

**FINANCIAL ASSISTANCE  
FUNDING OPPORTUNITY ANNOUNCEMENT**



**ADVANCED RESEARCH PROJECTS AGENCY – ENERGY (ARPA-E)  
U.S. DEPARTMENT OF ENERGY**

**MICRO-SCALE OPTIMIZED SOLAR-CELL ARRAYS WITH  
INTEGRATED CONCENTRATION (MOSAIC)  
(SBIR/STTR)**

Announcement Type: ~~Modification 01~~ **Modification 02**  
Funding Opportunity No. DE-FOA-0001256  
CFDA Number 81.135

<b>FOA Issue Date:</b>	December 8, 2014
<b>First Deadline for Questions to <a href="mailto:ARPA-E-CO@hq.doe.gov">ARPA-E-CO@hq.doe.gov</a>:</b>	5 PM ET, January 15, 2014
<b>Submission Deadline for Concept Papers:</b>	5 PM ET, January 22, 2015
<b>Second Deadline for Questions to <a href="mailto:ARPA-E-CO@hq.doe.gov">ARPA-E-CO@hq.doe.gov</a>:</b>	5 PM ET, <del>TBD</del> <b>April 30, 2015</b>
<b>Submission Deadline for Full Applications:</b>	5 PM ET, <del>TBD</del> <b>May 7, 2015</b>
<b>Submission Deadline for Replies to Reviewer Comments:</b>	5 PM ET, <del>TBD</del> <b>July 2, 2015</b>
<b>Expected Date for Selection Notifications:</b>	<del>TBD</del> <b>July 2015</b>
<b>Total Amount to Be Awarded</b>	Approximately \$10 million, subject to the availability of appropriated funds.
<b>Anticipated Awards</b>	ARPA-E may issue one, multiple, or no awards under this FOA. Awards may vary between \$225,000 and \$3.225 million.

- For eligibility criteria, see Section III.A – III.D of the FOA.
- For cost share requirements under this FOA, see Section III.E of the FOA.
- To apply to this FOA, Applicants must register with and submit application materials through ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov/Registration.aspx>). For detailed guidance on using ARPA-E eXCHANGE, see Section IV.H.1 of the FOA.
- Applicants are responsible for meeting each submission deadline. Applicants are strongly encouraged to submit their applications at least 48 hours in advance of the submission deadline.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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- ARPA-E will not review or consider noncompliant or nonresponsive applications. For detailed guidance on compliance and responsiveness criteria, see Sections III.F.1 and III.F.2 of the FOA.

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## MODIFICATIONS

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

Mod. No.	Date	Description of Modifications
01	12/31/2014	<ul style="list-style-type: none"> <li>Clarified expectation on use of existing commercial tracking methods for Subcategories 1A and 2A, see Section I.F of the FOA.</li> </ul>
02	03/23/2015	<ul style="list-style-type: none"> <li>Inserted certain deadlines, including the deadlines for submitting questions and Full Applications. See Cover Page and Required Documents Checklist.</li> <li>Added Section I.G: "Required Metrics and Calculations for Full Applications."</li> <li>Updated C.F.R. citation, see Section III.E.5 of the FOA.</li> <li>Revised the following sections of the FOA to provide guidance on required application forms and the content and form of Full Applications and Replies to Reviewer Comments: Required Documents Checklist and Sections IV.D, IV.E, IV.G of the FOA. Applicants are strongly encouraged to use the templates provided on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>).</li> <li>Inserted criteria that ARPA-E will use to evaluate Full Applications. See Section V.A.2 of the FOA.</li> <li>Inserted criteria that ARPA-E will use to evaluate Replies to Reviewer Comments in Section V.A.3 of the FOA.</li> <li>Inserted Program Policy Factors. See Section V.B.1 of the FOA.</li> <li>Inserted Anticipated Announcement &amp; Award Dates. See Section V.C of the FOA.</li> <li>Inserted information concerning Full Application Notifications. See Section VI.A.3 of the FOA.</li> <li>Inserted Administrative and National Policy Requirements. See Section VI.B of the FOA.</li> <li>Inserted Reporting Requirements. See Section VI.C of the FOA.</li> <li>Inserted information concerning Class Waivers. See Section VIII.F of the FOA.</li> <li>Inserted regulations applicable to resulting awards. See Section VIII.I of the FOA.</li> </ul>

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**TABLE OF CONTENTS**

**REQUIRED DOCUMENTS CHECKLIST** ..... - 1 -

**I. FUNDING OPPORTUNITY DESCRIPTION** ..... - 3 -

    A. AGENCY OVERVIEW ..... - 3 -

    B. SBIR/STTR PROGRAM OVERVIEW ..... - 5 -

    C. TECHNICAL PROGRAM OVERVIEW ..... - 6 -

    D. PROGRAM OBJECTIVES ..... - 14 -

    E. TECHNICAL CATEGORIES OF INTEREST ..... - 15 -

    F. TECHNICAL PERFORMANCE TARGETS ..... - 17 -

**G. REQUIRED METRICS AND CALCULATIONS FOR FULL APPLICATIONS** ..... - 20 -

    H. APPLICATIONS SPECIFICALLY NOT OF INTEREST ..... - 23 -

**II. AWARD INFORMATION** ..... - 23 -

    A. AWARD OVERVIEW ..... - 23 -

    B. ARPA-E FUNDING AGREEMENTS ..... - 25 -

    C. STATEMENT OF SUBSTANTIAL INVOLVEMENT ..... - 26 -

**III. ELIGIBILITY INFORMATION** ..... - 27 -

    A. ELIGIBLE APPLICANTS ..... - 27 -

        1. SBIR ..... - 27 -

        2. STTR ..... - 27 -

    B. ELIGIBLE SUBRECIPIENTS ..... - 28 -

        1. RESEARCH INSTITUTIONS ..... - 28 -

        2. OTHER PROJECT TEAM MEMBERS ..... - 28 -

    C. ELIGIBLE PRINCIPAL INVESTIGATORS ..... - 29 -

        1. SBIR ..... - 29 -

        2. STTR ..... - 29 -

    D. ELIGIBILITY OF PRIOR SBIR AND STTR AWARDEES: SBA BENCHMARKS ON PROGRESS TOWARDS COMMERCIALIZATION ..... - 29 -

    E. COST SHARING ..... - 30 -

        1. PHASE I ..... - 31 -

        2. PHASE II AND IIS COST SHARE REQUIREMENT ..... - 31 -

        3. LEGAL RESPONSIBILITY ..... - 31 -

        4. COST SHARE ALLOCATION ..... - 32 -

**5. COST SHARE TYPES AND ALLOWABILITY** ..... - 32 -

        6. COST SHARE CONTRIBUTIONS BY FFRDCs AND GOGOS ..... - 33 -

        7. COST SHARE VERIFICATION ..... - 33 -

    F. OTHER ..... - 33 -

        1. COMPLIANT CRITERIA ..... - 33 -

        2. RESPONSIVENESS CRITERIA ..... - 35 -

        3. LIMITATION ON NUMBER OF APPLICATIONS ..... - 35 -

**IV. APPLICATION AND SUBMISSION INFORMATION** ..... - 35 -

    A. APPLICATION PROCESS OVERVIEW ..... - 35 -

        1. REGISTRATION IN SBA COMPANY REGISTRY ..... - 35 -

        2. REGISTRATION IN ARPA-E eXCHANGE ..... - 36 -

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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3.	CONCEPT PAPERS.....	- 36 -
4.	FULL APPLICATIONS.....	- 36 -
5.	REPLY TO REVIEWER COMMENTS.....	- 36 -
6.	PRE-SELECTION CLARIFICATIONS AND "DOWN-SELECT" PROCESS.....	- 37 -
7.	SELECTION FOR AWARD NEGOTIATIONS.....	- 37 -
8.	MANDATORY WEBINAR.....	- 37 -
B.	APPLICATION FORMS.....	- 38 -
C.	CONTENT AND FORM OF CONCEPT PAPERS.....	- 38 -
1.	CONCEPT PAPER.....	- 39 -
A.	CONCEPT SUMMARY.....	- 39 -
B.	INNOVATION AND IMPACT.....	- 39 -
C.	PROPOSED WORK.....	- 39 -
D.	TEAM ORGANIZATION AND CAPABILITIES.....	- 40 -
2.	SECOND COMPONENT: SUMMARY SLIDE.....	- 40 -
3.	ADDITIONAL INSTRUCTIONS.....	- 41 -
D.	CONTENT AND FORM OF FULL APPLICATIONS.....	- 41 -
1.	FIRST COMPONENT: TECHNICAL VOLUME.....	- 43 -
2.	SECOND COMPONENT: SF-424.....	- 49 -
3.	THIRD COMPONENT: BUDGET JUSTIFICATION WORKBOOK/SF-424A.....	- 49 -
4.	FOURTH COMPONENT: SUMMARY FOR PUBLIC RELEASE.....	- 50 -
5.	FIFTH COMPONENT: SUMMARY SLIDE.....	- 51 -
6.	SIXTH COMPONENT: SBA REGISTRATION CERTIFICATE.....	- 52 -
7.	SEVENTH COMPONENT: CERTIFICATION FOR APPLICANTS MAJORITY-OWNED BY MULTIPLE VENTURE CAPITAL OPERATING COMPANIES, HEDGE FUNDS, AND PRIVATE EQUITY FIRMS.....	- 52 -
8.	EIGHTH COMPONENT: BUSINESS ASSURANCES & DISCLOSURES FORM.....	- 52 -
E.	CONTENT AND FORM OF REPLIES TO REVIEWER COMMENTS.....	- 53 -
F.	INTERGOVERNMENTAL REVIEW.....	- 54 -
G.	FUNDING RESTRICTIONS.....	- 54 -
1.	ALLOWABLE COSTS.....	- 54 -
2.	PRE-AWARD COSTS.....	- 54 -
3.	PATENT COSTS.....	- 55 -
4.	CONSTRUCTION.....	- 55 -
5.	FOREIGN TRAVEL.....	- 55 -
6.	PERFORMANCE OF WORK IN THE UNITED STATES.....	- 56 -
7.	PURCHASE OF NEW EQUIPMENT.....	- 56 -
8.	LOBBYING.....	- 56 -
9.	CONFERENCE SPENDING.....	- 57 -
H.	OTHER SUBMISSION REQUIREMENTS.....	- 57 -
1.	USE OF ARPA-E eXCHANGE.....	- 57 -
V.	APPLICATION REVIEW INFORMATION.....	- 58 -
A.	CRITERIA.....	- 58 -
1.	CRITERIA FOR CONCEPT PAPERS.....	- 59 -
2.	CRITERIA FOR FULL APPLICATIONS.....	- 60 -
3.	CRITERIA FOR REPLIES TO REVIEWER COMMENTS.....	- 61 -
B.	REVIEW AND SELECTION PROCESS.....	- 62 -

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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1.	PROGRAM POLICY FACTORS .....	- 62 -
2.	ARPA-E REVIEWERS.....	- 63 -
3.	ARPA-E SUPPORT CONTRACTOR .....	- 63 -
C.	ANTICIPATED ANNOUNCEMENT AND AWARD DATES.....	- 63 -
VI.	AWARD ADMINISTRATION INFORMATION.....	- 63 -
A.	AWARD NOTICES .....	- 63 -
1.	REJECTED SUBMISSIONS.....	- 63 -
2.	CONCEPT PAPER NOTIFICATIONS .....	- 64 -
3.	FULL APPLICATION NOTIFICATIONS .....	- 64 -
B.	ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS .....	- 65 -
1.	DUNS NUMBER AND SAM, FSRS, AND FEDCONNECT REGISTRATIONS.....	- 66 -
2.	NATIONAL POLICY ASSURANCES.....	- 66 -
3.	PROOF OF COST SHARE COMMITMENT AND ALLOWABILITY .....	- 67 -
4.	COST SHARE PAYMENTS.....	- 67 -
5.	ENVIRONMENTAL IMPACT QUESTIONNAIRE.....	- 68 -
6.	TECHNOLOGY-TO-MARKET PLAN.....	- 68 -
7.	INTELLECTUAL PROPERTY AND COMMERCIALIZATION RIGHTS AGREEMENT .....	- 68 -
8.	U.S. MANUFACTURING REQUIREMENT .....	- 69 -
9.	CORPORATE FELONY CONVICTIONS AND FEDERAL TAX LIABILITY .....	- 70 -
C.	REPORTING.....	- 71 -
VII.	AGENCY CONTACTS.....	- 71 -
A.	COMMUNICATIONS WITH ARPA-E .....	- 71 -
B.	DEBRIEFINGS .....	- 72 -
VIII.	OTHER INFORMATION .....	- 72 -
A.	FOAs AND FOA MODIFICATIONS.....	- 72 -
B.	OBLIGATION OF PUBLIC FUNDS.....	- 72 -
C.	REQUIREMENT FOR FULL AND COMPLETE DISCLOSURE .....	- 72 -
D.	RETENTION OF SUBMISSIONS .....	- 73 -
E.	MARKING OF CONFIDENTIAL INFORMATION .....	- 73 -
F.	TITLE TO SUBJECT INVENTIONS .....	- 74 -
G.	GOVERNMENT RIGHTS IN SUBJECT INVENTIONS .....	- 74 -
1.	GOVERNMENT USE LICENSE.....	- 74 -
2.	MARCH-IN RIGHTS .....	- 75 -
H.	RIGHTS IN TECHNICAL DATA.....	- 75 -
I.	REGULATIONS APPLICABLE TO RESULTING AWARDS .....	- 76 -
J.	PROTECTED PERSONALLY IDENTIFIABLE INFORMATION .....	- 76 -
K.	ADDITIONAL NOTICES .....	- 76 -
IX.	GLOSSARY.....	- 78 -

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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**REQUIRED DOCUMENTS CHECKLIST**

For an overview of the application process, see Section IV.A of the FOA.

For guidance regarding requisite application forms, see Section IV.B of the FOA.

For guidance regarding the content and form of Concept Papers, Full Applications, and Replies to Reviewer Comments, see Sections IV.C, IV.D, and IV.E of the FOA.

SUBMISSION	COMPONENTS	OPTIONAL/ MANDATORY	FOA SECTION	DEADLINE
Concept Paper	<ul style="list-style-type: none"> <li>• Each Applicant must submit a Concept Paper in Adobe PDF format by the stated deadline. The Concept Paper must not exceed 4 pages in length and must include the following:                             <ul style="list-style-type: none"> <li>○ Concept Summary</li> <li>○ Innovation and Impact</li> <li>○ Proposed Work</li> <li>○ Team Organization and Capabilities</li> </ul> </li> <li>• The Concept Paper must be accompanied by:                             <ul style="list-style-type: none"> <li>○ Summary Slide (1 page limit, Microsoft PowerPoint format) –A Summary Slide template is available on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>).</li> </ul> </li> </ul>	Mandatory	IV.C	5 PM ET, January 22, 2015
Full Application	<p>[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]</p> <ul style="list-style-type: none"> <li>• Each Applicant must submit a Technical Volume in Adobe PDF format by the stated deadline. Applicants may use the Technical Volume template available on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>). The Technical Volume must include the following:                             <ul style="list-style-type: none"> <li>○ Executive Summary (1 page max.)</li> <li>○ Sections 1-5 (30 pages max.)                                     <ul style="list-style-type: none"> <li>• 1. Innovation and Impact</li> <li>• 2. Proposed Work</li> <li>• 3. Team Organization and Capabilities</li> <li>• 4. Technology to Market</li> <li>• 5. Budget</li> </ul> </li> <li>○ Bibliographic References (no page limit)</li> <li>○ Personal Qualification Summaries (each PQS limited to 3 pages in length, no cumulative page limit)</li> </ul> </li> <li>• The Technical Volume must be accompanied by:                             <ul style="list-style-type: none"> <li>○ SF-424 (no page limit, Adobe PDF format);</li> <li>○ Budget Justification Workbook/SF424A (no page limit, Microsoft Excel format)</li> <li>○ Summary for Public Release (250 words max., Adobe PDF format);</li> <li>○ Summary Slide (1 page limit, Microsoft PowerPoint format) – Applicants may use the Summary Slide template available on ARPA-E eXCHANGE</li> </ul> </li> </ul>	Mandatory	IV.D	5 PM ET, TBD May 7, 2015

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	<p>(<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>);</p> <ul style="list-style-type: none"> <li>○ SBA Company Registration Certificate (Adobe PDF format);</li> <li>○ Certification for Applicants Majority-Owned by Multiple Venture Capital Operating Companies, Hedge Funds, or Private Equity Firms (Adobe PDF format); and</li> <li>○ Completed and signed Business Assurances &amp; Disclosures Form (no page limit, Adobe PDF format).</li> </ul>			
<p>Reply to Reviewer Comments</p>	<p>[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]</p> <ul style="list-style-type: none"> <li>● Each Applicant may submit a Reply to Reviewer Comments in Adobe PDF format. This submission is optional. Applicants must use the Reply to Reviewer Comments template available on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>). The Reply may include: <ul style="list-style-type: none"> <li>○ Up to 2 pages of text; and</li> <li>○ Up to 1 page of images.</li> </ul> </li> </ul>	<p>Optional</p>	<p>IV.E</p>	<p>5 PM ET, <del>FBD</del> July 2, 2015</p>

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## **I. FUNDING OPPORTUNITY DESCRIPTION**

### **A. AGENCY OVERVIEW**

The Advanced Research Projects Agency – Energy (ARPA-E), an organization within the Department of Energy, is chartered by Congress in the America COMPETES Act of 2007 (P.L. 110-69), as amended by the America COMPETES Reauthorization Act of 2010 (P.L. 111-358), to support the creation of transformational energy technologies and systems through funding and managing Research and Development (R&D) efforts. Originally chartered in 2007, the Agency was first funded through the American Recovery and Reinvestment Act of 2009.

The mission of ARPA-E is to identify and fund research to translate science into breakthrough energy technologies that are too risky for the private sector and that, if successfully developed, will create the foundation for entirely new industries.

Successful projects will address at least one of ARPA-E’s two Mission Areas:

1. Enhance the economic and energy security of the United States through the development of energy technologies that result in:
  - a. reductions of imports of energy from foreign sources;
  - b. reductions of energy-related emissions, including greenhouse gases; and
  - c. improvement in the energy efficiency of all economic sectors.
2. Ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.

**ARPA-E funds applied research and development.** ARPA-E exists to fund applied research and development, defined by the Office of Management and Budget as a “study (designed) to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met” and as the “systematic application of knowledge or understanding, directed toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements.” ARPA-E funds technology-focused applied research to create real-world solutions to important problems in energy creation, distribution and use and, as such, will not support basic research, defined as a “systematic study directed toward fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind.” While it is anticipated that in some instances some minor aspects of fundamental science will be clarified or uncovered during the conduct of the supported applied research, the major portion of activities supported by ARPA-E are directed towards applied research and development of new technologies.

While all technology-focused applied research will be considered, two instances are especially fruitful for the creation of transformational technologies:

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- the first establishment of a technology based upon recently elucidated scientific principles; and
- the synthesis of scientific principles drawn from disparate fields that do not typically intersect.

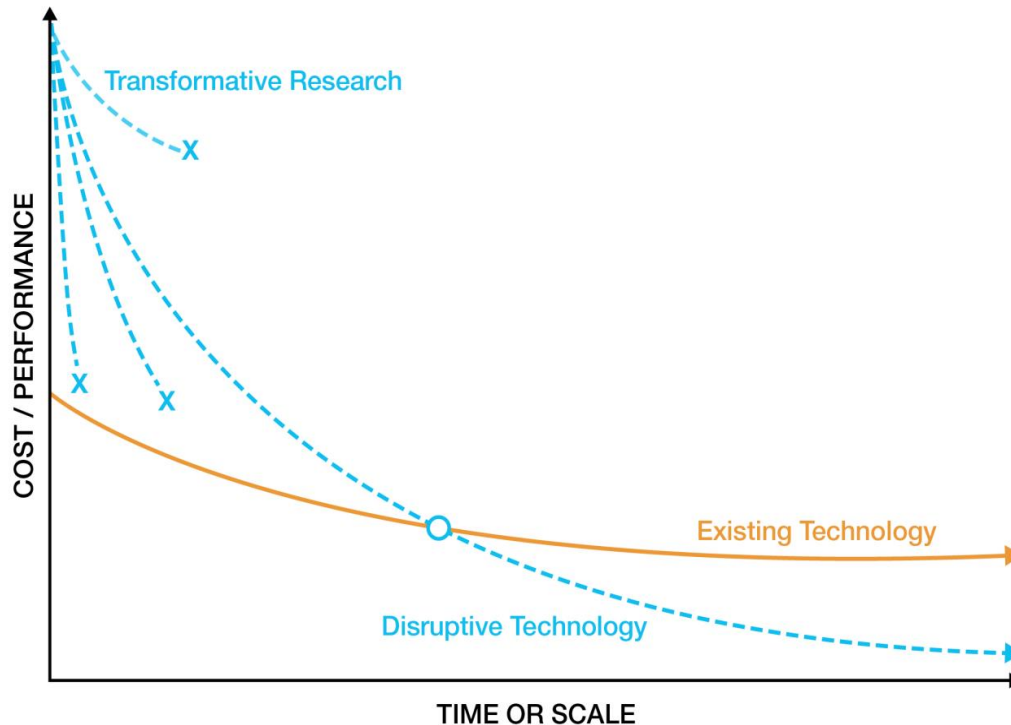


Figure 1. Description of transformational and disruptive technologies in terms of cost per unit performance versus time or scale. ARPA-E seeks to support research that establishes new learning curves that lead to disruptive technologies.

