Request for Information in the Area of Grid Integration of Solar Energy Systems and Other Inverter-based Resources

DATE: October 23, 2023
SUBJECT: Request for Information (RFI)

Description

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE), through its Solar Energy Technologies Office (SETO), is issuing a request for information (RFI) on technical challenges and opportunities for grid integration of solar energy systems and other inverter-based resources that include photovoltaics (PV) and energy storage facilities connected to bulk power systems, distribution systems, microgrids, and behind-the-meter systems. This RFI intends to solicit stakeholder feedback from industry, academia, research laboratories, government agencies, end-user groups, and other relevant organizations related to the cost-effective and reliable integration of solar and other variable and power-electronic based energy sources onto the electric grid. Some topic areas are specific to solar and battery energy storage, while others may be relevant to multiple variable or inverter-based resources. This feedback will help EERE and SETO identify key challenges, assess technology gaps, determine research needs and priorities, and develop new research, development, and demonstration (RD&D) initiatives to support rapid solar deployment and the smooth transition to a reliable, secure, resilient, and decarbonized grid of the future. This is solely a request for information and not a Funding Opportunity Announcement (FOA). EERE is not accepting applications.

Background

The electric power system is evolving toward a new mix of generation resources, such as solar and wind, which this RFI refers to as variable renewable energy resources (VRE), which can also be paired with energy storage. Some VRE are interfaced with the grid through power electronic inverters. These include solar PV, wind, and battery energy storage, and are known as inverter-based resources (IBR). As the deployment of VRE grows, the overall generation capacity of VRE relative to electric demand grows, as well as the amount of time system demand is mainly supported by VRE. While most solar capacity comes from large utility-scale systems connected to transmission lines, deployment of smaller solar plants connected at the distribution level and customer-owned, or behind-the-meter (BTM) sites is also increasing. Collectively, these smaller solar (and energy storage) systems are typically referred to as distributed energy resources (DER). Besides distributed generation, controllable loads such as electric vehicles, programmable thermostats, and other smart appliances are also expanding across the country.

This is a Request for Information (RFI) only. EERE will not pay for information provided under this RFI and no project will be supported as a result of this RFI. This RFI is not accepting applications for financial assistance or financial incentives. EERE may or may not issue a Funding Opportunity Announcement (FOA) based on consideration of the input received from this RFI.

Further, the decarbonization of the grid will not achieve its full potential if communities of color and low-income communities are left out. Affordable solar energy can help relieve energy burdens and provide clean, local electricity that can increase community resilience. Increasing equitable access to solar power includes driving down the “soft” costs of solar installations, as well as developing business models like community solar that are designed to engage these communities that are less likely to adopt solar power than high-income, non-diverse ones.

To achieve the Administration’s energy justice goals, EERE and SETO are working to ensure that the research it funds will support more equitable participation in the solar energy research community. To this end, recognizing the inherent advantages of diverse teams, EERE and SETO encourage the broadened participation of members from groups and institutions that have historically been underrepresented in solar energy research in response to this RFI. Specifically, we are seeking inputs from bulk power system planners and operators, distribution utilities, project developers, facility owners and operators, and technology providers. By advancing equity across the Federal Government, we can create opportunities for the improvement of communities that have been historically underserved, which benefits everyone.

The safe, reliable, and cost-effective integration of VRE energy is critical to achieving a 100% clean electricity system by 2035 and a net-zero energy system by 2050. According to DOE’s 100% Clean Electricity by 2035 Study[1], solar and wind energy will provide 60% - 80% of electricity generation in a clean electricity grid, representing a combined 2 TW of capacity. According to the Energy Storage Future Study, energy storage will grow significantly over the next decades and will reach about 200GW and 1200 GWh by 2050[2]. Energy storage technologies will greatly support the deployment of solar and other variable renewable energy resources.

