

Notice of Intent (NOI) No. DE-FOA-0003445**Issue Date: September 17, 2024**

DISCLAIMER: The “Notice of Intent to Issue” is for informational purposes only; the Department of Energy is not requesting comments on the information in this notice.

This is a Notice of Intent to Issue
Funding Opportunity Announcement No. DE-FOA-0003446
“HARMONY: Human-Centric Analytics for Resilient &
Modernized Power sYstems”

Prior to the end of calendar year 2024, the United States (U.S.) Department of Energy (DOE) intends to issue a Funding Opportunity Announcement (FOA) seeking applications for financial assistance awards that would support various Office of Electricity (OE) and other DOE programs. This FOA would support the Department’s vision to enhance grid reliability and resilience in the face of growing uncertainties and in the age of big data to accelerate pathways towards grid modernization goals.

OVERALL BACKGROUND AND TECHNICAL OBJECTIVES

The objective of this potential FOA is to enhance grid reliability and resilience in the face of growing uncertainties and in the age of digital information systems and networks. It is critical to quantify and clearly communicate risk and uncertainties to decision-makers and human operators to predict, prevent, mitigate and enable better understanding of cascading failures in power grids.

The ongoing transformation of the power grid is characterized by *deep* uncertainties^{1,2}, Deep uncertainties where experts cannot agree upon appropriate models, probability distributions, key variables and parameters, and how to value different outcomes³, are growing significantly due to:

1. Integration of distributed assets and intermittent renewable energy sources have shifted power supply,
2. The emergence of prosumers (consumers who also generate electricity),
3. The growing role of third-party aggregators managing these distributed assets,
4. Increased electrification leading to increased interdependencies among critical infrastructure, and
5. Increased digitization with associated cyber risks as well as increased volume and velocity of data.

These grid transformation trends are fundamentally shifting the physics of the power system Long-standing assumptions power system operations and simulations have been built on may no longer be accurate. The convergence of power systems and communication systems critical to operations

¹ Haas, C., Jahns, H., Kempa, K. and Moslener, U., 2023. Deep uncertainty and the transition to a low-carbon economy. *Energy Research & Social Science*, 100, p.103060.

² Marchau, V.A., Walker, W.E., Bloemen, P.J. and Popper, S.W., 2019. Decision making under deep uncertainty: from theory to practice (p. 405). Springer Nature.

³ Lempert, R.J., 2003. Shaping the next one hundred years: New methods for quantitative, long-term policy analysis.

challenges decision makers, requiring information on multi-sector risks associated with data integrity. In addition to the fundamental changes with grid systems, there are exogenous changes impacting reliability and resilience. The challenge associated with operating the grid under growing areas of uncertainty is further amplified by the changes in the frequency, intensity and (landfall) locations of extreme weather and climate events and increased frequency of compound climate risks under climate change.

To ensure a reliable and resilient grid operations and operational planning in this rapidly evolving landscape and to effectively manage the emerging risks, a more rigorous understanding, characterization, and visualization of uncertainties is crucial.

This necessitates a shift beyond simply characterizing *aleatory*⁴ uncertainties, due to statistical, inherent randomness (like signal noise). It is critical to also actively identify, assess, and effectively communicate epistemic¹, systematic uncertainties that stem from lack of clarity on the operational strategies, simulations, and system states. Epistemic uncertainties include uncertainties arising from knowledge limitations or incomplete data that system operators and decision-makers maybe have when managing a rapidly changing power system in real time.

Significant advancements have been made in recent years in modeling and managing various sources of uncertainty in power grids, with a primary emphasis on assessing aleatory/statistical uncertainties, capturing variabilities in 'data rich' system. However, there are still significant gaps, particularly in our understanding and ability to characterize, assess, and communicate epistemic/systematic uncertainties. These uncertainties are especially critical in "data-poor" systems, where limited historical information about weather patterns, grid behavior, and consumer demand can hinder accurate risk assessment. Addressing these data and knowledge gaps is essential for building robust and adaptable power systems that can navigate the uncertainties of the future. Filling these gaps requires providing grid operators and decision makers with actionable information that incorporates account both allegory/statistical and epistemic/systematic uncertainties.

