FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT (FOA)

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

HIGH ENERGY ADVANCED THERMAL STORAGE (HEATS)

Funding Opportunity Number DE-FOA-0000471
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FOA Issue Date:	April 20, 2011
Modification Issue Date:	June 27, 2011
First Deadline for Questions to ARPA-E-CO@hq.doe.gov *(72 hours before Submission Deadline for Concept Papers)*:	5 PM ET, May 16, 2011
Submission Deadline for Concept Papers:	5 PM ET, May 19, 2011
Expected Date of Concept Paper Feedback Notification:	5 PM ET, June 16, 2011
Second Deadline for Questions to ARPA-E-CO@hq.doe.gov *(96 hours before Submission Deadline for Full Applications)*:	5 PM ET, July 14, 2011
Submission Deadline for Full Applications:	5 PM ET, July 18, 2011
Submission Deadline for Replies to Reviewer Comments:	5 PM ET, August 25, 2011
Expected Date for Selection Notifications:	September 2011
Expected Date for Awards:	November 2011

- To apply to this FOA, please register with ARPA-E's online application portal, ARPA-E eXCHANGE, at https://arpa-e-foa.energy.gov/Registration.aspx. The eXCHANGE User Guide is available at https://arpa-e-foa.energy.gov/Manuals.aspx.
- Required forms for Full Applications (SF-424, SF-424A, Budget Justification Workbook, and Environmental Impact Questionnaire) are available at https://arpa-e-foa.energy.gov
- ARPA-E's Model Cooperative Agreement is available at http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx.
- See Section VII.A of the FOA for guidance on submitting questions to ARPA-E.
- ARPA-E strongly encourages Applicants to submit their Full Applications and Replies to Reviewer Comments at least 24 hours in advance of the submission deadline as noted in Section IV.E

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	04/28/2011	• Deleted the phrase "with no more than 26 lines per page" from Section IV.B, third bullet, to clarify that Concept Papers should be single-spaced, not double-spaced. • Add the phrase "but less than 100%" in the Executive Summary under "Cost Share Requirement" and Section III.B.3, third bullet, to clarify that the minimum cost share requirement is 10% for 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.
002	06/14/2011	• ARPA-E has revised the following sections of the FOA to provide guidance on required application forms, the content and form of Full Applications and Replies to Reviewer Comments, and the timely submission of applications: Sections IV.A, IV.C, IV.D, and IV.E and Appendix 2. In addition, ARPA-E has clarified its guidance on compliance criteria, evaluation criteria and program policy factors, Technology Transfer and Outreach expenditures, Commercialization Plans, award notifications, pre-selection communications, anticipated selection and award dates, and other topics in Sections III.A, III.C.1, IV.G.8, IV.H.1, V.A.2, V.A.3, V.B.1, V.B.2, V.C., VI.A.3, and VI.B.6. ARPA-E also added a definition to its glossary in Section IX of the FOA.
003	06/27/2011	• Narrowed the "Other Sources of Funding" requirement in Sections IV.C.1 and VI.B.9 of the FOA to focus on individuals (Principal Investigators, Co-PIs, and Key Participants) participating in the proposed project. Clarified disclosure requirements for Applicants selected for award negotiations.

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EXECUTIVE SUMMARY

Federal Agency	Advanced Research Projects Agency – Energy (ARPA-E), U.S. Department of Energy
FOA Title	High Energy Advanced Thermal Storage (HEATS)
FOA Type	Initial announcement for a new technology development program.
FOA Number	DE-FOA-0000471
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Expected Date for Selection Notifications:	September 2011
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Means of Submission	All submissions must be submitted to ARPA-E's online application portal, ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx) before the submission deadline. Submissions received through other means will not be reviewed or considered. ARPA-E strongly encourages