Generation technologies that harness energy from renewable sources, such as solar and wind generations, vary over time and location, and depend on weather conditions. As the deployment of such VREs grows, the overall VRE generation capacity relative to system demand as well as the amount of time that system demand is supported by VRE grows[3,4,5]. For example, on an April day in 2022, California Independent System Operator’s (CAISO) solar PV and other renewable electricity met nearly 100% of the system demand for a brief time[6]. This makes the amount of energy available to VRE at any given time and how much can be actively controlled, or dispatched, are less predictable than traditional generation sources. This makes it more

[1] https://www.nrel.gov/analysis/100-percent-clean-electricity-by-2035-study.html
[2] NREL, “Energy storage future study,” 2022
[3] Hawaiian Electric. December 2020. “Power Facts.” (https://www.hawaiianelectric.com/documents/about_us/company_facts/power_facts.pdf)
[4] Southwest Power Pool. 2019. “2019 Annual Report. Integration.” (https://www.spp.org/documents/62057/2019%20annual%20report%2020200428%20web.pdf)
[5] ERCOT. December 2021. “Combined Wind and Solar.”(https://www.ercot.com/gridmktinfo/dashboards/combinedwindandsolar)
[6] CAISO website, (http://www.caiso.com/Documents/California-ISO-Hits-All-Time-Peak-of-More-Than-97-Percent-Renewables.pdf)

challenging for grid operators to economically plan for adequate energy reserves as the generation fluctuates as well as the electric demand. As shown in Figure 1, high VRE contributions have already been a reality in several systems and the instantaneous penetration of such resources has even surpassed 100% in some systems such as CAISO and ERCOT[4,5,6]. Total annual energy consumption has also reached significantly higher level that demands more effective approaches for managing the variability of the future power system.

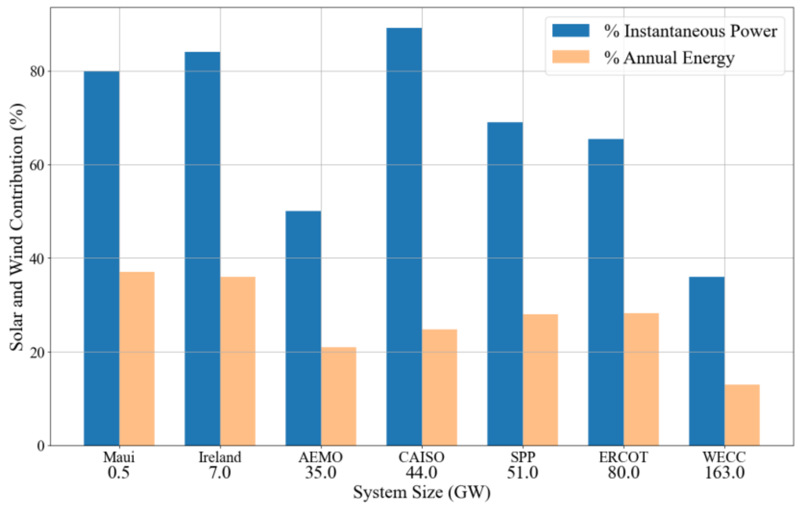

Figure 1: *Instantaneous and annual contributions of solar and wind (2022 data for ERCOT[7] and CAISO[8]; 2019 data for the rest) with respect to system peak[9] [2]*

The high VRE power contributions usually occurred during low-demand periods and the low VRE contributions usually occur during the high load periods (see the CAISO and ERCOT heat map with 2022 data in Figure 2 and Figure 3[10]). Such a situation creates unique challenges with respect to managing the energy surplus and deficit in a cost-effective manner as energy storage is not currently cost-effective to compensate such at-scale energy surplus or deficit. Developing scalable and cost-effective approaches for higher wind and solar power contribution during low- and high-demand periods remains a fundamental challenge.

