FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

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

ADVANCED MANAGEMENT AND PROTECTION OF ENERGY-STORAGE DEVICES (AMPED)

Announcement Type: Initial Announcement
Funding Opportunity No. DE-FOA-0000675
CFDA Number 81.135

FOA Issue Date:	April 2, 2012
Submission Deadline for Notice of Intent	5 PM ET, May 14, 2012
Deadline for Questions to ARPA-E-CO@hq.doe.gov:	5 PM ET, May 18, 2012
Submission Deadline for Full Applications:	5 PM ET, May 23, 2012
Submission Deadline for Replies to Reviewer Comments:	5 PM ET, June ~~19~~ 25, 2012
Expected Date for Selection Notifications:	July 2012
Mandatory Webinar:	July 2012

- **Notices of Intent, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE** (https://arpa-e-foa.energy.gov/), ARPA-E's online application portal (see Section IV.G.1 of the FOA). **ARPA-E will not review or consider applications submitted through other means.** 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).
- 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.** 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 noncompliant applications** (see Section III.C.1 of the FOA), **including but not limited to incomplete applications and applications submitted after the deadline stated in the FOA.** In addition, ARPA-E will not review or consider nonresponsive applications (see Section III.C.2 of the FOA).

Questions about this FOA? Email 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 (with FOA name and number in subject line).

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
001	April 12, 2012	• Updated Full Application section of the Required Documents Checklist. • Updated Appendix 4, Technical Volume to the Full Application Template.
002	May 17, 2012	• Changed the due date for Replies to Reviewer Comments to June 25, 2012. • Removed Section VI.B.11: Section VI.B.11 was intended to implement §316 of the Consolidated Appropriations Act, 2012. That section requires the recipients of Department of Energy grants in excess of $1,000,000 to upgrade any lighting in their facilities that does not meet the incandescent efficiency standards set forth in 42 U.S.C. §6295. ARPA-E removed this section because §316 applies exclusively to grants. It does not apply to any other form of financial assistance. In the unlikely event that ARPA-E awards a grant (which have not been issued to date, and are not expected to be issued in the future), the requirement in §316 of the Consolidated Appropriations Act, 2012 would apply.

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REQUIRED DOCUMENTS CHECKLIST

Notices of Intent, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/), ARPA-E's online application portal. ARPA-E will not review or consider applications submitted through other means. 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). Required forms for Full Applications are available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the SF-424, SF-424A, Business Assurances Form, and Other Sources of Funding Disclosure form. A sample response to the Other Sources of Funding Disclosure form is attached to this FOA as Appendix 2. A sample response to the Business Assurances Form is attached to this FOA as Appendix 3. Applicants must use the templates available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the template for the Technical Volume of the Full Application, the template for the Technical Milestones section of the Technical Volume, the Summary Slide template, and the Reply to Reviewer Comments template. A sample Summary Slide is attached to this FOA as Appendix 1.

SUBMISSION	COMPONENTS	OPTIONAL/ MANDATORY	FOA SECTION	DEADLINE
Notice of Intent	• Each Applicant must enter the following information in ARPA-E eXCHANGE by the stated deadline: o Project Title; o Lead Organization; o Organization Type (Business < 500 Employees; Business > 1000 Employees; Business 500-1000 Employees; Federally Funded Research and Development Center (FFRDC); Government Owned and Operated; Non-Profit; University); o Whether the application was previously submitted to DOE; o Principal Investigator or Technical Area (see Section I.E of the FOA); and o Abstract – The abstract provided should be 200 words in length, and should provide a truncated explanation of the proposed project.	Mandatory	IV.B	5 PM ET, May 14, 2012
Full Application	• Each Applicant must submit a Technical Volume in Adobe PDF format by the stated deadline. Applicants must use the Technical Volume template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov) The Technical Volume must include the following: o Technical Area (0.5 pages max.) o Technical Approach (1 page max.) o R&D Tasks (1 page max.) o R&D Strategy (20 pages max.) o Statement of Project Objectives (1 page max.) o Validation Protocols (5 pages max.) o Technical Milestones and Deliverables Table (5 pages max.) – Applicants must use the Technical Milestones template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov) o Budget Summary (2 pages max.) o Qualifications, Experience, and Capabilities (3 pages	Mandatory	IV.C	5 PM ET, May 23, 2012

	max. for each Personal Qualifications Summary) o Participating Organizations (1 page max.) o Prior Collaboration (1 page max.) o Management Plan (1 page max.) o Multi-Investigator Projects (2 pages max.) o Transition/Commercialization Strategy (2 pages max.) o Intellectual Property Strategy (no page limit) • The Technical Volume must be accompanied by: o SF-424 (no page limit, Adobe PDF format); o SF-424A (no page limit, Microsoft Excel format) o Summary for Public Release (no page limit, Adobe PDF format); o Summary Slide (1 page limit, Microsoft Powerpoint format) – Applicants must use the Summary Slide template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov); o Completed and signed Other Sources of Funding Disclosure form (no page limit, Adobe PDF format); o Completed and signed Business Assurances Form (no page limit, Adobe PDF format); and o Budget Justification Workbook justifying all proposed costs in the SF-424A (no page limit, Microsoft Excel format).			
Reply to Reviewer Comments	• Each Applicant may submit a Reply to Reviewer Comments in Adobe PDF format. This submission is optional. The Reply may include: o Up to 3 pages of text; and o Up to 2 page of images.	Optional	IV.D	5 PM ET, June 20, 2012

EXECUTIVE SUMMARY

Federal Agency	Advanced Research Projects Agency – Energy (ARPA-E), U.S. Department of Energy	
FOA Title	Advanced Management and Protection of Energy-storage Devices (AMPED)	
FOA Type	Initial announcement	
FOA Number	DE-FOA-0000675	
CFDA Number	81.135	
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Submission Deadline for Replies to Reviewer Comments:	5 PM ET, June 20, 2012	
Expected Date for Selection Notifications:	July 2012	
Means of Submission	Notices of Intent, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/), ARPA-E's online application portal (see Section IV.G.1 of the FOA). ARPA-E will not review or consider applications submitted through other means. 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).	
Total Amount to Be Awarded	Approximately $30 million	
Anticipated Awards	ARPA-E may issue one, multiple, or no awards under this FOA. Awards may vary between $250,000 and $10 million.	
Types of Funding Agreements	Cooperative Agreements, Technology Investment Agreements, Work Authorizations, and Interagency Agreements	
Period of Performance	Expected up to 36 months	
Eligibility – Individuals	U.S. citizens or permanent residents	May apply in their individual capacity as Standalone Applicant, as lead for a Project Team, or as member of a Project Team
Eligibility – Domestic Entities	Educational institutions, nonprofits,[1] and for-profit entities	May apply as Standalone Applicant, as lead organization for a Project Team, or as member of a Project Team
	Federally Funded Research and Development Centers (FFRDC), including DOE/NNSA FFRDCs	May apply as lead organization for a Project Team or as member of a Project Team

[1] 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 Prime Recipient or Subrecipient.

	DOE/NNSA Government-Owned Government-Operated laboratories (GOGOs)	Not eligible to apply for funding
	Non-DOE/NNSA GOGOs	May apply as member of a Project Team
	State and local government entities	May apply as member of a Project Team
Eligibility – Foreign Entities	May apply as Standalone Applicant, lead organization for a Project Team, or as member of a Project Team. However, all work by foreign entities must be performed by subsidiaries or affiliates incorporated in the United States (including U.S. territories).	
Eligibility – Consortium Entities	Consortium entities, which may include domestic and foreign entities, must designate one member of the consortium as the consortium representative to the Project Team. The consortium representative must be incorporated in the United States. The eligibility of the consortium will be determined by reference to the eligibility of the consortium representative under Section III.A of the FOA.	
Cost Share Requirement	Domestic educational institution or domestic nonprofit applying as a Standalone Applicant	Greater than or Equal to (≥) 5% of the Total Project Cost
	Project Teams composed exclusively of domestic educational institutions, domestic nonprofits, and/or FFRDCs	≥ 5% of the Total Project Cost
	Project Teams where domestic educational institutions, domestic nonprofits, and/or FFRDCs perform ≥ 80%, but less than 100%, of the work under the funding agreement, as measured by the Total Project Cost	≥ 10% of the Total Project Cost
	Technology Investment Agreements	≥ 50% of the Total Project Cost, to the maximum extent practicable
	All other projects	≥ 20% of the Total Project Cost
Number of Applications	Applicants may submit more than one application to this FOA, provided that each application is scientifically distinct.	
Agency Contact	See Section VII.A of the FOA for guidance on submitting questions to ARPA-E.	
Application Forms	Required forms for Full Applications are available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the SF-424, SF-424A, Business Assurances Form, and Other Sources of Funding Disclosure form. A sample response to the Other Sources of Funding Disclosure form is attached to this FOA as Appendix 2. A sample response to the Business Assurances Form is attached to this FOA as Appendix 3. Applicants must use the templates available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the template for the Technical Volume of the Full Application, the template for the Technical Milestones section of the Technical Volume, the Summary Slide template, and the Reply to Reviewer Comments template. A sample Summary Slide is attached to this FOA as Appendix 1.	

I. FUNDING OPPORTUNITY DESCRIPTION

A. AGENCY OVERVIEW

The Advanced Research Projects Agency – Energy (ARPA-E) is an organization within the Department of Energy, chartered by Congress in the America COMPETES Act (Pub. L. No. 110-69) 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. Since that time, the Agency has funded over 180 projects totaling more than $500 million across the entire technology landscape.[2]

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; and
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

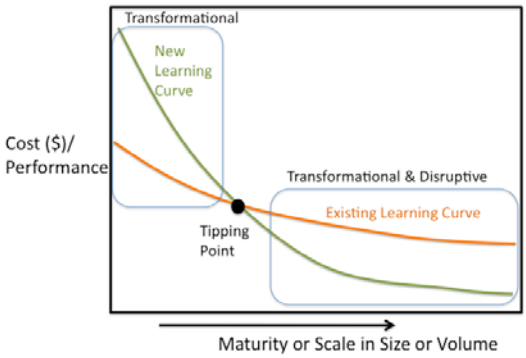

Figure 1: Description of transformational and disruptive technologies in terms of cost, performance and scale.

[2] Information on ARPA-E's projects is available at http://arpa-e.energy.gov/ProgramsProjects/Programs.aspx.

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:

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

ARPA-E exists to support transformational, rather than incremental, research. Technologies exist on learning curves. Following the creation of a technology, refinements to that technology and economies of scale that accrue as manufacturing and widespread distribution develop drive technology down that learning curve until an equilibrium price is found. 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 price (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).

ARPA-E does not own or manage any laboratories. ARPA-E will accomplish its mission by funding scientists, engineers, and technologists outside ARPA-E to perform research with the purpose of enabling major technological advances that address its mission.

Recipients of ARPA-E awards may include a full range of R&D entities. ARPA-E encourages collaboration and the mix of complementary expertise to perform the proposed R&D objectives. This may be a single performer or team, may be one or more institutions, and may include operational experts along with the research team.

B. APPLICATION PROCESS OVERVIEW

The first step in applying to this FOA is the timely submission of a compliant Notice of Intent, which is required to obtain a Control Number. Next, Applicants must submit a Full Application by the deadline stated in the FOA. Following ARPA-E's review of Full Applications, Applicants will receive written comments from reviewers and have a brief opportunity to submit an optional Reply to Reviewer Comments. ARPA-E will then perform a down-select of Full Applications that may include discussions and/or site visits with those remaining Applicants. ARPA-E will select Full Applications for award negotiations from this pool of remaining Applicants. ARPA-E considers a mix of quantitative and qualitative criteria (see Sections V.A and V.B.1 of the FOA) in determining whether to select a Full Application for award negotiations.

Notices of Intent, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/), ARPA-E's online application portal (see Section IV.G.1 of the FOA). **ARPA-E will not review or consider applications submitted through other means.** Applicants must register with ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/Registration.aspx) in order to submit an application to this FOA. 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).

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.** 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 Notice of Intent or Full Application. In addition, Applicants should allow at least 15 minutes to submit a Reply to 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 noncompliant applications (see Section III.C.1 of the FOA), **including incomplete applications and applications submitted after the deadline stated in 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 of the FOA;
- Failing to enter required information in ARPA-E eXCHANGE;
- Failing to upload required document(s) to ARPA-E eXCHANGE;
- 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.

ARPA-E will not review or consider nonresponsive applications (see Section III.C.2 of the FOA). Any "Applications Specifically Not of Interest," as described in Section I.G of the FOA, will be

deemed nonresponsive and not reviewed or considered.

1. NOTICES OF INTENT

Applicants must submit a separate Notice of Intent for each Full Application through ARPA-E eXCHANGE by the deadline stated in the FOA. Failure to comply with this requirement will render the Applicant's Full Application ineligible for consideration (see Section III.F.1 of the FOA). Section IV.B of the FOA provides instructions on submitting a Notice of Intent.

Applicants should submit a Notice of Intent early in the FOA process. The Notice of Intent consists of a short abstract and basic information about the proposed project, including project title, lead organization, organization type, Principal Investigator and Technical Area. In addition, the Applicant must indicate whether it submitted the application previously to DOE.

ARPA-E will not review or consider noncompliant Notices of Intent.

ARPA-E eXCHANGE automatically assigns a Control Number upon the submission of a compliant Notice of Intent. 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. The Control Number must be included in the header of the Full Application and optional Reply to Reviewer Comments.

ARPA-E is using Notices of Intent to facilitate and expedite the merit review process. Notices of Intent also ensure that ARPA-E has sufficient reviewers in each Technical Area of interest.

2. FULL APPLICATION

Applicants must submit their Full Application by the deadline stated in the FOA. The assigned Control Number must be marked in the header of each component of the Full Application. However, Applicants may alter their project title or the composition of their Project Team between the submission of the Notice of Intent and the submission of the Full Application. Section IV.C of the FOA provides instructions on submitting a Full Application.

The Full Application consists of eight components, including the Technical Volume, Forms SF-424 and SF-424A, Summary for Public Release, Summary Slide, Other Sources of Funding Disclosure form, Business Assurances Form, and Budget Justification Workbook. A Technical Volume template is provided as Appendix 4 to the FOA. A fillable version is available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/).

ARPA-E performs a preliminary review of Full Applications to determine whether they are compliant and responsive, as described in Section III.C of the FOA. ARPA-E will not review or consider noncompliant and/or nonresponsive Full Applications.

If selected for award negotiations, Applicants will be required to complete additional paperwork, including an Environmental Impact Questionnaire (see Section VI.B.6 of the FOA).

3. 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. Each Applicant will have access only to comments on its own application(s). Applicants may submit an optional Reply to Reviewer Comments, which must be submitted by the deadline stated in the FOA. The assigned Control Number must be marked in the header of the Reply. Section IV.D of the FOA provides instructions on submitting a Reply to Reviewer Comments. A Reply to Reviewer Comments template is provided as Appendix 5 to the FOA. A fillable version is available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/).

Applicants have approximately 4 calendar days from receipt of the reviewer comments to prepare and submit a Reply. The Reply to Reviewer Comments consists of three pages of text and two pages of visual displays of data.

ARPA-E performs a preliminary review of Replies to determine whether they are compliant, as described in Section III.C.1 of the FOA. ARPA-E will not review or consider noncompliant Replies. Submitting a Reply to Reviewer Comments is optional. 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.

4. "DOWN-SELECT" PROCESS

Once ARPA-E completes its review of Full Applications and Replies to Reviewer Comments, it will perform a "down-select" of Full Applications. The Contracting Officer may invite certain Applicants to participate in a meeting with ARPA-E via webinar, videoconference, or conference call. In the alternative, the Contracting Officer may invite Applicants to meet in person at ARPA-E's offices, the recipient's site, or a mutually agreed upon location. The Contracting Officer may also arrange pre-selection site visits to certain Applicants' facilities. ARPA-E will not reimburse Applicants for travel and other expenses relating to pre-selection meetings and site visits.

The Contracting Officer may arrange one, multiple, or no pre-selection meetings and site visits. 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.

ARPA-E may obtain additional information through pre-selection meetings and site visits that will be used to make a final selection determination.

