

Research, Development, and Demonstration Opportunities for FY 2022 Solar Manufacturing Incubator

DATE: October 15, 2021

SUBJECT: Request for Information (RFI)

Description

This Request for Information (RFI) is intended to inform the U.S. Department of Energy (DOE) Solar Energy Technologies Office (SETO) on the overall technical research, development, and demonstration opportunities in solar manufacturing and hardware product commercialization. SETO is seeking specific feedback on:

- Technical areas with opportunities to invest in innovative research and development (R&D) as well as research, development, and demonstration (RD&D) projects that enable solar to continue to drive down costs, while developing next-generation solar technologies, supporting the scalability of solar as deployment increases across the country, and boosting American solar manufacturing;
- Removal of the Concept Paper stage from the funding opportunity process to better align it with the needs of a fast-moving industry and community and in an effort to streamline the application process and reduce the time from application deadline to selection notification; and
- Ways to better engage and support partnerships between institutions representing diverse entities such as, but not limited to, Tribal communities; minority-serving institutions (MSI); minority business enterprises; minority-, woman-, and veteran-owned businesses¹; entities located in an underserved community or through linkages with Opportunity Zones.

Background

SETO's² mission is to accelerate the development and deployment of solar technology to support an equitable transition to a decarbonized electricity system by 2035 and decarbonized energy sector by 2050. Achieving this goal will support the nationwide effort to meet the threat of climate change and ensure that all Americans benefit from the transition to a clean energy economy. DOE recently released the Solar Futures Study,³ a report that explores the role of

¹ Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at [Opportunity Zones Resources](#). Also see, [frequently asked questions](#) about Qualified Opportunity Zones.

² <https://energy.gov/solar-office>

³ <https://www.energy.gov/eere/solar/solar-futures-study>

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solar energy in achieving these goals. SETO supports solar energy research, development, demonstration and technical assistance in five areas—photovoltaics (PV), concentrating solar-thermal power (CSP), systems integration, manufacturing and competitiveness, and soft costs—to improve the affordability, reliability, and domestic benefit of solar technologies on the electric grid. Domestic manufacturing of solar hardware creates jobs, produces ancillary economic activity, and promotes energy security. Reducing reliance on imported goods also reduces cost uncertainty and sensitivity to international supply-chain disruptions. Emerging concerns about cybersecurity may also be resolved by using U.S.-made or assembled hardware. America’s innovators have the potential to develop new value streams and products that can supply both domestic and global markets. These investments will help accelerate the growth of the solar industry, identify emerging opportunities, and drive down manufacturing costs for our domestic energy market, positioning the U.S. on the leading edge of solar industry advances.

SETO’s Manufacturing and Competitiveness team supports the transformation of research and development results into products that can be manufactured in the United States. This program addresses key barriers to bringing commercial solutions closer to the market that are too risky for the private sector to support on its own. Addressing these barriers will allow solar companies to attract private investment and commercialize solutions. SETO has supported the commercialization of solar innovations through funding programs that support entrepreneurs at various stages in their technology advancement. Each program⁴ has different goals and application processes tailored to different technology readiness levels and business maturity. Specifically:

- The American-Made Solar Prize⁵ is a competition designed to support entrepreneurs as they develop transformative technology ideas into concepts and then into early-stage prototypes ready for industry testing. It is composed of progressive phases structured to provide the resources and environment necessary to create new solutions and develop them into early-stage prototypes. Along the way, through a streamlined review process, competitors can receive cash prizes and technical support based on performance at demonstration days. The American-Made Solar Prize Round 5⁶ introduced tracks for both hardware⁷ and software⁸ technology development. Within the software track, teams can also compete for the new Justice, Equity, Diversity, and Inclusion (JEDI) Contest⁹, which is designed to recognize software solutions that enable underserved communities to overcome systemic solar

⁴ Please read the relative FOA to learn more about eligibility criteria and cost share requirements of each program. Please note that these programs may or may not be announced, based on Congressional appropriation, programmatic decision, and office priorities.