[7] ERCOT, "Hourly aggregated wind and solar output" (Data Product Details (ercot.com))
[8] CAISO, "Production and curtailment data" (California ISO - Managing Oversupply (caiso.com))
[9] U.S. Energy Information Administration, "Electricity data browser" [Link]
[10] California ISO, "Production and Curtailment Data," 2022 (http://www.caiso.com/informed/Pages/ManagingOversupply.aspx#dailyCurtailment)

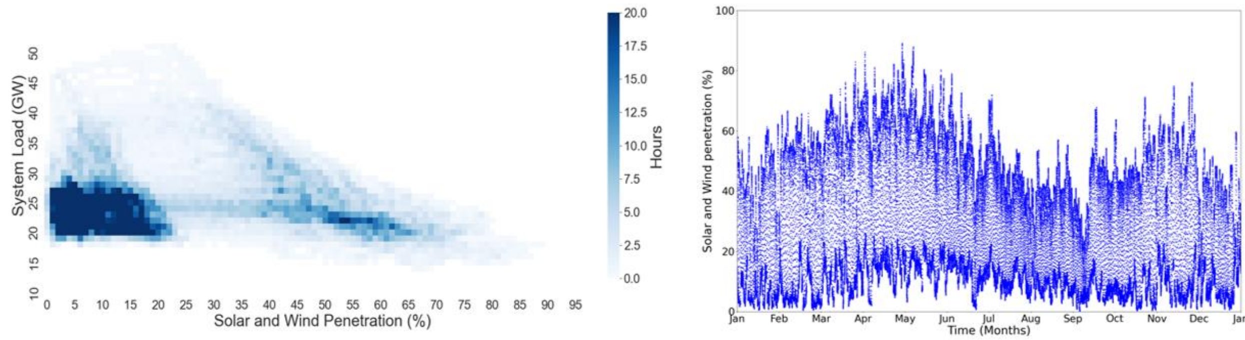

Figure 2: *CAISO 5-minutes wind and solar data 2022 a) heatmap plot of wind and solar penetration, b) time-series plot of wind and solar penetration*

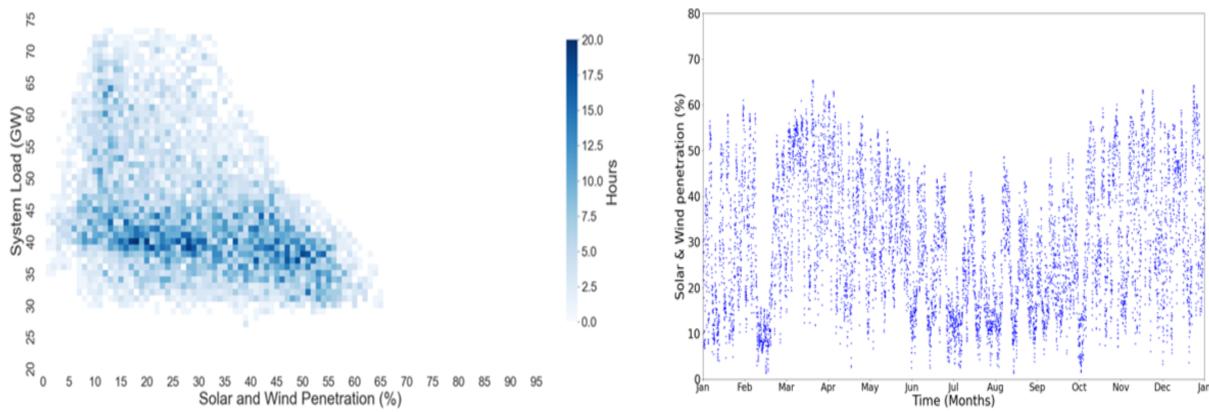

Figure 3: *ERCOT hourly wind and solar data 2022 a) heatmap plot of wind and solar penetration, b) time-series plot of wind and solar penetration*

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

Figure 4 illustrates an example disturbance from Odessa Texas where significant tripping of solar PV system occurred after the disturbance. The size of this disturbance nearly exceeded the Texas Interconnection Resource Loss Protection Criteria3 defined in NERC BAL-003 that is used to establish the largest credible contingency for frequency stability in an Interconnection. These types of concurrent and unexpected losses in generation pose a significant risk to BPS reliability when many of the underlying causes of abnormal performance are systemic in nature, should be captured in system planning assessments or interconnection studies, and are not mitigated in a timely manner[11].