**ARPA-E exists to support transformational, rather than incremental research.** Technologies exist on learning curves (Figure 1). Following the creation of a technology, refinements to that technology and the economies of scale that accrue as manufacturing and widespread distribution develop drive technology down that learning curve until an equilibrium cost/performance is reached. While this incremental improvement of technology is important to the ultimate success of a technology in the marketplace, ARPA-E exists to fund transformational research – i.e., research that creates fundamentally new learning curves rather than moving existing technologies down their learning curves.

**ARPA-E funded technology has the potential to be disruptive in the marketplace.** The mere creation of a new learning curve does not ensure market penetration. Rather, the ultimate value of a technology is determined by the marketplace, and impactful technologies ultimately become disruptive – that is, they are widely adopted and displace existing technologies from the marketplace or create entirely new markets. Energy technologies typically become disruptive at maturity rather than close to inception and the maturation of nascent

technologies often require significant incremental development to drives the technology down its natural learning curve to its ultimate equilibrium (see Figure 1 above). Such development might include modification of the technology itself, the means to produce and distribute that technology, or both. Thus, while early incarnations of the automobile were transformational in the sense that they created a fundamentally new learning curve for transportation, they were not disruptive, because of the unreliability and high cost of early automobiles. Continuous, incremental refinement of the technology ultimately led to the Ford Model T: as the first affordable, reliable, mass-produced vehicle, the Model T had a disruptive effect on the transportation market.

ARPA-E will not support technology development for extended periods of time; rather, ARPA-E supports the initial creation of technology. Following initial testing of the first prototype of a device, a system, or a process, other Federal agencies and the private sector will support the incremental development necessary to bring the technology to market.

While ARPA-E does not require technologies to be disruptive at the conclusion of ARPA-E funding, ARPA-E will not support technologies that cannot be disruptive even if successful. Examples of such technologies are approaches that require elements with insufficient abundances of materials to be deployed at scale, or technologies that could not scale to levels required to be impactful because of, for example, physical limits to productivity.

***ARPA-E will not support basic research aimed at discovery and fundamental knowledge generation, nor will it undertake large-scale demonstration projects of existing technologies.***

ARPA-E is not a substitute for existing R&D organizations within the Department of Energy, but rather complements existing organizations by supporting R&D objectives that are transformational and translational. Applicants interested in receiving basic research financial assistance should work with the Department of Energy's Office of Science (<http://science.energy.gov/>). Similarly, projects focused on the improvement of existing technology platforms may be appropriate for support by the applied programs – for example, the Office of Energy Efficiency and Renewable Energy (<http://www.eere.energy.gov/>), the Office of Fossil Energy (<http://fossil.energy.gov/>), the Office of Nuclear Energy (<http://nuclear.energy.gov/>), and the Office of Electricity Delivery and Energy Reliability (<http://energy.gov/oe/office-electricity-delivery-and-energy-reliability>).

## **B. SBIR/STTR PROGRAM OVERVIEW**

The Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs are Government-wide programs authorized under Section 9 of the Small Business Act (15 U.S.C. § 638). The objectives of the SBIR program are to (1) stimulate technological innovation in the private sector, (2) strengthen the role of Small Business Concerns in meeting Federal R&D needs, (3) increase private sector commercialization of innovations derived from Federal R&D activities, (4) foster and encourage participation by socially and economically

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disadvantaged and women-owned Small Business Concerns, and (5) improve the return on investment from Federally funded research and economic benefits to the Nation. The objective of the STTR program is to stimulate cooperative partnerships of ideas and technologies between Small Business Concerns and partnering Research Institutions through Federally funded R&D activities.<sup>1</sup>

ARPA-E administers a joint SBIR/STTR program in accordance with the Small Business Act and the SBIR and STTR Policy Directives issued by the U.S. Small Business Administration (SBA).<sup>2</sup> ARPA-E provides SBIR/STTR funding in three phases (Phase I, Phase II, and Phase IIS).

## C. TECHNICAL PROGRAM OVERVIEW

### 1. SUMMARY

The **MOSAIC** (**M**icro-scale **O**ptimized **S**olar-cell **A**rrays with **I**ntegrated **C**oncentration) Program will fund potentially disruptive technologies and related system concepts to achieve new performance and cost benchmarks for solar-electric generation from photovoltaics (PV). Specifically, **MOSAIC** will develop novel concepts that integrate arrays of high-performance micro-scale concentrated PV (micro-CPV) elements into modules that are similar in profile and cost to traditional non-concentrated “flat-plate” (FP) PV, but achieve the performance level associated with conventional Concentrated Photovoltaics (CPV). Realization of the aggressive targets of **MOSAIC** will require the formation of R&D teams from several communities, including material scientists, electrical and packaging engineers, optical engineers, micro-scale manufacturing specialists, and researchers in polymers and opto-electronics.

The **MOSAIC** Program’s overall technical target is solar-to-electrical power conversion efficiency (as measured against total annual incident solar radiation) of > 30% across a wide range of geographic locations with varying amounts of direct and diffuse insolation. This would represent an approximately 50% improvement over conventional “1-sun” FP PV module performance. Such an advance will significantly reduce the area and number of modules needed to provide a given power output – and thereby reduce those Balance of System (BOS) costs associated with installation and maintenance that are proportional to installed system area. If micro-CPV-based panels achieve production costs comparable to those of 1-sun conventional panels (now roughly \$100/m<sup>2</sup>), then the benefit from reduced BOS costs will lead to system costs as low as \$0.75/W and \$1.25/W for utility and residential market applications, respectively, resulting in a decrease in the PV-generated Levelized Cost of Energy (LCOE) across a wide geographic domain. Further, the significant reduction in the footprint needed for a

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<sup>1</sup> Research Institutions include FFRDCs, nonprofit educational institutions, and other nonprofit research organizations owned and operated exclusively for scientific purposes. Eligible Research Institutions must maintain a place of business in the United States, operate primarily in the United States, or make a significant contribution to the U.S. economy through the payment of taxes or use of American products, materials, or labor.

<sup>2</sup> See 77 Fed. Reg. 46806 (Aug. 6, 2012); 77 Fed. Reg. 46855 (Aug. 6, 2012).

given power output may also expand the adoption of PV solar in the constrained-space rooftop market, where many roofs are currently too small, too shaded, or sub-optimally oriented for installation of today's PV panel technology to be economical.

## 2. BACKGROUND

Solar PV technology offers a renewable-energy source of electricity at a cost that is increasingly competitive with fossil-fuel power generation. Advances in system performance (measured in Watts/m<sup>2</sup>) and economies-of-scale in manufacturing (represented in \$/m<sup>2</sup>) have substantially reduced cost from ~\$8-10/W at the system level in 2003 to \$2-4/W in 2013.<sup>3</sup> This translates to unsubsidized LCOE values as low as \$0.08/kWh. Of the 38 GW of PV product deployed in 2013, which enabled a ~\$100B PV systems market, more than 99%<sup>4</sup> was in the form of 1-Sun FP modules and systems. FP Crystalline Silicon (c-Si) module technologies typically achieve 16-20% conversion efficiency for the lowest cost of production.

CPV continues to make advances in system performance, reliability, and form-factor, but has not achieved widespread adoption. Further, the technology is currently considered viable only in a limited geographic region (i.e., the southwestern portions of the US) where the proportion of direct solar radiation (in contrast to diffuse solar radiation resulting from atmospheric light scattering) is maximized.

Current DOE programs in the Office of Energy Efficiency and Renewable Energy (EERE) (e.g., "SunShot") are developing FP and CPV technologies with cost targets of \$1.00/W and \$1.50/W for utility and residential markets, respectively. These programs and others have helped advance these technologies in both performance and cost. Consequently, there is increasing deployment of solar PV across the utility, commercial, and residential rooftop markets – and projections are for continued strong growth in solar PV adoption.

Estimates by the DOE's National Renewable Energy Laboratory (NREL) suggest that deploying PV systems on all available US residential roof space could provide as much as 500 GW of power generating capacity with 20% efficient panels —which amounts to a significant portion of the total US Electrical Power demand.<sup>5</sup> In principle, the combination of commercial and residential roof space and centralized utility solar farms, in conjunction with projected improvements in energy storage cost and performance, could provide all US electricity demand in a carbon-free form.

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<sup>3</sup> <http://www.nrel.gov/docs/fy13osti/60207.pdf>

<sup>4</sup> [http://www.semiconductor-today.com/news\\_items/2013/DEC/IHS\\_111213.shtml](http://www.semiconductor-today.com/news_items/2013/DEC/IHS_111213.shtml)

<sup>5</sup> <http://www.nrel.gov/docs/fy09osti/44073.pdf>

### 3. MOTIVATION

#### *a. Cost Analysis*

Achieving wide-spread deployment will require PV to be cost-competitive across the widest possible set of markets. Estimates using the NREL Open PV Project<sup>6</sup> suggest that if PV systems can achieve a \$1/W cost for a 5 kW residential rooftop system, the cost of electricity in the majority of US states would be equal to or less than the cost of electricity from other sources, such as natural gas power plants. The primary challenge to reaching these target cost benchmarks is to reduce BOS costs that are independent of FP module performance enhancements. Though FP module efficiency will continue to improve, achieving incremental improvements in a cost-effective manner will become increasingly difficult as c-Si approaches to within a few absolute percent of its Shockley-Queisser efficiency limit (~29%).

A significant portion of the BOS costs is proportional to total panel area (e.g., those associated with panel site preparation, installation, and maintenance). Consequently, increasing panel efficiency beyond what single-junction Si PV cells can achieve would have a direct impact on system BOS costs. Figure 2 shows the potential impact of increased panel efficiency on overall cost/W for an exemplar roof-top system. Since higher efficiency modules yield more output for a fixed area, the BOS costs are reduced on a per Watt basis as the efficiency is increased.

The **MOSAIC** Program's overall technical approach is therefore based on achieving system cost targets using integrated concentration to significantly increase PV module efficiency, but without increasing manufacturing costs appreciably. If FP PV panel costs can be nearly equaled while realizing the performance enhancement of CPV, then the geographic domain within which CPV is economical can be expanded.

Flat-panel display (FPD) technology provides an "existence proof" that complex micro-scale opto-electronic circuit technology can significantly impact the marketplace. The widespread deployment of FPDs has led to significant cost reductions in materials and non-material costs with each succeeding technology generation. **MOSAIC** technology could follow a similar path if deployment levels lead to significant exploitation of the economies-of-scale.

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<sup>6</sup> <https://openpv.nrel.gov/>

In addition, increasing PV module efficiency will expand the constrained-space PV market opportunity (e.g., small residential roof-tops with more limited access to solar illumination) – where current c-Si FP PV efficiency is not sufficient to justify PV installations and high-efficiency 1-sun PV based on multi-band gap III-V materials remains too expensive. Currently, CPV concepts exploit the high performance of III-V multi-band gap PV cells, and minimize the cost by using concentration that reduces the amount of expensive PV material required. Conventional CPV systems, however, are limited in their application domains due to their bulky form factor, reliance on only the direct component of the solar insolation, and need for expensive mechanical tracking mechanisms.

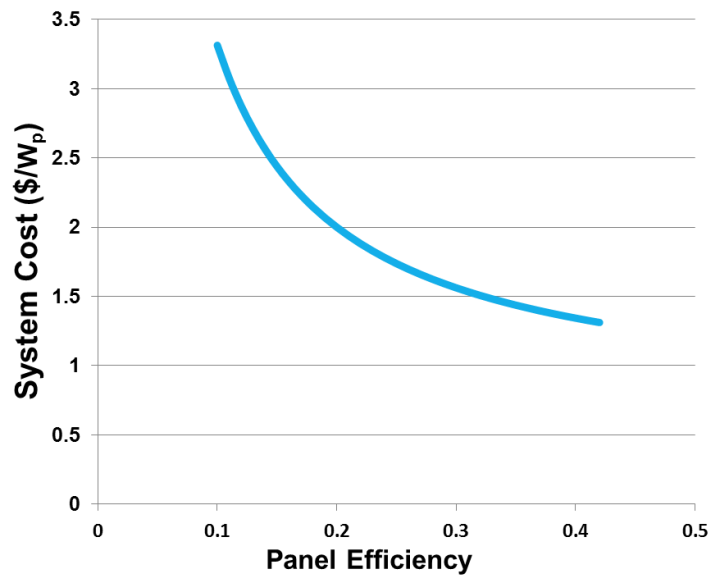


Figure 2. Estimated impact of module efficiency on system cost for a 400 ft<sup>2</sup> roof-top system. The analysis assumes a panel cost: \$.50/W<sub>p</sub> and a baseline BOS cost (at 20% panel efficiency) of \$1.50/W<sub>p</sub>.

**b. Comparison to Conventional Flat-Plate PV and Concentrating PV**

In a typical FP PV module, nearly all of the module area is covered with active semiconductor material that absorbs sunlight and converts it to electrical energy. The PV “converter” material, the associated electronic materials, and the cost of manufacturing these elements account for about half of the module cost. Packaging materials, such as glass and polymers that provide environmental protection, make up the balance. Within this material set, therefore, there is a need to balance the quality and cost of the materials and manufacturing processes used with the performance they provide. Crystalline Si (c-Si) and various thin-film materials fabricated into single-junction solar cells offer that balance. When packaged into a completed module, their streamlined form-factor and weight subsequently determine the kind and cost of mechanical structures that can be employed to install them in the field. These structures, plus additional electrical components, installation, engineering design, site preparation and permitting constitute the BOS. While FP 1-Sun solar cell modules can be fabricated from III-V

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materials with the efficiency sought by this program, it is unlikely that such approaches can achieve cost parity with c-Si or other single junction thin-film technologies.

In CPV, the approach is significantly different. Complex multi-junction solar cells employing expensive starting materials, and manufactured by higher-cost batch processing, are designed and fabricated to produce the highest possible efficiency. Whereas the areal cost of Si and thin-film solar materials that produce 15-20% efficiency modules are in the range of \$60-\$120/m<sup>2</sup>, the areal cost of multi-junction cells with efficiencies of ~40% may reach \$60,000/m<sup>2</sup>.<sup>7</sup> The exploitation of such high-efficiency PV material requires that the area percentage of coverage of the solar cell material be as small as possible, with optical elements employed to collect and concentrate the light onto the smaller cell area. The intensity of the concentrated sunlight ranges from about 20 to ~1500 times the 1-Sun intensity. In recent years, there has been considerable progress in reducing the manufacturing cost of CPV by “lifting off” high-efficiency III-V cells and re-use of expensive wafer substrates, thus potentially enabling lower concentration systems and simplified module architectures.

Figure 3 shows the trade space between harvesting density and cost density in PV systems. For reference, the 10 cents/kWh boundary, which is roughly where PV becomes competitive with other forms of electrical energy generation, is depicted. With the selected axes, points above the diagonal line correspond to systems with system costs of <10 cents/kWh. Any given system’s placement on the chart will depend on its geographic location (and hence total solar insolation levels) and cost (which will differ depending on market sector). In general, there is a trade-off between energy harvesting density and cost density, with projected conventional CPV and 1-sun PV systems falling in the regions shown. In keeping with the goal of **MOSAIC** to achieve the form-factor of 1-sun panels while approaching the harvesting performance of CPV, opportunities for **MOSAIC** technology are expected to lie in the region between CPV and 1-sun projections, as depicted.

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<sup>7</sup> T. James *et al*, “Installed system cost targets for high concentration photovoltaic (HCPV) power systems,” presented at UCSB Technology Roundtable: Focus on Concentrator Photovoltaics, July 25, 2012.



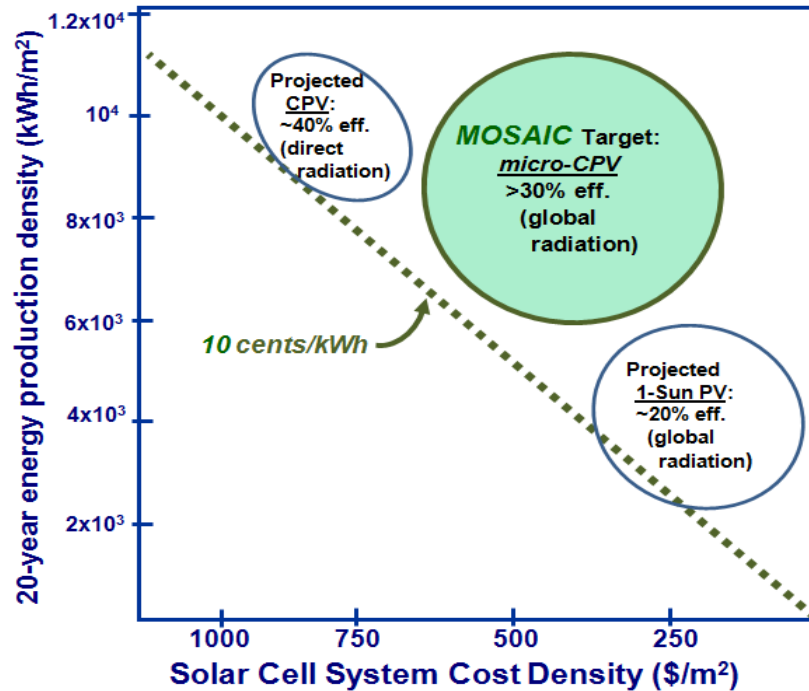


Figure 3. PV system energy harvesting potential vs. cost density: Projections show where future conventional CPV and 1-Sun PV systems will likely fall in order to achieve a <10 cents/kWh target. The **MOSAIC** opportunity falls in the space between these two domains, where the goal is to implement micro-CPV in a manner that achieves CPV harvesting performance, but with panel costs similar to 1-Sun FP costs.

### c. Market Expansion Opportunity

Global PV markets have grown dramatically in the past decade – from 566 MW in 2003 to over 38,000 MW in 2013.<sup>8</sup> During the same time period, market demographics have shifted away from Europe where its market share peaked in 2008 at 85% and has since dropped to 29%, where it is second behind China.<sup>9</sup> The U.S. market has also demonstrated strong growth, representing ~13% of the world market in 2013 with a compound annual growth rate from 2008 to 2013 of greater than 58%.<sup>10</sup> While this growth is impressive, solar PV still represents only 1.1% of U.S. power generation capacity and 0.2% of total energy generation.<sup>11</sup> In order to substantially increase PV penetration, further technological innovation and cost reductions are necessary. **MOSAIC** aims to benefit all three primary market sectors – residential, commercial and utility - with higher performance, lower cost technology.

<sup>8</sup>[http://www.epia.org/fileadmin/user\\_upload/Publications/EPIA\\_Global\\_Market\\_Outlook\\_for\\_Photovoltaics\\_2014-2018\\_-\\_Medium\\_Res.pdf](http://www.epia.org/fileadmin/user_upload/Publications/EPIA_Global_Market_Outlook_for_Photovoltaics_2014-2018_-_Medium_Res.pdf)

<sup>9</sup>Ibid (same as prior source above)

<sup>10</sup> <http://www.nrel.gov/docs/fy14osti/60197.pdf>

<sup>11</sup> <http://www.eia.gov/electricity/monthly/pdf/epm.pdf>

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A typical target for alternative energy technologies is to achieve “grid parity,” providing lower cost electricity than the utility grid. The variability of utility rates, in conjunction with the geographic variability for solar resources, manifests in a broad range of target values for solar PV cost. DOE’s SunShot initiative has set a goal of \$1.00/W for utility-scale PV. Significant progress has been made in 1-Sun FP PV – reaching levels below \$2.00/W in 2013 in some locations. As previously discussed, achieving \$1.00/W across a desired wider geographic domain will be challenging since FP PV is approaching limits in system performance, and module and BOS manufacturing cost reductions.

For PV generation assets placed closer to the end-user, “grid-parity” comparisons must take into account retail vs. wholesale electrical rates, pay-back periods after which the electricity will essentially be free, and enhanced security/independence factors that add value. With that in mind, DOE’s SunShot initiative has set a goal of \$1.50/W and \$1.25/W for residential- and commercial-scale PV, respectively. In 2013, industry data indicates an average installation cost of \$3.60-4.00/W.<sup>12</sup> Roughly 80% of that cost is non-module related. Some of that cost is associated with designing in space-constrained markets and where shadowing effects must be included in the performance and cost projections. Higher performing micro-CPV modules, with embedded solar tracking, could provide enhanced energy production in constrained spaces, and provide a path to lowering costs. Preliminary cost estimates for micro-CPV on fixed-tilt rooftops suggest it can meet and surpass the \$1.50/W system threshold.

Figure 4 shows the variance of global solar insolation and relative percentage that is due to diffuse radiation for various geographic locations in the contiguous USA. The wide variation in total insolation and diffuse/global ratio is depicted. Currently, CPV is regarded as having potential only in those regions of the US in which the direct component of solar radiation is the highest, i.e., principally the southwestern regions of the USA. **MOSAIC** aims to exploit micro-scale CPV technology to expand the geographic regions in which the benefits of CPV may be exploited cost-effectively. In addition, the program seeks to support innovative hybrid concepts that aim to cost-effectively integrate micro-scale CPV to collect Direct Normal Incident (DNI) solar radiation and also to collect the diffuse solar radiation and thereby extend the benefits of CPV to a the widest geographic expanse possible.