Advanced, physics- and human behavior-aware analytics are critical to address challenges related to new and variable system dynamics. These analytics are critical to enabling renewable integration, increased infrastructure decentralization, and infrastructure interdependency under a changing climate. Uncertainty-informed advanced analytics that extract actionable information from data and knowledge need to consider not only systems' physics but also human factors to be effective.

This FOA would seek applications to conduct Research and Development and Demonstration (RD&D) activities advancing **the state of the art for power system uncertainty and risk metrics to help human operators receive actionable information to better understand, predict, prevent, and mitigate cascading failures in power grids**. This includes, but is not limited to the following FOA objectives:

- Advance the state-of-the-art probabilistic risk analysis, and metrics, reflecting both epistemic and aleatory sources of uncertainty in power system operations and planning.
- Push the frontiers of knowledge in risk science, providing an integrated framework for grid

⁴ Hüllermeier, E. and Waegeman, W., 2021. Aleatoric and epistemic uncertainty in machine learning: An introduction to concepts and methods. Machine learning, 110(3), pp.457-506.

resilience under deep uncertainty.⁵

- Characterize and assess centralized vs decentralized (agile/modular) control architecture's response to uncertainty.
- Develop novel assumption-deviation analytics,⁶ allowing for effective communication of model's underlying assumptions to power system decision-makers.
- Develop advanced methodologies for quantifying cyber risk in electric power grid systems.
- Grid operations, information network operations – what information is useful to operational decision makers on grid information network operations, and how can this be integrated into day-to-day operational control displays.
- Identify topics related to novel market and rate design as well as econometrics of DERs and distributed assets leveraging data analytics and incorporate risks associated with uncertainties in human behavior.
- Characterize, assess, and visualize metrics on power system uncertainty to improve the grid operational human machine interfaces (HMI).

Each application would require, at a minimum:

- Budgetary Cost Estimates
- Clear Identification of Potential Challenges and Mitigations
- Clear Workforce/Business Development Plan
- Clear description of data types and sources, and letters of commitment from data owners when necessary
- A comprehensive data management and dissemination plan

This FOA would seek to establish a portfolio of projects that have demonstrations across a variety of geographic, economic, and climate conditions to create a varied and more comprehensive assessment of future deployment of advanced sensors technologies.

Although DOE is not requesting comments on this NOI, interested parties can choose to submit comments to DOE at NOI3455@netl.doe.gov. DOE will not entertain questions at this time regarding issuance of the FOA. Details on how to submit questions and comments will be provided in the FOA, if released.

PROJECT TEAMS

It is anticipated an applicant's project teams should include a university partner and an electric sector partner (utilities, wire owning/operating entities, aggregators, market operators, etc.). There is a preference for university lead work.

ANTICIPATED AWARDS

If the FOA is released, approximately \$5 million in Federal Funds, subject to annual congressional appropriation, is expected to be available for awarding new cooperative agreements. The number of

⁵ Logan, T.M., Aven, T., Guikema, S.D. and Flage, R., 2022. Risk science offers an integrated approach to resilience. *Nature Sustainability*, 5(9), pp.741-748.

⁶ Khorsandi, J. and Aven, T., 2017. Incorporating assumption deviation risk in quantitative risk assessments: A semi-quantitative approach. *Reliability Engineering & System Safety*, 163, pp.22-32.

applications selected for negotiations leading to award is anticipated to be up to four (4).

The number of awards will depend on the applications submitted and the availability of funds. DOE anticipates making awards that have a single Budget Period and do not exceed three (3) years.

DOE envisions the awarded projects will primarily consist of Research and Development (R&D) tasks. Award Recipients would be required to provide some non-federal cost share for R&D activities.

CONCEPT PAPERS

If the FOA is released, Concept Papers will be required prior to submitting a Full Application. If an applicant does not submit a Concept Paper, it cannot submit a Full Application. DOE would make an independent assessment of each Concept Paper based on the established criteria and will encourage a subset of applicants to submit Full Applications. Other applicants would be discouraged from submitting a Full Application.

An applicant who receives a “discouraged” notification may still submit a Full Application. By discouraging the submission of a Full Application, DOE intends to convey its lack of programmatic interest in the proposed project to save the applicant the time and expense of preparing an application that is unlikely to be selected for award negotiations.

