Notice of Intent No. DE-FOA-0003060

Notice of Intent to Issue
Funding Opportunity Announcement No. DE-FOA-0003058

The Office of Energy Efficiency and Renewable Energy (EERE) intends to issue, on behalf of the Solar Energy Technologies Office (SETO), a Funding Opportunity Announcement (FOA) entitled "Advancing U.S. Thin-Film Solar".

Table of Contents

This is a Notice of Intent (NOI) only. EERE may issue a FOA as described herein, may issue a FOA that is significantly different than the FOA described herein, or EERE may not issue a FOA at all.

Background and Technical Objectives

SETO intends to release the Advancing U.S. Thin-Film Solar FOA which will focus on accelerating the capabilities of two thin-film photovoltaic (PV) technologies: metal halide perovskite PV and cadmium telluride (CdTe) PV technologies. It will fund innovative industrial research and development projects for perovskite PV, and industrial research, development, and demonstration projects relevant to CdTe PV. This FOA promotes American leadership in thin-film PV technology, and the domestic manufacture of thin-film PV modules. This FOA will also support SETO in meeting Congressional direction provided in fiscal year 2023 to spend no less than $25 million to support the advancement of both perovskite PV and CdTe PV technologies ($50 million in total).

Thin-film PV technologies use direct band-gap semiconductors that have much thinner photoactive layers than the predominant PV technology, crystalline silicon (c-Si). The United States has been a leader in the development of thin-film PV technologies and is home to the largest thin-film PV manufacturer in the world, First Solar. Thin-film PV technologies have potential advantages over c-Si PV, such as less energy-intensive manufacturing, lower manufacturing capital expenditures, and simpler supply chains. CdTe thin film PV modules represent approximately 33% of all PV installed in the United States in 2022, yet less than 3% of the global PV market.[1, 2, 3, 4] Thin-film PV module efficiencies have lagged those of their crystalline silicon (c-Si) competitors, although they have shown potential to have better lifetime energy yield. The two thin-film PV technologies focused on in this FOA—perovskite and CdTe—face different major challenges based on their relative technological maturity to become competitive or stay competitive with c-Si PV.

Perovskite PV

Perovskite PV has seen an unprecedented rate of improvement in efficiency for an emerging PV technology, with single junction device power conversion efficiencies over 25% achieved in less than 10 years after its first reported use as a PV material. There are many aspects of perovskite PV's ease of processing and high-performance potential that make it deserving of additional investigation, in particular its potential in tandem PV applications. However, there are still fundamental durability and manufacturing challenges that need to be solved before it could substantially enter the market for grid-connected energy production.[5] If proven to be scalable, durable, and cost-competitive, perovskite PV could contribute substantially towards long-term decarbonization and deployment goals.

---

[1] David Feldman et. al. NREL. *Spring 2023 Solar Industry Update* - *www.nrel.gov/docs/fy23osti/86215.pdf*

[2] David Feldman et. al. NREL. *Summer 2022 Solar Industry Update* - https://www.nrel.gov/docs/fy22osti/83718.pdf; https://www.energy.gov/eere/solar/solar-photovoltaics-supply-chain-review-report

[3] Wood MacKenzie US-Solar Market Insight (2022) https://www.woodmac.com/industry/power-and-renewables/us-solar-market-insight/

[4] SEIA U.S. Solar Market Insight https://www.seia.org/us-solar-market-insight

[5] Substantially is defined here as >500 MW per year

Topic 1 will provide $20 million for perovskite PV research and development (R&D) projects in an industrial setting to enable future commercialization by reaching specific thresholds of efficiency, long-term reliability, manufacturability, and economic viability. It will not fund projects focused exclusively on manufacturing scale-up, but projects that, if successful, may enable pilot-scale manufacturing in the future. It will focus on hybrid tandem devices that combine perovskite PV with another PV material (e.g., silicon or CdTe). It will also set milestones that SETO believes the technology needs to meet by the end of calendar year 2026 to merit future funding for pilot manufacturing projects.