⁵ <https://americanmadechallenges.org/solarprize/index.html>

⁶ <https://www.energy.gov/eere/solar/american-made-solar-prize-round-5>

⁷ <https://www.energy.gov/eere/solar/american-made-solar-prize-round-5-hardware-track>

⁸ <https://www.energy.gov/eere/solar/american-made-solar-prize-round-5-software-track>

⁹ https://americanmadechallenges.org/solarprize/docs/rules/r5/American-Made_Solar_Prize_Rules_Software.pdf
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barriers and share in the societal benefits of solar deployment. In addition, the American-Made Perovskite Startup Prize¹⁰ was launched in March of 2021 to spur the formation of new companies manufacturing perovskite solar devices and to accelerate their path to market. This program opens quarterly for new applications until the prize pool is exhausted. Prizes have the lowest barrier to entry and fastest timeline among SETO's small-business programs.

- The two-phase Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs¹¹ provide financial assistance to early-stage research and development efforts at small businesses for a specific scope of work with clear objectives. The first phase is focused on proving the feasibility of an idea (awarding up to \$200,000); the second is focused on prototype development (awarding up to \$1.1 million). Only Phase I awardees can compete for a Phase II award. The STTR program is specifically designed to support technology transfer from research institutions to small businesses: for a STTR application, universities or national labs must be involved as subrecipient and conduct at least 30% of the work; the principal investigator can be employed either by the small business or the research institution. Both SBIR and STTR aim, among other goals, to stimulate technological innovation and foster and encourage participation in innovation and entrepreneurship by women and socially or economically disadvantaged persons.¹²
- The Incubator program¹³ accelerates commercialization of innovative product ideas that can substantively increase U.S. domestic manufacturing across the solar industry supply chain and expand private investment in U.S. solar manufacturing. This program is open to both R&D (product development) and RD&D (product development and demonstration) projects. These products and solutions will lower the cost of solar technologies and facilitate the secure integration of solar electricity into the nation's energy grid. SETO's goal is to retire technical, business, and market risks of solar hardware to validate pathways to commercial success through customer engagement and trials. Additional outputs include attracting follow-on private investment and producing technical publications (white papers) that lead to business growth, revenue, and job creation. The Incubator program was launched in 2007 and has supported more than 220 companies through more than 300 awards. The overall DOE investment (over \$360 million) has turned into nearly \$11 billion of follow-on-funding from the private sector, resulting in a 29x investment multiplier.
- The Technology Commercialization Fund¹⁴ promotes federal research and development investments in technology with commercial potential where DOE National Laboratories are

¹⁰ <https://www.energy.gov/eere/solar/american-made-challenges-perovskite-startup-prize>

¹¹ SETO. <https://energy.gov/solar-office/sbir>.

¹² A member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent Asian Americans, other groups designated from time to time by the Small Business Administration (SBA) to be socially disadvantaged, and any other individual found to be socially and economically disadvantaged by SBA pursuant to Section 8(a) of the Small Business Act, 15 U.S.C.; 637(a).

¹³ <https://www.energy.gov/eere/solar/incubator-program>

¹⁴ SETO. <https://energy.gov/eere/solar/funding-opportunities>.

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the lead applicants. Private-sector commercialization partners are expected to commit a significant project cost share and be involved in project formation and execution with the objective of transferring the lab developed technology to the commercial project partner.

Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on issues related to solar hardware manufacturing and product commercialization. DOE's Office of Energy Efficiency and Renewable Energy (EERE) is specifically interested in information on technical RD&D opportunities in solar manufacturing and hardware product commercialization; the effectiveness of the funding opportunity process; and strategies to increase the diversity of the applicant pool and the entities and groups benefitting from these investments. This is solely a request for information and not a funding opportunity announcement (FOA). EERE is not accepting applications.

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"

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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 or on a CD, 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 Categories and Questions

Category 1: Technical opportunities for R&D activities (product development)

1. SETO intends to support solutions that can advance domestic manufacturing of solar energy technologies, including materials and tools to develop a robust domestic supply chain, while facilitating the integration of solar energy into the nation’s grid. SETO is soliciting feedback on the appropriateness, value, timeliness, and impact of the following technical areas:
 - Advanced solar system integration technologies that enhance the ability of solar energy systems to contribute to grid reliability, resiliency, and security;
 - CSP and solar-thermal industrial process heat;
 - PV technologies, including materials and/or manufacturing innovations;
 - Hardware technologies that reduce the balance-of-system costs of a PV system.