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<sup>12</sup> <http://www.nrel.gov/docs/fy13osti/60207.pdf>

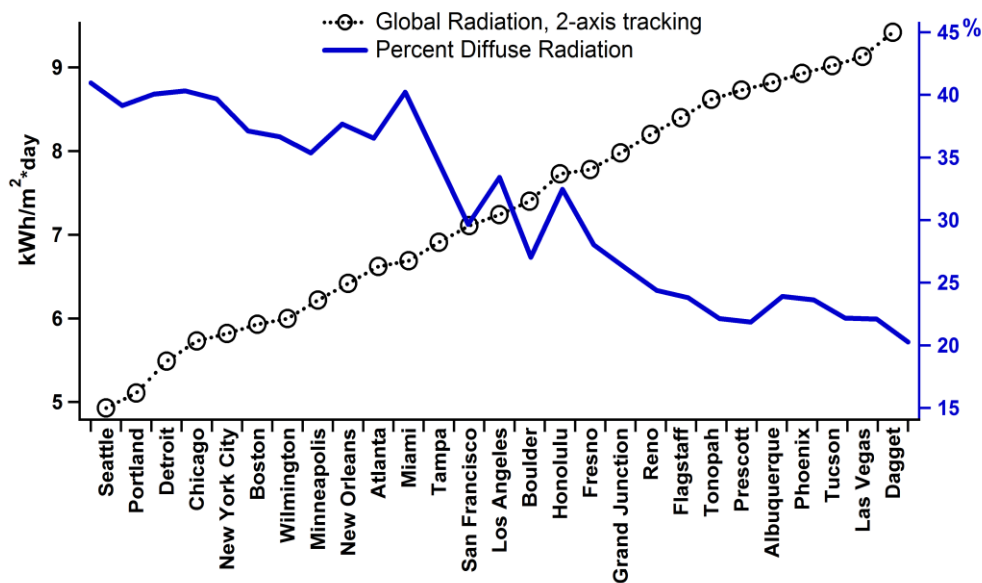


Figure 4. Global insolation and percentage of diffuse radiation as a function of geographical location in the U.S. Data adopted from National Solar Radiation Data Base (1961-1990), 1992

#### d. Potential Performance Benefits of Micro-Scale CPV

CPV systems use optics to concentrate DNI sunlight onto a smaller solar cell receiver. A particular design will define a collection (aperture) area, a normal dimension over which the light is focused, and a receiver dimension that establishes the size of the solar cell. This design is scalable over several orders of magnitude. Some currently deployed designs have lens and depth dimensions of between 10-100 cm. More recent competing designs have reduced these dimensions to 1-10cm. One-time manufacturing costs, annual operation & maintenance costs, and long-term reliability issues still renders CPV as a challenging choice for project developers. Their bulk, weight, and need for mechanical tracking also render CPV impractical for fixed-position roof-top markets. The micro-scale technology integration sought here significantly extends the current efforts in the CPV community that seek to shrink cell, optics, tracking, and module dimensions. The scalability of micro-systems-based approaches has the potential to remove manufacturing, operational and market barriers to full penetration of CPV. The potential performance benefits of micro-scale CPV may be considered in terms of scaling with the size of the unit cell in the array. Assuming that a macro-scale CPV module is replaced with an array of  $N^2$  micro-scale concentrators, while keeping the solar energy collection area fixed, then:

- **Mass of optics and module thickness decreases with increasing N**, this lowers Bill of Materials (BOM) and tracker costs, enables a significant module thickness reduction with shorter focal length and enables refractive optics that perform better than Fresnel lenses.

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- **Thermal dissipation difficulty scales as 1/N:** For equivalent concentration and total PV cell area, the pixilated micro-CPV approach has a perimeter-to-area ratio that scales as N, thus enhancing thermal dissipation cross the plane. For cell sizes <1mm, the operating temperature approaches 1-Sun levels, removing requirement for heat sinking.<sup>13</sup>
- **Wiring degrees-of-freedom scale as N<sup>2</sup>:** This enables optimized combining of current and voltage, lowers I<sup>2</sup>R losses, minimizes shading effects to avoid by-pass diodes, and enables power conversion closer to the cells, as well as other potential advantages.<sup>14</sup>

For non-rooftop applications, micro-CPV modules can employ traditional external tracking mechanisms that are optimized for micro-CPV deployment. Relative to traditional CPV tracking mechanisms, micro-CPV tracking should be substantially lower in cost due to the lower weight and potentially increased angular tolerance of refractive micro-CPV concentrators. For rooftop or similar stationary (fixed-tilt) applications, the **MOSAIC** program envisions concentrating optics embedded within the panel with the capability of tracking the sun throughout the day. There are opportunities to exploit micro-scale integration technology in a manner that combines mechanisms by which to capture and convert the direct and diffuse solar radiation within the same integrated structure. Harvesting enhancements from such *hybrid* micro-CPV architectures – which combine micro-CPV elements with low- or no-concentration PV elements – may lead to an expansion of PV into “low-DNI” markets (i.e., those regions to the left of “Reno” in Figure 4). A critical consideration for these options will be the relative cost/benefit of adding additional components necessary to achieve the hybrid functionality.

#### **D. PROGRAM OBJECTIVES**

The overall objective of the **MOSAIC** Program is to create new technology platforms that will enable the development and deployment of a new class of PV solar harvesting panels based on micro-scale CPV. If successful, **MOSAIC** will impact the full range of PV solar-harvesting markets. However, since the first market insertion opportunity that maximizes the potential impact is not yet clear, the **MOSAIC** program will focus on addressing a set of key technical challenges from which solutions may be derived for various potential markets.

ARPA-E recognizes that the challenges may differ in type and severity, depending on the specific system architecture and integrated technologies chosen, and the anticipated manufacturing methods that will be required. However, the **MOSAIC** program poses four critical challenges common to any proposed solution:

- Micro CPV pixilated cell array fabrication, integration, and packaging techniques;

<sup>13</sup> Gregory N. Nielson ; Murat Okandan ; Jose Luis Cruz-Campa ; Anthony L. Lentine ; William C. Sweatt, et al.

"Leveraging scale effects to create next-generation photovoltaic systems through micro- and nanotechnologies", Proc. SPIE 8373, Micro- and Nanotechnology Sensors, Systems, and Applications IV, 837317 (May 1, 2012)

<sup>14</sup> Lentine, A.L.; Nielson, G.N.; Okandan, M.; Cruz-Campa, J.-L.; Tauke-Pedretti, A., "Voltage Matching and Optimal Cell Compositions for Microsystem-Enabled Photovoltaic Modules," Photovoltaics, IEEE Journal, V4,N.6, pp.1593,1602, Nov. 2014

- Micro-scale optics that have high performance, robustness, and manufacturing scalability;
- Micro-optical tracking for fixed-tilt applications; and
- System fabrication costs commensurate with current FP PV.

The challenges listed above cannot be addressed in isolation from each other. In fact the rich micro-scale CPV architecture and technology space may allow many interesting design trade-offs. For example, using lower concentration may increase the cost of the PV material used, but allow simpler and cheaper micro-optics that are more tolerant to tracking errors. Also, some embedded solar tracking mechanisms may be more amenable to certain types of optical elements or actuation methods, or perhaps new solar luminescent concentrator (SLC) designs that use out of band photons could be integrated and add benefits for capturing diffuse light. In short, the best **MOSAIC** solutions will involve co-design of the various elements that make up the eventual micro-CPV-based system. Such a *co-optimization* could strike the right balance between the various elements to maximize performance/cost.

Addressing the **MOSAIC** technical challenges will require the full exploitation of the degrees-of-freedom afforded by the integration of micro-optical, micro-electrical, and possibly micro-mechanical technologies to enable a transformational advance beyond FP PV performance. New panel system concepts, and the development of new sub-system component technologies, will be needed. It is envisioned that such new micro-CPV technologies will enable a new learning curve for PV that will overcome the performance/cost barriers engendered by current discrete CPV and 1-sun PV technologies.

#### **E. TECHNICAL CATEGORIES OF INTEREST**

The **MOSAIC** program includes two complete system categories: complete micro-CPV-based system solutions appropriate to two geographical domains in the contiguous U.S. based on the relative percentage of direct and diffuse solar radiation and a third category seeking innovative partial solutions that do not comprise a full system but that attack the critical technology challenges posed above. Each full system category is divided into two sub-categories, corresponding to either a conventional tracking system for the full panel or embedded micro-tracking for fixed-tilt panels. Category 3 seeks innovative partial solutions that address critical aspects of full system solutions in Categories 1 and 2.

Given the rich technology and design space afforded by micro-scale integration, ARPA-E anticipates a wide range of potential micro-CPV solutions that may be considered to address the challenges within the four system sub-categories listed below. It is anticipated that proposed micro-scale CPV solutions will fall in the 10-1000x concentration range. Micro-CPV architectural elements of interest include, but are not limited to: micro-refractive, reflective, or diffractive optical concentrating and/or spectral splitting elements, solar luminescent concentration for diffuse light; tandem and/or lateral PV cell architectures; waveguiding and

concentrating structures, including fluorescent concentration; crystalline, thin-film, and multi-band-gap PV material systems; micro-tracking actuation systems with external or automatic (e.g., using non-linear optical effects) control; micro-actuation systems that operate at the individual CPV cell level, or actuate an entire sub-array; micro-tracking schemes that involve shifting, tilting, deforming the micro-optical elements or PV cells; and tracking micro-optics that employ micro-fluidics, electro-wetting or electro-active polymers.

### **Category 1: System Solutions for High-DNI Regions**

For the purposes of this FOA, a high-DNI region is defined as having annual averaged insolation that is <25% diffuse. With reference to Figure 4, this corresponds generally to portions of the West and Southwestern regions of the USA. In general, micro-CPV-based approaches that do not harvest a significant portion of the smaller diffuse solar component (just like traditional “macro” CPV) are expected to be appropriate to achieve the 30% harvesting target in high-DNI regions. In this case, the critical challenges center on the micro-optical concentration elements and pixilated PV cell arrays, and their integration into a common panel platform.

**Subcategory 1A:** Micro-scale CPV within a flat panel that may be mounted on conventional tracking systems.

**Subcategory 1B:** Micro-scale CPV within a flat panel that may be mounted in fixed-tilt applications, such as residential rooftops. Subcategory 1B approaches must therefore include embedded actuation mechanisms within the panel to track the sun as it moves during the day. Micro-tracking approaches may include active control of actuation (requiring some sort of open or closed-loop control and mechanical actuation of the micro-optics/PV unit cells), or passive tracking (e.g., based on some non-linear optical effect within the micro-concentrating optical elements). Tracking may be implemented at the individual micro-CPV cell level or across fixed arrays via shifts or rotations of entire arrays or sub-arrays within the FP structure. Such approaches could include (but are not limited to) micro-mechanical mechanisms, microfluidic-based approaches, electro-wetting lenses, and electro-active polymers.

### **Category 2: System Solutions for Low-DNI Regions**

Low-DNI regions are defined as having annual averaged insolation that is >25% diffuse, corresponding to the remaining portions of the contiguous U.S. shown in Figure 4, which include the heavily populated regions in the upper Midwest and Northeast. Achieving the aggressive harvesting goal of >30% in these low-DNI regions will require the integration of no- or low-concentration PV elements to capture as much as possible of the relatively larger portions of the diffuse radiation – in combination with the concentrated elements that harvest the direct components. Such hybrid direct/diffuse harvesting approaches will increase the technical and cost challenges, and are therefore relegated to a separate category. Any integrated approaches to capturing the diffuse solar components may

be considered, including, but not limited to, solar luminescent concentrators, light trapping films, or the use of conventional FP PV as a substrate to augment the micro-CPV system. Hybrid direct/diffuse collection solutions may also be appropriate for the high DNI regions of Category 1 (if shown to be cost-effective) as well. Therefore applicants may propose a single hybrid solution that may achieve the goals of both Category 1 and 2 simultaneously, however, ARPA-E does not anticipate that hybrid solutions will be competitive for Category 1 as this additional requirement complicates the design of potential solutions that should prioritize direct radiation.

**Subcategory 2A:** Micro-scale CPV or hybrid direct/diffuse systems within a flat panel that may be mounted on conventional tracking systems.

**Subcategory 2B:** Micro-scale CPV or hybrid direct/diffuse systems within a flat panel that may be mounted in fixed-tilt applications, such as residential rooftops. Category 2B approaches must therefore include embedded actuation mechanisms within the panel to track the sun as it moves during the day.

### **Category 3: Innovative Partial Solutions**

This Category seeks innovative partial solutions that address critical aspects, but are not part of a comprehensive solution required in Categories 1 and 2. Areas of specific interest for possible seedling funding include: (1) novel fabrication and integration concepts for pixelated PV cells that achieve high performance and low production costs; and (2) novel micro-optical tracking concentrator concepts that may be integrated with pixelated PV cell arrays. Applications in this category should be presented in the context of a notional full system to represent at least one of the system-level sub-categories described above. Also, to aid in evaluation of a proposed seedling idea, its ability to fit within full solutions should be articulated. For example, in the areas mentioned above, the range of potential cell sizes and pitch should be presented, as well as how cost will be impacted. This category is particularly appropriate for proof-of-concept awards (see Section II.A of the FOA).

#### **F. TECHNICAL PERFORMANCE TARGETS**

**MOSAIC** sets an aggressive target of >30% harvesting efficiency in both system Categories, but there are some differences in assumptions as explained in the comments following the tables for each the Subcategories below. For example, to facilitate evaluation, the harvesting efficiency goal of 30% is specified for the “worst-case” diffuse percentage in each of the geographic regions associated, i.e., specifying 25% and 40% diffuse solar radiation, for Categories 1 and 2, respectively. Similarly, some of the other metrics are common to Subcategories, but may have differing assumptions or constraints as explained in the comments.

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Applicants should use DNI and diffuse data for a geographic location within the high DNI region – available from the technical literature – to analytically characterize and project cumulative energy harvesting performance over an annual cycle. Applicants should estimate the total annual harvested energy at the output of the module based on an assumed tracking system that operates over the full range of solar angles during the year. It is expected that existing commercial tracking methods will be used for Subcategories 1A and 2A described below (ARPA-E will not fund the development of new tracker concepts in these Subcategories under this FOA), but the potentially higher angular acceptance of small optics could simplify the tracking problem somewhat over for current CPV systems.

**Subcategory 1A: High-DNI System with Macro-Tracking**

ID	Description	Target
1A.1	Solar Energy Harvesting Efficiency	≥ 30% at module output
1A.2	Production Cost	< \$125/m <sup>2</sup>
1A.3	Array height	< 2.5 cm
1A.4	Projected system degradation	< 1%/year

**Subcategory 1B: High-DNI System with Embedded Micro-Tracking**

ID	Description	Target
1B.1	Solar Energy Harvesting Efficiency	≥ 30% at module output
1B.2	Production Cost	< \$150/m <sup>2</sup>
1B.3	Array height	< 2.5 cm
1B.4	Projected system degradation	< 1%/year

**Subcategory 2A: Low-DNI System with Macro Tracking**

ID	Description	Target
2A.1	Solar Energy Harvesting Efficiency	≥ 30% at module output
2A.2	Production Cost	< \$150/m <sup>2</sup>
2A.3	Array height	< 2.5 cm
2A.4	Projected system degradation	< 1%/year

**Subcategory 2B: Low-DNI System with Embedded Micro-Tracking**

ID	Description	Target
2B.1	Solar Energy Harvesting Efficiency	≥ 30% at module output
2B.2	Production Cost	< \$175/m <sup>2</sup>
2B.4	Array height	< 2.5 cm
2B.5	Projected system degradation	< 1%/year

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### *Explanations of Technical Targets:*

#### Harvesting Efficiency (IDs : 1A.1, 1B.1, 2A.1, and 2B.1):

The harvesting targets corresponds to the percentage of global annual average radiation converted to electrical DC power out of the panel, assuming: 25% of total insolation is diffuse for the High-DNI case in Category 1; and 40% of total insolation is diffuse for the Low-DNI case in Category 2. The overall projected module system efficiency that is a combination of the anticipated PV conversion efficiency, micro-optics efficiency, and the efficiency effects of harvesting power from the pixilated PV cells should be described. Applications should show how the wiring complexity afforded by micro-scale PV array may be exploited to enhance energy yield. The efficiency with which the proposed architecture captures solar energy during tracking should be described in terms of all of the critical elements. For example, in Category 1A, the tolerance of the micro-CPV system to macro-tracking imperfections as it may relate to, e.g., acceptance angle, should be included.

#### Production Costs (IDs: 1A.2, 1B.2, 2A.2, and 2B.2):

The aggressive target for 1A.2 assumes economies-of-scale associated with very large scale production similar to current FP PV. The need to integrate micro-tracking for the fixed-tilt category 1B will engender higher costs, hence the elevated cost target for 1B.2. The need for a hybrid micro-CPV/diffuse harvesting solution in Subcategory 2A also will engender a higher cost target as shown. Lastly, Subcategory 2B requires both embedded micro-tracking and the integration of micro-CPV with diffuse solar harvesting in a hybrid configuration – and thus has the highest production cost target.

#### Array Height (IDs: 1A.3, 1B.3, 2A.3, and 2B.3):

There are practical considerations and limitations of how small the unit cell in a micro-CPV system might be. ARPA-E is seeking solutions where the total module thickness is consistent with current flat panel PV profiles – hence the total height of the **MOSAIC** modules is limited to <2.5 cm. The module thickness will determine other related parameters, depending on concentration levels, such as density of cell placement, aperture lens dimension, etc.

#### Degradation (IDs: 1A.4, 1B.4, 2A.4, and 2B.4):

Current high-performing FP PV systems are extremely robust to normal environmental and operational degradation – and achieve 1% or less degradation per year. The **MOSAIC** target is set to match this level of robustness in order to ensure that **MOSAIC** technology is a competitive option in future deployments.

## G. REQUIRED METRICS AND CALCULATIONS FOR FULL APPLICATIONS

### Performance Analysis of Proposed MOSAIC solutions

The MOSAIC program is seeking technical solutions that address either of two distinct outdoor solar illumination conditions: Category 1) High direct normal irradiance (DNI) – defined here as > 75% DNI (25% Diffuse); Category 2) Low DNI – defined here as < 60% DNI (40% Diffuse). For partial solutions that are relevant aspects of the system (for example, optics or PV arrays), the performance should be addressed in the context of an overall system concept. In the system context, harvesting efficiency ( $\eta_{Harvest,DC}$ ) is defined as:

$$\eta_{Harvest,DC} = \text{electrical power output} / \text{solar power input}$$

for DC power as delivered by the module, previously defined in Section I.B.1. As an example calculation to guide a performance model, we breakdown  $\eta_{Harvest,DC}$  into two (2) primary components: Optical efficiency ( $\eta_{opt}$ ) and PV cell efficiency ( $\eta_{PV}$ ). Additionally, we breakdown the optical and PV cell components into those that are designed for concentrated DNI light - ( $\eta_{opt,DNI}$ ,  $\eta_{PV,DNI}$ ) and those for diffuse radiation ( $\eta_{opt,DIFF}$ ,  $\eta_{PV,DIFF}$ ). This example excludes all 2<sup>nd</sup>-order effects such as cross-over sensitivity of devices to different radiation types, absorption effects in optical components, multiple reflections, etc.  $\eta_{Harvest,DC}$  can be written as

$$\eta_{Harvest,DC} = f_{DNI} \cdot g(\theta, \phi)_{DNI} \cdot \eta_{opt,DNI} \cdot \eta_{PV,DNI} \cdot F_{DNI} + (1 - f_{DNI}) \cdot g(\theta, \phi)_{DIFF} \cdot \eta_{opt,DIFF} \cdot \eta_{PV,DIFF} \cdot F_{DIFF}$$

where  $f_{DNI}$  is the fraction of DNI global insolation, and  $F$  represents other system factors not related to the PV material or optics, such as resistance, edge effects, and intensity. For Category 1 and 2 solutions,  $f_{DNI}$  is 0.75 and 0.60, respectively. For the case of internal (also referred to as “embedded tracking”, Categories 1B and 2B),  $g(\theta, \phi)$  is a factor that takes into account tracking efficiency and is here defined as the ratio of the harvested energy in the proposed system using internal tracking to the harvested energy when using an external tracking mechanism (i.e., the ability to tilt the entire panel on a given axis).