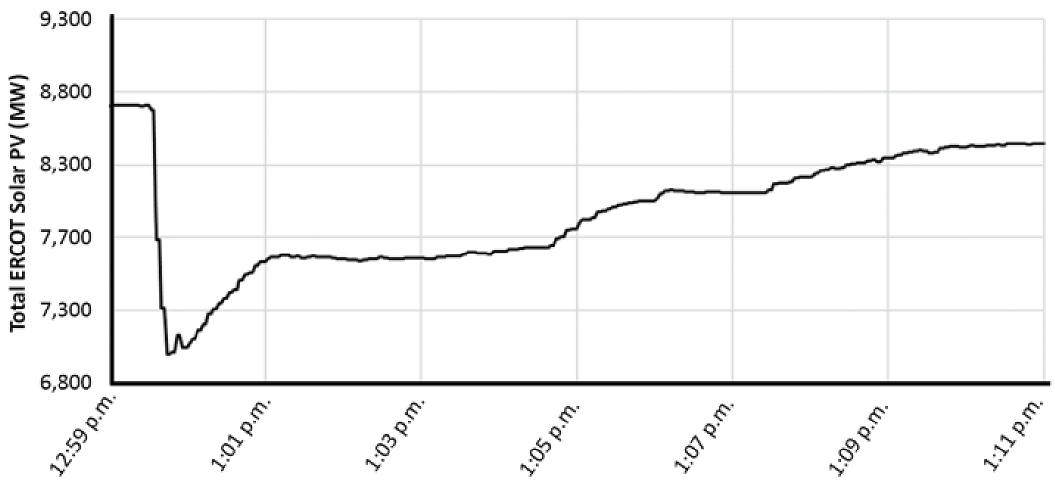

Figure 4: *ERCOT BPS-Connected solar PV generation during Odessa disturbance[11].*

As natural disasters such as hurricanes, flooding, and wildfires increase in severity and frequency, the power system's exposure to cyberattacks and physical hazards increases. During hazards, the power system can be reconfigured into independent segments that each contain load and generation. With enough DER such as PV systems, there are more opportunities for reconfiguration to enhance grid resilience. The fast-responding power electronics in solar generation and energy storage systems can provide blackstart capabilities to bring new segments more quickly back online[2]. DOE SETO recently launched a program called 'renewables advancing community energy resilience (RACER)' to enhance the resiliency of communities using solar, energy storage and other DERs[12]. Close coordination between DER and bulk and distribution power systems can be developed to ensure smooth transition between normal and recovery operations.

Realizing fast, adaptive response to physical disruptions or cyberattacks requires new modeling and simulation, new analysis, new inverter capabilities, and field demonstration[13]. We support modeling the effects of all hazards on power system performance arising from and affecting

[11] NERC, "2022 Odessa Disturbance report," 2022
[12] U.S. DOE, "Renewables advancing community energy resilience (RACER)" 2023 (https://www.energy.gov/eere/solar/renewables-advancing-community-energy-resilience-racer-funding-program)
[13] U.S. DOE, "Cyber security reports" (DOE Cybersecurity Report Provides Recommendations to Secure Distributed Clean Energy on the Nation's Electricity Grid | Department of Energy)

solar systems. These models will be used to test and optimize the grid's response to cyberattacks and physical disruptions, supporting new adaptive protection schemes, grid reconfiguration, emergency load balancing, islanding, and blackstart. An adaptive grid also requires technology to identify faults, attacks, and unexpected energization.