	Applicants to submit their Full Applications and Replies to Reviewer Comments at least 24 hours in advance of the submission deadline as noted in Section IV.E.	
Concise Program Description	More than 90% of energy technologies involve the transport and conversion of thermal energy. Therefore, advancements in thermal energy storage – both hot and cold – would dramatically improve performance for a variety of critical energy applications. ARPA-E seeks to develop revolutionary cost-effective thermal energy storage technologies in three focus areas: 1) high temperature storage systems to deliver solar electricity more efficiently around the clock and allow nuclear and fossil baseload resources the flexibility to meet peak demand, 2) fuel produced from the sun's heat, and 3) HVAC systems that use thermal storage to dramatically improve the driving range of electric vehicles.	
Total Amount to Be Awarded	Approximately $30 million is expected to be available for new awards under this FOA.	
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 issued to DOE/NNSA Federally Funded Research and Development Centers (FFRDCs) through the DOE/NNSA Field Work Proposal system for work performed under Department of Energy Management & Operation Contracts, and Interagency Agreements for work performed by Non-DOE/NNSA FFRDCs and U.S. Government-Owned Government-Operated laboratories (GOGOs). ARPA-E generally does not fund projects through Grants.	
Period of Performance	Expected up to 36 months	
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
	FFRDCs, including DOE/NNSA FFRDCs	May apply as lead organization for a Project Team or as member of a Project Team
	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 or otherwise headquartered in the United States.	

[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..

Eligibilty – 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 or otherwise headquartered 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 and "other transactions" agreements	≥ 50% of the Total Project Cost
	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	Applicants may contact ARPA-E through the following email addresses: • **ARPA-E-CO@hq.doe.gov** for questions regarding this FOA. Insert FOA title and number in subject line of emails. • **ExchangeHelp@hq.doe.gov** for questions regarding ARPA-E eXCHANGE. Insert FOA title and number in subject line of emails. See Section VII.A of the FOA for guidance on submitting questions to ARPA-E. ARPA-E will not accept or respond to communications received by other means (e.g., telephone calls, faxes). Emails sent to other email addresses will be disregarded.	
Application Forms	Required forms for Full Applications (SF-424, SF-424A, Budget Justification Workbook, and Environmental Impact Questionnaire) are available at https://arpa-e-foa.energy.gov.	

I. FUNDING OPPORTUNITY DESCRIPTION

A. AGENCY OVERVIEW

The Advanced Research Projects Agency – Energy (ARPA-E) is an agency within the Department of Energy (DOE) that has funded the development and deployment of transformational and disruptive energy technologies and systems since 2009.[2] ARPA-E focuses on high-risk concepts with potentially high rewards.

When it established ARPA-E, Congress directed ARPA-E 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.

Pursuant to its statute, ARPA-E seeks to accomplish its mission by identifying and promoting revolutionary advances in fundamental sciences, by translating scientific discoveries and cutting-edge inventions into technological innovations, and by accelerating transformational technological advances in areas that industry by itself is not likely to support because of technical and financial uncertainty.

ARPA-E is fundamentally different from other Government research, development, and demonstration (RD&D) programs and organizations. ARPA-E does not fund basic research aimed at discovery, incremental improvements to existing technologies, or the commercialization of proven technologies. ARPA-E does not itself engage in RD&D, and does not own or manage any laboratories.

ARPA-E sponsors outside entities to perform RD&D that is both transformational and disruptive. ARPA-E aims to establish new directions for energy research and technology

[2] Transformational change moves technology to new learning curves, but it does not necessarily have a disruptive transformation on the market – for example, it could be too expensive. A disruptive change occurs when price drives adoption to a new product. At its inception, the automobile was transformative with respect to the horse-and-buggy market, but the automobile was not disruptive because it was too expensive. By contrast, the Model T was disruptive to the horse-and-buggy market because it was affordable.

development and new paradigms for how energy is produced, transmitted, used, and stored. ARPA-E projects and programs are characterized by a clear view of a desired outcome, an understanding of the intervening barriers, and innovative pathways toward a new future. These projects and programs have the potential to radically change our understanding of important energy-related concepts or lead to the creation of new energy-related fields. They often depend on technical approaches that are novel, emergent, integrative, and enabling.

ARPA-E strongly encourages outstanding scientists and engineers from different organizations and countries and different scientific disciplines and technology sectors to form new teams. Interdisciplinary and cross-sectoral collaboration spanning organizational and national boundaries enables and accelerates the achievement of scientific and technological outcomes that were previously viewed as extremely difficult, if not impossible.