Not all Full Applications are expected to use the exact same variables and same analytical formulas, however, all Full Applications must provide quantitative estimates of optical efficiency, PV efficiency (which could factor in multi-junctions and/or multiple materials) and provide assumptions about other factors that will affect overall system efficiency. ARPA-E seeks a reasonably detailed justification of at least four major performance factors:  $\eta_{opt,DIFF}$ ,  $\eta_{PV,DIFF}$ ,  $\eta_{opt,DNI}$ ,  $\eta_{PV,DNI}$ . In the case of solar cell efficiencies,  $\eta_{PV,DNI}$  &  $\eta_{PV,DIFF}$ , the values provided should be representative of the performance expected under the light intensity anticipated. In the case of optical efficiencies,  $\eta_{opt,DNI}$  &  $\eta_{opt,DIFF}$ , values provided must be estimated and justified quantitatively to account for losses such as absorption, refraction, scattering, diffraction efficiency, and reflectivity. In addition, some qualitative discussion must be considered regarding the practicality of the system regarding ways in which performance

can be degraded, such as by debris, partial shading, manufacturing tolerances, PV cell illumination uniformity, and material degradation. All applications that address only categories 1A and 2A can assume  $g(\theta, \phi) = 1$ , which assumes equivalent performance in using conventional tracking methods. All proposed solutions in categories 1B and 2B must provide an estimate of either  $g(\theta, \phi)$ , or another metric that quantifies the effect of internal tracking on module energy production relative to an external tracking mechanism.

Figure 5 shows a simplified example schematic, followed by Table I.G.1, an example of a spreadsheet that clearly documents known and assumed efficiencies for major system component based on Figure 5. Full applications must provide a similar figure and table. Figure 5 and Table I.F.1 do not include estimates for electrical efficiency after photoelectric conversion in the PV cell, however, applicants are encouraged to include detail and trade-offs on these aspects of the system as well. For partial solutions (Category 3), all applications must make assumptions about the other system elements that are compatible with their proposed solution to calculate a reasonable estimate of how the module and system is expected to perform. Applications in Categories 1 and 2 must provide a calculation of the harvesting efficiency at the following DNI/Diffuse values: Category 1 at 75% DNI / 25% Diffuse and Category 2 at 60% DNI / 40% Diffuse.

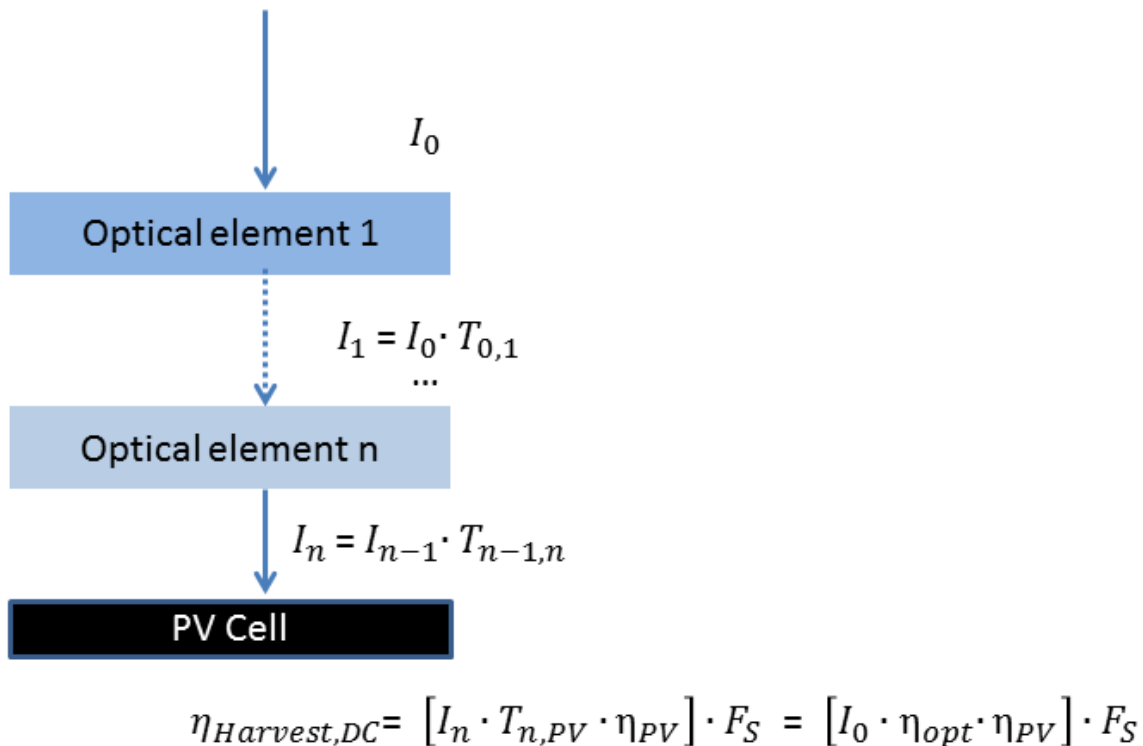


Figure 5. Simplified, notional schematic for calculating solar harvesting efficiency, considers only primary losses (not secondary reflections, for example).  $I_0$ : Incident intensity,  $I_1$ : Intensity propagating toward PV cell after first optical element, in this schematic  $T_{0,1}$  is the transmission coefficient for the first optical element and represents the ratio of the light that would reach the PV cell (in absence of subsequent interfaces) to the total incident light on that element. In this schematic, the overall optical efficiency is

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equal to the product of all transmission coefficients. Applicants do not need to use the exact notation used here, however, this provides an example of the type of minimalist model that must be described.

**Table I.G.1. Example component efficiencies of a notional system for a Category 1 solution with concentrating PV solution only**

Parameter	Symbol	Value	Estimated variation*
Fractional DNI	$f_{DNI}$	.75	
Optical efficiency	$\eta_{opt}$	.93	0.05
PV efficiency	$\eta_{PV}$	0.44	0.05
Other system efficiency	$F$	0.98	0.05
Solar Harvesting Efficiency	$\eta_{Harvest,DC}$	0.30	0.026

\*where possible, estimate and justify variation due to system components and designs.

**Cost modeling of Proposed MOSAIC solutions**

In order to practically evaluate the projected cost of the proposed system, applicants must include a simple calculation and justification of the values used, as well as any sources of uncertainty (whether qualitative or quantitative). At minimum, a projected bill of materials (BOM) must be supplied, along with rationale for projected costs, the associated volumes required to create the proposed system (or sub-system component), and estimates for manufacturing and assembly costs with references. Table I.G.2 shows an example of a simple calculation.

**Table I.G.2. Notional system with two optical materials and one PV material**

System element	Fraction of module area	\$/m <sup>2</sup>	\$/m <sup>2</sup> module integrated
Optics 1	0.95	29	28
Optics 2	0.95	19	18.30
PV cell 1	0.01 (100x)	5,000	50
PV cell 2	-	-	-
Other material 1	-	2.50	2.50
Other material 2	-	-	-
Total system BOM	-	-	\$98.80
Assembly markup	-	-	1.5x
Manufactured cost	-	-	\$148.20

The above tables and figure show examples of the type of analysis expected in order to justify each claim. Each Full Application may require different variables and methods of analysis;

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however, any claims regarding performance or cost must be quantified with a justification for each value used in the calculation.

## **H. APPLICATIONS SPECIFICALLY NOT OF INTEREST**

The following types of applications will be deemed nonresponsive and will not be reviewed or considered (see Section III.F.2 of the FOA):

- Applications that fall outside the technical parameters specified in Section I.F of the FOA
- Applications that have been submitted in response to other currently issued ARPA-E FOAs.
- Applications that are not scientifically distinct from applications submitted in response to other currently issued ARPA-E FOAs.
- Applications for basic research aimed solely at discovery and/or fundamental knowledge generation.
- Applications for large-scale demonstration projects of existing technologies.
- Applications for proposed technologies that represent incremental improvements to existing technologies.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates a law of thermodynamics).
- Applications for proposed technologies that are not transformational, as described in Section I.A of the FOA and as illustrated in Figure 1 in Section I.A of the FOA.
- Applications for proposed technologies that do not have the potential to become disruptive in nature, as described in Section I.A of the FOA. Technologies must be scalable such that they could be disruptive with sufficient technical progress (see Figure 1 in Section I.A of the FOA).
- Applications that are not scientifically distinct from existing funded activities supported elsewhere, including within the Department of Energy.
- Applications that propose the following:
  - non-PV solutions (e.g., concentrated solar thermal or thermal-electric solutions),
  - 1-sun (non-concentrated) solutions.
  - PV to be deployed in space, or on balloons or towers.

## **II. AWARD INFORMATION**

### **A. AWARD OVERVIEW**

ARPA-E will accept only new applications under this FOA. Applicants may not seek renewal or supplementation of their existing awards through this FOA.

ARPA-E expects to make approximately \$10 million available for new awards under this FOA, subject to the availability of appropriated funds. ARPA-E anticipates making approximately 4 to

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7 awards under this FOA. ARPA-E may issue one, multiple, or no awards.

ARPA-E encourages applications stemming from ideas that still require proof-of-concept R&D efforts as well as those for which some proof-of-concept demonstration already exists.

Applications requiring proof-of-concept R&D can propose a project with the goal of delivering on the program metric at the conclusion of the project period. Such applications are particularly relevant for Category 3, Innovative Partial Solutions. These applications should contain an appropriate cost and project duration plan that is described in sufficient technical detail to allow reviewers to meaningfully evaluate the proposed project. If awarded, such projects should expect a rigorous go/no-go milestone early in the project associated with the proof-of-concept demonstration. Alternatively, applications requiring proof-of-concept R&D can propose a project with the project end deliverable being an extremely creative, but partial solution. However, the Applicants are required to provide a convincing vision how these partial solutions can enable the realization of the program metrics with further development.

Applicants proposing projects for which some initial proof-of-concept demonstration already exists should submit concrete data that supports the probability of success of the proposed project. Applicants should identify the highest risk elements in their proposed project and set milestones based on those risks, as well as identify risk mitigation strategies.

Each Concept Paper and Full Application must identify the award category under which it is seeking funding (see Sections IV.C.1 and IV.D.1 of the FOA). ARPA-E has established two award categories for this FOA. **Concept Papers and Full Applications may not request funding under more than one award category.**

- **Category A (Combined Phase I/II Awards):** Combined Phase I/II Awards are intended to develop transformational technologies with disruptive commercial potential. Such commercial potential may be evidenced by (1) cost sharing or follow-on funding by private or non-SBIR/STTR sources, or (2) the Small Business Concern's record of successfully commercializing technologies developed under prior SBIR/STTR awards. Combined Phase I/II awards may be funded up to \$1,725,000 and have a period of performance up to 36 months (3 years). ARPA-E anticipates making 1-3 awards in this category.
- **Category B (Combined Phase I/II/IIS Awards):** Combined Phase I/II/IIS Awards are similar to Combined Phase I/II awards, but include a “sequential” (i.e., additional) Phase II award, a.k.a. “Phase IIS” award, to allow the continued development of promising energy technologies. Combined Phase I/II/IIS awards may be funded up to \$3,225,000 and may have a period of performance up to 48 months (4 years). ARPA-E anticipates making 3-4 awards in this category.

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In evaluating submissions for Combined Phase I/II and Combined Phase I/II/IIS awards, ARPA-E reserves the right to fund only Phase I, or to fund only Phase I and Phase II of a proposed project. Applicants may not apply exclusively for a Phase I award. The maximum award amount for a Phase I award is \$225,000.

Although each submission must designate a single award category, the Applicant may request both SBIR and STTR funding for that category. A Small Business Concern may request both SBIR and STTR funding under the same award category if:

- The Small Business Concern is partnered with a Research Institution;
- The Small Business Concern performs at least 66.7% of the work in Phase I and at least 50% of the work in Phase II and/or Phase IIS (as applicable), as measured by the Total Project Cost;
- The partnering Research Institution performs 30-33.3% of the work in Phase I and 30-50% of the work in Phase II and/or Phase IIS (as applicable), as measured by the Total Project Cost; and
- The Principal Investigator (PI) is employed by the Small Business Concern. If the PI is employed by the Research Institution, submissions will be considered only under the STTR program.

## **B. ARPA-E FUNDING AGREEMENTS**

ARPA-E uses Cooperative Agreements to provide financial and other support to Prime Recipients.<sup>15</sup>

Cooperative Agreements involve the provision of financial or other support to accomplish a public purpose of support or stimulation authorized by Federal statute. Under Cooperative Agreements, the Government and Prime Recipients share responsibility for the direction of projects.

Phase I of Combined Phase I/II awards and Combined Phase I/II/IIS awards will be made on a fixed-obligation basis. Phase II and Phase IIS of Combined Phase I/II awards and Combined Phase I/II/IIS awards will be made on a reimbursement basis.

ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement for SBIR/STTR Awards, which is available at <http://arpa-e.energy.gov/?q=arpa-e-site-page/sbir-sttr-guidance>.

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<sup>15</sup> The Prime Recipient is the signatory to the funding agreement with ARPA-E.

### C. STATEMENT OF SUBSTANTIAL INVOLVEMENT

Under Cooperative Agreements, ARPA-E is substantially involved in the direction of projects from inception to completion. For the purposes of an ARPA-E Cooperative Agreement, substantial involvement means:

- ARPA-E does not limit its involvement to the administrative requirements of the ARPA-E funding agreement. Instead, ARPA-E has substantial involvement in the direction and redirection of the technical aspects of the project as a whole. Project teams must adhere to ARPA-E technical direction and comply with agency-specific and programmatic requirements.
- ARPA-E may intervene at any time to address the conduct or performance of project activities.
- During award negotiations, ARPA-E Program Directors and Prime Recipients mutually establish an aggressive schedule of quantitative milestones and deliverables that must be met every quarter. Prime Recipients document the achievement of these milestones and deliverables in quarterly technical and financial progress reports, which are reviewed and evaluated by ARPA-E Program Directors (see Attachment 4 to ARPA-E's Model Cooperative Agreement for SBIR/STTR Awards, available at <http://arpa-e.energy.gov/?q=arpa-e-site-page/sbir-sttr-guidance>). ARPA-E Program Directors visit each Prime Recipient at least twice per year, and hold periodic meetings, conference calls, and webinars with Project Teams. ARPA-E Program Directors may modify or terminate projects that fail to achieve predetermined technical milestones and deliverables.
- ARPA-E reviews reimbursement requests for compliance with applicable Federal cost principles and Prime Recipients' cost share obligations for Phase II and Phase IIS of Combined Phase I/II awards and Combined Phase I/II/IIS awards. Upon request, Prime Recipients are required to provide additional information and documentation to support claimed expenditures. Prime Recipients are required to comply with agency-specific and programmatic requirements. Please refer to Section VI.B.3-4 of the FOA for guidance on proof of cost share commitment and cost share reporting.
- ARPA-E works closely with Prime Recipients to facilitate and expedite the deployment of ARPA-E-funded technologies to market. ARPA-E works with other Government agencies and nonprofits to provide mentoring and networking opportunities for Prime Recipients. ARPA-E also organizes and sponsors events to educate Prime Recipients about key barriers to the deployment of their ARPA-E-funded technologies. In addition, ARPA-E establishes collaborations with private and

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public entities to provide continued support for the development and deployment of ARPA-E-funded technologies.

### **III. ELIGIBILITY INFORMATION**

#### **A. ELIGIBLE APPLICANTS**

##### **1. SBIR**

SBA rules and guidelines regarding SBIR/STTR program eligibility govern eligibility to apply to this FOA. For information on program eligibility, please refer to SBA's "Guide to SBIR/ STTR Program Eligibility" available at [http://sbir.gov/sites/default/files/elig\\_size\\_compliance\\_guide.pdf](http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf).

A Small Business Concern<sup>16</sup> may apply as a Standalone Applicant<sup>17</sup> or as the lead organization for a Project Team.<sup>18</sup> If applying as the lead organization, the Small Business Concern must perform at least 66.7% of the work under the award in Phase I and at least 50% of the work under the award in Phase II and Phase IIS (as applicable), as measured by the Total Project Cost.<sup>19</sup>

##### **2. STTR**

SBA rules and guidelines regarding SBIR/STTR program eligibility govern eligibility to apply to this FOA. For information on program eligibility, please refer to SBA's "Guide to SBIR/ STTR Program Eligibility" available at [http://sbir.gov/sites/default/files/elig\\_size\\_compliance\\_guide.pdf](http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf).

A Small Business Concern may apply only as the lead organization for a Project Team. The Small Business Concern must perform at least 40% of the work under the award in Phase I, Phase II,

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<sup>16</sup> A Small Business Concern is a for-profit entity that: (1) maintains a place of business located in the United States; (2) operates primarily within the United States or makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor; (3) is an individual proprietorship, partnership, corporation, limited liability company, joint venture, association, trust, or cooperative; and (4) meets the size eligibility requirements set forth in 13 C.F.R. § 121.702. Where the entity is formed as a joint venture, there can be no more than 49% participation by foreign business entities in the joint venture.

<sup>17</sup> A "Standalone Applicant" is an Applicant that applies for funding on its own, not as part of a Project Team.

<sup>18</sup> The term "Project Team" is used to mean any entity with multiple players working collaboratively and could encompass anything from an existing organization to an ad hoc teaming arrangement. A Project Team consists of the Prime Recipient, Subrecipients, and others performing or otherwise supporting work under an ARPA-E funding agreement.

<sup>19</sup> The Total Project Cost is the sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs, FFRDCs, and GOCOs.

and/or Phase IIS (as applicable), as measured by the Total Project Cost. A single Research Institution must perform at least 30% of the work under the award in Phase I, Phase II, and/or Phase IIS (as applicable), as measured by the Total Project Cost. Please refer to Section III.B.1 of the FOA for guidance on Research Institutions' participation in STTR projects.

For information on eligibility as a Small Business Concern, please refer to SBA's Guide to "SBIR/STTR Program Eligibility" ([http://sbir.gov/sites/default/files/elig\\_size\\_compliance\\_guide.pdf](http://sbir.gov/sites/default/files/elig_size_compliance_guide.pdf))

## **B. ELIGIBLE SUBRECIPIENTS**

### **1. RESEARCH INSTITUTIONS**

A Research Institution<sup>20</sup> may apply only as a member of a Project Team (i.e., as a Subrecipient to a Small Business Concern). In STTR projects, a single Research Institution must perform at least 30%, but no more than 60%, of the work under the award in Phase I, Phase II, and/or Phase IIS (as applicable), as measured by the Total Project Cost.

### **2. OTHER PROJECT TEAM MEMBERS**

The following entities are eligible to apply for SBIR/STTR funding as a member of a Project Team (i.e., as a Subrecipient to a Small Business Concern):

- For-profit entities, including Small Business Concerns;
- Nonprofits other than Research Institutions;<sup>21</sup>
- Non-DOE/NNSA Government-Owned, Government Operated laboratories (GOGOs);
- State, local, and tribal government entities; and
- Foreign entities.<sup>22</sup>

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<sup>20</sup> Research Institutions include FFRDCs, nonprofit educational institutions, and other nonprofit research organizations owned and operated exclusively for scientific purposes. Eligible Research Institutions must maintain a place of business in the United States, operate primarily in the United States, or make a significant contribution to the U.S. economy through the payment of taxes or use of American products, materials, or labor.

<sup>21</sup> Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995 are not eligible to apply for funding as a Subrecipient.

<sup>22</sup> All work by foreign entities must be performed by subsidiaries or affiliates incorporated in the United States (see Section IV.G.6 of the FOA). However, the Applicant may request a waiver of this requirement in the Business Assurances & Disclosures Form submitted with the Full Application.

In SBIR projects, Project Team members other than the lead organization, including but not limited to Research Institutions, may collectively perform no more than 33.3% of the work under the award in Phase I and no more than 50% of the work under the award in Phase II and/or Phase IIS (as applicable). This includes efforts performed by Research Institutions.

In STTR projects, Project Team members (other than the lead organization and the partnering Research Institution) may collectively perform no more than 30% of work under the award in Phase I, Phase II, and/or Phase IIS (as applicable).

DOE/NNSA GOGOs are not eligible to apply for SBIR or STTR funding.

**C. ELIGIBLE PRINCIPAL INVESTIGATORS**

**1. SBIR**

For the duration of the award, the PI for the proposed project (or, if multiple PIs, at least one PI) must be employed by, and perform at least 50% of his or her work for, the Prime Recipient. The Contracting Officer may waive this requirement or approve the substitution of the PI.

For projects with multiple PIs, at least one PI must meet the primary employment requirement. That PI will serve as the contact PI for the Project Team.

**2. STTR**

For the duration of the award, the PI for the proposed project (or, if multiple PIs, at least one PI) must be employed by, and perform at least 50% his or her work for, with the Prime Recipient or the partnering Research Institution. The Contracting Officer may waive this requirement or approve the substitution of the PI.

For projects with multiple PIs, at least one PI must meet the primary employment requirement. That PI will serve as the contact PI for the Project Team.

**D. ELIGIBILITY OF PRIOR SBIR AND STTR AWARDEES: SBA BENCHMARKS ON PROGRESS TOWARDS COMMERCIALIZATION**

Applicants awarded multiple prior SBIR or STTR awards must meet DOE's benchmark requirements for progress towards commercialization before ARPA-E may issue a new Phase I award. For purposes of this requirement, applicants are assessed using their prior Phase I and Phase II SBIR and STTR awards across all SBIR agencies. If an awardee fails to meet either of the benchmarks, that awardee is not eligible for an SBIR or STTR Phase I award and any Phase II award for a period of one year from the time of the determination.

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ARPA-E applies two benchmark rates addressing an applicant's progress towards commercialization: (1) the DOE Phase II Transition Rate Benchmark and (2) the SBA Commercialization Rate Benchmark:

- The DOE Phase II Transition Rate Benchmark sets the minimum required number of Phase II awards the applicant must have received for a given number of Phase I awards received during the specified period. **This Transition Rate Benchmark applies only to Phase I applicants that have received more than 20 Phase I awards during the last five (5) year period, excluding the most recently completed fiscal year.** DOE's Phase II Transition Rate Benchmark requires that 0.25 of all Phase I awards received over the past five years transition to Phase II awards.