Cadmium Telluride PV

CdTe PV is a successful commercial technology, with significant high-volume manufacturing and nearly 9 GW_{dc} produced globally in 2022. CdTe manufacturing capacity is rapidly increasing in the U.S. However, CdTe PV technology (tools, processes, materials, metrology at each step in the supply chain) will require continued innovation to stay competitive with the rapidly innovating global c-Si sector, especially as a U.S. c-Si PV manufacturing industry develops and other technologies, such as metal halide perovskite PV, mature.

Since most of the globally produced CdTe PV is installed in the United States, there is a unique domestic need to assess quality and field performance at time of installation and throughout the system's lifetime. Many of the current tools for assessing PV reliability were designed for Si PV arrays. These could be optimized to gather data for CdTe PV systems, or unique approaches to assess CdTe PV arrays could be developed.

Topic 2 will provide $16 million for domestic research, development, demonstration, and commercialization projects across the CdTe PV materials, equipment, installation, and performance monitoring supply chain. Innovations are sought in the manufacturing supply chain that improve throughput, performance, energy intensity and production costs for unit process and integrated manufacturing while maintaining the quality and reliability of the domestic CdTe PV industry and supply chain. Innovations are also sought to enhance the performance, reliability, and technical aspects of bankability of CdTe PV systems.

Topic Area 1: Promoting Research & Development towards Industrial Manufacturing of Early-Stage Perovskite Tandem Photovoltaics (PRIMES Perovskite Tandem PV)

The goal of this topic area is to put domestically manufactured perovskite tandem PV on the path to have substantial market uptake by 2030. This notice of intent (NOI) outlines SETO's approach to supporting this goal starting in fiscal year 2023 (FY23). Quantifiable targets are provided to reflect both technology progression and changing market dynamics. The targets provided are ambitious and some may not be achievable today. SETO is communicating this information now so potential applicants have the opportunity to align their work with these targets before an FY23 FOA release and in anticipation of potential future funding opportunities, pending future appropriations.

The perovskite PV R&D community has demonstrated some of the fastest-paced efficiency improvements ever seen in an emerging PV technology. The lab-scale PV technology has achieved power conversion efficiencies (PCEs) over 25% in single-junction cells and over 30% in tandem cells with silicon. These PCE results, combined with the high-throughput potential of perovskite module manufacturing with various processing techniques, demonstrate the promise of perovskite semiconductors in next-generation solar modules. This promise is accelerating the push to bring perovskite PV to the market in the United States and internationally, with multiple announcements from companies to build and/or to begin operating >100 MW pilot manufacturing lines in the next 1-4 years. However, many industry announcements have been delayed multiple times. SETO believes additional R&D is needed to address reliability and performance-at-scale issues that remain unsolved with perovskite PV to support future pilot manufacturing efforts.

In support of the drive to commercialize perovskite PV, SETO developed, through a request for information (RFI) process in 2021, a Performance Target Matrix to align the domestic industry on several R&D metrics that would indicate a stronger readiness for manufacturing development (Table 1).[6] As of May 2023, SETO does not have data showing that any entity has met these metrics. To support well-known reliability challenges with perovskite PV, SETO funded the PV PACT Center[7] at Sandia National Laboratories and the National Renewable Energy Laboratory to support independent validation and improved understanding of outdoor fielded perovskite minimodule performance. As of May 2023, SETO has not seen a publicly available dataset for perovskite minimodules greater than 10 cm^2 in aperture area achieving efficiency ≥12% after 10 weeks of outdoor testing. Based on the available data about perovskite durability and performance and the status of the current commercial landscape, SETO believes perovskite PV is on a trajectory to reach substantial market entry for grid-connected energy production after 2030. SETO seeks to accelerate this timeline by supporting, through this topic, the achievement of the RFI Performance Target Matrix by the end of 2026.

[6] https://www.energy.gov/eere/solar/summary-performance-targets-perovskite-pv-research-development-and-demonstration

[7] https://pvpact.sandia.gov/

In support of this goal, the focus of this topic is on the further R&D needed to realize the full potential of perovskite PV and accelerate progress towards manufacturing efforts. This funding will support significant industrial R&D hosted at for-profit companies. While academic, lab-scale advances on 0.1-1 cm^2 devices have been substantial over the last decade, proving durability, efficiency, and reproducibility at even modest scales of >100 cm^2 has proven to be a much more significant barrier. Therefore, awards will be given to projects utilizing industrially relevant processing equipment and large sample sizes to understand process variability at high confidence. Use of structured experimentation methodology at statistically meaningful scale coupled with statistical analysis will be required, consistent with standard industrial R&D processes.

