systems, devices, applications or components) in their proposed solution as a method for assessing the full scope of the plan. It should be noted that an assessment of all interfaces is also required for an Interoperability Plan, and both plans can utilize the same assessment.

Content and Format: A statement of plan for designing in cybersecurity, including a defense in depth approach, and plans for sustaining cybersecurity for the life of the solution. Where existing practice or standards seem inadequate, Recipients should propose remedies through open public mechanisms to alleviate them over time. Existing, accepted community standards should be used where possible. Where community standards are missing or inadequate, the plan could propose alternate strategies, and should advise the sponsoring program.

Additional Guidance

The DOE, NIST and other organizations have worked with both public and private sector organizations to advance the state of the art of cybersecurity in energy delivery systems. Recipients are encouraged to seek out resources appropriate to their solution space, but should also consider the following links:

- **NISTIR 7628: http://nvlpubs.nist.gov/nistpubs/ir/2014/NIST.IR.7628r1.pdf**
- **The National Rural Electric Cooperative Association: https://groups.cooperative.com/smartgriddemo/public/CyberSecurity/Documents/CyberSecurityGuideforanElectricCooperative-U1.pdf**
- **Cybersecurity Procurement Language: http://www.energy.gov/oe/downloads/cybersecurity-procurement-language-energy-delivery-april-2014**

Plans should reflect relevant standards and community best practices and make use of community accepted resources whenever practicable.

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