5. 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.1 and V.B.1 of the FOA. ARPA-E may select or not select a Full Application for award negotiations. ARPA-E 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 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.

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

Selected Applicants are strongly encouraged to review the "Applicants' Guide to ARPA-E Award Negotiations" (http://arpa-e.energy.gov/FundingAgreements/Overview/PreAward.aspx) for guidance on the award negotiation process.

C. PROGRAM OVERVIEW

Energy storage can significantly improve U.S. energy independence, efficiency, and security by enabling a new generation of electric vehicles and by enhancing the capabilities of the U.S. electricity grid.[3] While rapid advances are being made in research and development of new battery materials and storage technologies, few transformational innovations have emerged in the management of energy storage systems.[4,5,6] Batteries are complex systems, and developing techniques to cost-effectively monitor, manage, and predict important performance measures remains a

[3] Goodenough, J. B. *et al*. Basic research needs for electrical energy storage. *Report of the Basic Energy Sciences Workshop for Electrical Energy Storage*, Department of Energy: Washington, DC, 2007.
[4] Armand, M. and Tarascon, J.M. Building better batteries. *Nature*, 451, 7179 (2008).
[5] http://arpa-e.energy.gov/ProgramsProjects/BEEST.aspx
[6] http://arpa-e.energy.gov/ProgramsProjects/GRIDS.aspx

key technological challenge. As a result, many battery systems are over-designed and operated well below their maximum energy and power capabilities to meet operational requirements that minimize the risk of premature or catastrophic failure. AMPED seeks to develop breakthrough technologies that can be practically deployed for superior management of commercial battery systems.

A Critical Need for Advances in Energy Storage Management Technology

Advances in energy storage management can rapidly accelerate the widespread adoption of electric vehicles and grid-scale energy storage. Today's electric vehicles illustrate the potential impact of superior management of energy storage devices. A typical electric or plug-in electric vehicle generally employs between 25% and 100% excess energy capacity (beyond what is required to propel the vehicle) in order to provide a conservative buffer to avoid unwanted cell degradation. A further 25-100% burden on weight, volume, and cost is levied by the various assemblies and components required to safely and reliably interconnect and manage these cells in a full battery pack.[7] In the worst case, this results in a vehicle battery system that is oversized by a factor of four. This overdesign directly translates into added weight, volume, and upfront capital cost to the consumer and presents a major barrier to mass-market adoption of electric vehicles.

Even with such conservatively engineered systems, the safety and lifetime of batteries remain a liability for automakers. Cases of premature failure in automotive batteries have already led to significant consumer dissatisfaction.[8] Meanwhile, automotive OEM concerns over safety have escalated with recent battery recalls and fires, an issue that in recent years cost hundreds of millions of dollars to consumer battery manufacturers in recalls and litigation.[9,10,11,12] Safety and lifetime risks meanwhile prohibit rapid charging of most electric vehicles, which has been shown to be a key market inhibitor.[13] While the

[7] Raghavan, S. and Khaligh, A. Electrification potential factor: Energy-based value proposition analysis of plug-In hybrid electric vehicles. *IEEE Transactions on Vehicular Technology*, 61, 3, 1052-1059 (2012).
[8] Bensinger, K. Fix for Civic hybrids' dying batteries may hurt gas mileage, acceleration. *Los Angeles Times*, August 14 (2010) http://articles.latimes.com/2010/aug/14/business/la-fi-honda-20100815.
[9] Trudell, C. and Ohnsman, A. A123 replacing batteries that led to Fisker Karma shutdown. *Bloomberg*, March 26 (2012) http://webfarm.bloomberg.com/news/2012-03-26/a123-replacing-defective-batteries-that-led-to-fisker-shutdown.html.
[10] Green, J. *et al*. GM volt fire after crash said to prompt lithium-battery probe. *Bloomberg,* November 12 (2011) http://www.bloomberg.com/news/2011-11-11/gm-volt-battery-fire-is-said-to-prompt-u-s-probe-into-electric-car-safety.html.
[11] NHTSA Statement on conclusion of chevy volt investigation. *NHTSA.gov*, January 20 (2012) http://www.nhtsa.gov/About+NHTSA/Press+Releases/2012/NHTSA+Statement+on+Conclusion+of+Chevy+Volt+Investigation.
[12] Arendt, S. Sony battery recall costs $429 million. *PCMag.com*, October 26 (2006) http://www.pcmag.com/article2/0,2817,2040936,00.asp.
[13] Hidrue, M. *et* al. Willingness to pay for electric vehicles and their attributes. *Resource and Energy Economics*, 33, 3, 686-705 (2011).

full impact of safety concerns on electric vehicle adoption requires further investigation, it is clear that uncertainties over battery safety and life can directly affect the cost and risk of deployment.[14,15]

One proposed approach to maximize payback and offset the high cost of energy storage is to employ battery systems in secondary applications, either concurrent with or subsequent to primary use. Recent studies have shown that vehicle-to-grid energy storage use has the potential to provide sufficient capacity to enable large-scale adoption of intermittent renewable power (e.g. up to 50% wind) on the U.S. grid, meanwhile allowing vehicle owners to offset a significant portion of the cost of their electric vehicle battery.[16,17] Presently, a major technological barrier that prevents the dual-use of battery systems is the inability to accurately assess, predict, and maximize remaining battery life and value after retirement from its primary application.[18,19]

The need for advanced battery management is similarly pronounced for energy storage systems designed specifically to provide grid support. These battery systems suffer from similar under-utilization losses as those that plague automotive batteries.[20] Meanwhile, the inability to accurately predict and maintain long life batteries is a key barrier to commercial adoption, since viability of grid-storage systems depends entirely on the ability to offer a solid case for return-on-investment over a 20-30 year asset life. Finally, safety is a major concern for grid-scale energy storage systems due to the sheer size of these battery systems and the commensurate risk. Recent examples of catastrophic failure of grid-scale energy storage batteries highlight the need for improving the detection of potential safety events in large-scale grid-storage battery system.[21]

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[14] In the early 2000s, the United States Navy and United States Special Operations Command, developed and operated the Advanced SEAL Delivery System (ASDS). Unfortunately, the ASDS project came to a dramatic halt after a massive fire destroyed the one and only prototype submarine. The submersible's newly installed lithium ion batteries, during charging, ignited a fire which burned for nearly six hours, destroying the interior of the submarine. This unfortunate incident has contributed to the inability to use high energy and power storage devices on military platforms.

[15] Cavas, C. Fire deals new setback to Navy's heralded mini-sub. *Navy Times*, *NavySEALs.com*, December 15 (2008) http://www.navyseals.com/fire-deals-new-setback-navys-heralded-mini-sub.

[16] Jaffe, S. Economic and cost modeling of the repurposing of electric vehicle batteries for stationary storage applications. *Biennial International Conference on Electrical Energy Storage Applications and Technology*, October (2011) http://www.sandia.gov/eesat/2011/papers/Tuesday/19_Jaffe_ESSAT_Abstract.pdf.

[17] Sovacool, B. and Hirsh, R. Beyond batteries: An examination of the benefits and barriers to Plug-in Hybrid Electric Vehicles (PHEVs) and a Vehicle-to-Grid (V2G) transition. *Energy Policy*, 37, 1095–1103 (2009).

[18] Kempton, W. and Tomic, J. Vehicle to grid power fundamentals: Calculating capacity and revenue. *Journal of Power Sources*, 144, 268–279 (2005).

[19] Hilletal, D. *et al*. Fleet operator risks for using fleets for V2G regulation. *Energy Policy*, 41, 221–231 (2012).

[20] Campbell C., Vartanian C. A123's Advanced grid storage, extending our experience to distributed resource applications and microgrids. *2nd International Conference in Microgeneration and Related Technologies*, April (2011) http://microgen11.supergen-hidef.org/microgenII/CD/full_papers/p154vFINAL.pdf.

[21] Q&A concerning the NAS battery fire, December (2011) http://www.ngk.co.jp/english/announce/111031_nas.html.

The Challenges of Battery Management and Opportunities for Breakthrough Technology Development

The challenge of battery management stems from the complexity of battery devices, compounded by the aggressive operational demands and severe cost constraints of intended applications.[22] Even the simplest charging and discharging scheme of an electrochemical battery depends on a wide-range of thermodynamic, kinetic, and transport processes. These processes are coupled with and dependent on the operating conditions of the battery.[23] To some extent, these processes can be represented by theoretical models; however, even the best models cannot predict the complex degradation and failure mechanisms that emerge from the confluence of highly coupled reactions with unpredictable operating and environmental stresses, defects, chemical impurities and other physical realities.[24,25,26] As a result, industry relies on years of empirical testing to identify and validate failure mechanisms.

To ensure the reliability of their products, manufacturers impose tight constraints on battery operating conditions that help guarantee battery life and safety. For example, most commercial lithium-ion battery systems only allow access to a fraction of the capacity stored by the device (ranging from 10% to 80%, depending on the application),[27] and power capabilities are likewise tightly restricted. Limiting battery utilization to achieve design life and safety is unavoidable due to the fundamental nature of degradation and failure mechanisms; however, today's restrictions are very conservative, severely limiting performance and increasing cost.

Conservative rule-based control is relied upon in part to deal with uncertainties in degradation and lifetime, but also to accommodate an inability to accurately determine a battery's state and vulnerability to failure. In theory, operating constraints are intended to manage the physical state of a battery cell and limit its susceptibility to adverse reactions. In practice, however, we lack the ability to probe parameters that directly reflect key physical properties related to the degradation and failure of batteries. State estimation in current battery management is based on simple voltage, current, and temperature measurements, which provide little direct information on the physical and chemical state internal to the cell. Moreover, these measurements generally lack the spatial and/or temporal resolution to adequately probe localized phenomena that can be key contributors to failure. With enhanced real-time state determination, not only could the fixed operating constraints imposed today be narrowed, they could be adjusted and

[22] Linden, D. and Reddy, T. Handbook of Batteries 3rd Edition, *McGraw-Hill*, 2001.
[23] Newman, J. and Thomas-Alyea, K.E., Electrochemical Systems 3rd Edition, *Wiley-Interscience*, 2004.
[24] Ramadesigan, V. *et al*. Modeling and simulation of lithium-Ion batteries from a systems engineering perspective. *J. of Electrochemical Soc*. 159, 3 (2012).
[25] Vetter, J. *et al*. Aging mechanisms in lithium-ion batteries. *J. Power Sources*, 147, 1-2 (2005).
[26] Broussely M. *et al*. Main aging mechanisms in Li-ion batteries. *J. Power Sources*, 146, 1-2 (2005).
[27] Turrentine, T. Plug-in Hybrid Electric Vehicle Research Roadmap. *UC Davis Plug-In Hybrid Electric Vehicle Research Center*, June 2011.

optimized dynamically to ensure maximum utilization at any given point in time. Advanced physical and electrochemical models that are able to deconvolve state-measurements to calculate and predict individual cell behavior is one possible enabler. Due to their high degree of complexity and long time to validation, these models have been of limited utility in setting real-time operational constraints and managing control of commercial systems. This is unlikely to change without entirely new tools and approaches to creating and validating such models for commercial use. Meanwhile, a compelling and underexplored alternative is to obviate the need for complex models by employing sensing technologies that can dramatically enhance the fidelity of current state-measurements, or *directly* probe physical parameters, such as structure and chemical composition, that would allow active and dynamic cell monitoring and management.

Moving from conservative rule-based management to control algorithms that rely instead on high-accuracy physical and electrochemical state determination could allow for dramatic improvements in performance. A recent study estimated that charging rates, overall power density, and available energy could be increased by approximately 50%, 22%, and 212%, respectively, for a hybrid-electric vehicle battery pack (6 Ah, 72 cell, 276 V Li-ion), by basing control on physical saturation/depletion and side reaction limits rather than more conservative fixed voltage limits.[28] ARPA-E believes that similar or even larger performance enhancements are possible with advanced battery management technologies based on better state determination and dynamic control.

Managing individual storage devices is a challenge; but even more difficult is the case of managing fully integrated battery systems, where hundreds or thousands of electrochemical cells are electrically coupled to meet energy and power requirements. The cost of monitoring and control of individual cells is currently not practical, so groups of cells in series and parallel configurations have coupled and interacting states. Moreover, cells subjected to different environments experience different degradation, a problem that is then accelerated by inter-cell interactions. This mandates active management of the environment and justifies the need for highly engineered and expensive thermal management. Even harder to manage is cell-to-cell variability, which despite efforts to bin cells for consistency, can cause cells to be driven into different states even when subjected to identical loads and environments.[29,30]

ARPA-E sees opportunity for innovation in design and control of systems to manage the difficulties of maintaining the state of health and safety of batteries. New approaches to achieve higher fidelity, more robust and lower cost sensing and control of the environment across a battery pack are needed. Approaches that optimize dispatch via

[28] Smith, K.A. and Wang, C.-Y. Power and thermal characterization of a lithium-ion battery pack for hybrid-electric vehicles. *J. Power Sources*, 160, 662-673 (2006).
[29] Moore, S. and Schneider, P. A review of cell equalization methods for lithium ion and lithium polymer battery systems. *Society of Automotive Engineers*, 2001.
[30] Dreyer, W. *et al*. The thermodynamic origin of hysteresis in insertion batteries. *Nature Materials,* 9, 448-453 (2010).

power electronics could also be employed to achieve performance gains in existing system architectures or to enable new designs that employ hybrid or flexible cell configurations. It is possible that a breakthrough can be achieved through any number of creative approaches; however, no solution will be transformational unless it can provide system level benefits that far exceed its implementation cost. AMPED seeks to support transformational new approaches to render novel system and control solutions that are feasible and cost-effective.

It is unlikely that any one particular innovation will completely solve the challenges of battery management. However, comprehensive system-level solutions that combine data from novel sensors with advanced models, system designs, and control paradigms can allow us to drastically enhance the utilization and rate capabilities of battery systems within safe limits, while extending their life and meeting operational requirements. Such an energy management system would be a game changer—significantly accelerating the adoption of energy storage for primary applications across a multitude of sectors and opening the door to dual or secondary use applications. Moreover, energy storage management breakthroughs will not only improve the capabilities of today's state-of-the-art technologies, but will also be applicable to new battery chemistries, thus providing a multiplier effect to the development of next generation energy storage materials and designs.

D. PROGRAM OBJECTIVES

AMPED seeks to support breakthrough solutions that offer a realistic path to achieve one or more of the targeted capabilities listed below. *Technologies that enable any single capability will be considered for award under this FOA, but a strong preference will be given to system-level solutions that can demonstrate the potential to substantially impact more than one of the objectives.*

Objective 1: Safety and Reliability

AMPED aims to reduce barriers to market-adoption and costs associated with safety risk and liability of current and future advanced battery systems. To constitute a significant improvement over the state-of-the-art, solutions should cost-effectively allow for fail-safe operation without the need for overly conservative energy and power utilization, while minimizing burdensome thermal and isolation system requirements. Approaches should manage known failure modes as well as those that are unexpected, such as events arising from cell design flaws, manufacturing defects, or unforeseen reactions occurring in use. AMPED seeks to enable the following new capabilities for improved safety:

Capability 1.1: *Real-time detection of internal cell faults*
Solutions should demonstrate the ability to detect internal mechanical faults with the goal of preventing costly and dangerous cell failures.

Capability 1.2: Prevention of catastrophic failure
Solutions should demonstrate the ability to automatically prevent catastrophic failure due to internal cell faults.