The SBIR/STTR Phase II transition rates and commercialization rates are calculated using the data in the SBA's TechNet database. For the purpose of these benchmark requirements, awardee firms are assessed once a year, on June 1st, using their prior SBIR and STTR awards across all agencies. SBA makes this tabulation of awardee transition rates and commercialization rates available to all federal agencies. ARPA-E uses this tabulation to determine which companies do not meet the DOE benchmark rates and are, therefore, ineligible to receive new Phase I awards.

- The Commercialization Rate Benchmark sets the minimum Phase III commercialization results that an applicant must have achieved from work it performed under prior Phase II awards (i.e. this measures an applicant's progress from Phase II to Phase III awards). **This benchmark requirement applies only to applicants that have received more than 15 Phase II awards during the last 10 fiscal years, excluding the two most recently completed fiscal years.**

The current Commercialization Benchmark requirement, agreed upon and established by all 11 SBIR agencies, is that the applicants must have received, to date, an average of at least \$100,000 of sales and/or investments per Phase II award received, or have received a number of patents resulting from the relevant SBIR work equal to or greater than 15% of the number of Phase II awards received during the period.

## E. **COST SHARING**<sup>23</sup>

Applicants are bound by the cost share proposed in their Full Applications. Specific cost-sharing requirements for this FOA are as follows:

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<sup>23</sup> Please refer to Section VI.B.3-4 of the FOA for guidance on cost share payments and reporting.

## 1. PHASE I

Prime Recipients/Project Teams are not required to contribute cost share during Phase I of an SBIR/STTR award.

## 2. PHASE II AND IIS COST SHARE REQUIREMENT

For Phase II and Phase IIS, Prime Recipients must contribute cost share as follows:

- Small businesses – or consortia of small businesses - will provide 0% cost share from the outset of the Phase II project through the first 12 months of Phase II (referred to as the “Cost Share Grace Period”). If the project is continued beyond the Cost Share Grace Period, then at least 10% of the Total Project Cost<sup>24</sup> (including the costs incurred during the Cost Share Grace Period) will be required as cost share over the remaining period of performance.
- Project Teams where a small business is the lead organization and small businesses perform greater than or equal to 80%, but less than 100%, of the total work under the funding agreement (as measured by the Total Project Cost) the Project Team are entitled to the same cost share reduction and Cost Share Grace Period as provided above to Standalone small businesses or consortia of small businesses.
- Project teams that do not meet any of the above criteria are subject to a minimum cost share requirement of 20%.

## 3. LEGAL RESPONSIBILITY

Although the cost share requirement applies to the Project Team as a whole, the funding agreement makes the Prime Recipient legally responsible for paying the entire cost share. The Prime Recipient’s cost share obligation is expressed in the funding agreement as a static amount in U.S. dollars (cost share amount) and as a percentage of the Total Project Cost (cost share percentage). If the funding agreement is terminated prior to the end of the project period, the Prime Recipient is required to contribute at least the cost share percentage of total expenditures incurred through the date of termination.

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

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<sup>24</sup> The Total Project Cost is the sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs and FFRDCs.

#### 4. COST SHARE ALLOCATION

Each Project Team is free to determine how much each Project Team member will contribute towards the cost share requirement. The amount contributed by individual Project Team members may vary, as long as the cost share requirement for the project as a whole is met.

#### 5. COST SHARE TYPES AND ALLOWABILITY

Every cost share contribution must be allowable under the applicable Federal cost principles, as described in Section IV.G.1 of the FOA.

Project Teams may provide cost share in the form of cash or in-kind contributions. Cash contributions may be provided by the Prime Recipient or Subrecipients. Allowable in-kind contributions include but are not limited to personnel costs, indirect costs, facilities and administrative costs, rental value of buildings or equipment, and the value of a service, other resource, or third party in-kind contribution. Project Teams may use funding or property received from state or local governments to meet the cost share requirement, so long as the funding or property was not provided to the state or local government by the Federal Government.

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

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

In addition, Project Teams may not use independent research and development (IR&D) funds<sup>25</sup> to meet their cost share obligations under cooperative agreements.

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

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<sup>25</sup> As defined in Federal Acquisition Regulation Section 31.205-18.

Cost share contributions must be specified in the project budget, verifiable from the Prime Recipient's records, and necessary and reasonable for proper and efficient accomplishment of the project. Every cost share contribution must be reviewed and approved in advance by the Contracting Officer and incorporated into the project budget before the expenditures are incurred.

Applicants may wish to refer to 10 C.F.R. parts 600 for additional guidance on cost sharing, specifically 10 C.F.R. §§ 600.30, 600.123, 600.224, and 600.313. Applicants may wish to refer to 2 C.F.R. Parts 200 and 910, and 10 C.F.R Part 603 for additional guidance on cost sharing, specifically 2 C.F.R. §§ 200.206 and 910.130, and 10 C.F.R. §§ 603.525-555.

## **6. COST SHARE CONTRIBUTIONS BY FFRDCs AND GOGOS**

Because FFRDCs are funded by the Federal Government, costs incurred by FFRDCs generally may not be used to meet the cost share requirement. FFRDCs may contribute cost share only if the contributions are paid directly from the contractor's Management Fee or a non-Federal source.

Because GOGOs/Federal Agencies are funded by the Federal Government, GOGOs/Federal Agencies may not provide cost share for the proposed project. However, the GOGO/Agency costs would be included in Total Project Costs for purposes of calculating the cost-sharing requirements of the applicant.

## **7. COST SHARE VERIFICATION**

Upon selection for award negotiations, Applicants are required to provide information and documentation regarding their cost share contributions. Please refer to Section VI.B.3 of the FOA for guidance on the requisite cost share information and documentation.

### **F. OTHER**

#### **1. COMPLIANT CRITERIA**

Concept Papers are deemed compliant if:

- The Applicant and proposed Project Team members meet the eligibility requirements in Section III.A – III.D of the FOA;
- The Concept Paper complies with the content and form requirements in Section IV.C of the FOA; and

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- The Applicant entered all required information, successfully uploaded all required documents, and clicked the “Submit” button in ARPA-E eXCHANGE by the deadline stated in the FOA.

ARPA-E will not review or consider noncompliant Concept Papers, including Concept Papers submitted through other means, Concept Papers submitted after the applicable deadline, and incomplete Concept Papers. A Concept Paper is incomplete if it does not include required information, such as the award category (see Section II.A of the FOA). ARPA-E will not extend the submission deadline for Applicants that fail to submit required information and documents due to server/connection congestion.

Full Applications are deemed compliant if:

- The Applicant submitted a compliant and responsive Concept Paper;
- The Applicant and proposed Project Team members meet the eligibility requirements in Section III.A - III.D of the FOA;
- The Full Application complies with the content and form requirements in Section IV.D of the FOA; and
- The Applicant entered all required information, successfully uploaded all required documents, and clicked the “Submit” button in ARPA-E eXCHANGE by the deadline stated in the FOA.

ARPA-E will not review or consider noncompliant Full Applications, including Full Applications submitted through other means, Full Applications submitted after the applicable deadline, and incomplete Full Applications. A Full Application is incomplete if it does not include required information and documents, such as such as the award category (see Section II.A of the FOA) or Forms SF-424 and 424A. ARPA-E will not extend the submission deadline for Applicants that fail to submit required information and documents due to server/connection congestion.

Replies to Reviewer Comments are deemed compliant if:

- The Applicant successfully uploaded all required documents to ARPA-E eXCHANGE by the deadline stated in the FOA.

ARPA-E will not review or consider noncompliant Replies to Reviewer Comments, including Replies submitted through other means and Replies submitted after the applicable deadline. ARPA-E will not extend the submission deadline for Applicants that fail to submit required information due to server/connection congestion. ARPA-E will review and consider each compliant and responsive Full Application, even if no Reply is submitted or if the Reply is found to be noncompliant.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).



## **2. RESPONSIVENESS CRITERIA**

ARPA-E performs a preliminary technical review of Concept Papers and Full Applications. Any “Applications Specifically Not of Interest,” as described in Section I.H of the FOA, are deemed nonresponsive and are not reviewed or considered.

## **3. LIMITATION ON NUMBER OF APPLICATIONS**

ARPA-E is not limiting the number of applications that may be submitted by Applicants. Applicants may submit more than one application to this FOA, provided that each application is scientifically distinct.

However, small businesses that qualify as a “Small Business Concern” may apply to only one of the two ARPA-E *MOSAIC* FOAs: ARPA-E FOA DE-FOA-0001256 (SBIR/STTR), Micro-Scale Optimized Solar-Cell Arrays With Integrated Concentration (MOSAIC), or ARPA-E FOA DE-FOA-0001255, Micro-Scale Optimized Solar-Cell Arrays With Integrated Concentration (MOSAIC). Small businesses that qualify as “Small Business Concerns” are strongly encouraged to apply under the former (SBIR/STTR FOA). To determine eligibility as a “Small Business Concern” under DE-FOA-0001256, please review the eligibility requirements in Sections III.A-III.D above.

## **IV. APPLICATION AND SUBMISSION INFORMATION**

### **A. APPLICATION PROCESS OVERVIEW**

#### **1. REGISTRATION IN SBA COMPANY REGISTRY**

The first step in applying to this FOA is registering in the U.S. Small Business Administration (SBA) Company Registry (<http://sbir.gov/registration>). Upon completing registration, Applicants will receive a unique small business Control ID and Registration Certificate in Adobe PDF format, which may be used at any participating SBIR and STTR agencies. Applicants that have previously registered in the SBA Company Registry need not register again.

Applicants that are sole proprietors and do not have an Employer Identification Number may use social security numbers for purposes of registering in the SBA Company Registry. Applicants that not possess a Dun and Bradstreet Data Universal Numbering System (DUNS) number may also use their social security number in the SBA Company Registry. Applicants selected for award negotiations will be required to obtain a DUNS number (See Section VI.B.1 of the FOA).

Applicants must submit their Registration Certificate in ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov>) as part of their Full Application (see Section IV.D of the FOA).

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

## **2. REGISTRATION IN ARPA-E eXCHANGE**

Prior to submitting any application materials to ARPA-E, Applicants must register in ARPA-E eXCHANGE, ARPA-E's online application portal. For detailed guidance on using ARPA-E eXCHANGE, please refer to Section IV.H.1 of the FOA and the "ARPA-E eXCHANGE User Guide" (<https://arpa-e-foa.energy.gov/Manuals.aspx>).

## **3. CONCEPT PAPERS**

Applicants must submit a Concept Paper by the deadline stated in the FOA. Section IV.C of the FOA provides instructions on submitting a Concept Paper.

ARPA-E performs a preliminary review of Concept Papers to determine whether they are compliant and responsive, as described in Section III.F of the FOA. ARPA-E makes an independent assessment of each compliant and responsive Concept Paper based on the criteria in Section V.A.1 of the FOA.

ARPA-E will encourage a subset of Applicants to submit Full Applications. Other Applicants will be discouraged from submitting a Full Application in order to save them the time and expense of preparing an application that is unlikely to be selected for award negotiations. By discouraging the submission of a Full Application, ARPA-E intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. Unsuccessful Applicants should continue to submit innovative ideas and concepts to future FOAs.

## **4. FULL APPLICATIONS**

Applicants must submit a Full Application by the deadline stated in the FOA. Applicants will have approximately 30 days from receipt of the Encourage/Discourage notification to prepare and submit a Full Application. Section IV.D of the FOA provides instructions on submitting a Full Application.

ARPA-E performs a preliminary review of Full Applications to determine whether they are compliant and responsive, as described in Section III.F of the FOA. ARPA-E reviews only compliant and responsive Full Applications.

## **5. REPLY TO REVIEWER COMMENTS**

Once ARPA-E has completed its review of Full Applications, reviewer comments on compliant and responsive Full Applications are made available to Applicants via ARPA-E eXCHANGE. Applicants may submit an optional Reply to Reviewer Comments, which must be submitted by

*Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).*

the deadline stated in the FOA. Section IV.E of the FOA provides instructions on submitting a Reply to Reviewer Comments.

ARPA-E performs a preliminary review of Replies to determine whether they are compliant, as described in Section III.F.1 of the FOA. ARPA-E will review and consider compliant Replies only. ARPA-E will review and consider each compliant and responsive Full Application, even if no Reply is submitted or if the Reply is found to be non-compliant.

## **6. PRE-SELECTION CLARIFICATIONS AND “DOWN-SELECT” PROCESS**

Once ARPA-E completes its review of Full Applications and Replies to Reviewer Comments, it may, at the Contracting Officer’s discretion, conduct a pre-selection clarification process and/or perform a “down-select” of Full Applications. Through the pre-selection clarification process or down-select process, ARPA-E may obtain additional information from select Applicants through pre-selection meetings, webinars, videoconferences, conference calls, or site visits that can be used to make a final selection determination. ARPA-E will not reimburse Applicants for travel and other expenses relating to pre-selection meetings and site visits, nor will these costs be eligible for reimbursement as pre-award costs.

ARPA-E may select applications for funding and make awards without pre-selection meetings and site visits. Participation in a pre-selection meeting or site visit with ARPA-E does not signify that Applicants have been selected for award negotiations.

## **7. SELECTION FOR AWARD NEGOTIATIONS**

ARPA-E carefully considers all of the information obtained through the application process and makes an independent assessment of each compliant and responsive Full Application based on the criteria and program policy factors in Sections V.A.2 and V.B.1 of the FOA. The Selection Official may select or not select a Full Application for award negotiations. The Selection Official may also postpone a final selection determination on one or more Full Applications until a later date, subject to availability of funds and other factors. ARPA-E will enter into award negotiations only with selected Applicants.

Applicants are promptly notified of ARPA-E’s selection determination. ARPA-E may stagger its selection determinations. As a result, some Applicants may receive their notification letter in advance of other Applicants. Please refer to Section VI.A of the FOA for guidance on award notifications.

## **8. MANDATORY WEBINAR**

All selected Applicants, including the Principal Investigator and the financial manager for the project, are required to participate in a webinar that is held within approximately one week of

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Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

the selection notification. During the webinar, ARPA-E officials present important information on the award negotiation process, including deadlines for the completion of certain actions.

## **B. APPLICATION FORMS**

Required forms for Full Applications are available on ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov>), including the SF-424, Budget Justification Workbook/SF-424A, and Business Assurances & Disclosures Form. A sample response to the Business Assurances & Disclosures Form and a sample Summary Slide are also available on ARPA-E eXCHANGE. Applicants are strongly encouraged to use the templates available on ARPA-E eXCHANGE, including the template for the Concept Paper, the template for the Technical Volume of the Full Application, the template for the Summary Slide, the template for the Summary for Public Release, and the template for the Reply to Reviewer Comments.

## **C. CONTENT AND FORM OF CONCEPT PAPERS**

**The Concept Paper is mandatory** (i.e. in order to submit a Full Application, a compliant and responsive Concept Paper and Summary Slide must have been submitted) and must conform to the following formatting requirements:

- The Concept Paper must not exceed 4 pages in length including graphics, figures, and/or tables.
- The Summary Slide may not exceed 1 page in length.
- The Concept Paper must be submitted in Adobe PDF format.
- The Summary Slide must be submitted in Microsoft PowerPoint format.
- The Concept Paper and Summary Slide must be written in English.
- All pages must be formatted to fit on 8-1/2 by 11 inch paper with margins not less than one inch on every side. Single space all text and use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures and tables).
- The ARPA-E assigned Control Number, Award Category (See Section II.A of the FOA), the Lead Organization Name, and the Principal Investigator's Last Name must be prominently displayed on the upper right corner of the header of every page. Page numbers must be included in the footer of every page.

ARPA-E will not review or consider noncompliant and/or nonresponsive Concept Papers (see Section III.F of the FOA).

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

Each Concept Paper should be limited to a single concept or technology. Unrelated concepts and technologies should not be consolidated into a single Concept Paper.

A fillable Concept Paper template is available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>.

Concept Papers must conform to the content requirements described below. If Applicants exceed the maximum page length indicated above, ARPA-E will review only the authorized number of pages and disregard any additional pages:

**1. CONCEPT PAPER**

**a. CONCEPT SUMMARY**

- Describe the proposed concept with minimal jargon, and explain how it addresses the Program Objectives of the FOA.

**b. INNOVATION AND IMPACT**

- Clearly identify the problem to be solved with the proposed technology concept.
- Describe how the proposed effort represents an innovative and potentially transformational solution to the technical challenges posed by the FOA.
- Explain the concept's potential to be disruptive compared to existing or emerging technologies.
- To the extent possible, provide quantitative metrics in a table that compares the proposed technology concept to current and emerging technologies and to the technical performance targets in Section I.F of the FOA for the appropriate Technology Category in Section I.E of the FOA.

**c. PROPOSED WORK**

- Describe the final deliverable(s) for the project and the overall technical approach used to achieve project objectives.
- Discuss alternative approaches considered, if any, and why the proposed approach is most appropriate for the project objectives.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- Describe the background, theory, simulation, modeling, experimental data, or other sound engineering and scientific practices or principles that support the proposed approach. Provide specific examples of supporting data and/or appropriate citations to the scientific and technical literature.
- Describe why the proposed effort is a significant technical challenge and the key technical risks to the project. Does the approach require one or more entirely new technical developments to succeed? How will technical risk be mitigated?
- Identify techno-economic challenges to be overcome for the proposed technology to be commercially relevant.

**d. TEAM ORGANIZATION AND CAPABILITIES**

- Indicate the roles and responsibilities of the organizations and key personnel that comprise the Project Team.
- Provide the percentage of effort that will be contributed by the Lead Organization.
- Provide the name, position, and institution of each key team member and describe in 1-2 sentences the skills and experience that he/she brings to the team.
- Identify key capabilities provided by the organizations comprising the Project Team and how those key capabilities will be used in the proposed effort.
- Identify (if applicable) previous collaborative efforts among team members relevant to the proposed effort.

**2. SECOND COMPONENT: SUMMARY SLIDE**

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. This slide will be used during ARPA-E's evaluation of Concept Papers. A summary slide template and a sample summary slide are available on ARPA-E eXCHANGE (<https://arpaefoa.energy.gov>). Summary Slides must conform to the content requirements described below:

- Project Title;
- Lead Organization, Principal Investigator, and key personnel names;
- ARPA-E Assigned Control Number;
- Technical Category;
- Estimated Total Project Cost;
- Technology Summary and Impact;

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- Bullet points that describe novel aspects of the technology, approach, and impact on the MOSAIC Program goals;
- Proposed Goals;
  - Including any important technical performance metrics;
  - Including quantitative description of the state of the art; and
  - Including quantitative descriptions of the proposed targets;
- Any key graphics (e.g., illustrations, charts and/or tables that summarize the technology, key innovations, and planned approach).

### 3. ADDITIONAL INSTRUCTIONS

- Applicants may propose a single hybrid direct/diffuse harvesting solution that may achieve the goals of Categories 1 and 2 simultaneously. However, ARPA-E does not anticipate that such hybrids will be competitive for Category 1 alone as hybridization complicates the design of potential solutions that should prioritize direct radiation.
- Category 3 submissions should be presented in the context of a notional full system to represent at least one of the system-level sub-categories described in Section I.E of the FOA. Also, to aid in evaluation of a proposed seedling idea, its ability to fit within full solutions should be articulated. For example, in the areas mentioned in Section I.E of the FOA, the range of potential cell sizes and pitch should be presented, as well as how cost will be impacted.

### D. CONTENT AND FORM OF FULL APPLICATIONS

~~[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]~~

Full Applications must conform to the following requirements:

- Each document must be submitted in the file format prescribed below.
- All Full Applications must be written in English.
- All pages must be formatted to fit on 8-1/2 by 11 inch paper with margins not less than one inch on every side. Single space all text and use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures and tables).
- The ARPA-E assigned Control Number, the Lead Organization Name, and the Principal Investigator's Last Name must be prominently displayed on the upper right corner of the header of every page. Page numbers must be included in the footer of every page.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

ARPA-E will not review or consider noncompliant and/or nonresponsive Full Applications (see Section III.E of the FOA).

Each Full Application should be limited to a single concept or technology. Unrelated concepts and technologies should not be consolidated in a single Full Application.

Fillable Full Application template documents are available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>.

Full Applications must conform to the content requirements described below.

Component	Required Format	Description and Information
Technical Volume	PDF	The centerpiece of the Full Application. Provides a detailed description of the proposed R&D project and Project Team. A Technical Volume template is available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ).
SF-424	PDF	Application for Federal Assistance ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ). Applicants are responsible for ensuring that the proposed costs listed in eXCHANGE match those listed on forms SF-424 and SF-424A. Inconsistent submissions may impact ARPA-E's final award determination.
Budget Justification Workbook/SF-424A	XLS	Budget Information – Non-Construction Programs ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> )
Summary for Public Release	PDF	Short summary of the proposed R&D project. Intended for public release. A Summary for Public Release template is available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ).
Summary Slide	PPT	A four-panel project slide summarizing different aspects of the proposed R&D project. A Summary Slide template is available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ).
SBA Company Registration Certificate	PDF	Registration Certificate generated upon completion of registration in the SBA Company Registry ( <a href="http://sbir.gov/registration">http://sbir.gov/registration</a> ).
Certification for Applicants Majority-Owned by Multiple Venture Capital Operating Companies, Hedge Funds, or Private Equity Firms	PDF	Requires SBIR Applicants that are majority-owned by multiple venture capital operating companies, hedge funds, or private equity firms to self-identify and verify registration as such in the SBA Company Registry ( <a href="http://sbir.gov/registration">http://sbir.gov/registration</a> ).