Current Research Activities

The following list provides an overview of SETO's current research activities in systems integration.[14]

- UNIFI: In 2021, the U.S. Department of Energy's Solar Energy Technologies Office funded a 5-year Universal Interoperability for Grid-Forming Inverters (UNIFI) consortium with the aim to develop innovative solutions and adoption of grid forming control technology for efficient, cost-effective, and reliable integration of solar energy technologies into the electricity grid.
- PEGI: Power Electronics Grid Interface (PEGI)[15] is a project funded by the U.S. Department of Energy's Solar Energy Technologies Office with the aim to provide a research platform to validate inverter-based resources and power-electronic dominant energy systems.
- RACER: In 2023, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) Renewables Advancing Community Energy Resilience (RACER) is a $33 million funding program supporting projects that enable communities to use solar and solar-plus-storage to prevent disruptions in power caused by extreme weather and other events, and to rapidly restore electricity if it goes down.
- Grid Services: In 2023, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) and Wind Energy Technologies Office (WETO) awarded eight projects to demonstrate the reliable operation of power systems that have up to 100% of their power contribution coming from solar, wind, and battery storage resources.
- OPTIMA: In 2023, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) announced the Operation and Planning Tools for Inverter-Based Resource Management and Availability for Future Power Systems (OPTIMA) funding opportunity to fund projects that address emerging challenges and opportunities for grid planning and operation engineers and technicians arising from the power system's transition to variable renewable energy sources and inverter-based power electronic grid interfaces.
- S2G: In 2021, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) awarded securing solar for the grid (S2G) program to ensure the cybersecurity of the electric grids with high penetrations levels of solar and other DERs.

[14] The U.S. DOE SEETO, "Solar research and development funding programs," [https://www.energy.gov/eere/solar/solar-research-and-development-funding-programs]

[15] NREL, "Power electronics grid interface" 2023 (https://www.nrel.gov/grid/power-electronics-grid-interface-workshop.html)

- EOS: In 2021, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) awarded Essential Operations for Solar (EOS) program to support development and adoption of standards required for grid integration of solar and other VREs into grids.
- OEDI-SI: In 2021, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) awarded Solar Grid Integration Data and Analytics Library (OEDI-SI) program to provides a single public repository for real and synthetic data, and support the development, benchmark testing, and validation of power system models and analytics for solar grid integration.
- Net Load Forecasting Prize: In 2023, the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) announced net load forecasting prize, that builds on Solar Forecasting Prize, and Solar Forecasting 2 Funding program, to demonstrate and promote the adoption of probabilistic forecasting in grid operations.

Other program offices in the U.S. Department of Energy (DOE), including the Office of Electricity (OE),[16] Wind Energy Technologies Office (WETO),[17] and Grid Deployment Office (GDO),[18] have also carried out many research activities to ensure grid reliability and resilience with the increasing deployment of IBR and DER technologies.

Purpose

EERE and SETO have identified three key challenges for integrating inverter-based resources, including solar, wind, and battery storage in the future grid: [19]

1. **Lower inertia:** Power electronics-connected generation and consumption reduce the mechanical inertia in the system.
2. **More Uncertain:** Uncertainties increase due to variable generation, smart loads, electric vehicles, generation and network contingencies, weather and cyber events, and hidden failures.
3. **More Distributed:** The grid trends to having many small active resources such as rooftop PVs, smart appliances, and electric vehicles.

This RFI focuses on ways to address these challenges through research, development, and demonstration of data, analytics, control, and hardware. The systems integration research portfolio aims to develop hardware and software solutions for grid system planning, system operation, resilience, and cybersecurity with the following features:

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[16] https://www.energy.gov/oe/office-electricity-oe-accomplishments
[17] https://www.energy.gov/eere/wind/renewable-systems-integration
[18] https://www.energy.gov/gdo/accomplishments
[19] Solar Energy Technologies Office Multi-Year Program Plan (2021)

1. **Responsiveness:** The high-speed control capabilities of power electronics present new opportunities for achieving a more responsive power grid.
2. **Adaptiveness:** The solutions can and should make the grid more adaptive – ramping requirements, network reconfiguration, AC/DC hybrid operation, and islanding at various granularities.
3. **Scalability:** Small resources are more scalable through various combinations as needed, e.g., against cyber or physical disturbances and during outage recovery.