Objective 2: Performance

AMPED aims to drive adoption of energy storage systems with breakthroughs in performance enabled through superior energy management technologies. This objective area is intended to capture the following cost and performance improvements that advanced management technologies and architectures may provide:

Capability 2.1: System Performance Improvement
Solutions should demonstrate a significant enhancement in the overall performance of a battery system via a reduction in overdesign (cost, weight, or volume) and/or via an increase in operating performance (lifetime, energy utilization, and/or power utilization) through advances in battery management. Examples of approaches that may be employed to achieve this objective include, but are not limited to:

For Reducing Overdesign

- Approaches that enable more accurate state-of-charge (SOC) estimation for overdesign reduction
- Approaches that reduce battery management system component mass and/or volume (e.g. wiring, sensors, etc.)
- Approaches that enable safe and reliable operation of higher-capacity cells, yielding higher packing factor
- Approaches that relax requirements on other balance of system components (e.g. thermal, isolation, etc.)
- Approaches that reduce over-sizing needed to accommodate end-of-life performance

For Increasing Operating Performance

- Techniques that dynamically control SOC allowance to maximize utilization and/or lifetime, without compromising other key performance metrics
- Approaches that dynamically control power capability at high and low SOC to maximize utilization and/or lifetime, without compromising other key performance metrics

Capability 2.2: Charge Rate Improvement
Solutions should demonstrate the ability to enable charging at significantly higher rates than currently achievable, without compromising system safety, energy density, or lifetime. Examples of approaches that may be employed to achieve this objective include, but are not limited to:

- Approaches that enable safe charging at higher rates through the prediction or avoidance of

incipient cell faults
- Approaches that enable safe charging at higher rates through novel approaches to system design and/or control
- Approaches that utilize advanced SOC estimation to adaptively determine charging protocols

Objective 3: Prognostics

AMPED aims to reduce uncertainty of remaining battery life and value for primary and secondary applications. Improved prognostics are necessary to fully exploit the benefits of advanced robust and adaptive management solutions in primary applications. Meanwhile, use of batteries in secondary applications can unleash significant value, but remains unfeasible without a clear means to ensure that this additional value outweighs any potential impact on life and safety. AMPED seeks to enable the following new capabilities:

Capability 3.1: Improvement *in lifetime prediction of advanced battery systems*
Solutions should demonstrate the ability to predict how specific duty cycles would impact lifetime of advanced battery systems—more quickly, economically, and with a higher degree of accuracy than currently achievable.

E. TECHNICAL AREAS OF INTEREST

Areas of interest for this FOA include, but are not limited to the following: advanced sensing, diagnostic and prognostic technologies, energy storage system designs, and control capabilities. Specific areas of interest include:

Area 1: Online Sensing
- Sensors that probe internal physical cell properties directly (i.e. structure, chemical composition, temperature, pressure, etc.)
- Sensors leveraging techniques and approaches from other fields
- Sensing approaches leveraging rapid progress in cost-performance learning curves of underlying technologies
- Sensors providing dramatically enhanced spatial and/or temporal resolution relative to the state-of-the-art
- Sensors integrated into cells and/or packs as an added component or in the form of a smart component or additive
  Invasive and non-invasive cell-level or pack-level sensors

Area 2: Offline or Online characterization for fast monitoring and prediction
- Diagnostic and prognostic tools that can be integrated into charging equipment
- Tools that allow for rapid validation and parameterization of diagnostic and prognostic models

Area 3: Technologies that enable active cell-level balancing and control

- Technologies to dramatically enhance capabilities such as signal processing, thermal monitoring, connectors and wiring, communications, safety systems

Area 4: Technologies that facilitate low-cost, high-performance, and/or plug-and-play hybridization and integration of disparate devices.

Area 5: Technologies that offer new control capabilities via advanced models, mechanisms, or actuators.

- Physics-based models and control
- Adaptive/dynamic models and control
- Non-traditional charge/dispatch algorithms
- Stochastic optimization
- Novel load management approaches

Technical Areas Specifically Not of Interest

- Solutions that depend on new active cell chemistries (i.e. solutions that rely on anodes or cathodes not in commercial use today).
- Solutions that only apply to a specific cell chemistry, and fail to offer technical advances that could be adapted to provide similar benefits to other state-of-art or advanced chemistries within the same class. For example, a solution whose benefits would only apply to one specific Li-ion cathode system would not be of interest.
- Approaches focused on optimizing networks of geographically distributed storage devices (e.g. dispatch optimization of distributed grid-tied storage).
- Approaches that fail to show how component innovations will be employed to achieve system benefits.
- Solutions that provide benefit in one or more of the primary objective areas, but have a significant adverse effect on other key performance metrics (unless clearly addressed and justified by the applicant).
- Incremental improvements to, or combinations of, existing products and technologies, wherein no significant advances in technical state-of-the-art, or reductions in technical uncertainty, are achieved.
- Solutions that have already received significant financial support from other government agencies and/or the private sector.

F. TECHNICAL PERFORMANCE TARGETS

Applicants are encouraged to carefully review the program objectives and areas of interest above for guidance in preparing their proposals. Applications will not be considered for funding unless they have a well-justified, realistic potential to meet or exceed all of the primary technical targets for at least one of the stated target capabilities

by the end of the period of performance for the proposed project. Preference will be given to system-level solutions that can demonstrate the potential to substantially impact more than one of the Objectives.

a. Primary Technical Targets

The application must clearly address the following program elements and primary technical targets:

Objective 1: Safety

Capability 1.1: Real-time detection of internal cell faults

The proposed solutions must demonstrate the ability to detect an internal mechanical cell fault before such a fault leads to cell failure or causes any appreciable thermal elevation in the cell.

- The proposed solution must approach 100% diagnostic sensitivity, and exhibit not less than 95% diagnostic specificity, under normal operation.
  - Sensitivity = (true positive)/(true positive + false negative)
  - Specificity = (true negative)/(true negative + false positive)

- Applicant must show that the proposed solution is based on a detection mechanism that could credibly detect mechanical faults stemming from a range of sources, including but not limited to, cell design flaws, manufacturing defects, unforeseen reactions, and abusive or aggressive operation.

- Validation protocol should ideally establish all of the following performance attributes:
  - Diagnostic performance
    - Time-before-failure detection capability
    - Sensitivity
    - Selectivity
  - Robustness to detect faults stemming from different causes
  - Ability to detect in a practical system environment (i.e. ability to detect for cells coupled in series or series/parallel configurations)

Capability 1.2: Prevention of catastrophic failure

The proposed solution must demonstrate the ability to prevent catastrophic failure due to internal cell faults with 100% effectiveness.

- The proposed solution must not significantly degrade cell performance capabilities under normal operation.

- If the prevention mechanism will impact cell performance (e.g. render the cell unusable), it should not be triggered unless an impending failure is imminent.

- Applicant must show that the proposed solution is based on a prevention mechanism that can reliably prevent failures stemming from a range of sources, including but not limited to, cell design flaws, manufacturing defects, unforeseen reactions, and abusive or aggressive operations and environments.

- Validation protocol should establish the following performance attributes:
  - Reliability of prevention
  - Robustness to preventing catastrophic failures stemming from different causes

Objective 2: Performance

Capability 2.1: Overall System Improvement:

- Applicant must demonstrate that the proposed solution can offer a significant enhancement in the overall performance of a battery system via a reduction in overdesign (cost, weight, or volume) and/or via an increase in operating performance (lifetime, energy utilization, and/or power utilization). For example:

  - For Vehicles: greater than 25% reduction in up-front cost, weight, or volume at the system level vs. what is achievable with state-of-the-art management, without impacting performance.
  - For Grid: greater than 2X increase in total generated revenue through dispatch of the battery system vs. what is achievable with state-of-the-art management.

- Specific targets proposed by Applicant should be constructed in relation to a specific application, and Applicant must clearly justify how reaching the stated targets in a commercial system would lead to significantly greater adoption and impact.

Capability 2.2: Charge Rate Improvement

- Applicant must demonstrate that the proposed solution can enable Commercially viable charging from a depleted state to 80% nameplate capacity at an average rate that:
    - Is at least 2x faster when compared against charging specifications for the best-in-class commercial system utilizing the same chemistry; and
    - Allows for such charging at no greater than 20 minutes

- Applicant must quantify and justify any adverse impact on cost or performance associated with their proposed fast charging method, based on the application and use-case.

Objective 3: Prognostics

Capability 3.1: Improvement in Lifetime Prediction of Advanced Battery Systems

- Given a battery with unknown environmental and operational history, the proposed solution should demonstrate the ability to predict remaining lifecycle energy throughput against any given duty cycle to within ±10% accuracy.

- Prognostic methods should adhere to the following restrictions
    - Testing should not involve more than 10 charge-discharge cycles and not more than 48 hours of testing to the battery system
    - Testing must not involve any techniques that have a significant adverse effect on the performance or lifetime of the device

- Applicants must clearly describe and justify the commercial relevance of the prediction method and anticipated use-cases (e.g. applicability to online control optimization, repurposing, new product validation, etc.)

- Validation protocol should ideally establish all of the following performance attributes:

- Prognostic accuracy
- Ability to predict lifetime for systems exposed to different operating histories and against new duty cycles

Additional Primary Targets for All Areas

In all cases, applicants must present data to quantitatively describe all of the following:

- The anticipated performance metrics of the proposed technology concept.
- The performance metrics of the current state-of-the-art and why the proposed metrics are a significant advance.
- Practical integration issues including signal fidelity, communication, data processing, and other aspects of implementation.
- Specifically how the proposed technology will affect system-level performance in key performance areas. Solutions that provide benefit in one or more of the primary objective areas, but have a significant adverse effect on other key performance metrics must be clearly justified.
- Specifically how the proposed technology will be leveraged to achieve system-level benefits, and the extent of those benefits. Note: Any projections or estimations of benefits must be supported by techno-economic model(s) with explicitly stated assumptions and variables.
- A clear protocol for testing and quantitatively evaluating the degree to which the stated performance targets have been achieved. Whenever possible, improvements enabled by the battery management system should (1) be validated on test systems employing state-of-the-art commercial cells from an established large-volume manufacturer, and (2) demonstrate applicability of the solution to practical systems (i.e. packs integrating multiple cells and with capacity >5kWh) within targeted applications in vehicles and/or the grid.
- The market relevance of the proposed solution.
- The ease with which the proposed solution, if successful, may be adapted to provide benefits to other state-of-the-art or advanced battery systems and chemistries.

Performance targets must be clearly stated, and the applicants shall propose final deliverables that are aligned with all targets.

Project Teams

AMPED aims to demonstrate advanced technologies that can offer significant system-level benefits for vehicle and grid energy storage applications. While some proposals may focus on component-level solutions, an understanding of the system and application will be important in order to assess how the technology will be used and how it will provide the intended benefit. As a result, we strongly encourage the formation of project teams that include complementary expertise in all aspects of the proposed solution, thus making the team uniquely suited to effectively demonstrate the technical capability as well as its relevance and applicability in commercial systems. In addition, applicants should note the following project team requirements:

- Applicants developing solutions that primarily focus on modeling should have significant involvement from an OEM or system integrator.

- Applicants developing solutions that rely on internal modifications to battery cells should have significant involvement from a battery manufacturer, component supplier, or other organizations with high-quality cell fabrication capability.

Seedling/Proof of Concept funding category for novel partial solutions

ARPA-E recognizes that there may be new high-impact ideas related to the aforementioned areas of interest that are exploratory in nature and may not yet be mature enough to meet the scale and degree of validation required in the primary targets above. For such unproven and yet promising ideas, ARPA-E seeks smaller seedling applications to conduct experiments to achieve a proof-of-concept. In this case, the proof-of-concept experiments must be designed in a way that the results obtained clearly indicate paths to approach full system applicability. See Section II.A below for further details.

G. APPLICATIONS SPECIFICALLY NOT OF INTEREST

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

- Applications that fall within the "Technical Areas Specifically Not of Interest" specified in Section I.E of the FOA.

- Applications for basic research aimed at discovery and 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 that do not address at least one of ARPA-E's Mission Areas (see Section I.A of the FOA).

- Applications for proposed technologies that are not transformational, as described in Section I.A of the FOA. Transformational, as illustrated in Figure 1 in Section I.A of the FOA, is the promise of high payoff in some sector of the energy economy.

- 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).

II. AWARD INFORMATION

A. AWARD OVERVIEW

ARPA-E expects to make approximately $30 million available for new awards under this FOA, subject to the availability of appropriated funds. ARPA-E anticipates making approximately 12-17 awards under this FOA. ARPA-E may issue one, multiple, or no awards.

Individual awards may vary between $250,000 and $10 million. ARPA-E will provide support at the upper ranges only for applications with significant technology risk, aggressive timetables, and careful management and mitigation of the associated risks.

The period of performance for funding agreements may range between a minimum of 12 months and a maximum of 36 months. ARPA-E expects the start date for funding agreements to be January 1, 2013, or as negotiated.

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

ARPA-E may issue awards in one or both of the following funding categories: "Proof-of-Concept Seedling Project" and "Technology Development Project."

- **Proof-of-Concept Seedling Project:** Awards range between $250,000 and $999,999.99. These projects typically focus on early-stage, proof-of-concept level R&D efforts.[31] Applicants should submit evidence of an idea, described in sufficient technical detail to allow reviewers to meaningfully evaluate the proposed project. ARPA-E may issue approximately 3 - 5 awards in this category, with an average award amount of $500,000.

- **Technology Development Project**: Awards range between $1 million and $10 million. These projects typically focus on early-stage prototypes of various technology concepts for which some kind of initial proof-of-concept component demonstration already exists. Applicants should submit concrete data that supports the success of the proposed project. ARPA-E may issue approximately 8 - 12 awards in this category, with an average award amount of $3 million.

ARPA-E may establish more than one budget period for each award and fund only the initial budget period(s). Applicants are not guaranteed funding beyond the initial budget period(s). Before the expiration of the initial budget period(s), ARPA-E may perform a down-select among different recipients and provide additional funding only to a subset of recipients.

B. ARPA-E FUNDING AGREEMENTS

Through Cooperative Agreements, Technology Investment Agreements, and similar agreements, ARPA-E provides financial and other support to projects that have the potential to realize ARPA-E's statutory mission. ARPA-E does not use such agreements to acquire property or services for the direct benefit or use of the U.S. Government.

Congress directed ARPA-E to "establish and monitor project milestones, initiate research projects quickly, and just as quickly terminate or restructure projects if such milestones are not achieved."[32] Accordingly, ARPA-E has substantial involvement in the direction of every project, as described in Section II.C below.

1. COOPERATIVE AGREEMENTS

ARPA-E generally uses Cooperative Agreements to provide financial and other support to Prime Recipients.[33]

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

[31] An early-stage, proof-of-concept project will be considered a "Technology Development Project" if the proposed budget exceeds $1 million.
[32] U.S. Congress, Conference Report to accompany the 21st Century Competitiveness Act of 2007, H. Rpt. 110-289 at 171-172 (Aug. 1, 2007).
[33] The Prime Recipient is the signatory to the funding agreement with ARPA-E.

Agreements, the Government and Prime Recipients share responsibility for the direction of projects.

ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement, which is available at http://arpa-e.energy.gov/FundingAgreements/Overview/Award.aspx#Cooperative_Agreements, in advance of award negotiations. ARPA-E created the Model Cooperative Agreement to facilitate and expedite award negotiations. **By submitting a Full Application, the Applicant accepts all terms and conditions in Attachments 1, 2, 4, and 6 of ARPA-E's Model Cooperative Agreement.** ARPA-E will not consider any changes to Attachments 1, 2, 4, and 6 unless they are requested in the Business Assurances Form submitted with the Full Application.

2. FUNDING AGREEMENTS WITH FFRDCS, GOGOS, AND FEDERAL INSTRUMENTALITIES[34]

Any Federally Funded Research and Development Centers (FFRDC) involved as a member of a Project Team must complete the "FFRDC Authorization" and "Field Work Proposal" section of the Business Assurances Form, which is submitted with the Applicant's Full Application.

When a FFRDC is the *lead organization* for a Project Team, ARPA-E executes a funding agreement directly with the FFRDC and a single, separate Cooperative Agreement with the rest of the Project Team. Notwithstanding the use of multiple agreements, the FFRDC is the lead organization for the entire project, including all work performed by the FFRDC and the rest of the Project Team.

When a FFRDC or non-DOE/NNSA GOGO is a *member* of a Project Team, ARPA-E executes a funding agreement directly with the FFRDC or non-DOE/NNSA GOGO and a single, separate Cooperative Agreement with the rest of the Project Team. Notwithstanding the use of multiple agreements, the Prime Recipient under the Cooperative Agreement is the lead organization for the entire project, including all work performed by the FFRDC or non-DOE/NNSA GOGO and the rest of the Project Team.