ARPA-E does not replace or duplicate private investment in emerging technologies. Instead, ARPA-E enables transformational energy technologies that have high technical and market risk to bridge the so-called "valley of death," where little or no public or private funding is available. The spectrum of technology research activities, from basic research to full system validation, is defined within a framework of nine "technology readiness levels" (TRLs). ARPA-E operates mainly within the "valley of death" between TRL-3 and TRL-7.[3]

Each ARPA-E project is expected to overcome key technical barriers currently preventing industrial adoption of the transformational technology, but not to carry the taxpayer investment beyond the point where industry and investors should shoulder the remaining technical and market risks.

The first step in applying for funding under the FOA is the submission of a short Concept Paper, which describes the essence and novelty of the proposed technology and its ability to meet or exceed the Primary Technical Targets and Secondary Technical Targets in Section I.B.4 of the FOA. The next step is the submission of a Full Application, which provides detailed information on the proposed project, including, among other items, an in-depth discussion of various aspects of the proposed project, a detailed budget, an environmental impact questionnaire, and a publically releasable summary of the project. Finally, Applicants have a brief opportunity to review written comments on their Full Application and prepare a short Reply to Reviewer Comments. Please refer to Section V.B.2 of the FOA for additional guidance on the merit review and selection process.

[3] Please refer to Appendix 1 for ARPA-E's Technical Readiness Level Scale.

B. PROGRAM OVERVIEW

1. BACKGROUND

Thermal energy transport and conversion play a very significant role in more than 90% of energy technologies. More than 60% of all primary energy consumption in the United States is currently wasted in the form of thermal energy. Thermal energy storage can significantly enable reuse of wasted energy and enhance the efficiency of energy delivery and consumption. Thermal storage - both hot and cold - can be employed for a variety of critical energy applications. This ARPA-E Funding Opportunity aims to support the development of novel, advanced thermal energy storage technologies to enable the following transformative energy solutions:

- Next generation non-intermittent and cost-competitive solar thermal power plants.
- Advanced nuclear power plants which can supply peaking power capability on the grid
- Production of fuel using thermochemical reactions to store solar energy in chemical form
- Novel Electric Vehicle HVAC systems with dramatic improvements in driving range.

Potential New Materials and Systems for Thermal Storage Innovations

ARPA-E is interested in all forms of thermal storage such as sensible heating, phase change, super-critical systems and thermochemical storage. With significant advancements in new materials in the past such as metal-organic-frameworks (MOFs)[4], ionic liquids[5], catalyzed decomposition reactions, high temperature composites and system design, it may be possible to develop highly efficient high temperature thermal storage system.

ARPA-E has significant interest in advancing the state of the art in thermophysical thermal storage technology. There have been significant advances in the field of material science with impacts on applications ranging from carbon capture[6] to high temperature rocket engines[7]. Some of these advances may be applied to thermal energy storage either in the direct

[4] O. Yaghi et al. Science, 2008, 319, 939-943
[5] J. Brennecke et al. J. Am. Chem. Soc., 2010, 132, 2116–2117
[6] J. Anthony et al., Int. Journal of Environmental Technology and Management, 2004, 4, 105 - 115
[7] D. Marshall, and Brian Cox, Annual Rev. of Materials Research, 2008, 38, 425- 443

thermophysical storage material or in the balance of systems. Examples include new developments in the properties of ionic liquids or molten salts, which can be designed to be used as high energy density thermal storage material for both sensible or phase change storage[8]. Nanotechnology can also potentially enable advanced thermal energy storage. For example some recent results suggest that mixing nanoparticles in liquids can anomalously enhance specific heat[9]. Alternative thermal storage mechanisms also merit renewed exploration with recent materials advances. For instance, adsorption/absorption based thermal storage may benefit from developments in ionic liquids, new sobents and MOFs, whose binding energy with a gas can be tuned based on recent advances in synthetic chemistry. Beyond the active thermal storage medium, recent developments may present an opportunity for relaxed constraints in system design. Supercritical fluidic system have the potential to be cheap storage materials due to their higher energy density, but the pressure vessel required for the supercritical system represents a significant added cost. Advancement in cheaper materials to be used as pressure vessels may thus enable supercritical thermophysical systems. Finally, cost effective thermal storage can also be enabled by better system design, for instance by eliminating heat exchangers between the storage medium and charging systems.