This RFI seeks input from stakeholders on the evolving challenges and opportunities for reliable, resilient, and cybersecure integration of solar energy, energy storage, and other inverter-based variable resources. The RFI responses will help SETO identify short-, mid-, and long-term research gaps in the SETO Multi-Year Program Plan and our current project portfolio and inform the development of new programmatic strategies and research initiatives.

This RFI seeks inputs in the following topic areas:

Topic Area - 1: System Planning for High IBR and DER Futures
Power system planning refers to the strategic process of designing, optimizing, and managing the a) infrastructure required to transmit and distribute electrical power and b) generation and storage resources required to ensure a reliable supply of electricity to end users. It involves analyzing current and future electricity demand, assessing available energy resources, and determining the most efficient and cost-effective methods to interconnect and integrate new resources to meet the energy needs of communities and industries. The feedback provided for this category should emphasize gaps in the models, tools, processes, standards, and methodologies required for grid planners to incorporate variability and dynamic features of VREs/IBRs for planning the bulk power system.

Topic Area - 2: System Operation for High IBR and DER Futures
Power system operation refers to activities performed by operators in utility control rooms and ISO markets on a day-to-day basis to ensure a safe and reliable electricity supply to meet customer demand. These activities include scheduling resources, dispatching units, switching transmission lines, and real-time monitoring and control of generation facilities and grid equipment. Inputs in this category are expected to illustrate gaps in the models, tools, processes, and methodologies required for reliable and stable grid operations, variability management, and system health assessment/monitoring with high penetrations of VREs.

Topic Area - 3: System Resilience for High IBR and DER Futures
System resilience refers to the ability of the power system to seamlessly adapt to and swiftly recover from disruptions or outages. Resilience primarily focuses on the ability of a power system to withstand and recover from disturbances or adverse events, such as natural disasters and equipment failures. Inputs in this category are expected to incorporate gaps in metrics, standards, practices, and processes on planning, responding, and recovering from adverse grid conditions of the future IBR-dominated systems.

Topic Area - 4: Cybersecurity for Solar and DER systems
In the context of this RFI, cybersecurity for solar and DER systems refer to the security of critical power system infrastructure from unauthorized access, manipulation, and disruption by malicious actors. It encompasses measures and protocols designed to safeguard interconnected systems, such as power grids, from cyber threats and ensure the reliability and resilience of the energy supply. Inputs in this category are expected to incorporate gaps in technologies for detecting, identifying, and mitigating cyber threats, developing the standards and their adoption in power industry, digital supply chain security, information sharing, data security and privacy, security by design, risk assessment and evaluation tools, and stakeholder training and engagement.

Topic Area - 5: Enabling Technologies for High IBR and DER Futures - Power Electronics, Communication, Sensing, Artificial Intelligence, and Machine Learning
In the context of this RFI, enabling technologies refers to a set of foundational concepts, tools, techniques, or methodologies such as power electronics, communication, artificial intelligence, and machine learning that play a crucial role in enabling cost-effective, efficient, and reliable grid integration of solar energy systems. Power electronics devices, which are estimated to represent 80% of electricity flow devices by 2030, need more advanced control capabilities to improve grid reliability and stability for high-IBR integration. Communication, sensing, artificial intelligence (AI), and machine learning (ML) technologies have great potential to improve the planning and operation of future power systems through precise measurement of system states and powerful data analytics for optimal decision-making. Inputs in this category are expected to provide gaps in enabling technologies, standards, and strategies required for better utilization of these technologies in integration of IBRs.