Funding agreements with DOE/NNSA FFRDCs take the form of Work Authorizations issued to DOE/NNSA FFRDCs through the DOE/NNSA Field Work Proposal system for work performed under Department of Energy Management & Operation Contracts. Funding agreements with non-DOE/NNSA FFRDCs, GOGOs, and Federal instrumentalities (e.g., Tennessee Valley Authority) generally take the form of Interagency Agreements. Any funding agreement with a FFRDC or non-DOE/NNSA GOGO will have substantially similar terms and conditions as ARPA-E's Model Cooperative Agreement (http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx).

[34] DOE/NNSA GOGOs are not eligible to apply for funding, as described in Section III.A of the FOA.

3. TECHNOLOGY INVESTMENT AGREEMENTS

ARPA-E may use its "other transactions" authority under the America COMPETES Reauthorization Act of 2010 or DOE's "other transactions" authority under the Energy Policy Act of 2005 to enter into Technology Investment Agreements with Prime Recipients. ARPA-E may negotiate a Technology Investment Agreement in order to:

- Encourage for-profit entities to participate in projects in which they would not otherwise participate;
- Facilitate the creation of new relationships among participants in a team that will foster better technology;
- Encourage Prime Recipients to use new business practices that will foster better technology or new technology more quickly or less expensively; or
- Enhance U.S. economic and energy security and/or maintain U.S. technological leadership in key energy sectors.

In a Technology Investment Agreement, ARPA-E may modify standard Government terms and conditions, including but not limited to:

- Intellectual property provisions: ARPA-E may negotiate special arrangements with Prime Recipients to avoid the encumbrance of existing intellectual property rights or to facilitate the commercial deployment of inventions conceived or first actually reduced to practice under the ARPA-E funding agreement.
- Accounting provisions: ARPA-E may authorize the use of generally accepted accounting principles (GAAP) where Prime Recipients do not have accounting systems that comply with Government recordkeeping and reporting requirements.

If Applicants are seeking to negotiate a Technology Investment Agreement, they are required to include an explicit request in their Full Applications. Please refer to the Business Assurances Form for guidance on the content and form of the request.

Please refer to Section III.B.2 of the FOA for guidance on cost share requirements for TIAs.

4. GRANTS

Although ARPA-E has the authority to provide financial support to Prime Recipients through Grants, ARPA-E generally does not fund projects through Grants.

5. PROCUREMENT CONTRACTS

Although ARPA-E has the authority to contract with Applicants to purchase goods or services for the benefit of the Government, ARPA-E generally does not fund projects through Contracts.

C. STATEMENT OF SUBSTANTIAL INVOLVEMENT

Generally, ARPA-E is substantially involved in the direction of projects (regardless of the type of funding agreement) from inception to completion. For the purposes of an ARPA-E project, substantial involvement means:

- ARPA-E shares responsibility with Prime Recipients for the direction of projects.
- ARPA-E may intervene at any time to address the conduct or performance of project activities.
- 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 project as a whole.
- Prime Recipients are required to submit detailed quarterly technical and financial reports on the project, as described in Attachment 4 to ARPA-E's Model Cooperative Agreement (http://arpa-e.energy.gov/FundingAgreements/Overview/Award.aspx#Cooperative_Agreements)
- ARPA-E Program Directors share responsibility with Prime Recipients for the direction of projects. During award negotiations, ARPA-E Program Directors 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 progress reports, which are reviewed and evaluated by ARPA-E Program Directors. 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.[35] Upon request, Prime

[35] To request reimbursement, Prime Recipients must submit: (1) a Standard Form (SF) 270 ("Request for Advance or Reimbursement"); (2) a "Reimbursement Request Spreadsheet," which must contain the information shown in Appendix B to Attachment 1 of ARPA-E's Model Cooperative Agreement (http://arpa-e.energy.gov/FundingAgreements/Overview/Award.aspx#Cooperative_Agreements); and (3) supporting documentation, which may consist of summary information (e.g., printouts from internal financial systems) or detailed documentation (e.g., invoices on appropriate letterhead, time cards, travel vouchers). The supporting

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.4-5 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 public entities to provide continued support for the development and deployment of ARPA-E-funded technologies.

documentation must show the method by which the Prime Recipient calculated the total Federal share and non-Federal cost share.

III. ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS

1. INDIVIDUALS

U.S. citizens or permanent residents may apply for funding in their individual capacity as a Standalone Applicant,[36] as the lead for a Project Team,[37] or as a member of a Project Team.

2. DOMESTIC ENTITIES

For-profit entities, educational institutions, and nonprofits[38] that are incorporated in the United States, including U.S. territories, are eligible to apply for funding as a Standalone Applicant, as the lead organization for a Project Team, or as a member of a Project Team.

FFRDCs are eligible to apply for funding as the lead organization for a Project Team or as a member of a Project Team, but not as a Standalone Applicant.

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

Non-DOE/NNSA GOGOs are eligible to apply for funding as a member of a Project Team, but not as a Standalone Applicant or as the lead organization for a Project Team.

State and local government entities are eligible to apply for funding as a member of a Project Team, but not as a Standalone Applicant or as the lead organization for a Project Team.

3. FOREIGN ENTITIES

Foreign entities, whether for-profit or otherwise, are eligible to apply for funding as Standalone Applicants, as the lead organization for a Project Team, or as a member of a Project Team. All work by foreign entities must be performed by subsidiaries or affiliates incorporated in the United States (including U.S. territories). The Applicant may request a waiver of this requirement in the Business Assurances Form, which is submitted with the Full Application. Please refer to the Business Assurances Form for guidance on the content and form of the request.

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[36] A Standalone Applicant is an Applicant that applies for funding on its own, not as part of a Project Team.

[37] 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.

[38] 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 Prime Recipient or Subrecipient.

4. CONSORTIUM ENTITIES

Consortia, which may include domestic and foreign entities, must designate one member of the consortium as the consortium representative to the Project Team. The consortium representative must be incorporated in the United States. The eligibility of the consortium will be determined by reference to the eligibility of the consortium representative under Section III.A.4 of the FOA. Each consortium must have an internal governance structure and a written set of internal rules. Upon request, the consortium entity must provide a written description of its internal governance structure and its internal rules to the Contracting Officer (ARPA-E-CO@hq.doe.gov).

Unincorporated consortia must provide the Contracting Officer with a collaboration agreement, commonly referred to as the articles of collaboration, which sets out the rights and responsibilities of each consortium member. This agreement binds the individual consortium members together and should discuss, among other things, the consortium's:

- Management structure;
- Method of making payments to consortium members;
- Means of ensuring and overseeing members' efforts on the project;
- Provisions for members' cost sharing contributions; and
- Provisions for ownership and rights in intellectual property developed previously or under the agreement.

B. COST SHARING OR MATCHING[39]

Applicants are bound by the cost share proposed in their Full Applications. In the Business Assurances Form accompanying the Full Application, Applicants must provide written assurance of their cost share commitments. Please refer to the Business Assurances Form available on ARPA-E eXCHANGE (https://www.arpa-e-foa.energy.gov) for additional guidance.

1. GENERAL COST SHARE REQUIREMENT

ARPA-E generally uses Cooperative Agreements to provide financial and other support to Prime Recipients (see Section II.B.1 of the FOA). Under a Cooperative Agreement, the Prime Recipient

[39] Please refer to Section VI.B.4-5 of the FOA for guidance on cost share payments and reporting.

must provide at least 20% of the Total Project Cost[40] as cost share except as provided in Sections III.B.2 or III.B.3 below. [41]

2. INCREASED COST SHARE REQUIREMENT

Large businesses are strongly encouraged to provide more than 20% of the Total Project Cost as cost share. ARPA-E considers the amount of cost share proposed by large businesses when selecting applications for award negotiations (see Section V.B.1 of the FOA).

The Prime Recipient may request the use of a Technology Investment Agreement (instead of a Cooperative Agreement) in the Business Assurances Form submitted with the Full Application (see Section II.B.3 of the FOA). Under a Technology Investment Agreement, the Prime Recipient must provide at least 50% of the Total Project Cost as cost share. ARPA-E, with the approval of the Contracting Officer, may reduce this minimum cost share requirement, as appropriate.

3. REDUCED COST SHARE REQUIREMENT

ARPA-E has reduced the minimum cost share requirement for the following types of projects:

- A domestic educational institution or domestic nonprofit applying as a Standalone Applicant is required to provide at least 5% of the Total Project Cost as cost share.

- Project Teams composed exclusively of domestic educational institutions, domestic nonprofits, and/or FFRDCs are required to provide at least 5% of the Total Project Cost as cost share.

- Project Teams where domestic educational institutions, domestic nonprofits, and/or FFRDCs 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) are required to provide at least 10% of the Total Project Cost as cost share.

Projects that do not meet any of the above criteria are subject to the minimum cost share requirements described in Sections III.B.1 and III.B.2 of the FOA.

4. 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

[40] 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 FFRDCs and GOGOs.
[41] Energy Policy Act of 2005, Pub.L. 109-58, sec. 988.

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.

5. 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.

6. COST SHARE TYPES AND ALLOWABILITY

Every cost share contribution must be allowable under the applicable Federal cost principles, as described in Section IV.F.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 to meet their cost share obligations under cooperative agreements. However, Project Teams may use IR&D funds to meet their cost share obligations under Technology investment 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.

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 and 603 for additional guidance on cost sharing, specifically 10 C.F.R. §§ 600.30, 600.123, 600.224, 600.313, and 603.525-555.

7. COST SHARE CONTRIBUTIONS BY FFRDCS AND GOGOS

Because FFRDCs and GOGOs are funded by the Federal Government, costs incurred by FFRDCs and GOGOs 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.

8. COST SHARE VERIFICATION

Applicants are required to provide written assurance of their proposed cost share contributions in their Full Applications. Please refer to the Business Assurances Form for guidance on the cost share information that must be included.

Upon selection for award negotiations, Applicants are required to provide additional information and documentation regarding their cost share contributions. Please refer to Section VI.B.4 of the FOA for guidance on the requisite cost share information and documentation.

C. OTHER

1. COMPLIANT CRITERIA

Notices of Intent are deemed compliant if:

- The Applicant entered all required information and clicked the "Create Submission" button in ARPA-E eXCHANGE by the deadline stated in the FOA.

ARPA-E will not review or consider noncompliant Notices of Intent, including Notices of Intent submitted through other means, Notices of Intent submitted after the applicable deadline, and incomplete Notices of Intent.

Full Applications are deemed compliant if:

- The Applicant submitted a compliant Notice of Intent;
- The Applicant meets the eligibility requirements in Section III.A of the FOA;
- The Full Application complies with the content and form requirements in Section IV.C 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 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.

2. RESPONSIVENESS CRITERIA

ARPA-E performs a preliminary technical review of each Full Application. Any "Applications Specifically Not of Interest," as described in Section I.G 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.

IV. APPLICATION AND SUBMISSION INFORMATION

A. APPLICATION FORMS

Required forms for Full Applications are available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the SF-424, SF-424A, Business Assurances Form, and Other Sources of Funding Disclosure form. A sample response to the Other Sources of Funding Disclosure form is attached to this FOA as Appendix 2. A sample response to the Business Assurances Form is attached to this FOA as Appendix 3. Applicants must use the templates available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov), including the template for the Technical Volume of the Full Application, the template for the Technical Milestones section of the Technical Volume, the Summary Slide template, and the Reply to Reviewer Comments template. A sample Summary Slide is attached to this FOA as Appendix 1.

B. CONTENT AND FORM OF NOTICE OF INTENT

Each Applicant must enter the following information into ARPA-E eXCHANGE by the deadline stated in the FOA:

- Project Title;
- Lead Organization;
- Organization Type (Business < 500 Employees; Business > 1000 Employees; Business 500-1000 Employees; Federally Funded Research and Development Center (FFRDC); Government Owned and Operated; Non-Profit; University);
- Whether the application has been previously submitted to DOE;
- The Principal Investigator for the Prime Recipient;
- Technical Area (see Section I.E of the FOA); and
- Abstract – The abstract provided should be 200 words in length, and should provide a truncated explanation of the proposed project.

ARPA-E will not review or consider noncompliant Notices of Intent (see Section III.F.1 of the FOA).

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. The Control Number must be included in the header of the Full Application and optional Reply to Reviewer Comments.

C. CONTENT AND FORM OF FULL APPLICATIONS

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. Use Times New Roman typeface, a black font color, and a font size of 12 points or larger (except in figures and tables). A Symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies.
- 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 and/or nonresponsive Full Applications (see Section III.C 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.

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. Applicants must use the Technical Volume template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov). In addition, Applicants must use the Technical Milestones template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov) for the Technical milestones section of the Technical Volume.

SF-424	PDF	Application for Federal Assistance (https://arpa-e-foa.energy.gov)
SF-424A	XLS	Budget Information – Non-Construction Programs (https://arpa-e-foa.energy.gov)
Summary for Public Release	PDF	Short summary of the proposed R&D project. Intended for public release.
Summary Slide	PPT	A four-panel slide summarizing different aspects of the proposed R&D project. Applicants must use the Summary Slide template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov).
Business Assurances Form	PDF	Requires the Applicant to disclose potential improprieties, potential conflicts of interest within the Project Team, and written assurance of its cost share commitment. 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 modification or waiver of the Performance of Work in the United States requirement, the TT&O spending requirement, and/or the U.S. manufacturing requirement. In addition, allows the Applicant to request the use of a Technology Investment Agreement. This form is available on ARPA-E eXCHANGE at https://arpa-e-foa.energy.gov. A sample response to the Business Assurances Form is attached to this FOA as Appendix 3.
Other Sources of Funding Disclosure Form	PDF	Requires the PI to describe the additionality and risks associated with the proposed project, disclose financial assistance from Federal entities, disclose funding from non-Federal entities for related work, and provide letters or other communications from private investors explaining why they decided not to fund the proposed R&D project. This form is available on ARPA-E eXCHANGE at https://arpa-e-foa.energy.gov. A sample response to the Other Sources of Funding Disclosure form is provided as Appendix 2 to this FOA.
Budget Justification Workbook	XLS	Applicants are required to submit a Budget Justification Workbook to accompany and justify the costs listed in the SF-424A. The Budget Justification Workbook is available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov).

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. If Applicants exceed the maximum page lengths 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).