ARPA-E also has significant interest in developing insulation free thermal storage which can be enabled by thermochemical storage. Although there have been some investigations in the literature on thermochemical systems, several issues have limited the technological applications. The potential benefits of these thermochemical storage technologies include the ability to store heat for a variable, controllable period of time and to control the rate of charging or discharging reactions using catalysts. Some thermochemical storage systems have been proposed in the past using endothermic decomposition reactions such as[10] $CaCO_3$ <=> $CaO + CO_2$. However, the volumetric energy densities of these thermochemical storage systems are low because at least one component in the reaction, in this case CO_2, is a gaseous state. The energy density of these systems can be increased by storing the gases at a higher density using new materials such as ionic liquids of metal-organic-frameworks (MOFs). Additionally, to maintain an acceptable energy density per unit mass (MJ/kg), the storage materials must have a moderate molecular weight.

Alternatively, the energy density of thermochemical storage systems can be increased by using reactions of the form AB<=>A+B that are exclusively in the condensed phase. Like the storage technologies discussed above, the molecular weight of these components should be low

[8] B. Wu et al, Proceedings of Solar Forum 2001, Solar Energy: The Power to Choose, April 21-25, 2001, Washington, DC
[9] D. Shin and D. Banerjee, J. of Heat Transfer, 2011, 133, 24501
[10] G. Ervin, Journal of Solid State Chemistry, 1977, 22, 51-61

enough to maintain an acceptable energy density per unit mass. Some reactions that could be used to meet these metrics include organic reverse Diels-Alder[11]/sigmatropic[12], disproportionation[13] and depolymerization[14] reactions. These are common reactions in synthetic organic chemistry, but have never been applied to thermal storage technologies. For any of these reactions, and others, energy costs associated with separating the two product components (A and B) must be accounted for. Additionally, there is interest in developing catalysts that can be used to control the rate of the charging and discharging thermal storage reactions.

Thermal Storage for next-generation non-intermittent and cost-competitive solar thermal power plants

Thermal energy storage (TES) can significantly increase the capacity factor of concentrated solar thermal power plants, from ~30% to greater than 60% which in turn can reduce the levelized cost of electricity (LCOE) produced. The concentrated solar power (CSP) program in DOE's EERE program has significantly advanced the technology of thermal storage for CSP by funding multiple programs on a variety of materials and systems, most notably molten salts. These programs have established a critical base of knowledge and significantly increased the understanding of solar thermal storage; but, nearly all work to date has focused on storage compatible with traditional parabolic trough systems, which operate at temperatures less than 500 ^{o}C. The Sunshot program that leverages the technical expertise across DOE has now established an aggressive target LCOE for solar-based electricity of 5-6 cents/kWh by 2017 so that solar electricity can scale without subsidies, while making US globally competitive. It is increasingly clear that traditional parabolic trough systems will struggle to reach these aggressive targets due to efficiency limits at low temperatures. As such, a new generation of solar thermal technologies is in development, providing higher efficiency by greater concentration and higher operating temperatures. To accommodate this next generation of technology, and achieve the goal of low cost, dispatchable solar energy, there is a strong need for novel thermal storage solutions operating at much higher temperatures than previously investigated.

[11] H. Kwart et al. Chem. Rev., 1968, 68 (4), pp 415–447
[12] Hoffmann R. Acc. Chem. Res., 1968, 1 (1), pp 17–22
[13] Swain et al., J.Am Chem. Soc., 1979, 101,3576-3583
[14] Duda and Penczek, Macromolecules 1990, 23, 1636-1639

Thermal Storage for advanced nuclear power plants that can supply peaking power capability on the grid