SETO understands that R&D of this nature, which is critical to reach the next stages of commercialization, is inherently more resource intensive and best led by industry. As such, lead applicants will be restricted to for-profit entities; however, teaming with universities, national laboratories, and other supply chain or ecosystem partners is encouraged (additional details below). SETO anticipates providing a total of $20 million in financial assistance awards in the form of cooperative agreements. These awards will last 18-36 months, with $3 million-$20 million federal share per project and a cost share requirement of 20%.

This topic will specifically target advancing hybrid perovskite tandem devices (PV modules that combine perovskites with another absorber layer, including c-Si, CdTe, CIGS, or organic PV), as opposed to single-junction devices. As incumbent technologies like c-Si PV continue to improve in efficiency and lifetime while reducing cost, the window of opportunity for a new single-junction absorber technology is shrinking, regardless of the cost of the absorber layer. Perovskite tandem PVs, paired with other established technologies such as c-Si, have demonstrated the potential to achieve >30% PCE, which exceeds the currently understood practical efficiency limits of single-junction c-Si PV. Hybrid tandems also have the advantage of being able to leverage the large incumbent capacity base as opposed to competing against it. Projects on all-perovskite tandem or single-junction devices (that are not tandem compatible) are not of interest for this topic.

Furthermore, projects will be requested to address the four major research challenges that SETO has previously communicated: durability, efficiency, manufacturing, and bankability.[8] Of these four, durability remains the top priority—especially light and heat durability, and durability at the minimodule scale—without sacrificing efficiency.

It is SETO's expectation that applicants who successfully complete projects under this topic area will be able to achieve (or be on the path to achieving) the Performance Target Matrix by the end of 2026. Achievement of these targets is critical to enabling successful pilot manufacturing for perovskite PV. Achieving these targets by the end of 2026 will be critical for the U.S. industry

[8] https://pubs.acs.org/doi/full/10.1021/acsenergylett.2c00698

to establish competitiveness with the incumbent industry and international competitors. SETO understands that substantial risk exists in achieving these targets and that additional support beyond the scope of this FOA may be needed. Future needs will be assessed in alignment with these stated goals and pending future appropriations. Projects solely focused on ramping up manufacturing processes to >1 m^2 size are not of interest at this time.

Table 1: SETO RFI Performance Target Matrix

Goal: To demonstrate these metrics by the end of 2026

Aperture Area PCE[a]	Total Module Area[b]	Durability	Sample Population Requirements
27% PCE (for hybrid tandems)	>=500 cm^2 with at least 4 interconnected cells	Pass IEC 61215 Module Quality Test (MQT) 10, 11, 13 and 21 and ISOS-L-2 at specified durations with <10% relative performance loss per test[c] 6 months continuous outdoor testing with <3% relative degradation overall and <1% degradation in the final 3-month span[d]	>1 kW total, at least 20 modules for outdoor testing[e]

a. *Average of tested devices, measured after at least 10 kWh/m2 outdoor or AM1.5 exposure (NOTE: this will be updated as the PACT Validation Center generates initial preconditioning test protocols)*

b. *Aperture/total module area > 75%*

c. *Validation Center (or other independent laboratory) will assign devices to each test from available sample population. Standard sampling protocols may not be followed due to available sample population sizes. Test overview:*

- *MQT 10 – UV preconditioning test: 15 kWh/m2, 60°C*
- *MQT 11 – Thermal cycling test: 50 cycles, −40°C to +85°C*
- *MQT 13 – Damp heat test: 1000 h at +85°C, 85% RH*
- *MQT 21 – Potential induced degradation test: IEC TS 62804-1 +85°C, 85% RH at maximum system voltage for 96 hours*
- *ISOS-L-2 – Light-soaking: 1000 h, 1 sun AM1.5, +75°C, ambient environment*

d. *Conducted by the Validation Center; Averaged utilizing only on top-performing 90% of fielded devices (10% dropout acceptable)*

e. *Devices will be assigned to accelerated or outdoor testing by the Validation Center or other independent laboratory (not by the fabricator)*

Competitive Project Guidelines at Different Funding Levels (Tabular Format)

Within an application, teams may propose projects at multiple levels of funding between $3 million-$20 million. The guidelines below describe what a competitive application is expected to include for a few example funding levels. Applicants may apply at levels between those mentioned below and should extrapolate/interpolate between the requirements proportionately. It is expected that teams may excel in one or more of the areas identified below but underperform in others; however, teams that underperform in all areas of the guidelines below should not expect a favorable review. SETO is communicating this information now so potential applicants can take advantage of the intervening time before a FOA is released to identify and fill possible gaps in their capabilities.