SECTION	PAGE LIMIT	DESCRIPTION
Technical Area	0.5 pages max.	• Provide the Technical Area addressed by the Application. The response for this section must match the response to the Technical Area portion of the Notice of Intent.
Technical Approach	1 page max.	▪ Provide a concise summary of the proposed R&D project. The summary should be written for a technically literate, but non-specialist, audience.
R&D Tasks	1 page max.	▪ Describe succinctly: o the purpose of the proposed R&D project, o the underlying hypothesis(es)/technical concept(s) guiding the approach, and o a list of the tasks the research team will undertake and accomplish to achieve this purpose.
R&D Strategy	20 pages max.	• Applicants are <u>required</u> to address the following factors: o <u>Innovation</u> – Describe specifically: ▪ the performance of the current state of the art in the specific technology area of the application, ▪ how the work proposed is a departure from currently available technology and/or represents a significant improvement to the performance of the current state of the art, ▪ how the proposed approach differs from others under investigation in the field, and ▪ how the work, if successful, could leapfrog today's approaches and significantly impact both technology and business. o <u>Preliminary Results</u> – Provide preliminary data and results (if available) that support the feasibility of the application. o <u>Significance With Respect to FOA Requirements and Targets</u> – Describe specifically: ▪ how the proposed effort is responsive to each aspect of the detailed FOA topic description, and ▪ the impact that successful completion of the proposed work would have on the FOA target areas. o <u>Performance Team</u> – Describe succinctly: o the members of the proposed research team, and o why the proposed team is uniquely qualified to carry out the proposed research. Synopses of past research accomplishments are insufficient to

		demonstrate that a team is "uniquely qualified." Applicants are required to identify the unique combination of training and experience that make the proposed team uniquely qualified to successfully execute the proposed project. Preference will be given to multidisciplinary teams where different Project Team members complement each other and have expertise in different aspects of the technology.
Statement of Project Objectives	5 pages max.	• Applicants must complete Part A of Attachment 3 to the ARPA-E Model Cooperative Agreement (http://arpa-e.energy.gov/FundingAgreements/Overview/Award.aspx#Cooperative_Agreements) in accordance with the instructions below. The Statement of Project Objectives should provide a clear and concise statement of the project goals and expected outcomes. If the Applicant is selected for award negotiations, the ARPA-E funding agreement will incorporate this Statement of Project Objectives and may be released to the public. o Objectives: Please provide a single paragraph discussing both (1) the overall objective(s) of the work and (2) the objective(s) for each phase of the work described in R&D Tasks above. Please do not include any confidential, proprietary, or privileged information in the Objectives. o Scope of Work: Please summarize the effort and approach to achieve the objective(s) of the work for each phase of the work described in R&D Tasks above. The Scope of Work section should not exceed one half-page. Please do not include any confidential, proprietary, or privileged information in the Scope of Work. In addition, please do not include dollar amounts, specific dates, or names of Subrecipients.
Validation Protocols	5 pages max.	• Applicants must present a clear protocol for testing and quantitatively evaluating the degree to which the stated performance targets have been achieved. Whenever possible, improvements enabled by the battery management system should (1) be validated on test systems employing state-of-the-art commercial cells from an established large-volume manufacturer, and (2) demonstrate applicability of the solution to practical systems (i.e. packs integrating multiple cells and with capacity >5kWh) within targeted applications in vehicles and/or the grid. • As an example, the following testing protocol illustrates one possible approach to validating target performance for a solution addressing Capability 1.1 above in Section I.D. Note that this example is provided as general guidance only, and is

		not a specific requirement: *We will construct a proxy battery pack comprising 5 cells in series configuration. This test pack will incorporate our detection technology and other system components representative of a commercially relevant use environment.* *A highly aggressive duty profile (designed based on predetermined criteria) will be applied to the test pack, followed by a rest period, and subsequent application of a slightly more power-intensive version of the same duty profile. This will be repeated until the application of the duty profile causes a failure in at least one cell within the pack.* *During each rest period, we will diagnose the system and predict whether a failure will occur in one of the next 3 cycles. If we predict a failure, and failure occurs, we will register a True Positive detection. If we predict a failure, and no failure occurs, we will register a False Positive detection, and end the test. If a failure occurs, which we had not predicted, we will register a False Negative detection. We will repeat this experiment 100 times, and report the following data:* ➢ *Sensitivity* ➢ *Specificity* ➢ *Detection failure rate, defined as # of False Negative detections / Total # of tests* *This experiment will be carried out using state-of-the-art commercial cells from an established large-volume manufacturer to test predictive capability of failure due to aggressive or abusive cycling. Separately, to test predictive capability of failures arising from defective cells, the same test protocol will be employed on a sample of cells in which intentionally defected cells have been randomly included.*
Technical Milestones and Deliverables	5 pages max.	• Applicants must submit proposed technical milestones and deliverables using the Technical Milestones template available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/). • Applicants are required to provide a set of detailed technical milestones and deliverables

		based on the tasks described in the "R&D Tasks" section above. The milestones and deliverables should provide a clear path to completion of the R&D Tasks, with specific proposed "Go/No-Go" milestones at the end of each year of the proposed project. Milestones should be concrete, objective, and quantitative. ARPA-E evaluates the progress of a project by comparing actual progress to predetermined technical milestones and deliverables. Milestones are not aspirational, nor do they describe simple effort (e.g. examine 10 strains; complete report). Milestones describe specific, objective quantitative deliverables due every quarter (e.g. production of xx g/L of fuel; energy density of yyW h kg-1). Aggressive technical milestones and deliverables are required for all projects. Technical milestones and deliverables help focus effort and resources on critical path technology components. Annual/End-of-Project milestones may be subject to independent measurement or verification. ARPA-E Program Directors will require revisions to proposed technical milestones and deliverables during award negotiations. In addition, ARPA-E Program Directors may modify or terminate projects that fail to achieve predetermined technical milestones and deliverables.
Budget Summary	2 pages max.	• Applicants are required to provide a two-page budget summary, broken down by milestones. The summaries must conform to the following guidelines: o The budget summary should be clearly associated with the milestones outlined as part of the Technical R&D Plan and reflect quarterly progress on the proposed project. o All major equipment purchases must be included in the budget summary. For equipment acquired as part of the proposed R&D project, state the proposed disposition of the equipment after the project's completion. Specifically, state if the useful life of the equipment will correlate with its authorized purpose under the proposed project. o If costs are less than would normally be expected due to large amounts of previous R&D work done by one or more members of the research team, please describe and explain accordingly. o Applicants are required to estimate the potential materials and manufacturing costs of the proposed technology to justify the technology's potential to approach, meet, or exceed the cost targets given in each FOA. In making these estimations, Applicants must describe the manufacturing approaches that will most likely scale up the proposed technologies.

Qualifications, Experience, and Capabilities	For each PQS, 3 page max.	• Applicants are required to provide a Personal Qualification Summary (PQS) for the PI and a PQS for each Key Participant.[42] Each PQS is limited to 3 pages maximum. Curriculum vitae will not be considered. Each PQS must include: o Education/training, o Employment history, o Awards and honors, o Up to 10 peer-reviewed publications specifically related to the proposed R&D project, o Up to 10 other peer-reviewed publications demonstrating capabilities in the broad field, and o Up to 10 non-peer reviewed publications and patents demonstrating capabilities in the broad field.
Participating Organizations	1 page max.	• Describe succinctly why each proposed organization is qualified to accomplish their portion of the proposed R&D project. Please describe the Project Team's unique qualifications, expertise, equipment, or facilities that will facilitate the successful completion of the proposed project.
Prior Collaboration	1 page max.	• Describe succinctly: o any prior projects, programs, and initiatives on which the Project Team has collaborated; o the roles of each Project Team member in the project, program, or initiative; o whether the project, program, or initiative was ultimately successful; and o any management, intellectual property, or other issues that arose within the Project Team and how they were resolved.
Management Plan	1 page max.	• An effective management plan is essential to ensure continuous effective communication between performance members. Describe succinctly: o the roles of each Project Team member; o any critical handoffs/interdependencies between Project Team members; o the technical (i.e., decision-making based on technical understanding of the problem) and management (i.e., monitoring different elements of the project and technology to ensure that it is well-integrated) aspects of the Management Plan and the role of the PI.

[42] A Key Participant is any individual who would contribute in a substantive, measurable way to the execution of the proposed project.

Multi-Investigator Projects	2 pages max.	• Roles of Participants: For multi-organizational or multi-investigator projects, describe succinctly: o the roles and the work to be performed by each PI and Key Participant; o business agreements between the Applicant and each PI and Key Participant; and o how the various efforts will be integrated and managed. • Multiple PIs: Standalone Applicants and Project Teams are required to disclose if the project will include multiple PIs. If multiple PIs will be designated, identify the Contact PI/Project Coordinator, and provide a "Coordination and Management Plan" that describes the organization structure of the project as it pertains to the designation of multiple PIs. This plan should include: o process for making decisions on scientific/technical direction; o publication arrangements; o intellectual property issues; o communication plans; o procedures for resolving conflicts; and o PIs' roles and administrative, technical, and scientific responsibilities for the project.
Transition/ Commercialization Strategy	2 pages max.	• ARPA-E supports energy technology R&D projects for a limited period of time at critical high-risk points in the technology development cycle. ARPA-E technologies **are not required to** achieve commercial deployment by the end of the project period; however, funded projects must be on a reasonable path toward making substantive impact on ARPA-E's mission areas through ultimate commercial adoption and wide-scale market deployment. Please describe: o High-level milestones for development that follow the end of the proposed project; o the path by which the proposed technology is expected to transition from its current stage of development and continuing through to ultimate commercial deployment; o specific organizations (partners, customers, etc.) expected to be involved in transition of the technology from research to commercial deployment and their anticipated involvement; and o resource needs for the next phase of development that follows the end of the ARPA-E project ; o why the proposed research is not being pursued by industry today; and o why a successful project outcome will result in a commercially viable outcome. • Applicants are required to certify in the Full Application that they have met the 5%

		requirement for TT&O expenditures in their SF424A unless they submit a waiver request in the Business Assurances Form. See Section IV.F.8 of the FOA for guidance on TT&O expenditures.
Intellectual Property Strategy	No page limit	• Describe specifically: o existing intellectual property that will be used to develop the new intellectual property o new intellectual property and data that will be created as part of this effort; o how the intellectual property strategy will increase the probability that the proposed transformational technology will reach the market and widely penetrate the installed base; and o the plan for disposition/ownership of the intellectual property, including intellectual property agreements or memorandums of understanding between Project Team members.

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 January 1, 2013, or as negotiated.
- The list of certifications and assurances in Block 21 can be found at http://management.energy.gov/documents/CERTSASSUR.doc.
- 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.

3. THIRD COMPONENT: SF-424A

Applicants are required to complete the SF-424A Excel spreadsheet entitled "Budget Information Non-Construction Programs." The SF-424A must be submitted in Microsoft Excel format. This form is available on ARPA-E eXCHANGE at https://arpa-e-foa.energy.gov.

Applicants must create multiple, separate tabs in the SF-424A workbook, as described below.

- For the project as a whole (i.e., all work to be performed by the Project Team under the ARPA-E funding agreement), Applicants must create:

(1) One tab showing the budget for the entire project period (from the project start date to the project end date) by budget category element for requested Federal funding and by budget category element for non-Federal funding contributed as cost share, and

(2) A separate tab showing the budget for each year of the project period by budget category element for requested Federal funding and by budget category element for non-Federal funding contributed as cost share.

- For each FFRDC participant, Applicants must create:

(1) One tab showing the FFRDC budget for the entire project period (from the project start date to the project end date) by budget category element for requested Federal funding and by budget category element for non-Federal funding contributed as cost share (if applicable), and

(2) A separate tab showing the FFRDC's budget for each year of the project period by budget category element for requested Federal funding and by budget category element for non-Federal funding contributed as cost share (if applicable).

- For each entity that is performing at least 10% of the work under the ARPA-E funding agreement (as measured by the Total Project Cost), Applicants must create:

(1) One tab showing that entity's budget for the entire project period (from the project start date to the project end date) by budget category element for requested Federal funding and by budget category element for non-Federal funding contributed as cost share (if applicable), and

(2) A separate tab showing that entity's budget for each year of the project period by budget category element for requested Federal funding and by budget category element for non-Federal funding contributed as cost share (if applicable).

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

- In Section B of the SF-424A, Applicants may request funds under any of the listed object class categories 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.

- All Technology Transfer & Outreach (TT&O) costs requested must be included in the Applicant's proposed budget and identified as TT&O costs in the SF-424A and the Budget Justification Workbook (see Section IV.C.8 below) with the costs being requested under the "Other" budget category. All budgeted activities must relate to achieving specific objectives, technical milestones and deliverables outlined in the Statement of Project Objectives. The Contracting Officer may impose TT&O allowance restrictions for Recipients that propose excessive TT&O costs or costs that are not clearly furthering advancement of the specific proposed technology. Applicants may not expend more than 5% of the Total Project Cost on TT&O activities without the prior approval of the Contracting Officer (see Section IV.F.8 of the FOA).

- For pricing purposes, assume a project start date of January 1, 2013, or as negotiated.

4. FOURTH COMPONENT: SUMMARY FOR PUBLIC RELEASE

Applicants are required to submit a one-page summary of their project. The Summary for Public Release must be submitted in Adobe PDF format. This summary is intended for public release, so it 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. Applicants should avoid over-reliance on technical terms that are not familiar or well-understood by the general public.

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. A sample slide is attached as Appendix 1 to this FOA. This slide is used during the evaluation process. Applicants must use the Summary Slide template available on ARPA-E eXCHANGE (https://arpa-e.foa.energy.gov). A sample Summary Slide is attached as Appendix 1 to this FOA.

The slide should be split into four parts as a "quad chart":

- Non-technical description of the proposed technology;

- Potential impact of the proposed technology relative to the state of the art;
- Project overview consisting of the proposed period of performance, requested ARPA-E funding, proposed cost share, total budget for the entire project period, and a year-by-year breakdown of the project's key milestones and deliverables; and
- A listing of the Key Participants.

6. SIXTH COMPONENT: BUSINESS ASSURANCES FORM

Applicants are required to complete a Business Assurances 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.

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

- Disclose potential improprieties, such as convictions for fraud and export control violations;
- Disclose potential conflicts of interest within the Project Team; and
- Provide written assurance of its cost share commitment;
- 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, the Applicant may:

- Request authorization to perform some work overseas;
- Request a waiver of the TT&O spending requirement;
- Request the use of a Technology Investment Agreement instead of ARPA-E's Model Cooperative Agreement; and
- Request a modification or waiver of the U.S. Manufacturing requirement;

7. SEVENTH COMPONENT: OTHER SOURCES OF FUNDING DISCLOSURE FORM

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."[43] In accordance with its statutory mandate, ARPA-E requires the PI to complete the Other Sources of Funding Disclosure form and submit it with the Full Application. The form must be submitted in Adobe PDF format. The Other Sources of Funding Disclosure form is available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov).

In the Other Sources of Funding Disclosure form, the PI is required to:

- Describe the additionality and risks associated with the proposed R&D project;
- Disclose whether the PI or any Co-PI(s) have submitted the same application to any Federal or non-Federal entities;
- Disclose whether the PI or any Co-PI(s) have submitted any applications for related work to any Federal or non-Federal entities within the last 24 months;
- Disclose all financial assistance from any Federal entity that the PI or any Co-PI(s) is currently receiving or has received within the last 5 years;
- Disclose any funding from non-Federal entities for related work that the PI or any Co-PI(s) is currently receiving or has received within the last 5 years; and
- Provide letters or other communications from private investors explaining why they decided not to fund the proposed R&D project or related work.

8. EIGHTH COMPONENT: BUDGET JUSTIFICATION WORKBOOK

Please refer to ARPA-E's website (https://arpa-e-foa.energy.gov) for the Budget Justification Workbook template and detailed guidance on completing the Budget Justification Workbook. Applicants are required to complete a Budget Justification Workbook to accompany and justify the costs listed in the SF-424A. The Budget Justification Workbook must be submitted in Microsoft Excel format. Applicants must complete each tab of the Budget Justification Workbook for the project as a whole and provide requested documentation (e.g., a Federally-

[43] 21st Century Competitiveness Act, Pub. L. No. 110-69, § 5012, 121 Stat. 572 (2007) (codified at 42 U.S.C. § 16538).

approved forward pricing rate agreement, Defense Contract Audit Agency or Government Audits and Reports, if available).

- 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 Statement of Project Objective tasks are being performed, the purpose/need for the effort, and a sufficient basis for the estimated costs.

D. CONTENT AND FORM OF REPLIES TO REVIEWER COMMENTS

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 Reply to Reviewer Comments template is provided as Appendix 5 to the FOA. A fillable version 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.

- 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). A Symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies.

- 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 (see Section III.C.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 five pages and disregard any additional pages.

SECTION	PAGE LIMIT	DESCRIPTION
Text	3 pages maximum	• Applicants may respond to one or more reviewer comments or supplement their Full Application.
Images	2 page maximum	• Applicants may provide graphs, charts, or other data to respond to reviewer comments or supplement their Full Application.

E. INTERGOVERNMENTAL REVIEW

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

F. FUNDING RESTRICTIONS

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/FundingAgreements/Overview/PostAward.aspx#Applicable_Federal_Regulations.

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.

Upon selection for award negotiations, Applicants may incur pre-award costs at their own risk. 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 if the award is made for a lesser amount than the Applicant expected.

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) before incurring any pre-award costs. However, Prime Recipients may submit reimbursement requests for insignificant costs (i.e., $20,000 or less in total aggregate costs) incurred within the 90-day period immediately preceding the effective date of the funding agreement.

Prime Recipients are required to obtain written authorization from the Contracting Officer (ARPA-E-CO@hq.doe.gov) for (i) insignificant costs (i.e., $20,000 or less in total aggregate costs) incurred outside of the 90-day period immediately preceding the effective date of the funding agreement, and (ii) significant costs (i.e., more than $20,000 in total aggregate costs). In reviewing pre-award costs, the Contracting Officer will consider, among other factors, the time between selection and award, the time between receipt of application and award, the value of the pre-award costs to the overall success of the project, the severability of the funded project to the Prime Recipient's overall activities, the effect on the Total Project Cost, and any statutory authorizations and appropriations for the programmatic area.