Existing nuclear power plants operate free of greenhouse gas emissions, but are used exclusively for providing base load power. In contrast, peaking plants, primarily based on fossil fuels, are responsible for significant CO_2 emissions due to their poor efficiency. As sources of clean electricity generation (based on various technologies such as solar, wind, hydro, and nuclear) become more prevalent, there is a strong need for emission-free on-demand peaking capability to ensure a clean, efficient, and secure power grid. Thermal storage can enable the use of nuclear power plants for providing peaking power by storing part of the thermal energy from the nuclear reactor to subsequently run a thermodynamic cycle, such as the Brayton cycle, for power generation. While current generation light water nuclear reactors work at temperatures less than 300 ^{o}C, Gen IV advanced reactors[15] are being planned for temperatures higher than 700 ^{o}C. Given similar output temperatures, there are significant synergies in developing high temperature thermal storage for enhanced dispatchability of both CSP and nuclear power. The nuclear industry is exploring various power generation technology such as those based on He and supercritical CO_2 cycles[16] for high temperature generation. If CSP is pushed to high temperatures the power generation technologies being developed for nuclear industry can also be used for CSP. Some discussions on this already exist in the literature[17].

Production of fuel using thermochemical reactions that store solar energy in chemical form

Production of fuel from sunlight is also a form of energy storage. In this case, thermal energy is stored in the form of chemical bonds. ARPA-E, other parts of DOE and other Federal funding agencies have significantly funded research and development of a wide range of methods for producing fuel from sunlight including traditional approaches to biofuel and biomass production and the direct fuel production by chemical and biological catalysts[18]. On the other hand thermochemical production of fuel from sunlight, where solar energy is used to produce heat to break chemical bonds, has not been investigated to the same extent. The theoretical efficiency of thermochemical production of fuel from sunlight is very high and limited primarily by the collector efficiency[19]. Recent reports[19] suggest that due to significant improvement in a

[15] C. Oh et al, Development of a Supercritical Carbon Dioxide Brayton Cycle: Improving PBR Efficiency and Testing Material Compatibility Project Number: 02-190Nuclear Energy Research Initiative
for October 2004 to September 2004, Idaho National Lab, INEEL/EXT-04-02437
[16] V. Dostal, M.J. Driscoll, P. Hejzlar, A Supercritical Carbon Dioxide Cycle for Next Generation Nuclear Reactors, MIT-ANP-TR-100, March 10, 2004
[17] C. Turchi, Proceedings of SCCO2 Power Cycle Symposium 2009, RPI, Troy, NY, April 29-30, 2009
[18] http://www.science.doe.gov/bes/Hubs/JCAP_Tech_Summary.pdf
[19] T. Kodama and N. Gokon, Chemical Review, 2007, 107, 4048 - 4077

two-step solid-state catalytic process it's possible to generate syngas by thermolysis of CO_2 and H_2O with high efficiency. The efficiency of this process can be further increased by improved reactor design and heat harvesting and recycling. This discovery and other recent developments suggest that there is a renewed opportunity to develop high efficiency thermochemical routes to solar fuels. Moreover, because thermolysis requires very high temperatures, the development of high temperature thermal storage systems can benefit from the significant synergies between thermochemical production of fuel and thermoelectrical systems for production of electricity.

Thermal Storage for novel Electric Vehicle HVAC systems with dramatic improvements in driving range

While the above applications relate to large scale, high temperature thermal energy storage systems, there is separately a strong need for advances in modular, high energy density thermal energy storage. Such systems could have a dramatic impact in next-generation HVAC (Heating Ventilation Air Conditioning) systems for plug in hybrid electric vehicles (PHEV) and electric vehicles (EV). In today's electric vehicles both cabin cooling and heating loads must be provided by the electrical energy stored in a battery whose capacity determines the range of the vehicle. These cabin HVAC loads can be significant relative to the powertrain load, and in some cases can cause reduction in EV range by as much as 40%[20]. An advanced Thermal Energy Storage system that provides heating and cooling to the vehicle cabin can reduce or eliminate the added load on the electrical storage system, and thereby significantly increase the range of next generation EVs with little or no added cost or packaging. The TES solution will ideally be a single system that can provide both cooling and heating at minimal cost, weight and volume when compared with the vapor compression based air conditioners and resistive heaters currently in use. If successfully developed modular thermal-storage based HVAC systems could have a broad energy impact beyond the automotive sector. For instance, coupled to combined heat and power systems or as a novel solution for distributed, location-specific building HVAC that can rely on off-peak power while delivering heating and cooling during peak hours.