Competitive Project Guidelines for $5 million Federal Award:

- Team has demonstrated **either**:[9]
  - (1) single-junction perovskite small area cells (~0.1 cm^2 aperture area[10]) with a PCE ≥18% on devices with ≥1.6 eV band gap, **or**
  - (2) tandem-perovskite small area cells (~0.1 cm^2 aperture area) with a PCE ≥23%
- Team has demonstrated combined heat and light stress testing:[11]
  - ≥5 cells measured at V_{oc}, ≥5 cells measured at Maximum Power Point (MPP) subjected to ≥60°C for ≥1000 hours at ~ 1 sun illumination.[12]
  - The drop in efficiency must be ≤20% relative at 1000 hours.
- Team has a minimum cell fabrication capability of 100 devices/week and have a plan to scale throughput to ≥100 devices per week at ≥100 cm^2 aperture area.[13]

Competitive Project Guidelines for $10 million Federal Award:

- The for-profit lead applicant of the project team has established and documented:
  - Experience in industrial R&D and manufacturing (preferably in the PV sector);
  - Clearly defined roles, responsibilities and decision making processes;
  - Business systems for supplier selection for capital equipment and critical raw materials;
  - Experience in statistical experimental design and statistical procedures for qualifying processes and tools.
- The for-profit lead applicant of the project team has demonstrated ISO 17025 CTL (Certified Test Laboratory) verified performance of **both**:

[9] Data must be provided to show that this performance can be readily reproduced with a mean PCE across a minimum of 20 cells across >4 substrates produced across ≥2 days.

[10] In order to be defined as "aperture area" a rectangular opaque mask must be used to define the optically active area.

[11] Cell starting performance for degradation testing must be greater than or equal to cell performance requirement.

[12] Cells should be appropriately preconditioned using heat/light stabilization or dark soaking. ≥10 cells should be from a single batch of production. Cells may be encapsulated or unencapsulated in controlled environment.

[13] The production capability listed is considered the peak capability and it is understood that teams will not typically operate at this level for multiple weeks.

- (1) single-junction perovskite cells (≥ 1 cm^2 aperture area[14]) with a PCE ≥18% on devices with ≥1.6 eV band gap **or** tandem-perovskite cells with a PCE ≥24%,[15] **and**
- (2) single-junction perovskite minimodules of ≥25 cm^2 aperture area with PCE ≥15% **or** tandem-perovskite minimodules of ≥25 cm^2 with PCE >20%.[16]

- Team has samples on-sun at outdoor testing facilities (preferably with samples at PACT[17])
- Team has demonstrated combined heat- and light-stress testing on encapsulated minimodules:[18]
  - ≥5 devices measured at V_{oc}, ≥5 devices measured at Maximum Power Point (MPP) subjected to ≥60°C for ≥1000 hours at ~ 1 sun illumination.[19]
  - The drop in efficiency must be ≤10% relative at 1000 hours.
- Team has a minimum cell fabrication capability of 100 minimodules/week (which should be from ≥25 substrates of ≥100 cm^2 area each) and have a plan to scale to ≥100 devices per week at ≥500 cm^2 aperture area.[20]

Competitive Project Guidelines for $20 million Federal Award:

- In addition to the $10 million Federal Award requirements, the for-profit lead applicant of the project team has established and documented:
  - Management team and senior leadership with significant experience bringing products from R&D to production in a manufacturing environment (preferably in the PV sector);
  - Modern project and program management practices informed through theory of constraints;
  - Well-developed business systems for supplier selection, change control, risk assessment and mitigation and data management with full traceability from incoming material to outgoing product;
  - Quality systems including statistical process control, statistical design of experiments, statistically informed raw and intermediate materials specifications.