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
 Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).



<b>Business Assurances &amp; Disclosures Form</b>	PDF	Requires the Applicant to acknowledge eligibility with SBIR/STTR program requirements, make responsibility disclosures, disclose potential conflicts of interest within the Project Team, and provide written assurance of its cost share commitment. Requires the Applicant to describe the additionality and risks associated with the proposed project, disclose applications for funding currently pending with Federal and non-Federal entities, and disclose funding from Federal and non-Federal entities for work in the same technology area as the proposed R&D project. If the Applicant is a FFRDC, requires the Applicant to provide written authorization from the cognizant Federal agency and, if a DOE/NNSA FFRDC, a Field Work Proposal. Allows the Applicant to request a waiver or modification of the Performance of Work in the United States requirement and/or the Technology Transfer & Outreach (TT&O) spending requirement. This form is available on ARPA-E eXCHANGE at <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> . A sample response to the Business Assurances & Disclosures Form is also available on ARPA-E eXCHANGE.
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ARPA-E provides detailed guidance on the content and form of each component below.

## 1. FIRST COMPONENT: TECHNICAL VOLUME

The Technical Volume must be submitted in Adobe PDF format. A Technical Volume template is available at <https://arpa-e-foa.energy.gov>. The Technical Volume must conform to the following content and form requirements, including maximum page lengths specified below. If Applicants exceed the maximum page lengths specified for each section indicated below, ARPA-E will review only the authorized number of pages and disregard any additional pages.

Applicants must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical Volume. ARPA-E and reviewers may review primary research literature in order to evaluate applications. However, ARPA-E and reviewers are under no obligation to review cited sources (e.g., Internet websites).

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

<b>PAGE LIMIT</b>	<b>SECTION</b>	<b>DESCRIPTION</b>
1 page max.	<b>EXECUTIVE SUMMARY</b>	<p>Summarize the objective(s) and technical approach of the proposed effort at a technical level appropriate for scientific and engineering peers.</p> <p><b>INSTRUCTIONS:</b></p> <ol style="list-style-type: none"> <li>(1) The Project Title should be brief and descriptive of the proposed technology.</li> <li>(2) Identify the most relevant Technical Category for the proposed technology from the “Technical Categories of Interest” in Section I.E of the FOA. Select only one Technical Category unless the FOA specifically allows applications to name multiple categories.</li> <li>(3) Enter the estimated Total Project Cost in U.S. dollars and percentage cost share in parentheses.</li> <li>(4) Enter the Project Duration in months.</li> <li>(5) The Executive Summary shall not exceed 1 page in length</li> <li>(6) The Executive Summary may contain graphics, figures, or tables as needed to summarize the technical concept.</li> </ol>
Sections 1-5 30 pages max.	<b>Section 1 INNOVATION AND IMPACT</b>	<p>Describe how the proposed work offers an innovative approach to achieve the program objectives of the FOA and how it will impact the mission areas of ARPA-E.</p> <p><b>1.1 Overall Description.</b></p> <ul style="list-style-type: none"> <li>• Describe the conceptual basis for the project and how the proposed technology works with minimal jargon.</li> <li>• Explain the objective(s) and performance characteristics of the proposed effort.</li> </ul> <p><b>1.2 Potential Impact.</b></p> <ul style="list-style-type: none"> <li>• Clearly identify the problem that is being solved with the proposed technology.</li> <li>• Describe how the proposed effort addresses one (or more) of the “Technical Categories of Interest” from Section I.E of the FOA.</li> <li>• Explain the project’s potential to be disruptive relative to the existing technology or how the project establishes a basis for new innovations.</li> </ul> <p><b>1.3 Innovativeness.</b></p> <ul style="list-style-type: none"> <li>• Describe how the proposed effort represents a new and innovative solution to the overall program challenge described in the FOA.</li> <li>• Indicate the technical goals and anticipated results, using appropriate metrics, for the project. Provide a description of how the metrics were derived, citing key previous results and/or assumptions.</li> <li>• Include and discuss, as appropriate, a table in which the targeted performance of the proposed technology is compared with the “Technical Performance Targets” in Section I.F of the FOA and with other competing or emerging technologies that might achieve the</li> </ul>

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
 Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

		<p style="text-align: center;"><b>FOA Technical Performance Targets.</b></p> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Innovation and Impact Section may include figures, tables, and graphics.</p> <p>(2) The suggested length of the Innovation and Impact Section is 4 pages.</p>
	<p><b>Section 2 PROPOSED WORK</b></p>	<p>Describe and discuss for the proposed effort the technical background and approach, the R&amp;D tasks, and the key technical risks. This Section should justify the proposed approach as being appropriate to achieve the project's objective(s).</p> <p><b>2.1 Approach.</b></p> <ul style="list-style-type: none"> <li>• Describe the technical approach and how this approach will achieve the proposed project objective(s).</li> <li>• Discuss alternative approaches considered, if any, and why the selected approach is most appropriate for the identified objective(s).</li> <li>• Describe the background, theory, simulation, modeling, experimental data, or other sound engineering and scientific practices or principles that support achieving the project objective(s). Provide specific examples of supporting data and/or appropriate citations to the scientific and technical literature.</li> <li>• Provide the following based on <b>new FOA Section I.G:</b> <ul style="list-style-type: none"> <li>○ All Full Applications <b>must</b> provide a system schematic that accounts for energy losses at various stages similar to Figure 5 in Section I.G of the FOA.</li> <li>○ All Full Applications <b>must</b> provide a table and supporting calculations that quantify the module efficiency and other component efficiencies similar to Table I.G.1. in Section I.G of the FOA, based on the relevant DNI percentage as described in Section I.G of the FOA.</li> <li>○ All Full Applications <b>must</b> provide a table for cost modeling similar to Table I.G.2 in Section I.G of the FOA, along with supporting calculations and assumptions.</li> </ul> </li> </ul> <p><b>2.2 Technical Risk.</b></p> <ul style="list-style-type: none"> <li>• Identify potential technical issues and risks, e.g., the approach requires a never-before-demonstrated fabrication technique or greater-than-previously-demonstrated sub-component performance, etc.</li> <li>• Describe appropriate mitigation techniques and plans, if any, for each identified issue and risk.</li> </ul> <p><b>2.3 Schedule.</b></p> <ul style="list-style-type: none"> <li>• Provide a schedule for the proposed effort by major tasks, including major milestones or Go/No-Go decision points as appropriate. (<b>A Gantt chart is recommended.</b>)</li> </ul>

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
 Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

		<p><b>2.4 Task Descriptions.</b></p> <ul style="list-style-type: none"> <li>Identify and provide a full technical description for each main task in the proposed effort.</li> <li>Discuss the reason the identified tasks are appropriate and sufficient for the identified approach.</li> <li>Describe the key technical milestones and how these define the critical path for successful completion of the task.</li> <li>Indicate how completion of each task relates to reducing technological uncertainty and achieving the overall project objective(s).</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Proposed Work Section may include figures, tables, and graphics.  (2) The suggested length of the Proposed Work Section is 12 pages.</p>
	<p><b>Section 3 TEAM ORGANIZATION AND CAPABILITIES</b></p>	<p>Describe and discuss the, organization, capabilities, and management of the team and how these enable successful execution of the proposed effort.</p> <p><b>3.1 Organization.</b></p> <ul style="list-style-type: none"> <li>Indicate roles and responsibilities of the organizations on the proposed Project Team, e.g., subrecipient, consultant, subcontractor, or lead organization for each of the project tasks. Include relevant organization charts and teaming organization charts, as applicable.</li> <li>Identify Key Personnel, describe how their qualifications relate to the proposed effort, and indicate their roles and responsibilities for each of the project tasks.</li> <li>Identify previous collaborative efforts among team members if relevant to the proposed effort.</li> </ul> <p><b>3.2 Capabilities, Facilities, Equipment, and Information.</b></p> <ul style="list-style-type: none"> <li>Identify capabilities of the Applicant or proposed Project Team, e.g., relevant experience, previous or current R&amp;D efforts, or related government or commercial projects, that support the proposed effort.</li> <li>Identify all required facilities, equipment, and information for the proposed effort and discuss their adequacy and availability.</li> <li>Indicate any key equipment that must be fabricated or purchased.</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) This Section may include figures, tables, and graphics.  (2) The suggested length of the Team Section is 4 pages.</p>
	<p><b>Section 4 TECHNOLOGY TO MARKET</b></p>	<p>The significant impact sought by ARPA-E depends upon successful projects finding a path to large-scale adoption. ARPA-E projects are not required to achieve commercial deployment by the end of the project period, but the agency asks the applicant to define a reasonable path for the proposed technology toward commercial adoption.</p>

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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		<p><b>4.1 Technology to Market Strategy.</b></p> <ul style="list-style-type: none"> <li>Describe how the proposed technology is expected to transition from the lab to commercial deployment, including a description of the eventual product, potential near- and long-term market entries, likely commercialization approach (startup, license, etc.), specific organizations expected to be involved in the transition (partners, customers, etc.), and the commercialization timeline.</li> <li>Discuss manufacturing, cost, and scalability risks associated with the technology.</li> <li>Describe anticipated resource needs for the next phase of development following the end of the ARPA-E project.</li> <li>Explain why the proposed research is not being pursued by industry today.</li> <li>Discuss the anticipated roles for the proposed research team in the commercialization of the technology.</li> </ul> <p><b>4.2 Intellectual Property.</b></p> <ul style="list-style-type: none"> <li>Describe existing intellectual property, if any, that will be used to develop the new intellectual property; and</li> <li>Discuss new intellectual property and data that is anticipated to be created as part of this effort, if any.</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Technology to Market Section may include figures, tables, and graphics.</p> <p>(2) The suggested length of the Technology to Market Section is 4 pages.</p>																																										
	<p><b>Section 5 BUDGET</b></p>	<p>Indicate the budget, in US dollars, and provide a high-level budget summary, demonstrating that the budget is reasonable and appropriate for the proposed effort.</p> <p><b>5.1 Budget Breakdown.</b></p> <p>Provide in tabular form following the template give below, a breakdown of the project budget by entity and major task in US dollars.</p> <table border="1" data-bbox="623 1541 1495 1793"> <thead> <tr> <th>Task Name</th> <th>[Prime]</th> <th>[Sub #1]</th> <th>[Sub #2]</th> <th>[Sub #3]</th> <th>[Sub #4]</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>[Task #1]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>[Task #2]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>[Task #3]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>[Task #4]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><b>Total</b></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table> <p>Replace “Prime” with name of the primary (lead) entity and “Sub #n” with the name of the sub-recipient or sub-contractor entities, if applicable. Task</p>	Task Name	[Prime]	[Sub #1]	[Sub #2]	[Sub #3]	[Sub #4]	Total	[Task #1]							[Task #2]							[Task #3]							[Task #4]							<b>Total</b>						
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		<p>names should clearly correspond to major tasks listed in Section 2.4. Expand or contract the table as needed to add/subtract entities (columns) or tasks (rows).</p> <p><b>5.2 Budget Summary.</b></p> <p>Provide a high-level summary for the project by major budget category, including at least these three:</p> <ul style="list-style-type: none"> <li>• Key Personnel and technical staff to be utilized (e.g., scientists, engineers, technicians, postdocs, graduate students, etc.)</li> <li>• Equipment</li> <li>• Materials and Supplies</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Budget Section may include figures, tables, and graphics.  (2) The suggested length of the Budget Section is 4 pages.</p>
<p><b>No page limit</b></p>	<p><b>REFERENCES</b></p>	<p>Provide a list of references appropriate to Sections 1-5.</p> <p><b>INSTRUCTIONS:</b></p> <p>(1) Only bibliographic information may be contained in the references. No additional text or commentary is allowed.  (2) There is no page limit for the Bibliographic References Section, which is outside of the overall 30-page limit for Sections 1-5.</p>
<p><b>Each PQS limited to 3 pages in length, no cumulative page limit</b></p>	<p><b>PERSONAL QUALIFICATION SUMMARIES</b></p>	<p>A Personal Qualification Summary (PQS) is required for the PI and all other Key Personnel. Each PQS must include a description of the following only:</p> <ul style="list-style-type: none"> <li>• Education and training</li> <li>• Employment history</li> <li>• Awards and honors</li> <li>• A list of no more than 10 peer-reviewed publications related to the proposed project</li> <li>• A list of no more than 10 other peer-reviewed publications demonstrating capabilities in the broad field</li> <li>• A list of no more than 10 non-peer-reviewed publications and patents demonstrating capabilities in the broad field</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) Each Personal Qualification Summary is limited to 3 pages in length and there is no page limit for this Section, which is outside of the 30-page limit for Sections 1-5.  (2) Curriculum Vitae should not be submitted.</p>

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

## **2. SECOND COMPONENT: SF-424**

The SF-424 must be submitted in Adobe PDF format. This form is available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>.

The SF-424 includes instructions for completing the form. Applicants are required to complete all required fields in accordance with the instructions.

Prime Recipients and Subrecipients are required to complete SF-LLL (Disclosure of Lobbying Activities), available at <http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf>, if any non-Federal funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with your application or funding agreement. The completed SF-LLL must be appended to the SF-424.

ARPA-E provides the following supplemental guidance on completing the SF-424:

- Each Project Team should submit only one SF-424 (i.e., a Subrecipient should not submit a separate SF-424).
- Assume a project start date of October 2015, or as negotiated.
- The list of certifications and assurances in Block 21 can be found at <http://energy.gov/management/downloads/certifications-and-assurances-use-sf-424>.
- The dates and dollar amounts on the SF-424 are for the entire project period (from the project start date to the project end date), not a portion thereof.
- Applicants are responsible for ensuring that the proposed costs listed in eXCHANGE match those listed on forms SF-424 and SF-424A. Inconsistent submissions may impact ARPA-E's final award determination.

## **3. THIRD COMPONENT: BUDGET JUSTIFICATION WORKBOOK/SF-424A**

Applicants are required to complete the Budget Justification Workbook/SF-424A Excel spreadsheet. This form is available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>. Prime Recipients must complete each tab of the Budget Justification Workbook for the project as a whole, including all work to be performed by the Prime Recipient and its Subrecipients and Contractors, and provide all requested documentation (e.g., a Federally-approved forward pricing rate agreement, Defense Contract Audit Agency or Government Audits and Reports, if available). The SF-424A form included with the Budget Justification Workbook will "auto-

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

populate” as the Applicant enters information into the Workbook. Applicants should carefully read the “Instructions and Summary” tab provided within the Budget Justification Workbook.

Subrecipient information must be submitted as follows:

- Each Subrecipient incurring greater than or equal to 10% of the Total Project Cost must complete a separate Budget Justification workbook to justify its proposed budget. These worksheets must be inserted as additional sheets within in the Prime Recipient’s Budget Justification.
- Subrecipients incurring less than 10% of the Total Project Cost are not required to complete a separate Budget Justification workbook. However, such Subrecipients are required to provide supporting documentation to justify their proposed budgets. At a minimum, the supporting documentation must show which tasks/subtasks are being performed, the purpose/need for the effort, and a sufficient basis for the estimated costs.

ARPA-E provides the following supplemental guidance on completing the Budget Justification Workbook/SF-424A:

- Applicants may request funds under the appropriate object class category tabs as long as the item and amount requested are necessary to perform the proposed work, meet all the criteria for allowability under the applicable Federal cost principles, and are not prohibited by the funding restrictions described herein.
- If Patent costs are requested, they must be included in the Applicant’s proposed budget (see Section IV.G.3 of the FOA for more information on Patent Costs).
- For pricing purposes, assume a project start date of October 2015, or as negotiated.
- For more information, please refer to the ARPA-E Budget Justification Guidance document at <https://arpa-e-foa.energy.gov>.

#### **4. FOURTH COMPONENT: SUMMARY FOR PUBLIC RELEASE**

Applicants are required to provide a 250 word max. Summary for Public Release. A Summary for Public Release template is available on ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov>). The Summary for Public Release must be submitted in Adobe PDF format. This summary should not include any confidential, proprietary, or privileged information. The summary should be written for a lay audience (e.g., general public, media, Congress) using plain English.

<b>250 Words</b>	<b>SUMMARY FOR PUBLIC</b>	Briefly describe the proposed effort, summarize its objective(s) and technical approach, describe its ability to achieve the “Program Objectives” (see Section
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Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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	<b>RELEASE</b>	I.D of the FOA), and indicate its potential impact on “ARPA-E Mission Areas” (see Section I.A of the FOA). The summary should be written at technical level suitable for a high-school science student and is designed for public release.  <b>INSTRUCTIONS:</b> (1) The Summary for Public Release shall not exceed 250 words and one paragraph. (2) The Summary for Public Release shall consist only of text—no graphics, figures, or tables. (3) For applications selected for award negotiations, the Summary may be used as the basis for a public announcement by ARPA-E; therefore, <b>this Cover Page and Summary should not contain confidential or proprietary information</b> . See Section VIII.E of the FOA for additional information on marking confidential information
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## 5. FIFTH COMPONENT: SUMMARY SLIDE

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. The slide must be submitted in Microsoft PowerPoint format. This slide will be used during ARPA-E’s evaluation of Full Applications. A summary slide template and a sample summary slide are available on ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov>). Summary Slides must conform to the content requirements described below:

- A Technology Summary;
  - Bullet points that describe novel aspects of the proposed technology and technology approach;
- A description of the technology’s impact;
  - Quantitative description (through text or graphic) of the impact the proposed project will provide to the market and ARPA-E mission areas;
- Proposed Targets;
  - Including any important technical performance metrics and/or impact categories;
  - Including quantitative description of the state of the art;
  - Including quantitative descriptions of the proposed targets;
- Any key graphics (illustrations, charts and/or tables) summarizing technology development and/or impact;
- The project’s key idea/takeaway;
- Project title and Principal Investigator information; and
- Requested ARPA-E funds and proposed applicant cost share.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

## **6. SIXTH COMPONENT: SBA REGISTRATION CERTIFICATE**

Applicants are required to provide a copy of the SBA Registration Certificate generated in the SBA Company Registry (<http://sbir.gov/registration>) in Adobe PDF format (see Section IV.A.1 of the FOA). Applicants that have previously registered in the SBA Company Registry may submit a copy their existing Registration Certificate.

## **7. SEVENTH COMPONENT: CERTIFICATION FOR APPLICANTS MAJORITY-OWNED BY MULTIPLE VENTURE CAPITAL OPERATING COMPANIES, HEDGE FUNDS, AND PRIVATE EQUITY FIRMS**

Applicants that are majority-owned by multiple venture capital operating companies, hedge funds, or private equity firms are required to complete the Certification for Applicants Majority-Owned by Multiple Venture Capital Operating Companies, Hedge Funds, and Private Equity Funds. The certification must be submitted in Adobe PDF format. This form is available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>.

In the Certification for Applicants Majority-Owned by Multiple Venture Capital Operating Companies, Hedge Funds, and Private Equity Funds, the Applicant is required to self-identify as an entity that falls into one of those categories, verify its ownership status, and verify that it has registered in the SBA Company Registry (<http://sbir.gov/registration>) as such an entity.

Applicants that are not majority-owned by multiple venture capital operating companies, hedge funds, or private equity firms are not required to complete this certification.

## **8. EIGHTH COMPONENT: BUSINESS ASSURANCES & DISCLOSURES FORM**

Applicants are required to complete a Business Assurances & Disclosures Form. The form must be submitted in Adobe PDF format. This form is available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>. A sample response to the Business Assurances & Disclosures Form is also available on ARPA-E eXCHANGE.

In the Business Assurances & Disclosures Form, the Applicant is required to:

- Acknowledge that it has reviewed SBA's eligibility requirements for the SBIR and STTR programs and that it anticipates that it will be able to certify eligibility to participate in ARPA-E's SBIR/STTR program at the time of award;
- Disclose conditions bearing on responsibility, such as criminal convictions and Federal tax liability;
- Disclose potential conflicts of interest within the Project Team;

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- If the Applicant is a FFRDC, submit written authorization from the cognizant Federal agency; and
- If the Applicant is a DOE/NNSA FFRDC, submit a Field Work Proposal.

In addition, ARPA-E is required by statute to “accelerat[e] transformational technological advances in areas that industry is by itself not likely to undertake because of technical and financial uncertainty.”<sup>26</sup> In accordance with ARPA-E’s statutory mandate, the Applicant is required to:

- Describe the additionality and risks associated with the proposed R&D project;
- Disclose any applications for the same project or related work currently pending with any Federal or non-Federal entities;
- Disclose all funding for work in the same technology area as the proposed project received from any Federal or non-Federal entity within the last 5 years; and
- Finally, the Applicant may use the Business Assurances & Disclosures Form to request authorization to perform some work overseas.