Topic Area - 6: Other Emerging Topics for High IBR and DER Futures
Other emerging topics refers to new or evolving areas of focus that are not captured in the previous topics. Inputs on this topic are expected to identify gaps in emerging technologies, the energy landscape, and regulatory aspects that are not directly captured in other topics.

To streamline the processing of your inputs, we have developed a set of questions that cover the subjects presented above. These questions are presented in the “Request for Information Categories and Questions” section. Please supply your answers by responding to as many questions or topics as you feel comfortable.

Disclaimer and Important Notes

This RFI is not a Funding Opportunity Announcement (FOA); therefore, EERE is not accepting applications at this time. EERE may issue a FOA in the future based on or related to the content and responses to this RFI; however, EERE may also elect not to issue a FOA. There is no guarantee that a FOA will be issued as a result of this RFI. Responding to this RFI does not provide any advantage or disadvantage to potential applicants if EERE chooses to issue a FOA regarding the subject matter. Final details, including the anticipated award size, quantity, and timing of EERE-funded awards, will be subject to Congressional appropriations and direction.

Any information obtained as a result of this RFI is intended to be used by the Government on a non-attribution basis for planning and strategy development; this RFI does not constitute a formal solicitation for proposals or abstracts. Your response to this notice will be treated as information only. EERE will review and consider all responses in its formulation of program strategies for the identified materials of interest that are the subject of this request. EERE will not provide reimbursement for costs incurred in responding to this RFI. Respondents are advised that EERE is under no obligation to acknowledge receipt of the information received or provide feedback to respondents with respect to any information submitted under this RFI. Responses to this RFI do not bind EERE to any further actions related to this topic.

Confidential Business Information

Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked “confidential” including all the information believed to be confidential, and one copy of the document marked “non-confidential” with the information believed to be confidential deleted. Submit these documents via email, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Evaluation and Administration by Federal and Non-Federal Personnel

Federal employees are subject to the non-disclosure requirements of a criminal statute, the Trade Secrets Act, 18 USC 1905. The Government may seek the advice of qualified non-Federal personnel. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The respondents, by submitting their response, consent to EERE providing their response to non-Federal parties. Non-Federal parties given access to responses must be subject to an appropriate obligation of confidentiality prior to being given the access. Submissions may be reviewed by support contractors and private consultants.

Request for Information Questions

The following questions are prepared to receive feedback from relevant stakeholders on the evolving challenges and opportunities for reliable, resilient, and cybersecure integration of **solar energy, battery energy storage, and other inverter-based variable resources**. We kindly request respondents to thoughtfully select and respond to all or subsets of questions that align with their areas of expertise and relevance.

Topic Area - 1: **System Planning for High IBR and DER Futures**

1. What are the biggest technical challenges for utility-scale IBR and DER grid integration from the perspectives of system planners, project developers, and/or technology providers?
2. Which software tools do you use for bulk power or distribution system planning studies? What are their limitations?
3. Are existing methods, processes, and requirements adequate for planning the future bulk power system with high utility-scale IBR and DER deployment? Why or why not?
4. What are the existing practices for representing DER in bulk power and distribution system planning? Are the existing practices adequate for system reliability and resource adequacy planning? Why or why not?

Topic Area - 2: **System Operation for High IBR and DER Futures**

1. What are the biggest technical challenges to managing the large amounts of utility-scale IBR and DER from the perspectives of system operators, utilities, or technology providers?
2. What are the gaps in existing methods, processes, and requirements used in decision-making for system operation?
3. What are the limitations of the existing tools for system operators in risk and uncertainty assessment, variability management, and real-time monitoring, control, and dispatch of IBR and DER? How can these be addressed?
4. What are the existing practices for representing DER in bulk power and distribution system operation? How can the potential of DER be maximized?