---

[14] In order to be defined as “aperture area” a rectangular opaque mask must be used to define the optically active area.

[15] Data must be provided to show that this performance can be readily reproduced with a mean PCE across a minimum of 20 cells across ≥4 substrates produced across ≥2 days.

[16] Data must be provided to show that this performance can be readily reproduced with a mean PCE across a minimum of 10 separate devices produced across ≥2 days.

[17] https://pvpact.sandia.gov/

[18] Minimodule starting performance for degradation testing must be greater than or equal to minimodule performance requirement.

[19] Devices should be appropriately preconditioned using heat/light stabilization or dark soaking. ≥10 minimodules should be from a single batch of production.

[20] The production capability listed is considered the peak capability and it is understood that teams will not typically operate at this level for multiple weeks.

- The for-profit lead applicant of the project team has demonstrated ISO 17025 CTL verified PCE of the SETO RFI Performance Target Matrix for tandem-perovskite minimodules of ≥25 cm^2.[21]
- Team has demonstrated ≥3 months of outdoor field testing with <3% relative degradation (with minimodules on test at PACT[22] for ≥10 weeks) with ≥10 W of samples (≥20 minimodules).[23]
- Team has passed at least 4 of the 5 accelerated stress tests specified in the Performance Target Matrix (i.e., MQT 10, MQT 11, MQT 13, MQT 21, ISOS-L-2).[24]
- Team has a minimum cell-fabrication capability of 500 minimodules/week (which should be from ≥100 substrates of ≥100 cm^2 area each) and have a plan to scale to 1-shift operation capable of producing ≥2000 devices per week at ≥500 cm^2 aperture area.[25]

[21] Data must be provided to show that this performance can be readily reproduced with a mean PCE across a minimum of 20 separate samples produced across ≥7 days.
[22] https://pvpact.sandia.gov/
[23] Minimodule starting performance for degradation testing must be greater than or equal to minimodule performance requirement.
[24] Minimodule starting performance for degradation testing must be greater than or equal to minimodule performance requirement.
[25] The production capability listed is considered the peak capability and it is understood that teams will not typically operate at this level for multiple weeks.

Topic Area 2: Improving the Market Potential of Advanced Cadmium Telluride Photovoltaics (IMPAC$_d$T$_e$ PV)

The goal of this topic area is to drive advances along the entire supply chain for domestically manufactured and deployed cadmium telluride (CdTe) thin-film PV. CdTe PV is the leading domestically fabricated PV technology and the only thin-film technology significantly competing with c-Si PV. CdTe serves an important role in the U.S. utility-scale PV market, representing approximately 33% of domestic installations in 2022. This trend of increasingly large-scale deployment of CdTe PV is anticipated to continue and accelerate in the United States for the foreseeable future.

Highly desirable CdTe attributes include low embodied energy, fast production process, lower sensitivity to temperature, and established bankability. In contrast to c-Si modules, which are comprised of discrete solar cells arranged in strings, CdTe modules are monolithically integrated and directly deposited on single flat sheets of glass in a single facility.

The streamlined manufacturing process of CdTe PV offers advantages over today's c-Si PV: an 18.5% efficient CdTe module has about 36% of the embodied energy compared to a single-crystal silicon module.[26] CdTe manufacturing also has the potential for reduced capital expenditures because its fabrication requires fewer unit processes compared to silicon. In addition, today's U.S. manufactured CdTe modules have a domestic content of 60-90%, as opposed to U.S. manufactured silicon modules, for which the vast majority of components are currently imported.

Based on the expected impacts of the Inflation Reduction Act and recent announcements in CdTe PV manufacturing capacity expansion, the United States will be in a unique position in the global PV ecosystem with two significantly different PV technologies being deployed at scale (c-Si and CdTe). CdTe PV must continue to innovate and improve to maintain its competitive position with c-Si PV, especially as a U.S. c-Si PV manufacturing industry develops and other technologies, such as perovskite PV, mature. At the same time, the U.S. PV system installation, inspection, operations, and maintenance industry needs to innovate to adapt to the unique aspects of CdTe PV systems, which will represent a large fraction of U.S. utility-scale PV capacity.