3. PATENT COSTS

ARPA-E will fully reimburse the following types of patent costs:

- Cost of preparing and submitting invention disclosures to ARPA-E and DOE;
- Cost of searching the art to the extent reasonable and necessary to make invention disclosures to ARPA-E and DOE, as required by Attachment 2 to the funding agreement; and
- Cost of preparing the reports and other documents required by Attachment 2 to the funding agreement.

ARPA-E will reimburse up to $30,000 in costs and fees incurred in preparing and filing domestic and foreign patents. The Prime Recipient may request a waiver of the $30,000 cap. Because all patent costs are considered to be Technology Transfer & Outreach (TT&O) costs (see Section IV.F.8 of the FOA below), the waiver request is subject to review by the ARPA-E Program Director and approval by the 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. Please note that Davis-Bacon Act requirements do not apply to ARPA-E funding agreements.

5. FOREIGN TRAVEL

ARPA-E generally does not fund projects that involve major foreign travel. Recipients are required to obtain written authorization from the Contracting Officer before incurring any major foreign travel costs (i.e., foreign travel costs in excess of $10,000 in any twelve-month period) and must 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 and national 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 Form, which is part of the Full Application submitted to ARPA-E. Such waivers are granted where there is a demonstrated need.

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. TECHNOLOGY TRANSFER AND OUTREACH

By law, ARPA-E is required to contribute a percentage of appropriated funds to Technology Transfer and Outreach (TT&O) activities. In order to meet this mandate every Project Team will need to spend at least 5% of the Federal funding provided by ARPA-E on TT&O activities to promote and further the development and deployment of ARPA-E-funded technologies. Examples of TT&O expenditures are provided below.

- Applicants are encouraged to include TT&O activities in their proposed budgets as they relate to achieving the objectives outlined in the Statement of Project Objectives, including the Technical Milestones and Deliverables. Applicants must list TT&O costs under the appropriate object class category in the SF-424A and the appropriate budget category in the Budget Justification with a clear description of what activities are to take place (e.g. travel to the Annual ARPA-E Innovation Summit, work devoted to a commercialization plan, etc.).

- During award negotiations, Prime Recipients are required to negotiate and complete a Technology-to-Market Plan with the ARPA-E Program Director, as described in Section VI.B.7 of the FOA.

- For each invoice submitted the Prime Recipient will be required to provide a breakdown by budget category of all incurred TT&O costs and provide supporting documentation (e.g., trip reports). The invoice must show the TT&O budgeted costs and actual costs incurred for the relevant billing period and cumulative TT&O costs incurred to date. The budgeted and actual costs incurred must comport with the Prime Recipient's budget. Any variances must be explained in the invoice. The Prime Recipient must explain how particular objectives in the Statement of Project Objectives, including the Technical Milestones and Deliverables that are advanced by the TT&O activities.

- Only TT&O costs that relate to a specific technology funded by ARPA-E will be allowed. For TT&O activities aimed at advancing a portfolio of technologies and/or products owned by the Recipient or Project Partner, only the portion of costs specifically attributable to advancing the ARPA-E funded technology will be reimbursed.

All TT&O expenditures are subject to the applicable Federal cost principles, as described in Section IV.F.1 of the FOA.

ARPA-E will reimburse the following types of TT&O expenditures, which comply with Federal cost principles.

- Documented travel and registration for the ARPA-E Energy Innovation Summit and other energy-related conferences and events;

- Documented travel to meet with potential suppliers, partners, or customers;

- Documented work by salaried or contract personnel to develop commercialization models or plans;

- Documented costs of acquiring industry-accepted market research reports; and

- Approved patent costs.

ARPA-E will not reimburse the following types of TT&O expenditures, which do not comply with Federal cost principles.

- Meals or entertainment;
- Gifts to potential suppliers, partners, or customers;
- TT&O activities that do not relate to the ARPA-E-funded technologies or to at least one objective in the Statement of Project Objectives; including the Technical Milestones and Deliverables; and,
- Undocumented TT&O activities.

Applicants may seek a waiver of the TT&O requirement by including an explicit request in the Business Assurances Form. Please refer to the Business Assurances Form for guidance on the content and form of the waiver request.

ARPA-E Program Directors may waive or modify the TT&O requirement, as appropriate.

9. 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.[44]

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:

- 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.

G. OTHER SUBMISSION REQUIREMENTS

[44] 18 U.S.C. § 1913.

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). Notices of Intent, 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).

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.

V. APPLICATION REVIEW INFORMATION

A. CRITERIA

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

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

1. CRITERIA FOR FULL APPLICATIONS

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.

(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 feasibility of the proposed work ;
- The extent to which the Applicant proposes a sound technical approach to accomplish the proposed R&D objectives;

- The extent to which the Applicant manages risk, by identifying major technical R&D risks and clearly proposes feasible, effective mitigation strategies; and

- The extent to which project outcomes and deliverables are clearly defined;

- Whether the Applicant presents a technology development plan that demonstrates credible and well-justified technical potential to meet or exceed the Primary Technical Targets in Section I.F of the FOA; and

- The extent to which the Applicant proposes a strong and convincing technology development strategy, including a feasible pathway to transition the program results to the next logical stage of R&D and/or directly into commercial development and deployment.

(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;

- 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 is reasonable.

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 State of the Art	30%
Overall Scientific and Technical Merit	30%

Qualifications, Experience, and Capabilities	30%
Sound Management Plan	10%

2. CRITERIA FOR REPLIES TO REVIEWER COMMENTS

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

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

- Programmatic balance of risk and technology areas;
- The degree to which the proposed project optimizes use of available ARPA-E funding to achieve programmatic objectives;
- Availability of funding from public and private sources to support the proposed project;
- The budget for the proposed project;
- The proposed cost share for the project;
- For projects involving one or more large businesses, the cost share proposed by the large business(es);
- Whether the proposed cost share is above the minimum established by ARPA-E and appropriate for the maturity of the technology under development;
- The financial and other resources of the Applicant or Project Team;
- For projects involving a Project Team, the quality of the teaming arrangement;
- The extent to which the project includes industry participation;
- Demonstrated ability to meet technical objectives within predetermined budgets;

- Demonstrated ability to commercialize the technology;
- The technical, market, and organizational risks associated with the R&D project;
- Soundness of the Intellectual Property Strategy and Transition/Commercialization Strategy;
- If the lead organization is a large business, why this R&D project is not being sponsored internally;
- If the lead organization is a small business sponsored by private investors, why this R&D project is not being supported by its investors;
- If the lead organization is a startup not sponsored by private investors, why this R&D project has been unable to attract private financing;
- If the lead organization is a university, nonprofit, or FFRDC, what sort of institutional resources will be leveraged, and why has this leverage not been available to date;
- Whether the proposed transition path is likely to lead to increased employment and manufacturing in the United States;
- Whether the project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty; and
- The degree to which the proposed project directly addresses ARPA-E's statutory mission to:
    - Enhance the economic and energy security of the United States through the development of energy technologies that result in reductions of imports of energy from foreign sources, reductions of energy-related emissions, and improvements in the energy efficiency of all economic sectors; and
    - Ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies.
- Whether the project is expected to meet or surpass the 5% requirement for Technology Transfer & Outreach (TT&O) expenditures; and

- Whether the Applicant has submitted a credible proposal for a Technology Investment Agreement.

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 by which they disclose their knowledge of any actual or apparent conflicts and agree to safeguard confidential information contained in Notices of Intent, 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) 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

ARPA-E expects to announce selections under this FOA in [DATE] and to execute funding agreements in Fall 2012.

Please refer to the "Applicant's Guide to ARPA-E Award Negotiations" (http://arpa-e.energy.gov/LinkClick.aspx?fileticket=epWL1jxq_G8%3d&tabid=442) for guidance on the award negotiation process.

VI. AWARD ADMINISTRATION INFORMATION

A. AWARD NOTICES

1. REJECTED SUBMISSIONS

Noncompliant and nonresponsive 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 Full Application was rejected.

2. FULL APPLICATION NOTIFICATIONS

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

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.F.2 of the FOA for guidance on pre-award costs. Please also refer to the "Applicant's Guide to ARPA-E Award Negotiations" (http://arpa-e.energy.gov/LinkClick.aspx?fileticket=epWL1jxq_G8%3d&tabid=442) 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.F.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

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 CCR, FSRS, AND FEDCONNECT REGISTRATIONS

Upon selection for award negotiations, Prime Recipients and Subrecipients are required to obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number at http://fedgov.dnb.com/webform. In addition, Prime Recipients and Subrecipients are required to register with the Central Contractor Registry (CCR) at https://www.bpn.gov/ccr/default.aspx.

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 the CCR 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/.[45] 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

[45] The Federal Funding Accountability and Transparency Act, P.L. 109-282, 31 U.S.C. 6101 note.

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 CCR and FSRS registrations. In addition, the Prime Recipient may not execute subawards with Subrecipients until they obtain a DUNS number and complete their CCR registration. Prime Recipients and Subrecipients are required to keep their CCR 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 (http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx) for guidance on the National Policy Assurances.

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 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. The letter must state, in unconditional and unequivocal terms, its commitment to provide cost share. The letter may not include any conditions for receipt of the cost share contributions. The letter must state the amount and form of cost share, the source and precise nature of the contribution, and the duration and timing of the commitment (e.g., two years beginning in January 2013).

4. COST SHARE PAYMENTS[46]

[46] Please refer to Section III.B of the FOA for guidance on cost share requirements.

All proposed cost share contributions 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 over the life of the funding agreement.[47] Specifically, every Prime Recipient is required to contribute, at a minimum, the cost share percentage of total expenditures incurred during every billing period. For example, a Prime Recipient is required to contribute at least 31% of the total expenditures incurred during every billing period if the funding agreement states that the cost share percentage is 31%.

If Prime Recipients anticipate difficulty providing the requisite cost share every billing period, they may request authorization from ARPA-E upon selection for award negotiations to (1) contribute the cost share percentage of total expenditures incurred every quarter (i.e., every three months), or (2) contribute the cost share percentage of total expenditures incurred every half-year (i.e., every six months). Such requests must be sent by email to the ARPA-E Budget Director during award negotiations and include the following information: (1) a detailed justification for the request; (2) a proposed schedule of payments, including amounts and dates; (3) a written commitment to meet that schedule; and (4) such evidence as necessary to demonstrate that the Prime Recipient has complied with its cost share obligations to date. The Contracting Officer must approve all such requests before they may go into effect. ARPA-E may revoke its authorization at any time for any reason.

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. COST SHARE REPORTING[48]

Written documentation showing that the Prime Recipient (or Project Team, as appropriate) paid at least the cost share percentage of total expenditures incurred during the relevant billing period must accompany all reimbursement requests.

If authorized by ARPA-E to provide the requisite cost share on a quarterly or biannual basis, Prime Recipients are required to submit the cost share report for the relevant quarter or half-year with the reimbursement request for that period. Written documentation showing that the Prime Recipient (or Project Team, as appropriate) paid at least the cost share percentage of total expenditures incurred during the relevant quarter or half-year must accompany these reports.

[47] Prime Recipients may elect to pay the entire cost share amount at the start of the project.
[48] Please refer to Section III.B of the FOA for guidance on cost share requirements.

In terms of written documentation, Prime Recipients may provide ARPA-E with (1) summary documentation that presents an overview of expenditures incurred during the relevant billing period (e.g., printouts from internal financial software) or (2) detailed documentation of expenditures incurred during the relevant billing period, including but not limited to invoices on appropriate letterhead, equipment purchase requisitions, and travel vouchers.
ARPA-E may deny reimbursement requests, in whole or in part, or modify or terminate funding agreements where Prime Recipients (or Project Teams) fails to comply with ARPA-E's cost share reporting requirements.

6. ENVIRONMENTAL IMPACT QUESTIONNAIRE

By law, ARPA-E is required to evaluate the potential environmental impact of projects that it is considering for funding.[49] 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. The Environmental Impact Questionnaire must be submitted in Adobe PDF format. This form is available on ARPA-E eXCHANGE at https://arpa-e-foa.energy.gov. The Environmental Impact Questionnaire is due within 21 calendar days of the selection announcement.

Prime Recipients are required to complete the Environmental Impact Questionnaire for the project as a whole, including all work to be performed by the Prime Recipient and its Subrecipients and Contractors. Prime Recipients may not limit their responses to work performed by the Prime Recipient.

In completing the Environmental Impact Questionnaire, Prime Recipients must provide specific information regarding the nature of the Project Team's proposed action, including information on their size, operations, and the types and quantities of air emissions, wastewater discharges, solid wastes, land disturbances, etc. Prime Recipients should identify the location(s) of the proposed action and specifically describe the activities that would occur at each location.

Upon request, the Prime Recipient or Subrecipients are required to provide additional information to the ARPA-E NEPA Compliance Officer.

7. TECHNOLOGY-TO-MARKET PLAN

During award negotiations, Prime Recipients are required to negotiate and complete a Technology-to-Market Plan with the ARPA-E Program Director. Prime Recipients must show how budgeted Technology Transfer and Outreach (TT&O) costs relate to furthering elements of the Technology-to-Market Plan. Prime Recipients are required to submit updated versions of the plan every six months through the end of the project period. Prime Recipients may be required to perform other actions to further the commercialization of their respective technologies.

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

8. INTELLECTUAL PROPERTY MANAGEMENT PLAN

ARPA-E requires every Project Team to negotiate and establish an Intellectual Property Management Plan for the management and disposition of intellectual property arising from the project. The Prime Recipient must submit a completed and signed Intellectual Property Management plan to ARPA-E within six weeks of the effective date of the ARPA-E funding agreement. All Intellectual Property Management Plans are subject to the terms and conditions of the ARPA-E funding agreement and applicable Federal laws, regulations, and policies, all of which take precedence over the terms of Intellectual Property Management Plans.

ARPA-E has developed a template for Intellectual Property Management Plans (http://arpa-e.energy.gov/FundingAgreements/Overview.aspx) 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.

9. U.S. MANUFACTURING REQUIREMENT

ARPA-E requires 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 through the Business Assurances Form submitted with the Full Application.

a. SMALL BUSINESSES

Small businesses 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).[50] This requirement does not apply to products that are manufactured for use or sale overseas.

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 Prime Recipients or 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 invention(s).[51] This requirement applies to products that are manufactured for use or sale in the United States and overseas.

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 Prime Recipients or 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.

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[50] 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/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf).

[51] 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/idc/groups/public/documents/sba_homepage/ serv_sstd_tablepdf.pdf).

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.

10. SUBJECT INVENTION UTILIZATION REPORTING

To ensure that Prime Recipients and Subrecipients holding title to subject inventions are taking the appropriate steps to commercialize subject inventions, ARPA-E requires Recipients to submit annual reports (throughout the project period and for the duration of U.S. patents resulting from the ARPA-E project) on the utilization of subject inventions and efforts made by Recipients or their licensees or assignees to stimulate such utilization. The reports must include information regarding the status of development, date of first commercial sale or use, gross royalties received by the Recipient, and such other data and information as ARPA-E may specify.

~~11. MANDATORY LIGHTING UPGRADES~~

~~The Prime Recipient of any ARPA-E award in excess of $1 million will be required to certify that it will, by the end of the fiscal year, upgrade the efficiency of its facilities by replacing any lighting that does not meet or exceed the energy efficiency standard for incandescent light bulbs set forth in Section 325 of the Energy Policy and Conservation Act (42 U.S.C. § 6295). This requirement is derived from the Consolidated Appropriations Act of 2012, available at http://www.gpo.gov/fdsys/pkg/BILLS-112hr2055enr/pdf/BILLS-112hr2055enr.pdf.~~

C. REPORTING

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 (http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx).

VII. AGENCY CONTACTS

A. COMMUNICATIONS WITH ARPA-E

Upon the issuance of a FOA, ARPA-E personnel 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.

- Every Friday, ARPA-E will post responses to any questions that were received by Wednesday at 12 PM Eastern Time. (Questions received after Wednesday at 12 PM Eastern Time will be answered the following week.) ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.