Within these areas, SETO is soliciting feedback on the appropriateness, value, timeliness, and impact on the following market needs or technology gaps:

Photovoltaic Building Materials and Building-Integrated Photovoltaics

As cumulative PV installations increase, the value of integrated, multi-technology, and multi-sector systems may grow significantly. One of the areas where significant market opportunities might arise is the integration of solar into

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the building envelope, including solar technologies that are fully integrated into windows, facades, canopies, or roofing materials.

SETO is interested in opportunities for innovation in both photovoltaic building materials (PVBm) and building-integrated photovoltaics (BIPV) as long as an improved combined value-to-cost ratio of the building envelope and generation system can be demonstrated. This will include items such as innovative product designs (e.g., form factors, and/or system designs for more complete roof and building envelope integration); innovative mounting and wiring or power transfer concepts; and solutions that address system aesthetics and/or customer acceptance or perception of solar installations.

Advanced Silicon and Cadmium Telluride Photovoltaic Module Materials and Manufacturing Processes

The global PV market has changed dramatically over the past decade. Module prices have been decreasing rapidly, and global deployment is experiencing strong growth. However, manufacturing is concentrated mainly in Asia.¹⁵ Innovation-driven cost, performance, and quality improvements, along with strong projected solar demand in the United States, could increase the attractiveness of U.S.-based solar manufacturing. Although improvements to standard PV modules have produced deep cost reductions, the returns on such improvements appear to be diminishing, and more dramatic innovations in module design and manufacturing may be needed to maintain the path of rapid progress while opening further opportunities for domestic manufacturing.

SETO is interested in opportunities for new silicon and cadmium telluride module manufacturing technologies, equipment development, or innovation on individual manufacturing process steps that lend themselves to being domestically manufactured and can accomplish one or more of the following objectives:

- Develop advanced materials and components affecting the traditional module supply chain (including but not limited to metallization paste, backsheets, glass, connectors, junction boxes, encapsulants, transparent conductive oxides);

¹⁵ <https://www.energy.gov/eere/solar/quarterly-solar-industry-update>

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- Develop new technologies and/or processes to increase quality assurance and quality controls of the module supply chain, including new metrology tools for fast and/or in-line inspection of material quality;
- Modify and repurpose existing or dormant manufacturing technologies in order to utilize an existing infrastructure and demonstrate synergies with existing or new module technologies;
- Reduce the number of steps in a module assembly (from cells or completed thin-film device stack to completed module);
- Develop new module-assembly technologies, methods, and improved form factors that optimize module cost per watt;
- Replace manufacturing bottlenecks (e.g., lamination, encapsulation) with faster and more efficient processes; and
- Increase environmental sustainability and improve end-of-life value.

Innovative Photovoltaic Module Architectures and Emerging Materials

American ingenuity has allowed for the conception and development of a huge range of devices and products now part of the solar industry. Even in a scenario in which most of the manufacturing of the prevalent PV module architecture (based on silicon cells) happens abroad, there are significant opportunities to innovate and leverage domestic supply chains to build the next generation of PV modules.

SETO is interested in opportunities for innovative module architectures, possibly including emerging absorbing materials, that can accomplish one or more of the following objectives:

- Develop applications and/or climate-specific module architectures able to withstand specific environmental conditions or address specific market needs;
- Develop module manufacturing methods that enable incorporation of new and emerging cell technologies, such as perovskite or high-efficiency silicon architectures (e.g., tunnel oxide passivated contact - TOPCon); or
- Develop techniques that could allow for the manufacture of mechanically stacked or fully integrated tandem technologies.