This topic solicits applications that can lead to improvements in performance, cost reduction, and/or energy intensity reduction at each step in the CdTe supply chain (from manufacturing, to deployment, to decommissioning and recycling). Areas where improvement can have impact include, but are not limited to: metrology, lifetime improvements, quality control, demonstration of energy yield, performance monitoring, recycling at end-of-life, equipment design, raw materials extraction (especially for tellurium, a critical mineral for CdTe manufacturing), refining and compounding, glass superstrate and back glass, module recycling and resource recovery, as well as the tools and processes used in CdTe module fabrication,

[26] (144 half-cell bifacial silicon PERC module with 21.13% efficiency)

measurement, and testing, including automation. By encouraging innovation across the supply chain, this approach is intended to yield proposals with significant impact in advancing the state of the art of this established technology.

Lead applicants for this topic will be restricted to for-profit entities, although collaborations with universities, national laboratories, and other companies are encouraged. Lead applicants are expected to manage projects using modern business systems including:

- Risk assessment/mitigation, data management, and traceable change control
- Statistical design of experiments and, for processes at scale, statistical process control
- Clearly defined RACI (Responsible, Accountable, Consulted, Informed roles) Matrix for project team

EERE will provide up to $16 million for two or more financial assistance awards in the form of cooperative agreements. These awards will last 12-36 months, with $1 million-$15 million federal share per project and cost share requirements of 20-50%. The applications selected will employ the state of the art in quality systems, project/program management and reliability testing to ensure value for the industry, stakeholders, and consumers.

This topic area is divided into two main categories: R&D and demonstration. Applications proposing less than $3 million in federal funding are expected to consist primarily of R&D activities and may have lower cost-share requirements (20%). Projects requesting between $3 million and $15 million in federal funding are expected to occur at the demonstration scale and are expected to carry 50% cost share. It is possible for entities to propose a mix of these activities.

R&D-focused projects should address one or more of the following goals:

- Monitoring fielded performance/energy yield of CdTe PV systems through innovations in metrology and instrumentation;
- Improving metrology for CdTe related processes and materials;
- Reducing the cost and resource intensity of domestically produced CdTe PV modules;
- Improving manufacturing throughput and or reducing manufacturing cost for CdTe raw materials, intermediates, or modules;
- Innovating CdTe technology across the supply chain, including processing, measurement, and Quality Assurance (QA)/Quality Control (QC);
- Increasing the fielded lifetime and/or energy yield of CdTe PV modules and reducing the lifecycle costs of CdTe PV systems;
- Expanding the domestic supply chain for CdTe PV material production, in particular increasing the availability of tellurium for module manufacturers, including reclamation of materials from end-of-life modules;
- Improving the viability of tandem-module architectures where CdTe is one of the active layers;
- Improving the recycling process for CdTe PV modules.

Applicants proposing demonstration activities should have ready access to the facilities necessary to carry out work at this scale and should have experience executing previous efforts with similar demands and complexity. Demonstration projects may address any of the goals for R&D projects, and should include one or more of the following activities:

- Demonstration of new CdTe hardware component(s) or novel system architectures in robust, commercially relevant pilot tests;
- Demonstration of methods and instrumentation to facilitate monitoring of fielded performance of CdTe PV at scale;
- Demonstration of high-volume or high-throughput manufacturing processes for CdTe supply-chain components, processes, tools, metrology, and input materials that reduce cost, energy requirements, and greenhouse gas emissions, and that can be manufactured competitively in the United States;
- Demonstration of improved tellurium resource recovery from metal refining operations at scale;
- Production of a sufficiently large number of CdTe modules for statistically robust field testing and validation;
- Demonstration of recycling and reclamation of CdTe modules and materials used to manufacture CdTe modules at scale.

Teaming Information

The United States has strong domestic R&D capabilities across a multitude of universities and national laboratories. The United States is also in the process of rebuilding manufacturing equipment capabilities. It is expected that private for-profit manufacturing entities, who are the target prime recipients for this FOA, will benefit greatly from developing strong partnerships with this ecosystem. As such, teaming arrangements are strongly encouraged. This FOA will encourage potential applicants to form partnerships with academia, national laboratories, other industry members, supply chain partners, and equipment developers.