- ARPA-E will cease to accept questions approximately 3 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/About/FAQs.aspx).

Applicants may submit questions regarding ARPA-E eXCHANGE, ARPA-E's online application portal, to 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.

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.

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 I.B 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 to unsuccessful Applicants. However, ARPA-E

provides Applicants with feedback on compliant and responsive Full Applications. Reviewer comments on Full Applications are made available 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/). 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.

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 Form and the Other Sources of Funding Disclosure form. Disclosure of the requested information is mandatory. Any failure to make a full and complete disclosure of the requested information may result in:

- The rejection of a 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 Notices of Intent, 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 Notices of Intent, Full Applications, and Replies to Reviewer Comments strictly for evaluation purposes. Applicants should not include confidential, proprietary, or privileged information in their Notices of Intent, Full Applications, or Replies to Reviewer Comments unless such information is necessary to convey an understanding of the proposed project.

Notices of Intent, 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 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.

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.

- 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.

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.

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 satisfied manner;

- The owner has not met public use requirements specified by Federal statutes in a reasonably satisfied 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 awards may be protected from public disclosure for up to five years. Such data should be clearly marked as described in Section VIII.E of the FOA. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

I. 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).

J. ANNUAL COMPLIANCE AUDITS FOR FOR-PROFIT ENTITIES

If a for-profit entity is a Prime Recipient or Subrecipient, an annual compliance audit performed by an independent auditor may be required. For additional information, please refer to 10 C.F.R. § 600.316 and for-profit audit guidance documents posted under the "Coverage of Independent Audits" heading at http://management.energy.gov/business_doe/business_forms.htm.

IX. GLOSSARY

Applicant: The entity 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 Notice of Intent, Full Application and Reply to Reviewer Comments.

ARPA-E: Advanced Research Projects Agency-Energy.

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

DOE: U.S. Department of Energy.

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

Down-Select Process: Once ARPA-E completes its review of Full Applications and Replies to Reviewer Comments, it will perform a "down-select" of Full Applications. Certain Applicants will be invited to participate in a meeting with ARPA-E via webinar, videoconference, or conference call. In the alternative, ARPA-E may invite Applicants to meet in person at ARPA-E's offices, the recipient's site, or a mutually agreed upon location. ARPA-E may also conduct pre-selection site visits to certain Applicants' facilities.

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.

PI: Principal Investigator.

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

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.

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

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

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 FFRDCs and GOGOs.

TT&O: Technology Transfer and Outreach. (See Section IV.F.8 of the FOA for more information)

APPENDIX 1: SAMPLE SUMMARY SLIDE

3D XYZ-based Battery - The Most Epic Battery Material Ever

John Smith, ABC University

0000-1234

ARPA-E funds: $5.55M

Cost share: 25%

Technology Summary

- Develop novel material XYZ, which, because of it's structure, inherently has the most active sites of all battery materials.
- Demonstrate roll to roll printing of mechanically stable material XYZ
- Integration of XYZ into novel 3D battery architecture (shown in picture)

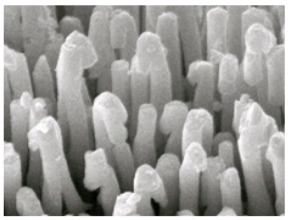
Technology Impact

- Reduces cost of batteries by 4X, enables higher penetration of EVs
- Maintain US leadership in $100B market

Proposed Targets

Metric	State of the Art	Proposed
Active sites	25/cm^2	100/cm^2
Stability	2 defects/cm^2	1 defect/cm^2
Energy Density	33 J/kg	100J/kg
Recharge time	60 min	15 min
Manufacturing cost	$1,000	$250

Supporting Figures, Tables, & Illustrations



Material XYZ, with many active sites

Proposed 3D battery architecture

Transportation scale batteries with 3X energy density at ¼ cost

APPENDIX 2: SAMPLE RESPONSE TO THE OTHER SOURCES OF FUNDING DISCLOSURE FORM

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

INSTRUCTIONS: The Principal Investigator (PI) is required to complete and submit this form with the Full Application. Additional instructions are provided below. A sample response to this form is attached to the Funding Opportunity Announcement.

Certification: I certify that the information contained in this disclosure form is accurate and complete. I understand that false statements or misrepresentations may result in civil and/or criminal penalties under 18 U.S.C. § 1001.

PI Name: Jane Doe, Ph.D.

Date: 02-13-12

PI Signature: [Insert below. Electronic signatures are acceptable.]

X

Principal Investigator

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

(1) ADDITIONALITY AND RISK: Mandatory. 4 pages maximum. The PI must provide a narrative response to each question below. If the question is not applicable, please insert "N/A" in the space provided.

a. Describe the technical, market, and organizational risks associated with the proposed R&D project.

ThermoCapture's proposed technology will use supercritical fluids in a thermal energy storage device that can be integrated with utility-scale solar thermal and geothermal generating sources. A thermal energy storage of the proposed scale has never been developed by researchers in the field, making ThermoCapture's proposed device advanced relative to the existing state of the art.

To date, ThermoCapture's research has focused on identification and optimization of appropriate supercritical fluids that demonstrate ideal P-V-T characteristics for thermal energy storage. However, supercritical fluids have not been integrated into a scaled proof-of-concept system sufficient to demonstrate the full potential of supercritical thermal storage capacity for large-scale power systems. As a result private investors have deemed ThermoCapture's technology premature for commercialization and risky from an investment standpoint (see Item (e) below). Intensive RD&D is required to overcome this perceived market barrier and situate the proposed technology for scaled manufacturing, market penetration, and commercial deployment. Securing public funding to support the proposed RD&D is critical to meeting these objectives.

b. Describe why the proposed Prime Recipient or Project Team needs ARPA-E funding for the proposed R&D project, relative to other funding sources.

The proposed RD&D project seeks to prove the technical and commercial feasibility of using supercritical fluid in a proposed thermal energy storage system through proof-of-concept prototype testing. This work will lay the foundation for eventual commercial-scale demonstration activities. These are critical steps towards scale up, market penetration, and commercial deployment.

Given the technical risk of RD&D that remains for ThermoCapture's proposed technology, at a proof-of-concept scale private investors are hesitating to provide further backing towards ThermoCapture. In particular, the risks associated with developing a compression technology matching the P-V-T characteristics identified in basic research of the supercritical fluid are high. In addition, as the P-V-T characteristics of the supercritical fluid have been investigated on a basic science basis, the proposed technology has advanced to a level of development beyond basic science (TRL 2), making funding from public sources such as the National Science Foundation inappropriate. Finally, due to the intensive involvement of the National Renewable Energy Laboratory (NREL) in

the proposed project, funding under public programs such as the Small Business Innovation Research program is inappropriate.

Within the Department of Energy, ARPA-E is particularly well situated to fund a project of this nature. The project presents significant technical risk and demonstrates immense innovation potential, while other sources of funding are unavailable.

c. Describe how, if the successful, the proposed R&D project may lead to increased employment and manufacturing in the United States.

In its 3 years of operation, ThermoCapture has generated 21 high technology and 3 administrative jobs. Based on existing growth trajectory, ThermoCapture plans to develop new manufacturing facilities that will expand the company's size to 110 personnel within 2-3 years. If successful in this project, ThermoCapture may accelerate this growth.

d. If the proposed Prime Recipient is a large business, describe why this R&D project is not being sponsored internally.

N/A

e. If the proposed Prime Recipient is a small business sponsored by private investors, identify the types of private investors that have supported your business and explain why this R&D project is not being supported by the private investors. In addition, describe technical outcomes of the proposed R&D project that could lead to additional private investment following a successful ARPA-E project.

In April 2010, ThermoCapture raised $1,500,000 in Series A capital based on support from EnergyFund LLC, a venture capital fund. This funding was used to recruit a strong research team and support preliminary RD&D through computational modeling, and laboratory and bench-scale research. Since May 2011, ThermoCapture has sought Series B funding, but has not succeeded in securing additional venture backing.

An appraisal of ThermoCapture's intellectual property portfolio has characterized ThermoCapture's technologies as "systematically unique" and "innovative." However, the company has failed to secure next-round financing due to investor concern that its core thermal energy storage system is too premature for commercialization and would require a proof-of-concept scale demonstration.

A successful ARPA-E project could prove the technical and financial feasibility of utilizing supercritical fluids for thermal energy storage at the commercial scale and demonstrate the proposed technology's flexible use with a variety of renewable energy applications. Funding from ARPA-E will thus assist ThermoCapture in bringing the proposed technology to a point of development at which investor confidence will increase.

f. If the proposed Prime Recipient is a small business not sponsored by private investors, describe why this R&D project has been unable to attract private financing. In addition, describe technical outcomes of the proposed R&D project that could lead to private investment following a successful ARPA-E project.

N/A

g. If the proposed Prime Recipient is a university, nonprofit, or national laboratory, describe the institutional or other resources that may be leveraged, and explain why these resources have not been available to date.

N/A

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(2) POTENTIAL OVERLAP WITH OTHER APPLICATIONS: Mandatory. No page limit. The PI must answer "Yes" or "No" to each question below. If the answer to either question is "Yes," the PI must provide the requested information.

a. Has the PI or any Co-PIs submitted this application to any Federal or non-Federal entity (including but not limited to industry, private investors, and foreign, state, or local governments)?

YES ☐ NO ☒

If "Yes," complete a separate table for each Federal and non-Federal entity. If additional tables are required, include the tables in an addendum to this form.

Source of Funding #1:
Date of Submission:
Title of Submission:
Application Status:

Source of Funding #2:
Date of Submission:
Title of Submission:
Application Status:

b. Has the PI or any Co-PI(s) submitted any application(s) for related work (i.e., work that relates directly or indirectly to the proposed R&D project) to any Federal or non-Federal entity (including but not limited to industry, private investors, and foreign, state, or local governments) within the last 24 months?

YES ☒ NO ☐

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

If "Yes," complete a separate table for each Federal and non-Federal entity. If additional tables are required, include the tables in an addendum to this form.

Source of Funding #1: U.S. Department of Energy - Small Business Innovation Research Program
Date of Submission: 09/15/2009
Title of Submission: Development of Supercritical Fluids for Thermal Energy Storage Devices
Application Status: Funded - Project Completed (see Section 3 below)

Source of Funding #2:
Date of Submission:
Title of Submission:
Application Status:

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(3) OTHER SOURCES OF FUNDING: Mandatory. No page limit. The PI is required to disclose all Federal financial assistance received by the PI and Co-PIs. In addition, the PI is required to disclose any funding from non-Federal entities for related work (i.e., work relating directly or indirectly to the proposed R&D project).

a. The PI is required to disclose **all financial assistance from any Federal entity** that the **PI or any Co-PI(s)** is **currently receiving or has received within the last 5 years**. Complete a separate table for each Federal entity. If additional tables are required, include the tables in an addendum to this form. If the PI and any Co-PI(s) have not received any such financial assistance, check the box marked "None" below.

If NONE, check here ☐

Federal Entity #1: U.S. Department of Energy
Federal Program Manager Name and Title: Tommy Johnson
Federal Program Manager Telephone: (202) 555-5555
Federal Program Manager Email Address: Tommy. Johnson@hq.doe.gov
Federal Program Manager Postal Address: U.S. Department of Energy 1000 Independence Ave., SW Washington, DC 20585
Title of Project: Development of Supercritical Fluids for Thermal Energy Storage Devices
Federal Funding: $150,000 (Phase I SBIR)
Non-Federal Funding: $0

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

Start and End Dates: 10/15/2009 – 04/15/2010
Abstract for Project This project focsed on the development of a supercritical fluid to accommodate heat-based, grid-scale energy storage. Various supercritical fluid mediums were examined in order to determine which allowed for the highest capacity of energy storage within traditional metrics.

Federal Entity #2:
Federal Program Manager Name and Title:
Federal Program Manager Telephone:
Federal Program Manager Email Address:
Federal Program Manager Postal Address:
Title of Project:
Federal Funding:
Non-Federal Funding:
Start and End Dates:
Abstract for Project:

b. The PI is required to disclose **any funding from any non-Federal entity** for **related work (i.e., work that is related directly or indirectly to the proposed R&D project)** that the **PI or any Co-PI(s)** is **currently receiving or has received within the last 5 years**. Please complete a separate table below for each source of funding. If additional tables are required, include the tables in an addendum to this form. If the PI and Co-PI(s) have not received any such funding, check the box marked "None" below.

If NONE, check here ☐

Non-Federal Entity #1: EnergyFund LLC

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

Point of Contact Name and Title: John Smith, President and CEO
Point of Contact Telephone: 650-555-5555
Point of Contact Email Address: JSmith@genericemailaddress.com
Point of Contact Postal Address: EnergyFund LLC 123 Venture Way Suite 430 Palo Alto, CA 94301
Title of Project: Optimization of Supercritical Fluids for Thermal Energy Storage Devices
Funding Amount: $1,500,000
Start and End Dates: 04/2010 - ongoing
Abstract for Project: ThermoCapture raised $1,500,000 in internal Series A capital. The uses of funds were explicitly defined in the investment agreement as "general working capital" under the direction and approval of EnergyFund's Board of Directors. This funding was used to recruit a strong research team and support preliminary applied RD&D through computational modeling, and laboratory and bench-scale research, to optimize supercritical fluids for use in an integrated proof-of-concept-scale thermal storage system.

Non-Federal Entity #2:
Point of Contact Name and Title:
Point of Contact Telephone:
Point of Contact Email Address:
Point of Contact Postal Address:
Title of Project:
Funding Amount:
Start and End Dates:

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

Abstract for Project:

OTHER SOURCES OF FUNDING DISCLOSURE FORM
FULL APPLICATION

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(4) LETTERS OF CORROBORATION: Mandatory. No page limit.

a. **The PI is required to provide any letter(s) or other communications (e.g., emails) from private investors explaining why they decided not to fund the proposed R&D project or related work** (i.e., work that is related directly or indirectly to the proposed R&D project). Append copies of the letters or other communications to this form.

b. **If the PI has not received any such letters or other communications, the PI must document any interaction(s) with private investors.** Complete a separate table for each source of funding. If additional tables are required, include the tables in an addendum to this form.

Source of Funding #1: EnergyFund LLC
Point of Contact(s): John Smith, President and CEO
Dates of Interaction(s): May 17, 2011
Reason(s) Given for Not Funding the Proposed R&D Project: Investor concern regarding technological maturity relative to commercialization horizon

Source of Funding #2: NextGen Tech LLC
Point of Contact(s): Lawrence Johnson, President
Dates of Interaction(s): October 3, 2011
Reason(s) Given for Not Funding the Proposed R&D Project: Investor concern regarding technological maturity relative to commercialization horizon

APPENDIX 3: SAMPLE RESPONSE TO THE BUSINESS ASSURANCES FORM

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

INSTRUCTIONS: The Applicant is required to complete and submit this form with the Full Application. Additional instructions are provided below. A sample response to this form is attached to the Funding Opportunity Announcement.

Certification: I certify that the information contained in this disclosure form is accurate and complete. I understand that false statements or misrepresentations may result in civil and/or criminal penalties under 18 U.S.C. § 1001.

Authorized Representative Name: Jane Doe, Ph.D.

Date: 02-13-12

Authorized Representative Signature: [Insert below. Electronic signatures are acceptable.]

X

Prinicpal Investigator

(1) DISCLOSE OF POTENTIAL IMPROPRIETIES: Mandatory. No page limit. The Applicant is required to disclose if any of the following conditions exist. If the answer to any of the questions below is "Yes," the Applicant is required to append a detailed explanation to this form.

a. Is the proposed Prime Recipient, Subrecipient(s), Principal Investigator (PI), or Co-PI(s) under investigation for potential fraud or similar acts?

YES ☐ NO ☒

b. Has the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) been convicted of fraud or similar acts?

YES ☐ NO ☒

c. Is the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) under investigation for potential violations of U.S. export controls laws and regulations?

YES ☐ NO ☒

d. Has the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) been convicted of any violations of U.S. export controls laws and regulations?

YES ☐ NO ☒

e. Is the proposed Prime Recipient or Subrecipient(s) under investigation for potential violations of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701, et seq.)?