[20] R. Barnitt, A. Brooker, L. Ramroth, J. Rugh, and K. Smith, "Analysis of Off-Board Powered Thermal Preconditioning in Electric Drive Vehicles," Presented at the 25th World Battery, Hybrid and Fuel Cell Electric Vehicle Symposium & Exhibition Shenzhen, China November 5 – 9, 2010, NREL/CP-5400-49252 ,December 2010

2. PROGRAM OBJECTIVES

The focus of this FOA is to develop revolutionary, cost effective thermal storage systems for:

1) Large scale, high temperature systems for high efficiency, non-intermittent CSP and zero-emission peaking power from nuclear energy
2) Thermochemical production of fuel from sunlight
3) Small scale, high-density thermal storage based HVAC systems for range-enhanced Electric Vehicles

3. AREAS OF INTEREST

- **Areas of Particular Interest:**

Area of Interest 1: Utility scale thermal storage for next-generation CSP and Nuclear power generation with storage temperatures greater than 600°C

ARPA-E seeks innovative applications in the area of high-temperature storage for both CSP and nuclear applications. As described above, advanced CSP and Nuclear reactor designs suggest a strong and urgent need to develop thermal storage at higher temperatures than previously investigated. Internal research by ARPA-E and the CSP program of EERE, along with information gathered through focused workshops, suggests that in order to achieve an LCOE of ≤ 6 cents/kWh for CSP electricity generation, systems must be operated at temperatures higher than roughly 600 °C. Storage at similar temperatures would also open an entirely new opportunity to extract green house gas emission-free peak power capabilities from next-generation nuclear plants.

In developing thermal storage technologies, round-trip energy efficiency is often cited as a key metric of performance; however, it is in fact most critical that *exergetic* efficiency be very high to ensure that heat quality is maintained after storage. Therefore the primary technology target specification for this focus area is based on round-trip exergetic efficiency. Figure (1) shows for sake of illustration a generic sensible heating thermal storage system – note that other systems are possible and applicants are highly encouraged to look into alternative approaches including chemical and physio-chemical means of storage.
Exergy transfer is given by:

$$\Delta G = \Delta H - T_{amb}\Delta s \qquad (1)$$

Where ΔG is the exergy transfer, ΔH the change in enthalpy, Δs the change in entropy and T_{amb} is the ambient temperature. T_{amb} should be assumed to be 300 K (27 ^{o}C) in evaluating the roundtrip efficiency. Round trip exergetic efficiency (ε) of the storage is defined by:

$$\varepsilon = \left|\frac{\Delta G_d}{\Delta G_c}\right| = \left|\frac{(\Delta H - T_{amb}\Delta s)_d}{(\Delta H - T_{amb}\Delta s)_c}\right| \qquad (2)$$

Where subscripts *c* and *d* refer to charging and discharging of thermal storage respectively. For example for the system shown in Figure (1), Eq. (2) for incompressible substance reduces to

$$\varepsilon = \left|\frac{\Delta G_d}{\Delta G_c}\right| = \left|\frac{(\Delta H - T_{amb}\Delta s)_d}{(\Delta H - T_{amb}\Delta s)_c}\right| = \left|\frac{\int_{T_{di}}^{T_{do}} c_p(T)dT - T_{amb}\int_{T_{di}}^{T_{do}} \frac{c_p(T)dT}{T}}{\int_{T_{ci}}^{T_{co}} c_p(T)dT - T_{amb}\int_{T_{ci}}^{T_{co}} \frac{c_p(T)dT}{T}}\right| \qquad (3)$$

where c_p is the specific heat. Note that absolute value is used in Eq. (3) because exergy transfer from the charging fluid is negative in the charging stage and positive in the discharging stage.

It is to be noted that Figure (1) is one possible embodiment of thermal storage based on sensible heating concept, however it is expected that there are multiple other schemes possible where charging/discharging of the storage may take place at constant temperature. Therefore, applicants are expected to use the generic Eq. (2) for deriving the exergetic efficiency of their system. In the application, applicants are required to clearly show the exergy formula based on Eq. (2) for their system to evaluate the exergetic efficiency of the storage systems. The main area of interest is for storage systems that can enable the downstream power plant to operate at temperatures greater than 600 ^{o}C. Therefore, for this area of interest only solutions that can accommodate downstream operating temperature greater than 600 ^{o}C will be entertained.