Next-Generation Power Electronics based on Silicon Carbide and/or Planar Magnetics

Driven by the expanding electric vehicle industry, silicon carbide (SiC) chips of certain power ratings are dropping in price quickly. This creates an opportunity

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to use them in power-electronics components for the solar industry in a cost-competitive way compared to incumbent technologies. Furthermore, the United States is a pre-eminent supplier of high-quality SiC wafers and chips, which—when used with advanced inverter topologies, which facilitate pick-and-place manufacturing—make a compelling case for domestic manufacturing.

SETO is interested in opportunities for new power-electronics equipment that leverage the dropping costs of SiC and/or gallium nitride (GaN) grown on SiC wafers and implements innovative topologies, which may include transformerless designs, to create cost-competitive, high-performance alternatives to today's industry-standard silicon-based equipment. Additionally, SETO is interested in opportunities to incorporate improvements to the state of the art in planar transformer designs and/or build processes for high-frequency-switching applications. This must be considered in conjunction with new SiC and/or GaN-based power electronics, given that planar magnetic components are very well suited for use with emerging GaN and SiC devices.

Category 2: Technical opportunities for RD&D activities (product development and demonstration)

1. SETO intends to support pilot-scale testing and demonstration of products or solutions. This includes high-volume or high-throughput manufacturing processes for solar hardware, the production of a large number of devices sufficient for statistically robust field testing and validation, or the demonstration of a system (for example, a microgrid or an innovative solar system) primarily focused on pilot-testing new hardware. SETO is soliciting feedback on the appropriateness, value, timeliness, and impact of the following technical areas:

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

Within these areas, SETO is soliciting feedback on the appropriateness, value, timeliness, and impact on the following market needs or technology gaps:

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Multiuse Integrated Photovoltaic Systems

As cumulative PV installations increase, the value of integrated, multi-technology, and multi-sector systems may grow significantly. SETO is interested in opportunities to demonstrate technologies that integrate PV into synergistic applications where proximity and/or form factor facilitates both the PV and at least one other function. Some examples include technology components and systems that integrate PV technologies with other energy, agricultural, or built environments and the transportation system.

SETO is interested in opportunities for improvement in the following areas:

- Overall system performance using solar. Beyond simply avoiding negative impacts on other elements of an integrated system, adding solar technologies can directly increase value. For example, partial shading from PV arrays may increase crop yields through reduced plant stress and water loss, or decrease cooling loads in buildings. Integrating solar with water systems can decrease evaporative losses from irrigation canals and reservoirs, increasing water availability for other uses.
- Reductions in land-use competition. Similarly, more solar installations may lead to competition with other land uses, particularly in areas of grid congestion where interconnection location is critical. Combining solar with other technologies and land uses in a manner that enables high performance of all elements of the combined system can increase siting flexibility and mitigate conflict with other sectors and communities, increasing value for all stakeholders.
- Improvements in system grid responsiveness. Due to changes in electricity generation sources and end-use load profiles, grid responsiveness will be increasingly important. PV systems alone have a limited capability to provide direct grid services and participate in all available markets. Combining solar with other generation, storage, building, transportation, and energy-efficiency technologies can increase overall system performance and responsiveness.
- Reduction of carbon emissions. Integrating solar PV with grid-tied and/or off-grid systems can accelerate the electrification of industry sectors and products, while providing an alternative and more effective energy source for current and future needs.

Specific applications include but are not limited to:

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- **Agricultural Photovoltaics (Agrivoltaics):** Demonstrations of innovative technologies that can reduce the installed cost of streams from agricultural solar systems; improve the systems' energy yield and the agricultural yield; facilitate their installation and grid interconnection; and enable additional value.
- **Floating Photovoltaics (FPV):** Demonstration of robust, cost-effective integration of PV into systems that operate on bodies of water providing practical resistance to environmental factors.
- **Transportation-Integrated and Vehicle-Integrated Photovoltaics (TIPV and VIPV):** Demonstration of the integration of PV into vehicle and vehicle-associated surfaces, (e.g., trucks, trailers, refrigerated containers, etc.) and transportation-adjacent surfaces (e.g., parking lot shades, sidewalk awnings, bridges, elevated walkways, etc.).
- **Building Integrated Photovoltaics (BIPV)/PV Building Materials:** Integration of PV into the building envelope (e.g., canopies, shades, façades) and building materials (e.g., roofing, siding, etc.).