YES ☐ NO ☒

f. Has the proposed Prime Recipient or Subrecipient(s) been convicted of any violations of the Drug-Free Workplace Act of 1988?

YES ☐ NO ☒

g. Is the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) under investigation for research misconduct?

YES ☐ NO ☒

h. Has the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) been convicted of research misconduct?

YES ☐ NO ☒

i. Has any Federal agency proposed the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) for suspension or debarment?

YES ☐ NO ☒

j. Is the proposed Prime Recipient, Subrecipient(s), PI, or Co-PI(s) debarred, suspended, or otherwise declared ineligible from receiving Federal contracts, subcontracts, or financial assistance and benefits?

YES ☐ NO ☒

k. Is the proposed Prime Recipient or Subrecipient(s) insolvent?

YES ☐ NO ☒

l. Has the proposed Prime Recipient or Subrecipient(s) filed for bankruptcy or insolvency in any domestic or foreign jurisdiction?

YES ☐ NO ☒

m. Is the proposed Prime Recipient or Subrecipient(s) at risk of insolvency?

YES ☐ NO ☒

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(2) POTENTIAL CONFLICTS OF INTEREST WITHIN PROJECT TEAM: Mandatory. No page limit. The Applicant is required to disclose potential conflicts of interest within the Project Team. An apparent or actual conflict of interest may exist where an individual or entity has different, and potentially conflicting, duties or relationships with respect to other individuals or entities within the Project Team. Complete a separate table for each potential conflict of interest. If additional tables are required, include the tables in an addendum to this form. If no conflicts of interest exist, check the box marked "None" below. Examples of potential conflicts of interest include but are not limited to:

- The PI for the Prime Recipient has an equity stake in a Subrecipient;
- The PI for a Subrecipient has a consulting arrangement with the Prime Recipient; or
- A Subrecipient is a subsidiary of or otherwise affiliated with the Prime Recipient.

If NONE, check here ☐

Conflicted Individual or Entity #1: Co-PI John Doe, Ph.D. and Subrecipient Analytics Technologies
Description of Potential Conflict of Interest: Co-PI John Doe was a majority shareholder and founding partner of Analytics Technologies, selected to be a subrecipient on this project. To correct the conflict, Dr. Doe has divested all stock held in the Analytics Technologies and stepped down from Analytics' Board of Directors. There is no longer any financial or business relationship between the parties.

Conflicted Individual or Entity #2:
Description of Potential Conflict of Interest:

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(3) COST SHARE VERIFICATION: Mandatory. The Applicant must provide written assurance of its cost share commitment. The Applicant is bound by the cost share proposed in this form. Complete a separate table for each source of cost share. If additional tables are required, include the tables in an addendum to this form.

Source of Cost Share #1: ThermoCapture LLC
Type of Contribution (Cash or In-Kind): 70% Cash ($1,853,098); 30% In-Kind ($794,185)
Value of Contribution (in Dollars): $2,647,283
Value of Contribution (as % of Total Project Cost): 45.3%
If In-Kind, Detailed Description of Contribution: ThermoCapture LLC is purchasing two key pieces of equipment in order to carry out project objectives, and offers this equipment as in-kind Cost Share. The first piece is a customized containment tank designed to withstand temperatures of over 3000 Kelvin and 75 bar. ThermoCapture will acquire this chamber for $562,100. Secondly, ThermoCapture will acquire a specialized monitoring system for the containment tank, which will cost $232,085.
If In-Kind, Relevance to Project Objectives: The containment chamber and monitoring system are required to conduct assements of the supercritical fluid's feasibility to meet the project objectives. Only by studying and carefully monitoring the supercritical fluid at an optimal temperature and pressure will accurate results be possible.

Source of Cost Share #2: Midwestern University
Type of Contribution (Cash or In-Kind): In-Kind
Value of Contribution (in Dollars): $276,000
Value of Contribution (as % of Total Project Cost): 4.7%
If In-Kind, Detailed Description of Contribution: Midwestern University will contribute the time of Co-PIs Drs. Mahoney and Doe.
If In-Kind, Relevance to Project Objectives: Drs. Mahoney and Doe are leading authorities in the field of supercritical liquid energy storage. They will be responsible for development and experimentation of various supercritical fluids to determine the optimal arrangment for this project.

Source of Cost Share #3:
Type of Contribution (Cash or In-Kind):
Value of Contribution (in Dollars):
Value of Contribution (as % of Total Project Cost):
If In-Kind, Detailed Description of Contribution:
If In-Kind, Relevance to Project Objectives:

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(4) WAIVER REQUEST – FOREIGN WORK: Optional. No page limit. ARPA-E requires all work to be performed in the United States (i.e., Prime Recipients must expend 100% of the Total Project Cost in the United States). Applicants may request a waiver of this requirement if they wish to perform some work overseas. Complete a separate table for each entity performing work overseas. If additional tables are required, include the tables in an addendum to this form. If no work will be performed overseas, check the box marked "Not Applicable" below.

If NOT APPLICABLE, check here ☐

Entity #1: Specialized Systems
Countries in Which Work Will Be Performed : Canada
Description of Work to Be Performed: Specialized will manufacture the supercritical containment chamber necessary to house the supercritical fluids studied in this project.
Rationale for Performing Work Overseas: Specialized Systems is a leading manufacturer of high-heat, high-pressure containment chambers. Due to the heat and pressure demands the proposed supercritical fluid will place on any chamber in which it is placed, there is an overriding need for a highly-customized and reliable containment chamber in order to create a likelihood of project success.

Entity #2:
Countries in Which Work Will Be Performed :
Description of Work to Be Performed:
Rationale for Performing Work Overseas:

Entity #3:

Countries in Which Work Will Be Performed :
Description of Work to Be Performed:
Rationale for Performing Work Overseas:

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(5) WAIVER REQUEST – TECHNOLOGY TRANSFER AND OUTREACH COSTS: Optional. No page limit. ARPA-E requires the Prime Recipient to spend at least 5% of ARPA-E funding on Technology Transfer and Outreach (TT&O) activities. Applicants may request a waiver of this requirement in whole or in part. If the Applicant is seeking a waiver, please provide the information in the table below. If the Applicant is not seeking a waiver, check the box marked "Not Applicable" below.

If NOT APPLICABLE, check here ☐

Proposed % to Be Spent on TT&O Activities: 0%
Rationale for Waiver Request : The proposed project is still at a very early stage of development. Ideal goals at project completion will be testing and analysis of proof-of-concept. Commercialization activities, at this stage, would be an inappropriate use of funding, and the 5% normally required for Technology Transfer and Outreach would better serve development of the technology to proof-of-concept levels.

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(6) REQUEST – TECHNOLOGY INVESTMENT AGREEMENT: Optional. No page limit. Applicants may request a Technology Investment Agreement by responding to the questions below. If the Applicant is not requesting a Technology Investment Agreement, check the box marked "Not Applicable" below.

If NOT APPLICABLE, check here ☐

a. **Briefly explain why you would prefer to use a Technology Investment Agreement instead of ARPA-E's Model Cooperative Agreement** (http://arpa-e.energy.gov/FundingAgreements/Overview/Award.aspx#Cooperative_Agreements)

If ThermoCapture is able to demonstrate proof-of-concept, the supercritical fluid will represent a significant advance in energy storage technology. ThermoCapture would ideally to prefer to commercialize the technology as rapidly as possible, at that time. Due to potential investor fears regarding some aspects of the ARPA-E Cooperative Agreement, specifically the "March-In" rights and Unlimited Government Use license, ThermoCapture would like to remove these provisions from the Cooperative Agreement before finalization.

b. **Briefly describe the specific objectives that you are seeking to accomplish through the Technology Investment Agreement, including any special terms and conditions.**

ThermoCapture would like to negotiate the removal of the "March-In" rights and Government Use License provisions of the ARPA-E Cooperative Agreement.

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(7) REQUEST – MODIFICATION OR WAIVER OF U.S. MANUFACTURING REQUIREMENT: Optional. No page limit. Applicants may request a modification or waiver of the U.S. Manufacturing Requirement described in Section VI.B of the FOA. Modifications or waivers will be granted only in exceptional circumstances. In return for a modification or waiver, the Applicant is required to make specific, tangible commitments for investments in the United States that are consistent with ARPA-E's statutory mission (42 U.S.C. § 16538(c)). If the Applicant is not seeking a modification or waiver of the U.S. Manufacturing Requirement, check the box marked "Not Applicable" below.

If NOT APPLICABLE, check here ☐

a. Briefly describe your business model and plans for manufacturing products embodying subject inventions (or products produced through the use of subject inventions) in the United States and overseas, and explain why the products cannot be manufactured in the United States.

ThermoCapture intends to design a system that will enable energy storage with the use of extremely high-heat and high-pressure supercritical fluid stored in a customized containment chamber. The amount of heat and pressure necessary to sustain the system will not vary from model to model, and therefore each unit will need to have a customized containment chamber in order to accommodate the fluid. Currently, there is only one manufacturer of containment systems that has the ability to produce such a chamber: Specialized Systems in Ontario, Canada. Therefore, ThermoCapture has an agreement with Specialized for the production of the containment chambers and final integration of the supercritical fluid at Specialized's facilities in Canada. Until a competitive American containment chamber alternative exists, the subject invention cannot be manufactured in the United States.

b. Briefly describe your existing investments in the United States, including (1) the number of employees, facilities, and locations, and (2) the types of activities performed at each location (e.g., RD&D, manufacturing, administration).

ThermoCapture has one facility comprised of 8 employees in Kingston, NY. We are are a startup, so the bulk of our work is focused on R&D, with light manufacturing for product testing and design. In addition, we have a three-member administrative team performing non-scientific, day-to-day activities at the facility.

c. Briefly describe your planned investments in the United States with respect to the subject inventions, including staffing, manufacturing, RD&D, and facility usage or buildout.

Due to the very early nature of project progress, no significant investments are planned at this time. However, if the technology studied in this program is successful, ThermoCapture hopes to produce a manufacturing facility in Kingston, NY, that will allow us to domestically produce and sell products related to this research.

d. Briefly describe your business plan for the subject inventions (e.g., initial work in the United States with subsequent global diversification).

The idea for energy storage using supercritical fluid was conceived in an attempt to address specific issues regarding the American electrical grid system. The bulk of our business plan is to tailor or produce to help grow and strengthen the grid. Global diversification would ideally occur if the success of our product in creating stable price signals for intermittent forms of energy generation such as Solar and Wind allowed us to expand internationally. Our technology will ideally be suitable for electrial grids worldwide.

e. Briefly describe any U.S. jobs that will be created as a result of activities relating to the subject inventions.

If we are successfully able to leverage initial profits into a manfacturing plant, we expected to need approximately 150 workers to staff that facility. For the current work, some additional personnel may be brought in if necessary.

f. Briefly describe how your investments will further the development and deployment of the technology in the United States and any other benefits that its work may have for the U.S. economy.

This technology was conceived primarily with American energy and grid interests in mind. Despite the necessary manufacture in Canada in the near term, ThermoCapture hopes to eventually create domestic production facilities that will create jobs in underserved locations. Furthermore, the technology itself is designed to bring

stability to intermittent energy generation, which will enhance the overall reliability and manageability of the electrical grid, creating long-term economic benefits.

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(8) FFRDC AUTHORIZATION: Mandatory <u>for FFRDCs only</u>. No page limit. Before submitting a Full Application, DOE/NNSA FFRDCs are required to obtain written authorization from the cognizant DOE/NNSA contracting officer. Non-DOE/NNSA FFRDCs are required to obtain written authorization from the cognizant Federal agency sponsoring the FFRDC. If the Applicant is not a FFRDC, check the box marked "Not Applicable" below.

If NOT APPLICABLE, check here ☒

The written authorization must be appended to this form and be signed and dated by the authorizing contracting officer. The following wording is suggested (but not mandatory) for the written authorization. The authorizing contracting officer may use other language, as appropriate.

> "Authorization is granted for [FFRDC Name] to participate in the proposed project. The work proposed for [FFRDC Name] is consistent with or complimentary to the missions of [FFRDC Name], will not adversely impact execution of assigned programs at [FFRDC Name], and will not place [FFRDC Name] in direct competition with the domestic private sector."

Applicant: ThermoCapture LLC
Application Control Number: 0123-4567

(9) FIELD WORK PROPOSAL: Mandatory for DOE/NNSA FFRDCs only. No page limit. DOE/NNSA FFRDCs are required to append a Field Work Proposal to this form. The Field Work Proposal must conform to the instructions in DOE O 412.1, "Work Authorization System" (http://energy.gov/sites/prod/files/maprod/documents/o4121.pdf). If the Applicant is not a DOE/NNSA FFRDC, check the box marked "Not Applicable" below.

If NOT APPLICABLE, check here ☒

Applicant Name:
Control Number:

APPENDIX 4: TECHNICAL VOLUME TO THE FULL APPLICATION TEMPLATE

I. **TECHNICAL AREA:** Mandatory. 0.5 pages maximum. See Section IV.C.1 of the FOA for content requirements.

II. **TECHNICAL APPROACH:** Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.

III. **R&D TASKS:** Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.

IV. **R&D STRATEGY:** Mandatory. 20 pages maximum. See Section IV.C.1 of the FOA for content requirements.

V. **STATEMENT OF PROJECT OBJECTIVES:** Mandatory. 5 pages maximum. See Section IV.C.1 of the FOA for content requirements.

VI. **VALIDATION PROTOCOLS:** Mandatory. 5 pages maximum. See Section IV.C.1 of the FOA for content requirements.

VII. **TECHNICAL MILESTONES AND DELIVERABLES:** Mandatory. 5 pages maximum. See Section IV.C.1 of the FOA for content requirements.

VIII. **BUDGET SUMMARY:** Mandatory. 2 pages maximum. See Section IV.C.1 of the FOA for content requirements.

Applicant Name:
Control Number:

IX. QUALIFICATIONS, EXPERIENCE, AND CAPABILITIES: Mandatory. 3 pages maximum for each Personal Qualification Summary. See Section IV.C.1 of the FOA for content requirements.

X. PARTICIPATING ORGANIZATIONS: Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.

XI. PRIOR COLLABORATION: Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.

XII. MANAGEMENT PLAN: Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.

XIII. MULTI-INVESTIGATOR PROJECTS: Mandatory. 2 pages maximum. See Section IV.C.1 of the FOA for content requirements.

XIV. TRANSITION/COMMERCIALIZATION STRATEGY: Mandatory. 2 pages maximum. See Section IV.C.1 of the FOA for content requirements.

XV. INTELLECTUAL PROPERTY STRATEGY: Mandatory. No page limit. See Section IV.C.1 of the FOA for content requirements.

Applicant Name:
Control Number:

~~I. TECHNICAL APPROACH: Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~II. R&D TASKS: Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~III. R&D STRATEGY: Mandatory. 20 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~IV. STATEMENT OF PROJECT OBJECTIVES: Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~V. VALIDATION PROTOCOLS: Mandatory. 5 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~VI. TECHNICAL MILESTONES AND DELIVERABLES: Mandatory. 5 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~VII. BUDGET SUMMARY: Mandatory. 2 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~VIII. QUALIFICATIONS, EXPERIENCE, AND CAPABILITIES: Mandatory. 3 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

Applicant Name: **Control Number:**

~~**IX. PARTICIPATING ORGANIZATIONS:** Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~**X. PRIOR COLLABORATION:** Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~**XI. MANAGEMENT PLAN:** Mandatory. 1 page maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~**XII. MULTI-INVESTIGATOR PROJECTS:** Mandatory. 2 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~**XIII. TRANSITION/COMMERCIALIZATION STRATEGY:** Mandatory. 2 pages maximum. See Section IV.C.1 of the FOA for content requirements.~~

~~**XIV. INTELLECTUAL PROPERTY STRATEGY:** Mandatory. No page limit. See Section IV.C.1 of the FOA for content requirements.~~

Applicant Name:
Control Number:

APPENDIX 5: REPLIES TO REVIEWER COMMENTS TEMPLATE

I. **TEXT REPLY:** Optional. 3 pages maximum. See Section IV.D of the FOA for content requirements.

II. **IMAGES:** Optional. 2 page maximum. See Section IV.D of the FOA for content requirements.