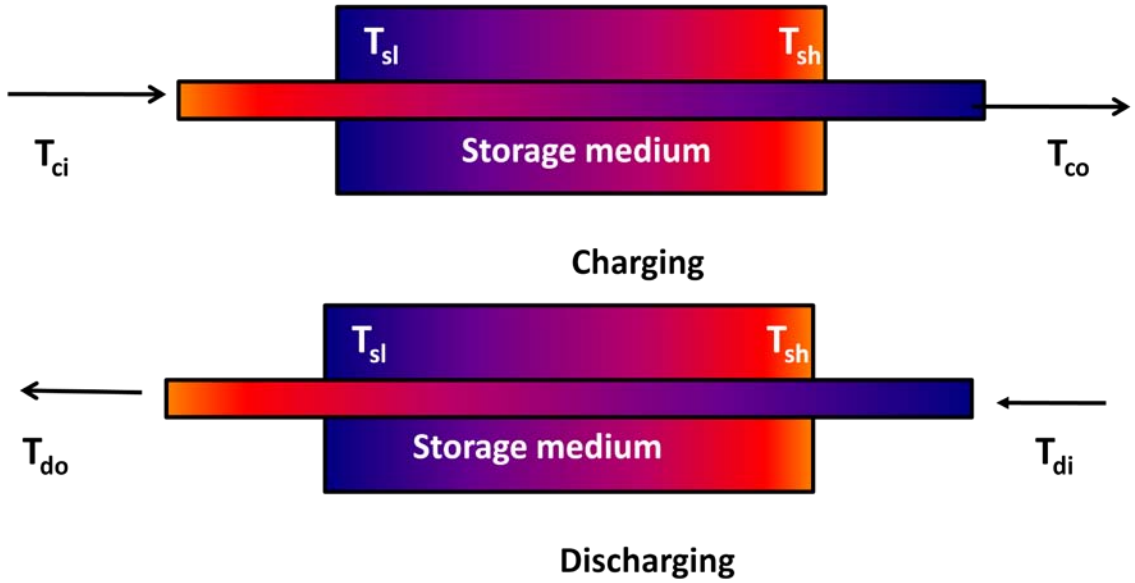

Figure 1: *A schematic demonstrating the charging and discharging of thermal storage system. Note that this is for illustration purposes only. Other embodiments of thermal storage are also possible and the general Eq. (2) should be used for other embodiments to evaluate the exergetic efficiency. It is expected that applicants will provide the right equation based on Eq. (2) for their specific idea. In this figure T denotes the temperature, i, o, c, and d in the subscript denote inlet, outlet, charging and discharging respectively, sl and sh in the subscript denote lower and higher temperature of the storage media respectively.*

An ideal team for addressing this area of interest would comprise of materials, chemical, thermal, and/or mechanical engineers/scientists as well as individuals or organizations with expert knowledge of CSP or Nuclear power plant design and operation. It's important that the team should have expertise in every aspect of the system including a solid understanding of CSP and/or nuclear systems.

The technology target specification for this area of interest is given in Section I.B.4 a and b. Proposed technology development plans must have well justified, realistic potential to meet or exceed the stated "Primary Technology Target Specification" by the end of the period of performance of the proposed project in order to be considered for award. Proposed technologies will secondarily be evaluated against their well-justified, realistic potential to approach the "Secondary Technology Target Specification" by the end of the period of performance of the proposed project. Proposed technologies will still be considered for award if they fall short of one or more of the Secondary Technical Targets below, but will be evaluated and compared to one another according to their strengths and weaknesses in addressing these targets. For purpose of target evaluation, the storage system is intended to describe the full system i.e. it includes all components such as charging and discharging devices, pumps, storage

containers, insulation, and storage material. While the application should focus on the thermal storage solution, applicants are expected to understand and describe the imagined use-case for thermal storage in CSP and/or Nuclear applications, and should consider integration with both the heat source and down-stream power generation mechanism. For example, applications should indicate the type of power block system that would be expected to be used for the CSP or the nuclear system (e.g. supercritical steam plant vs. supercritical CO_2 cycle, etc.). *Any parasitic load in the system such as the power consumed by the pumps should be clearly stated in the application.*