Demonstration of Advanced Silicon and Cadmium Telluride Photovoltaic Module Materials and Manufacturing Processes in High-Volume Environment

The global PV market has changed dramatically over the past decade. Module prices have been decreasing rapidly, and deployment is accelerating and growing. However, manufacturing is concentrated mainly in Asia.¹⁶ Innovation-driven cost, performance and quality improvements, along with strong projected solar demand in the United States, could increase the attractiveness of U.S.-based solar manufacturing. Although improvements to standard PV modules have produced deep cost reductions, the returns on such improvements appear to be diminishing, and the demonstration of new manufacturing technologies and processes at high volume may be needed to enable new opportunities for domestic manufacturing.

SETO is interested in opportunities for demonstration in high-volume manufacturing environment of new silicon and cadmium telluride module manufacturing technologies, equipment development, or innovation on individual manufacturing process steps that can accomplish one or more of the following objectives:

¹⁶ <https://www.energy.gov/eere/solar/quarterly-solar-industry-update>

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- Development of advanced materials and components affecting the traditional module supply chain (including but not limited to metallization paste, backsheets, glass, connectors, junction boxes, encapsulants, transparent conductive oxides);
- Reduction of the number of steps in a module assembly (from cells or completed thin film device stack to completed module);
- Development of new tools or technologies that will increase the throughput of existing or new processes;
- Development of new module assembly technologies, methods, and improved form factors that optimize module cost per watt;
- Development of new module technologies and equipment that lower the tool footprint or optimizes usage of the factory floor;
- Replace manufacturing bottlenecks (e.g., lamination, encapsulation) with faster and more efficient processes; and
- Increase environmental sustainability and improve end-of-life value.

Category 3: Opportunities to streamline and accelerate the funding opportunity application process – Removing the Concept Paper stage

1. SETO intends to streamline its funding opportunity application process to reduce the time between the application deadline and the selection announcement. SETO solicits feedback on the possibility of removing the Concept Paper requirement. When a funding opportunity is issued, the application process would include a mandatory letter of intent and, after that, the deadline to submit the full application package (including technical volume, budget justification, and other application forms).

Category 4: Opportunities to increase diversity of the applicant pool, entities, and groups that will benefit from the outcomes and outputs of the selected projects

1. SETO solicits ideas and feedback on how to better reach out to, engage, and partner with under-resourced and disadvantaged communities in support of the Biden Administration's Justice40 Initiative. As defined in the Office of Management and Budget Memo M-21-28 (Interim Implementation Guidance for the Justice40 Initiative),¹⁷ it is one of the Administration's objectives to ensure that 40% of the benefits of the Government investments flow to disadvantaged communities.¹⁸ In particular, SETO is

¹⁷ <https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf>

¹⁸ The definition of disadvantage community is based on a combination of variables that may include, but are not limited to, the following:

- Low income, high and/or persistent poverty

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soliciting feedback on how to encourage effective partnership between for-profit entities and underserved communities, to ensure every American can benefit from technology innovation and participate in RD&D activities.

Request for Information Response Guidelines

Responses to this RFI must be submitted electronically to seto.rfi.mc@ee.doe.gov no later than 5:00pm (ET) on November 7, 2021. 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 2 pages in length, 12 point font, 1 inch margins. Only electronic responses will be accepted.

Please identify your answers by responding to a specific question or topic if applicable. Respondents may answer as many or as few questions 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.

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- High unemployment and underemployment
 - Racial and ethnic residential segregation, particularly where the segregation stems from discrimination by government entities
 - Linguistic isolation
 - High housing cost burden and substandard housing
 - Distressed neighborhoods
 - High transportation cost burden and/or low transportation access
 - Disproportionate environmental stressor burden and high cumulative impacts
 - Limited water and sanitation access and affordability
 - Disproportionate impacts from climate change
 - High energy cost burden and low energy access
 - Jobs lost through the energy transition
 - Access to healthcare.

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