Concept Papers would be submitted to an email address designated in the FOA. Concept Papers are not being requested under this NOI.

SUBMISSION AND REGISTRATION REQUIREMENTS FOR FULL APPLICATION

If the FOA is released, it will be posted at Grants.gov (<http://www.grants.gov>) and at FedConnect (<http://www.fedconnect.net>). Entities interested in applying for awards under the FOA are strongly encouraged to register at these sites to receive notification of announcements regarding the FOA. If DOE decides to issue the FOA, applications can only be submitted through Grants.gov.

There are several one-time actions an applicant must complete to submit a Full Application in Grants.gov (e.g., register with the System for Award Management (SAM), obtain a Unique Entity Identifier (UEI) number, register with Grants.gov, and register with FedConnect.net to submit questions). 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.

- **SAM** - Applicants must register with SAM at <http://www.sam.gov/> prior to submitting an application in response to an FOA. Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in SAM registration. Failure to register with SAM will prevent your organization from applying through Grants.gov. The applicant must maintain an active SAM registration with current information at all times during which it has an active Federal award or an application under consideration. More information about SAM registration for

applicants is found at:

https://www.fsd.gov/gsafsd_sp?id=gsafsd_kb_articles&sys_id=650d493e1bab7c105465eaccac4_bcbcb.

NOTE: If clicking the SAM links do not work, please copy and paste the link into your browser.

- **UEI** - Applicants must obtain an UEI from the SAM to uniquely identify the entity. The UEI is available in the SAM entity registration record.

NOTE: Subawardees/subrecipients at all tiers must also obtain an UEI from SAM and provide the UEI to the Prime Recipient before the subaward can be issued.

- **Grants.gov** - Applicants must register with Grants.gov and set up your Workspace. You cannot submit an application through Grants.gov unless registered. **Please read the registration requirements carefully and start the process immediately.**
 - 1) The Authorized Organizational Representative (AOR) must register at: <https://apply07.grants.gov/apply/OrcRegister>
 - 2) An email is sent to the E-Business (E-Biz) POC listed in SAM. The E-Biz POC must approve the AOR registration using their MPIN from their SAM registration.

More information about the registration steps for Grants.gov is provided at:
<https://www.grants.gov/web/grants/applicants/registration.html>

In addition:

- Add a Profile to a Grants.gov Account: A profile in Grants.gov corresponds to a single applicant organization the user represents (i.e., an applicant) or an individual applicant. If you work for or consult with multiple organizations and have a profile for each, you may log in to one Grants.gov account to access all of your grant applications. To add an organizational profile to your Grants.gov account, enter the UEI for the organization in the UEI field while adding a profile. For more detailed instructions about creating a profile on Grants.gov, refer to:
<https://www.grants.gov/web/grants/applicants/registration/add-profile.html>
- EBiz POC Authorized Profile Roles: After you register with Grants.gov and create an Organization Applicant Profile, the organization applicant's request for Grants.gov roles and access is sent to the EBiz POC. The EBiz POC will then log in to Grants.gov and authorize the appropriate roles, which may include the AOR role, thereby giving you permission to complete and submit applications on behalf of the organization. You will be able to submit your application online any time after you have been assigned the AOR role.

NOTE: When applications are submitted through Grants.gov, the name of the organization applicant with the AOR role that submitted the application is inserted into

the signature line of the application, serving as the electronic signature. The EBiz POC **must** authorize people who are able to make legally binding commitments on behalf of the organization as a user with the AOR role; **this step is often missed and it is crucial for valid and timely submissions.**

For more detailed instructions about creating a profile on Grants.gov, refer to: <https://www.grants.gov/web/grants/applicants/registration/authorize-roles.html>

To track your role request, refer to:

<https://www.grants.gov/web/grants/applicants/registration/track-role-status.html>

Questions relating to the **registration process, system requirements, or how an application form works** must be directed to Grants.gov at 1-800-518-4726 or support@grants.gov.

- **FedConnect.net** - Applicants must register with FedConnect to submit questions. FedConnect website: www.fedconnect.net.

DISCLAIMER

This NOI is issued so that interested parties are aware that DOE may issue a FOA on this topic. Any information contained in this NOI is subject to change.

Currently, no Concept Papers or Full Applications are being accepted.