DOE is compiling a "Teaming Partner List" to facilitate the formation of new project teams for this FOA. The Teaming Partner List allows organizations who may wish to participate on an application to express their interest to other applicants and to explore potential partnerships. Updates to the Teaming Partner List will be available in the EERE Exchange website. The Teaming Partner List will be regularly updated to reflect new teaming partners who provide their organization's information.

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

DISCLAIMER: By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of the above-referenced information. By facilitating the Teaming Partner List, DOE is not endorsing, sponsoring, or otherwise evaluating the qualifications of the individuals and organizations that are self-identifying themselves for placement on this Teaming Partner List. DOE will not pay for the provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

Next Steps for Potential Applicants

This Notice is issued so that interested parties are aware of the EERE's intention to issue this FOA in the near term. All of the information contained in this Notice is subject to change. EERE will not respond to questions concerning this Notice. Once the FOA has been released, EERE will provide an avenue for potential Applicants to submit questions.

EERE plans to issue the FOA on or about September 2023 via the EERE eXCHANGE website https://eere-eXCHANGE.energy.gov/. If Applicants wish to receive official notifications and information from EERE regarding this FOA, they should register in EERE eXCHANGE. When the FOA is released, applications will be accepted only through EERE eXCHANGE.

In anticipation of the FOA being released, Applicants are advised to complete the following steps, which are **required** for application submission:

- Register and create an account in EERE eXCHANGE at https://eere-eXCHANGE.energy.gov. This account will allow the user to apply to any open EERE FOAs that are currently in EERE eXCHANGE.

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

  It is recommended that each organization or business unit, whether acting as a team or a single entity, use only one account as the contact point for each submission. Questions related to the registration process and use of the EERE Exchange website should be submitted to: EERE-eXCHANGESupport@hq.doe.gov

- 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. Upon registration, SAM will automatically assign a Unique Entity ID (UEI).

  NOTE: Due to the high demand of UEI requests and SAM registrations, entity legal business name and address validations are taking longer than expected to process. Entities should start the UEI and SAM registration process as soon as possible. If entities have technical difficulties with the UEI validation or SAM registration process they should utilize the HELP feature on SAM.gov. SAM.gov will work entity service tickets in the order in which they are received and asks that entities not create multiple service tickets for the same request or technical issue. Additional entity validation resources can be found here: GSAFSD Tier 0 Knowledge Base - Validating your Entity.

- Register in FedConnect at https://www.fedconnect.net/. To create an organization account, your organization's SAM MPIN is required. For more information about the SAM MPIN or other registration requirements, review the FedConnect Ready, Set, Go! Guide at https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf
- Register in Grants.gov to receive automatic updates when Amendments to a FOA are posted. However, please note that applications will not be accepted through Grants.gov. http://www.grants.gov/. All applications must be submitted through EERE eXCHANGE.

Topic Area 1: Competitive Project Guidelines at Different Funding Levels: Tabular Format