## **E. CONTENT AND FORM OF REPLIES TO REVIEWER COMMENTS**

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

Written feedback on Full Applications is made available to Applicants before the submission deadline for Replies to Reviewer Comments. Applicants have a brief opportunity to prepare a short Reply to Reviewer Comments responding to one or more comments or supplementing their Full Application. A fillable Reply to Reviewer Comments template is available on ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov>).

Replies to Reviewer Comments must conform to the following requirements:

- The Reply to Reviewer Comments must be submitted in Adobe PDF format.
- The Reply to Reviewer Comments must be written in English.

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<sup>26</sup> America COMPETES Act, Pub. L. No. 110-69, § 5012 (2007), as amended (codified at 42 U.S.C. § 16538).

- All pages must be formatted to fit on 8-1/2 by 11 inch paper with margins not less than one inch on every side. Use Times New Roman typeface, a black font color, and a font size of 12 points or larger (except in figures and tables).
- The Control Number must be prominently displayed on the upper right corner of the header of every page. Page numbers must be included in the footer of every page.

ARPA-E will not review or consider noncompliant Replies to Reviewer Comments (see Section III.F.1 of the FOA). ARPA-E will review and consider each compliant and responsive Full Application, even if no Reply is submitted or if the Reply is found to be noncompliant.

Replies to Reviewer Comments must conform to the following content and form requirements, including maximum page lengths, described below. If a Reply to Reviewer Comments is more than three pages in length, ARPA-E will review only the first three pages and disregard any additional pages.

SECTION	PAGE LIMIT	DESCRIPTION
Text	2 pages maximum	<ul style="list-style-type: none"><li>• Applicants may respond to one or more reviewer comments or supplement their Full Application.</li></ul>
Images	1 page maximum	<ul style="list-style-type: none"><li>• Applicants may provide graphs, charts, or other data to respond to reviewer comments or supplement their Full Application.</li></ul>

## F. INTERGOVERNMENTAL REVIEW

This program is not subject to Executive Order 12372 (Intergovernmental Review of Federal Programs).

## G. FUNDING RESTRICTIONS

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

### 1. ALLOWABLE COSTS

All expenditures must be allowable, allocable, and reasonable in accordance with the applicable Federal cost principles. ARPA-E has listed the Federal cost principles for different categories of Applicants at <http://arpa-e.energy.gov/?q=arpa-e-site-page/post-award-guidance-sbir-sttr>.

### 2. PRE-AWARD COSTS

ARPA-E will not reimburse any pre-award costs incurred by Applicants before they are selected for award negotiations. Please refer to Section VI.A of the FOA for guidance on award notices.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A. Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

Upon selection for award negotiations, Applicants may incur pre-award costs at their own risk, consistent with the requirements in 2 C.F.R. Part 200, as modified by 2 C.F.R. Part 910, and other Federal laws and regulations. ARPA-E generally does not accept budgets as submitted with the Full Application. Budgets are typically reworked during award negotiations. ARPA-E is under no obligation to reimburse pre-award costs if, for any reason, the Applicant does not receive an award or the award is made for a lesser amount than the Applicant expected, or if the costs incurred are not allowable, allocable, or reasonable.

Given the uncertainty of award negotiations, it is strongly recommended that Prime Recipients and Subrecipients consult with the Contracting Officer ([ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov)) before incurring any pre-award costs.

Please refer to the “SBIR/STTR Applicants’ Guide to ARPA-E Award Negotiations” (<http://arpa-e.energy.gov/?q=arpa-e-site-page/pre-award-guidance-sbir-sttr>) for additional guidance on pre-award costs.

### **3. PATENT COSTS**

For Subject Inventions disclosed to DOE under an award, ARPA-E will reimburse the Prime Recipient – in addition to allowable costs associated with Subject Invention disclosures - up to \$30,000 of expenditures for filing and prosecution of United States patent applications, including international applications (“PCT application”) submitted to the USPTO.

The Prime Recipient may request a waiver of the \$30,000 cap which is subject to approval by the ARPA-E Program Director and Contracting Officer.

### **4. CONSTRUCTION**

ARPA-E generally does not fund projects that involve major construction. Recipients are required to obtain written authorization from the Contracting Officer before incurring any major construction costs.

### **5. FOREIGN TRAVEL**

ARPA-E generally does not fund projects that involve foreign travel. Recipients are required to obtain written authorization from the Contracting Officer before incurring any foreign travel costs and provide trip reports with their reimbursement requests.

## 6. PERFORMANCE OF WORK IN THE UNITED STATES

ARPA-E strongly encourages interdisciplinary and cross-sectoral collaboration spanning organizational boundaries. Such collaboration enables the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

ARPA-E requires all work under ARPA-E funding agreements to be performed in the United States – i.e., Prime Recipients must expend 100% of the Total Project Cost in the United States. However, Applicants may request a waiver of this requirement where their project would materially benefit from, or otherwise requires, certain work to be performed overseas.

Applicants seeking a waiver of this requirement are required to include an explicit request in the Business Assurances & Disclosures Form, which is part of the Full Application submitted to ARPA-E. Such waivers are granted where there is a demonstrated need, as determined by ARPA-E.

## 7. PURCHASE OF NEW EQUIPMENT

All new equipment purchased under ARPA-E funding agreements must be made or manufactured in the United States, to the maximum extent practicable. This requirement does not apply to used or leased equipment. Project Teams may purchase foreign-made equipment where comparable domestic equipment is not reasonably available.

## 8. LOBBYING

Prime Recipients and Subrecipients may not use any Federal funds to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters.<sup>27</sup>

Prime Recipients and Subrecipients are required to complete and submit SF-LLL, “Disclosure of Lobbying Activities” (<http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf>) if any non-Federal funds have been paid or will be paid to any person for influencing or attempting to influence any of the following in connection with your application:

1. An officer or employee of any Federal agency,
2. A Member of Congress,
3. An officer or employee of Congress, or

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<sup>27</sup> 18 U.S.C. § 1913.

4. An employee of a Member of Congress.

## 9. CONFERENCE SPENDING

Prime Recipients and Subrecipients may not use any Federal funds to:

- Defray the cost to the United States Government of a conference held by any Executive branch department, agency, board, commission, or office which is not directly and programmatically related to the purpose for which their ARPA-E award is made and for which the cost to the United States Government is more than \$20,000; or
- To circumvent the required notification by the head of any such Executive Branch department, agency, board, commission, or office to the Inspector General (or senior ethics official for any entity without an Inspector General), of the date, location, and number of employees attending such a conference.

## H. OTHER SUBMISSION REQUIREMENTS

### 1. USE OF ARPA-E eXCHANGE

To apply to this FOA, Applicants must register with ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov/Registration.aspx>). Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov/login.aspx>). ARPA-E will not review or consider applications submitted through other means (e.g., fax, hand delivery, email, postal mail). For detailed guidance on using ARPA-E eXCHANGE, please refer to the “ARPA-E eXCHANGE User Guide” (<https://arpa-e-foa.energy.gov/Manuals.aspx>).

Upon creating an application submission in ARPA-E eXCHANGE, Applicants will be assigned a Control Number. If the Applicant creates more than one application submission, a different Control Number will be assigned for each application.

Once logged in to ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov/login.aspx>), Applicants may access their submissions by clicking the “My Submissions” link in the navigation on the left side of the page. Every application that the Applicant has submitted to ARPA-E and the corresponding Control Number is displayed on that page. If the Applicant submits more than one application to a particular FOA, a different Control Number is shown for each application.

Applicants are responsible for meeting each submission deadline in ARPA-E eXCHANGE. **Applicants are strongly encouraged to submit their applications at least 48 hours in advance of the submission deadline.** Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), Applicants should allow at least 1 hour to submit a Concept Paper, or Full Application. In addition, Applicants should allow at least 15 minutes to submit a Reply to

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

Reviewer Comments. Once the application is submitted in ARPA-E eXCHANGE, Applicants may revise or update their application until the expiration of the applicable deadline.

**Applicants should not wait until the last minute to begin the submission process.** During the final hours before the submission deadline, Applicants may experience server/connection congestion that prevents them from completing the necessary steps in ARPA-E eXCHANGE to submit their applications. **ARPA-E will not extend the submission deadline for Applicants that fail to submit required information and documents due to server/connection congestion.**

**ARPA-E will not review or consider incomplete applications and applications received after the deadline stated in the FOA.** Such applications will be deemed noncompliant (see Section III.F.1 of the FOA). The following errors could cause an application to be deemed “incomplete” and thus noncompliant:

- Failing to comply with the form and content requirements in Section IV.C – IV.E of the FOA;
- Failing to enter required information in ARPA-E eXCHANGE;
- Failing to upload required document(s) to ARPA-E eXCHANGE;
- Failing to click the “Submit” button in ARPA-E eXCHANGE by the deadline stated in the FOA;
- Uploading the wrong document(s) or application(s) to ARPA-E eXCHANGE; and
- Uploading the same document twice, but labeling it as different documents. (In the latter scenario, the Applicant failed to submit a required document.)

ARPA-E urges Applicants to carefully review their applications and to allow sufficient time for the submission of required information and documents.

## **V. APPLICATION REVIEW INFORMATION**

### **A. CRITERIA**

ARPA-E performs a preliminary review of Concept Papers and Full Applications to determine whether they are compliant and responsive (see Section III.F of the FOA). ARPA-E also performs a preliminary review of Replies to Reviewer Comments to determine whether they are compliant.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).



ARPA-E considers a mix of quantitative and qualitative criteria in determining whether to encourage the submission of a Full Application and whether to select a Full Application for award negotiations.

## **1. CRITERIA FOR CONCEPT PAPERS**

(1) *Impact of the Proposed Technology Relative to FOA Targets (50%)* - This criterion involves consideration of the following factors:

- The extent to which the proposed quantitative material and/or technology metrics demonstrate the potential for a transformational and disruptive (not incremental) advancement compared to existing or emerging technologies;
- The extent to which the proposed concept is innovative and will achieve the technical performance targets defined in Section I.F of the FOA for the appropriate technology Category in Section I.E of the FOA; and
- The extent to which the Applicant demonstrates awareness of competing commercial and emerging technologies and identifies how the proposed concept/technology provides significant improvement over existing solutions.

(2) *Overall Scientific and Technical Merit (50%)* - This criterion involves consideration of the following factors:

- The feasibility of the proposed work, as justified by appropriate background, theory, simulation, modeling, experimental data, or other sound scientific and engineering practices;
- The extent to which the Applicant proposes a sound technical approach to accomplish the proposed R&D objectives, including why the proposed concept is more appropriate than alternative approaches and how technical risk will be mitigated;
- The extent to which project outcomes and final deliverables are clearly defined;
- The extent to which the Applicant identifies techno-economic challenges that must be overcome for the proposed technology to be commercially relevant; and
- The demonstrated capabilities of the individuals performing the project, the key capabilities of the organizations comprising the Project Team, the roles and responsibilities of each organization and (if applicable) previous collaborations among team members supporting the proposed project.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

Submissions will not be evaluated against each other since they are not submitted in accordance with a common work statement. The above criteria will be weighted as follows:

Impact of the Proposed Technology Relative to FOA Targets	50%
Overall Scientific and Technical Merit	50%

## 2. CRITERIA FOR FULL APPLICATIONS

~~[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]~~

Full Applications are evaluated based on the following criteria:

(1) *Impact of the Proposed Technology Relative to State of the Art* (30%) - This criterion involves consideration of the following factors:

- The extent to which the proposed quantitative material and/or technology metrics demonstrate the potential for a transformational and disruptive (not incremental) advancement in one or more energy-related fields;
- The extent to which the Applicant demonstrates a profound understanding of the current state-of-the-art and presents an innovative technical approach to significantly improve performance over the current state-of-the-art; and
- The extent to which the Applicant demonstrates awareness of competing commercial and emerging technologies and identifies how its proposed concept/technology provides significant improvement over these other solutions; and
- The extent to which the Applicant proposes a reasonable and effective strategy for transitioning the proposed technology from the laboratory to commercial deployment.

(2) *Overall Scientific and Technical Merit* (30%) - This criterion involves consideration of the following factors:

- The extent to which the proposed work is unique and innovative;
- The extent to which project outcomes and deliverables are clearly defined;
- The extent to which the proposed project is likely to meet or exceed the technical performance targets identified in this FOA;

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Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- The feasibility of the proposed work based upon preliminary data or other background information and sound scientific and engineering practices and principles;
- The extent to which the Applicant proposes a sound technical approach, including appropriately defined technical tasks, to accomplish the proposed R&D objectives; and
- The extent to which the Applicant manages risk, by identifying major technical R&D risks and clearly proposes feasible, effective mitigation strategies.

(3) *Qualifications, Experience, and Capabilities of the Proposed Project Team* (30%) - This criterion involves consideration of the following factors:

- The extent to which the PI and Project Team have the skill and expertise needed to successfully execute the project plan, evidenced by prior experience that demonstrates an ability to perform R&D of similar risk and complexity; and
- The extent to which the Applicant has access to the equipment and facilities necessary to accomplish the proposed R&D effort and/or a clear plan to obtain access to necessary equipment and facilities.

(4) *Soundness of Management Plan* (10%) - This criterion involves consideration of the following factors:

- The extent to which the Applicant presents a plausible plan to manage people and resources;
- The extent to which the Applicant proposes allocation of appropriate levels of effort and resources to proposed tasks;
- Whether the proposed schedule, including major milestones is reasonable; and
- The appropriateness of the proposed budget to accomplish the proposed project.

Submissions will not be evaluated against each other since they are not submitted in accordance with a common work statement.

### **3. CRITERIA FOR REPLIES TO REVIEWER COMMENTS**

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

ARPA-E has not established separate criteria to evaluate Replies to Reviewer Comments. Instead, Replies to Reviewer Comments are evaluated as an extension of the Full Application.

## **B. REVIEW AND SELECTION PROCESS**

### **1. PROGRAM POLICY FACTORS**

~~[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]~~

In addition to the above criteria, ARPA-E may consider the following program policy factors in determining which Full Applications to select for award negotiations:

I. **ARPA-E Portfolio Balance.** Project balances ARPA-E portfolio in one or more of the following areas:

- a. Technological diversity;
- b. Organizational diversity;
- c. Geographic diversity;
- d. Technical or commercialization risk; or
- e. Stage of technology development.

II. **Relevance to ARPA-E Mission Advancement.** Project contributes to one or more of ARPA-E's key statutory goals:

- a. Reduction of US dependence on foreign energy sources;
- b. Stimulation of domestic manufacturing;
- c. Reduction of energy-related emissions;
- d. Increase in U.S. energy efficiency;
- e. Enhancement of U.S. economic and energy security; or
- f. Promotion of U.S. advanced energy technologies competitiveness.

III. **Synergy of Public and Private Efforts.**

- a. Avoids duplication and overlap with other publicly or privately funded projects;
- b. Promotes increased coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer; or
- c. Increases unique research collaborations.

IV. **Low likelihood of other sources of funding.** High technical and/or financial uncertainty that results in the non-availability of other public, private or internal funding or resources to support the project.

V. **High Project Impact Relative to Project Cost.**

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

## 2. ARPA-E REVIEWERS

By submitting an application to ARPA-E, Applicants consent to ARPA-E's use of Federal employees, contractors, and experts from educational institutions, nonprofits, industry, and governmental and intergovernmental entities as reviewers. ARPA-E selects reviewers based on their knowledge and understanding of the relevant field and application, their experience and skills, and their ability to provide constructive feedback on applications.

ARPA-E requires all reviewers to complete a Conflict-of-Interest Certification and Nondisclosure Agreement through which they disclose their knowledge of any actual or apparent conflicts and agree to safeguard confidential information contained in Concept Papers, Full Applications, and Replies to Reviewer Comments. In addition, ARPA-E trains its reviewers in proper evaluation techniques and procedures.

Applicants are not permitted to nominate reviewers for their applications. Applicants may contact the Contracting Officer by email ([ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov)) if they have knowledge of a potential conflict of interest or a reasonable belief that a potential conflict exists.

## 3. ARPA-E SUPPORT CONTRACTOR

ARPA-E utilizes contractors to assist with the evaluation of applications and project management. To avoid actual and apparent conflicts of interest, ARPA-E prohibits its support contractors from submitting or participating in the preparation of applications to ARPA-E.

By submitting an application to ARPA-E, Applicants represent that they are not performing support contractor services for ARPA-E in any capacity and did not obtain the assistance of ARPA-E's support contractor to prepare the application. ARPA-E will not consider any applications that are submitted by or prepared with the assistance of its support contractors.

### C. ANTICIPATED ANNOUNCEMENT AND AWARD DATES

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

ARPA-E expects to announce selections for negotiations in approximately July 2015 and to execute funding agreements in approximately September 2015.

## VI. AWARD ADMINISTRATION INFORMATION

### A. AWARD NOTICES

#### 1. REJECTED SUBMISSIONS

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

Noncompliant and nonresponsive Concept Papers and Full Applications are rejected by the Contracting Officer and are not reviewed or considered. The Contracting Officer sends a notification letter by email to the technical and administrative points of contact designated by the Applicant in ARPA-E eXCHANGE. The notification letter states the basis upon which the Concept Paper or Full Application was rejected.

## 2. CONCEPT PAPER NOTIFICATIONS

ARPA-E promptly notifies Applicants of its determination to encourage or discourage the submission of a Full Application. ARPA-E sends a notification letter by email to the technical and administrative points of contact designated by the Applicant in ARPA-E eXCHANGE. ARPA-E provides feedback in the notification letter in order to guide further development of the proposed technology.

Applicants may submit a Full Application even if they receive a notification discouraging them from doing so. By discouraging the submission of a Full Application, ARPA-E intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. The purpose of the Concept Paper phase is to save Applicants the considerable time and expense of preparing a Full Application that is unlikely to be selected for award negotiations.

A notification letter encouraging the submission of a Full Application does not authorize the Applicant to commence performance of the project. Please refer to Section IV.G.2 of the FOA for guidance on pre-award costs.

## 3. FULL APPLICATION NOTIFICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

ARPA-E promptly notifies Applicants of its determination. ARPA-E sends a notification letter by email to the technical and administrative points of contact designated by the Applicant in ARPA-E eXCHANGE. The notification letter may inform the Applicant that its Full Application was selected for award negotiations, or not selected. Alternatively, ARPA-E may notify one or more Applicants that a final selection determination on particular Full Applications will be made at a later date, subject to the availability of funds or other factors.

Written feedback on Full Applications is made available to Applicants before the submission deadline for Replies to Reviewer Comments. By providing feedback, ARPA-E intends to guide the further development of the proposed technology and to provide a brief opportunity to respond to reviewer comments.

### **a. SUCCESSFUL APPLICANTS**

ARPA-E has discretion to select all or part of a proposed project for negotiation of an award. A notification letter selecting a Full Application for award negotiations does not authorize the Applicant to commence performance of the project. **ARPA-E selects Full Applications for award negotiations, not for award.** Applicants do not receive an award until award negotiations are complete and the Contracting Officer executes the funding agreement. ARPA-E may terminate award negotiations at any time for any reason.

Please refer to Section IV.G.2 of the FOA for guidance on pre-award costs. Please also refer to the "SBIR/STTR Applicants' Guide to ARPA-E Award Negotiations" (<http://arpa-e.energy.gov/?q=arpa-e-site-page/pre-award-guidance-sbir-sttr>) for guidance on the award negotiation process.

### **b. POSTPONED SELECTION DETERMINATIONS**

A notification letter postponing a final selection determination until a later date does not authorize the Applicant to commence performance of the project. ARPA-E may ultimately determine to select or not select the Full Application for award negotiations.

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

### **c. UNSUCCESSFUL APPLICANTS**

By not selecting a Full Application, ARPA-E intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. ARPA-E hopes that unsuccessful Applicants will submit innovative ideas and concepts for future FOAs.

## **B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS**

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

The following administrative and national policy requirements apply to Prime Recipients. The Prime Recipient is the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues, including but not limited to disputes and claims arising out of any agreement between the Prime Recipient and a FFRDC contractor. Prime Recipients are required to flow down these requirements to their Subrecipients through subawards or related agreements.

## 1. DUNS NUMBER AND SAM, FSRS, AND FEDCONNECT REGISTRATIONS

Upon selection for award negotiations, Prime Recipients and Subrecipients are required to obtain a DUNS number at <http://fedgov.dnb.com/webform>. In addition, Prime Recipients and Subrecipients are required to register with the System for Award Management (SAM) at <https://www.sam.gov/portal/public/SAM/>. Applicants who currently have an active record in the Central Contractor Registry (CCR) have an active record in SAM, but a new username must still be registered.

Prime Recipients and Subrecipients should commence this process as soon as possible in order to expedite the execution of a funding agreement. Obtaining a DUNS number and registering with SAM could take several weeks.

By law, Prime Recipients are also required to register with the Federal Funding Accountability and Transparency Act Subaward Reporting System (FSRS) at <https://www.fsrs.gov/>.<sup>28</sup> Prime Recipients are required to report to FSRS the names and total compensation of each of the Prime Recipient's five most highly compensated executives and the names and total compensation of each Subrecipient's five most highly compensated executives. Please refer to <https://www.fsrs.gov/> for guidance on reporting requirements.

ARPA-E may not execute a funding agreement with the Prime Recipient until it has obtained a DUNS number and completed its SAM and FSRS registrations. In addition, the Prime Recipient may not execute subawards with Subrecipients until they obtain a DUNS number and complete their SAM registration. Prime Recipients and Subrecipients are required to keep their SAM and FSRS data current throughout the duration of the project.