Topic Area - 3: **System Resilience for High IBR and DER Futures**

1. What are the biggest challenges in using IBR and DER technologies to enhance the resilience of the power system, i.e., to prepare, protect, detect, and respond to disruptions and enable rapid isolation and restoration of affected areas?
2. What are existing practices to improve the resilience using IBR and DER technologies? If there are technological gaps, explain how they can be addressed through research.
3. What are the existing performance metrics used to measure the system resilience? Are they adequate to capture the impacts of a growing number of extreme events and natural disasters and the energy transition of the power system? Are there metrics that should be considered when thinking about the resilience of underserved communities? What are the potential impacts of cascading failures across interdependent critical infrastructures (e.g., water, gas, transportation, telecommunications) in the event of a widespread grid disruption, and how can we develop cross-sector collaboration and resilience strategies to address these challenges?

Topic Area - 4: **Cybersecurity for High IBR and DER Futures**

1. What are the existing challenges to ensure the secure integration of IBR and DER systems into the grid, considering the diverse range of technologies, communication protocols, and control mechanisms involved?
2. What are the potential cyber vulnerabilities specific to grid-integrated solar systems? How can the resilience of grid-integrated solar systems against cyber-attacks be enhanced? Which existing countermeasures help to mitigate these risks, and are they adequate?
3. What are the implications of emerging technologies such as Internet of Things (IoT), blockchain, and artificial intelligence (AI) on the cybersecurity of grid-integrated solar systems, and are existing security frameworks adequate to address these implications?
4. What gaps exist in cybersecurity standards, and how can such gaps between industry needs and existing standards be bridged?

Topic Area - 5: **Enabling Technologies for High IBR and DER Futures - Power Electronics, Communication, Artificial Intelligence, and Machine Learning**

1. Which recent innovations in power electronics will be most impactful for utility-scale IBR and DER grid integration?
2. Which recent innovations in sensing and communication technologies can be applied to solar and DER grid integration?

3. What are the limitations of current IBR, DER, and power system control techniques? Are current grid-forming and grid-following inverter control functionalities sufficient for future high-IBR and high-DER grids? Explain why.
4. What are the opportunities in applying AI/ML techniques in solar forecasting, state estimation, and other areas of IBR and DER grid integration?

Topic Area - 6: **Other Emerging Topics for High IBR and DER Futures**

1. Which other technology areas are important for utility-scale IBR and DER grid integration but have not been discussed? Please explain why federal funding is necessary to support them.
2. Are there particular skills or capabilities that DOE should consider developing training programs around to ensure grids operate effectively in the future? How can DOE best collaborate with stakeholders to identify and deliver education to stakeholders that need it?
3. Of the topics listed above, are there any where workforce development is strongly needed? Why and what kind of entity would best provide that educational experience?
4. What are specific strategies or initiatives that DOE SETO should prioritize to ensure diversity, equity, and justice are effectively integrated into its programs and initiatives?

Request for Information Response Submission Guidelines

Responses to this RFI must be submitted electronically to SETO-SI-2023-RFI@ee.doe.gov no later than 5:00pm (ET) on November 30, 2023. Responses must be provided as attachments to an email. It is recommended that attachments with file sizes exceeding 25MB be compressed (i.e., zipped) to ensure message delivery. Responses must be provided as a Microsoft Word (.docx) attachment to the email, and no more than 8 pages in length, 12-point font, 1-inch margins. Only electronic responses will be accepted.

It is recommended that responses are directly provided to the specific topics and questions of this RFI following the layout presented in the Request for Information Categories and Questions section of this document. Please clearly identify the specific category or question you are providing information for in your submission using the numbering convention provided in the RFI to identify the answer (for example 5.1). Respondents may provide information for as many or as few topics as they wish.

EERE will not respond to individual submissions or publish publicly a compendium of responses. A response to this RFI will not be viewed as a binding commitment to develop or pursue the project or ideas discussed.

Respondents are requested to provide the following information at the start of their response to this RFI:

- Company / institution name
- Company / institution contact
- Contact's address, phone number, and e-mail address