<table>
<tr><th></th><th>$5 million Federal Award</th><th>$10 million Federal Award</th><th>$20 million Federal Award</th></tr>
<tr><td>Performer</td><td>The Team as a Whole</td><td>For-Profit Lead Applicant</td><td>For-Profit Lead Applicant</td></tr>
<tr><td>Team</td><td>No formal guideline beyond the basic applicant eligibility requirements.</td><td>Project team has established and documented:
• Experience in industrial R&D and manufacturing (preferably in the PV sector).
• Clearly defined roles, responsibilities and decision making processes;
• Business systems for supplier selection for capital equipment and critical raw materials;
• Experience in statistical experimental design and statistical procedures for qualifying processes and tools;</td><td>In addition to $10 million requirements, project team has established and documented:
• Management team and senior leadership with significant experience bringing products from R&D to production in a manufacturing environment (preferably in the PV sector);
• Modern project and program management practices informed through theory of constraints;
• Full traceability from incoming materials to outgoing products;
• Quality systems including statistical process control, statistical design of experiments, statistically informed raw and intermediate materials specifications.</td></tr>
<tr><td>Single Junction Cell Performance</td><td>Demonstrated small area cells (~0.1 cm^2 aperture area[27]) with PCE ≥18% on devices with ≥1.6 eV band gap</td><td>ISO 17025 CTL (Certified Test Laboratory) verified performance of cells ≥ 1 cm^2 aperture area[27] with PCE ≥18% on devices with ≥1.6 eV band gap</td><td rowspan="4">No formal guideline</td></tr>
<tr><td></td><td>OR</td><td>OR</td></tr>
<tr><td>Tandem Cell Performance</td><td>Demonstrated small area cells (~0.1 cm^2 aperture area[27]) with PCE ≥23%</td><td>ISO 17025 CTL verified performance of cells ≥ 1 cm^2 aperture area[27] with PCE ≥24%</td></tr>
<tr><td>Notes:</td><td colspan="2">Data must be provided to show that this performance can be readily reproduced with a mean PCE for ≥20 cells across ≥4 substrates produced across ≥2 days</td></tr>
<tr><td>Single Junction Minimodule Performance</td><td rowspan="3">No formal guideline</td><td>ISO 17025 CTL verified performance of minimodules ≥25 cm^2 aperture area[27] with PCE ≥15%</td><td rowspan="2">No formal guideline</td></tr>
<tr><td></td><td>OR</td></tr>
<tr><td>Tandem Minimodule Performance</td><td>ISO 17025 CTL verified performance of minimodules ≥25 cm^2 aperture area[27] with PCE >20%</td><td>ISO 17025 CTL verified PCE of the SETO RFI Performance Target Matrix for minimodules ≥25 cm^2 aperture area[27]</td></tr>
</table>

[27] In order to be defined as "aperture area" a rectangular opaque mask must be used to define the optically active area.

Notes:		Data must be provided to show that this performance can be readily reproduced with a mean PCE across a minimum of 10 separate devices produced across ≥2 days.	Data must be provided to show that this performance can be readily reproduced with a mean PCE across a minimum of 20 separate samples produced across ≥7 days.
Durability Testing - Lab	Demonstrated combined heat and light stress testing: • ≥5 cells measured at V_{oc}, ≥5 cells measured at Maximum Power Point (MPP) subjected to ≥60°C for ≥1000 hours at ~1 sun illumination. • The drop in efficiency must be ≤20% relative at 1000 hours.	Demonstrated combined heat- and light-stress testing on encapsulated minimodules: • ≥5 devices measured at V_{oc}, ≥5 devices measured at Maximum Power Point (MPP) subjected to ≥60°C for ≥1000 hours at ~1 sun illumination. • The drop in efficiency must be ≤10% relative at 1000 hours.	Passed at least 4 of the 5 accelerated stress tests specified in the Performance Target Matrix (i.e., MQT 10, MQT 11, MQT 13, MQT 21, ISOS-L-2).
Durability Testing - Outdoor	No formal guideline	Devices on-sun at outdoor testing facilities (preferably with samples at PACT[28])	Demonstrated ≥3 months of outdoor field testing with <3% relative degradation (with minimodules on test at PACT[28] for ≥10 weeks) with ≥10 W of samples (≥20 minimodules).
Notes:	• Cell starting performance and size for degradation testing must be greater than or equal to cell performance requirement. • Cells should be appropriately preconditioned using heat/light stabilization or dark soaking. • ≥10 cells should be from a single batch of production. • Cells may be encapsulated or unencapsulated in controlled environment.	• Minimodule starting performance and size for degradation testing must be greater than or equal to minimodule performance requirement. • Devices should be appropriately preconditioned using heat/light stabilization or dark soaking. • ≥10 minimodules should be from a single batch of production	• Minimodule starting performance and size for degradation testing must be greater than or equal to minimodule performance requirement.
Fabrication Capability - Current	≥100 devices/week	≥100 minimodules/week (which should be from ≥25 substrates of ≥100 cm^2 area each)	≥500 minimodules/week (which should be from ≥100 substrates of ≥100 cm^2 area each)
Fabrication Capability - Future Plan	≥100 devices per week at ≥100 cm^2 aperture area	≥100 devices per week at ≥500 cm^2 aperture area	scale to 1-shift operation capable of producing ≥2000 devices per week at ≥500 cm^2 aperture area
Notes	The production capability listed is considered the peak capability and it is understood that teams will not typically operate at this level for multiple weeks.		

This is the end of the Notice of Intent. Thank you for reading.

[28] https://pvpact.sandia.gov/