Finally, Prime Recipients are required to register with FedConnect in order to receive notification that their funding agreement has been executed by the Contracting Officer and to obtain a copy of the executed funding agreement. Please refer to <https://www.fedconnect.net/FedConnect/> for registration instructions.

## 2. NATIONAL POLICY ASSURANCES

Project Teams, including Prime Recipients and Subrecipients, are required to comply with the National Policy Assurances attached to their funding agreement. Please refer to ARPA-E's Model Cooperative Agreement for SBIR/STTR awards (<http://arpa-e.energy.gov/arpa-e-site-page/award-guidance>) for guidance on the National Policy Assurances.

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<sup>28</sup> The Federal Funding Accountability and Transparency Act, P.L. 109-282, 31 U.S.C. 6101 note.



### 3. PROOF OF COST SHARE COMMITMENT AND ALLOWABILITY

Upon selection for award negotiations, the Prime Recipient must confirm in writing that the proposed cost share contribution is allowable in accordance with applicable Federal cost principles.

The Prime Recipient is also required to provide cost share commitment letters from Subrecipients or third parties that are providing cost share, whether cash or in-kind. Each Subrecipient or third party that is contributing cost share must provide a letter on appropriate letterhead that is signed by an authorized corporate representative. Please refer to the “SBIR/STTR Applicants’ Guide to ARPA-E Award Negotiations” (<http://arpa-e.energy.gov/?q=arpa-e-site-page/pre-award-guidance-sbir-sttr>) for guidance on the contents of cost share commitment letters.

### 4. COST SHARE PAYMENTS<sup>29</sup>

All proposed cost share contributions for Phase II and Phase IIS of Combined Phase I/II awards and Combined Phase I/II/IIS awards must be reviewed in advance by the Contracting Officer and incorporated into the project budget before the expenditures are incurred.

ARPA-E requires Prime Recipients to contribute the cost share amount incrementally during the performance of work in Phase II and/or Phase IIS (as applicable).<sup>30</sup> Specifically, every Prime Recipient is required to contribute, at a minimum, the cost share percentage of total expenditures incurred during every billing period in Phase II and/or Phase IIS (as applicable). For example, a Prime Recipient is required to contribute at least 31% of the total expenditures incurred during every billing period in Phase II if the funding agreement states that the cost share percentage in Phase II is 31%.

Prime Recipients must submit written documentation with every reimbursement request demonstrating that it (or Project Team, as appropriate) has provided the requisite cost share during the relevant billing period.

If Prime Recipients anticipate difficulty providing the requisite cost share every billing period, they may request authorization from the Contracting Officer upon selection for award negotiations to deviate from ARPA-E’s standard cost share payment schedule.

Please refer to the “SBIR/STTR Applicants’ Guide to ARPA-E Award Negotiations” (<http://arpa-e.energy.gov/?q=arpa-e-site-page/pre-award-guidance-sbir-sttr>) for additional guidance on cost share payment requirements.

<sup>29</sup> Please refer to Section III.D of the FOA for guidance on cost share requirements.

<sup>30</sup> Prime Recipients may elect to pay the entire cost share amount at the start of the project.

ARPA-E may deny reimbursement requests, in whole or in part, or modify or terminate funding agreements where Prime Recipients (or Project Teams) fail to comply with ARPA-E's cost share payment requirements.

## **5. ENVIRONMENTAL IMPACT QUESTIONNAIRE**

By law, ARPA-E is required to evaluate the potential environmental impact of projects that it is considering for funding. In particular, ARPA-E must determine before funding a project whether the project qualifies for a categorical exclusion under 10 C.F.R. § 1021.410 or whether it requires further environmental review (i.e., an environmental assessment or an environmental impact statement).

To facilitate and expedite ARPA-E's environmental review, Prime Recipients are required to complete an Environmental Impact Questionnaire during award negotiations. This form is available on ARPA-E's website at <http://arpa-e.energy.gov/?q=arpa-e-site-page/pre-award-guidance-sbir-sttr>. The Environmental Impact Questionnaire is due within 21 calendar days of the selection announcement.

## **6. TECHNOLOGY-TO-MARKET PLAN**

During award negotiations, Prime Recipients are required to negotiate and submit an initial Technology-to-Market Plan for Phase II and Phase IIS with the ARPA-E Program Director, and obtain the ARPA-E Program Director's approval prior to the execution of the award. During the project period, Prime Recipients are required to provide regular updates on the initial Technology-to-Market plan and report on implementation of Technology-to-Market activities. Prime Recipients may be required to perform other actions to further the commercialization of their respective technologies. Prime Recipients are not required to negotiate a Technology-to-Market Plan for Phase I only awards.

ARPA-E Program Directors may waive or modify this requirement, as appropriate.

## **7. INTELLECTUAL PROPERTY AND COMMERCIALIZATION RIGHTS AGREEMENT**

ARPA-E requires every Project Team to negotiate and establish an Intellectual Property and Commercialization Rights Agreement that governs the management and disposition of intellectual property arising from the project, and allocates rights to carry out any follow-on research, development, or commercialization activities. The Prime Recipient must submit a completed and signed Intellectual Property and Commercialization Rights Agreement to ARPA-E within six weeks of the effective date of the ARPA-E funding agreement. All Intellectual Property and Commercialization Rights Agreements are subject to the terms and conditions of the ARPA-E funding agreement and its intellectual property provisions, and applicable Federal laws, regulations, and policies, all of which take precedence over the terms of Intellectual Property and Commercialization Rights Agreements.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

ARPA-E has developed a template for Intellectual Property and Commercialization Rights Agreements (<http://arpa-e.energy.gov/?q=arpa-e-site-page/award-guidance-sbir-sttr>) so as to facilitate and expedite negotiations between Project Team members. ARPA-E does not mandate the use of this template. ARPA-E and DOE do not make any warranty (express or implied) or assume any liability or responsibility for the accuracy, completeness, or usefulness of the template. ARPA-E and DOE strongly encourage Project Teams to consult independent legal counsel before using the template.

## **8. U.S. MANUFACTURING REQUIREMENT**

ARPA-E requires products embodying or produced through the use of subject inventions (i.e., inventions conceived or first actually reduced to practice under ARPA-E funding agreements) to be substantially manufactured in the United States by Project Teams and their licensees, as described below. The Applicant may request a modification or waiver of the U.S. Manufacturing Requirement.

### ***a. SMALL BUSINESSES***

Small businesses (including Small Business Concerns) that are Prime Recipients or Subrecipients under ARPA-E funding agreements are required to substantially manufacture the following products in the United States for any use or sale in the United States: (1) products embodying subject inventions, and (2) products produced through the use of subject invention(s).<sup>31</sup> This requirement does not apply to products that are manufactured for use or sale outside the U.S.A.

Small businesses must apply the same U.S. Manufacturing requirements to their assignees, licensees, and entities acquiring a controlling interest in the small business. Small businesses must require their assignees and entities acquiring a controlling interest in the small business to apply the same U.S. Manufacturing requirements to their licensees.

### ***b. LARGE BUSINESSES AND FOREIGN ENTITIES***

Large businesses and foreign entities that are Subrecipients under ARPA-E funding agreements are required to substantially manufacture the following products in the United States: (1) products embodying subject inventions, and (2) products produced through the use of subject

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<sup>31</sup> Small businesses are generally defined as domestically incorporated entities that meet the criteria established by the U.S. Small Business Administration's "Table of Small Business Size Standards Matched to North American Industry Classification System Codes" (<http://www.sba.gov/content/small-business-size-standards>). Small businesses include Small Business Concerns, as defined in Note 5.

invention(s).<sup>32</sup> This requirement applies to products that are manufactured for use or sale in the United States and outside the United States.

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

### ***c. EDUCATIONAL INSTITUTIONS AND NONPROFITS***

Domestic educational institutions and nonprofits that are Subrecipients under ARPA-E funding agreements must require their exclusive licensees to substantially manufacture the following products in the United States for any use or sale in the United States: (1) articles embodying subject inventions, and (2) articles produced through the use of subject invention(s). This requirement does not apply to articles that are manufactured for use or sale overseas.

Educational institutions and nonprofits must require their assignees to apply the same U.S. Manufacturing requirements to their exclusive licensees.

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

### ***d. FFRDCs and State and Local Government Entities***

FFRDCs and state and local government entities are subject to the same U.S. Manufacturing requirements as domestic educational institutions and nonprofits.

## **9. CORPORATE FELONY CONVICTIONS AND FEDERAL TAX LIABILITY**

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

- It is not a corporation that has been convicted of a felony criminal violation under any Federal law within the preceding 24 months; and
- It is not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed,

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<sup>32</sup> Large businesses are generally defined as domestically incorporated entities that do not meet the criteria established by the U.S. Small Business Administration's "Table of Small Business Size Standards Matched to North American Industry Classification System Codes" (<http://www.sba.gov/content/small-business-size-standards>).

and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

### **C. REPORTING**

[TO BE INSERTED BY FOA MODIFICATION IN MARCH 2015]

Recipients are required to submit periodic, detailed reports on technical, financial, and other aspects of the project, as described in Attachment 4 to ARPA-E's Model Cooperative Agreement for SBIR/STTR Awards (<http://arpa-e.energy.gov/?q=arpa-e-site-page/award-guidance-sbir-sttr>).

## **VII. AGENCY CONTACTS**

### **A. COMMUNICATIONS WITH ARPA-E**

Upon the issuance of a FOA, only the Contracting Officer may communicate with Applicants. ARPA-E personnel and our support contractors are prohibited from communicating (in writing or otherwise) with Applicants regarding the FOA. This "quiet period" remains in effect until ARPA-E's public announcement of its project selections.

During the "quiet period," Applicants are required to submit all questions regarding this FOA to [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov).

- ARPA-E will post responses on a weekly basis to any questions that are received. ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.
- ARPA-E will cease to accept questions approximately 5 business days in advance of each submission deadline. Responses to questions received before the cutoff will be posted approximately one business day in advance of the submission deadline. ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.
- Responses are posted to "Frequently Asked Questions" on ARPA-E's website (<http://arpa-e.energy.gov/faq>).

Applicants may submit questions regarding ARPA-E eXCHANGE, ARPA-E's online application portal, to [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov). ARPA-E will promptly respond to emails that raise legitimate, technical issues with ARPA-E eXCHANGE. ARPA-E will refer any questions regarding the FOA to [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov).

ARPA-E will not accept or respond to communications received by other means (e.g., fax, telephone, mail, hand delivery). Emails sent to other email addresses will be disregarded.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

During the “quiet period,” only the Contracting Officer may authorize communications between ARPA-E personnel and Applicants. The Contracting Officer may communicate with Applicants as necessary and appropriate. As described in Section IV.A.6 of the FOA, the Contracting Officer may arrange pre-selection meetings and/or site visits during the “quiet period.”

**B. DEBRIEFINGS**

ARPA-E does not offer or provide debriefings. ARPA-E provides Applicants with a notification encouraging or discouraging the submission of a Full Application based on ARPA-E’s assessment of the Concept Paper. In addition, ARPA-E provides Applicants with reviewer comments on Full Applications before the submission deadline for Replies to Reviewer Comments.

**VIII. OTHER INFORMATION**

**A. FOAs AND FOA MODIFICATIONS**

FOAs are posted on ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov/>), Grants.gov (<http://www.grants.gov/>), and FedConnect (<https://www.fedconnect.net/FedConnect/>), and the Government-wide SBIR/STTR website (<http://www.sbir.gov/solicitations>). Any modifications to the FOA are also posted to these websites. You can receive an e-mail when a modification is posted by registering with FedConnect as an interested party for this FOA. It is recommended that you register as soon as possible after release of the FOA to ensure that you receive timely notice of any modifications or other announcements. More information is available at <https://www.fedconnect.net>.

**B. OBLIGATION OF PUBLIC FUNDS**

The Contracting Officer is the only individual who can make awards on behalf of ARPA-E or obligate ARPA-E to the expenditure of public funds. A commitment or obligation by any individual other than the Contracting Officer, either explicit or implied, is invalid.

ARPA-E awards may not be transferred, assigned, or assumed without the prior written consent of a Contracting Officer.

**C. REQUIREMENT FOR FULL AND COMPLETE DISCLOSURE**

Applicants are required to make a full and complete disclosure of the information requested in the Business Assurances & Disclosures Form. Disclosure of the requested information is mandatory. Any failure to make a full and complete disclosure of the requested information may result in:

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- The rejection of a Concept Paper, Full Application, and/or Reply to Reviewer Comments;
- The termination of award negotiations;
- The modification, suspension, and/or termination of a funding agreement;
- The initiation of debarment proceedings, debarment, and/or a declaration of ineligibility for receipt of Federal contracts, subcontracts, and financial assistance and benefits; and
- Civil and/or criminal penalties.

**D. RETENTION OF SUBMISSIONS**

ARPA-E expects to retain copies of all Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions. No submissions will be returned. By applying to ARPA-E for funding, Applicants consent to ARPA-E's retention of their submissions.

**E. MARKING OF CONFIDENTIAL INFORMATION**

ARPA-E will use data and other information contained in Concept Papers, Full Applications, and Replies to Reviewer Comments strictly for evaluation purposes.

Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

The cover sheet of the Concept Paper, Full Application, Reply to Reviewer Comments, or other submission must be marked as follows and identify the specific pages containing confidential, proprietary, or privileged information:

Notice of Restriction on Disclosure and Use of Data:

Pages [\_\_\_] of this document may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes or in accordance with a financial assistance or loan agreement between the submitter and the Government. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: “Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure.” In addition, every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

## **F. TITLE TO SUBJECT INVENTIONS**

Ownership of subject inventions is governed pursuant to the authorities listed below. Typically, either by operation of law or under the authority of a patent waiver, Prime Recipients and Subrecipients may elect to retain title to their subject inventions under ARPA-E funding agreements.

- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions. If they elect to retain title, they must file a patent application in a timely fashion.
- All other parties: The Federal Non Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (*see below*).
- Class Waiver: Under 42 U.S.C. § 5908, title to subject inventions vests in the U.S. Government and large businesses and foreign entities do not have the automatic right to elect to retain title to subject inventions. However, ARPA-E typically issues “class patent waivers” under which large businesses and foreign entities that meet certain stated requirements may elect to retain title to their subject inventions. If a large business or foreign entity elects to retain title to its subject invention, it must file a patent application in a timely fashion. **If the class waiver does not apply, a party may request a waiver in accordance with 10 C.F.R. §784.**

## **G. GOVERNMENT RIGHTS IN SUBJECT INVENTIONS**

Where Prime Recipients and Subrecipients retain title to subject inventions, the U.S. Government retains certain rights.

### **1. GOVERNMENT USE LICENSE**

The U.S. Government retains a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States any subject invention throughout the world. This license extends to contractors doing work on behalf of the Government.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).



## 2. MARCH-IN RIGHTS

The U.S. Government retains march-in rights with respect to all subject inventions. Through “march-in rights,” the Government may require a Prime Recipient or Subrecipient who has elected to retain title to a subject invention (or their assignees or exclusive licensees), to grant a license for use of the invention. In addition, the Government may grant licenses for use of the subject invention when Prime Recipients, Subrecipients, or their assignees and exclusive licensees refuse to do so.

The U.S. Government may exercise its march-in rights if it determines that such action is necessary under any of the four following conditions:

- The owner or licensee has not taken or is not expected to take effective steps to achieve practical application of the invention within a reasonable time;
- The owner or licensee has not taken action to alleviate health or safety needs in a reasonably satisfactory manner;
- The owner has not met public use requirements specified by Federal statutes in a reasonably satisfactory manner; or
- The U.S. Manufacturing requirement has not been met.

### H. RIGHTS IN TECHNICAL DATA

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

- Background or “Limited Rights Data”: The U.S. Government will not normally require delivery of technical data developed solely at private expense prior to issuance of an award, except as necessary to monitor technical progress and evaluate the potential of proposed technologies to reach specific technical and cost metrics.
- Generated Data: The U.S. Government normally retains very broad rights in technical data produced under Government financial assistance awards, including the right to distribute to the public. However, pursuant to special statutory authority, certain categories of data generated under ARPA-E SBIR/STTR awards may be protected from public disclosure for up to four years from delivery of the last deliverables under the agreement. Such data should be clearly marked as described in Attachment 4 to ARPA-E’s Model Cooperative Agreement for SBIR/STTR Awards (<http://arpa-e.energy.gov/?q=arpa-e-site-page/sbir-sttr-guidance>). In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

## **I. REGULATIONS APPLICABLE TO RESULTING AWARDS**

Effective December 26, 2014, this FOA and any awards made under it will be governed by 2 C.F.R. Part 200, the Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards, as modified by 2 C.F.R. Part 910, the Department of Energy Financial Assistance Rules.

## **J. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION**

Applicants may not include any Protected Personally Identifiable Information (Protected PII) in their submissions to ARPA-E. Protected PII is defined as data that, if compromised, could cause harm to an individual such as identity theft. Listed below are examples of Protected PII that Applicants must not include in their submissions.

- Social Security Numbers in any form;
- Place of Birth associated with an individual;
- Date of Birth associated with an individual;
- Mother's maiden name associated with an individual;
- Biometric record associated with an individual;
- Fingerprint;
- Iris scan;
- DNA;
- Medical history information associated with an individual;
- Medical conditions, including history of disease;
- Metric information, e.g. weight, height, blood pressure;
- Criminal history associated with an individual;
- Ratings;
- Disciplinary actions;
- Performance elements and standards (or work expectations) are PII when they are so intertwined with performance appraisals that their disclosure would reveal an individual's performance appraisal;
- Financial information associated with an individual;
- Credit card numbers;
- Bank account numbers; and
- Security clearance history or related information (not including actual clearances held).

## **K. ADDITIONAL NOTICES**

- This FOA is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR or STTR funding agreement, the terms of the funding agreement are controlling.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

- Before award of an SBIR or STTR funding agreement, ARPA-E may request the selectee to submit certain organizational, management, personnel, and financial information to assure responsibility of the Prime Recipient. In addition, selectees will be required to make certain legal commitments at the time of execution of funding agreements resulting from this FOA. ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement for SBIR/STTR Awards, which is available at <http://arpa-e.energy.gov/?q=arpa-e-site-page/sbir-sttr-guidance>.
- ARPA-E will not pay a fee or profit on Cooperative Agreements resulting from this FOA to recipients or subrecipients.
- Actual or suspected fraud, waste, or abuse may be reported to the DOE Office of Inspector General (OIG) at 1-800-541-1625.

*Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).*

## **IX. GLOSSARY**

**Applicant:** The Small Business Concern that submits the application to ARPA-E. In the case of a Project Team, the Applicant is the lead organization listed on the application.

**Application:** The entire submission received by ARPA-E, including the Concept Paper, Full Application, and Reply to Reviewer Comments.

**ARPA-E:** Advanced Research Projects Agency-Energy.

**Cost Share:** The Prime Recipient required share of the Total Project Cost.

**Deliverable:** A deliverable is the quantifiable goods or services that will be provided upon the successful completion of a project task or sub-task.

**DOE:** U.S. Department of Energy.

**DOE/NNSA:** U.S. Department of Energy/National Nuclear Security Administration

**FFRDCs:** Federally Funded Research and Development Centers.

**FOA:** Funding Opportunity Announcement.

**GOGOs:** U.S. Government Owned, Government Operated laboratories.

**Key Participant:** Any individual who would contribute in a substantive, measurable way to the execution of the proposed project.

**Milestone:** A milestone is the tangible, observable measurement that will be provided upon the successful completion of a project task or sub-task.

**Prime Recipient:** The signatory to the funding agreement with ARPA-E.

**PI:** Principal Investigator.

**Project Team:** A Project Team consists of the Prime Recipient, Subrecipients, and others performing or otherwise supporting work under an ARPA-E funding agreement.

**R&D:** Research and development.

**SBA:** U.S. Small Business Administration.

**SBIR:** Small Business Innovation Research Program.

Questions about this FOA? Email [ARPA-E-CO@hq.doe.gov](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
Problems with ARPA-E eXCHANGE? Email [ExchangeHelp@hq.doe.gov](mailto:ExchangeHelp@hq.doe.gov) (with FOA name and number in subject line).

**Small Business Concern:** A for-profit entity that: (1) maintains a place of business located in the United States; (2) operates primarily within the United States or makes a significant contribution to the United States economy through payment of taxes or use of American products, materials or labor; (3) is an individual proprietorship, partnership, corporation, limited liability company, joint venture, association, trust, or cooperative; and (4) meets the size eligibility requirements set forth in 13 C.F.R. § 121.702. Where the entity is formed as a joint venture, there can be no more than 49% participation by foreign business entities in the joint venture.

**Standalone Applicant:** An Applicant that applies for funding on its own, not as part of a Project Team.

**STTR:** Small Business Technology Transfer Program.

**Subject Invention:** Any invention conceived or first actually reduced to practice under an ARPA-E funding agreement.

**Task:** A task is an operation or segment of the work plan that requires both effort and resources. Each task (or sub-task) is connected to the overall objective of the project, via the achievement of a milestone or a deliverable.

**Total Project Cost:** The sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs and FFRDCs.