Area of Interest 2: Thermochemical production of fuel from sunlight

Thermochemical production of fuel provides a possible pathway to produce fuel from solar energy. However, demonstrated efficiency is less than 1 %[21] whereas theoretical efficiency can be significantly higher than 10%[19]. ARPA-E is interested in developing thermochemical method to produce chemical fuels from sunlight. The solar-to-fuel conversion efficiency is given by

$$\eta = \frac{r_{fuel}\Delta H_{fuel}}{p_{solar}+p_{parasitic}} \qquad (4)$$

where r_{fuel} is the molar fuel production rate, ΔH_{fuel} is the higher heating value of the fuel, p_{solar} is the incident solar radiation power and $p_{parasitic}$ is any parasitic power used in the system. The technology target specification for this area of interest is given in Section I.B.4 c. It is expected that for this area of interest applicants will develop a prototype reactor which can reach the high temperature needed for thermochemical production of fuel.

Ideal team for this area of interest should comprise of materials, chemical, thermal, mechanical engineers/scientists. It's important that the team should have expertise in every aspect of the system and good understanding of solar energy collection, and reactor design. Teams should demonstrate and articulate a strong understanding of the practical use-case for the proposed fuel cycle, including both commercial and operational merits and limitations.

Area of Interest 3: High density thermal storage to provide heating and cooling for Electric Vehicles

Electric battery capacity and cost represent the highest barriers to wide scale adoption of electric vehicles as the large and expensive batteries needed to provide significant driving range can result in unattractive vehicle design and price-points. A key drain on the electrical battery

[21] W. Chueh, Science, 330, 2010, 1797

system of an Electric Vehicle is the need to serve cabin heating and cooling loads. To make matters worse, today's EVs generally use electric battery capacity for highly inefficient resistive heating as opposed to internal-combustion vehicles, which simply route waste engine heat to the cabin. In general, Cabin Climate conditioning can significantly reduce the electric range of plug-in and full Electric Vehicles, by as much as 40% in extreme cases[20], or inversely can increase the battery size and cost by a comparable amount for the same range.

Significant reduction in size/cost of EV batteries or significant increase in driving range can be enabled by eliminating the need for cabin climate load to draw on the electrical battery system. ARPA-E has significant interest in developing thermal battery technology that can provide both cooling and heating to the vehicle cabin, freeing critical electrical battery capacity for driving loads. Today's thermal storage solutions are already lower cost than electrical energy storage systems, at comparable energy densities. If the design and energy density of thermal battery systems can be improved, then an ancillary thermal battery could supply cabin climate loads without introducing significant additional space or volume to the vehicle. In today's vehicles, heating and cooling systems must be sized to meet peak demand while most normal operation is to serve a much lower steady state load. In the ideal case, the space occupied by thermal battery for partial heating and cooling would be equivalent to the total space saved by downsizing or eliminating the existing vapor compression cooling system and the existing heating system in PHEVs and EVs. In that case, cost effective climate control can be achieved with no tradeoff in vehicle design performance. In the typical use case, such a thermal battery would simply be charged upon plug-in, in tandem with the electrical battery being charged.

Most vehicles will require some level of heating/cooling capabilities once the thermal battery is depleted. As such, we envision hybrid HVAC solutions in which a thermal battery can deliver some portion of the peak cooling/heating power, but a minimal level of active HVAC is available on demand from the electrical battery. Various hybrid systems are possible. For example, intelligent systems can be designed where in case of emergency the on-board charging system for the thermal battery can be directly used for cooling/heating by deriving energy from the electrical battery. Figure 2 shows one particular embodiment of this concept however applicants are highly encouraged to provide other system designs and concepts. Furthermore, this system can also provide thermal management of the electrical battery pack which is very important for reliable operation of the electrical battery[20].

Although preference will be given to systems that can provide both heating and cooling, new concepts that represent significant energy density advances in either cold or hot storage materials will be also entertained. It is expected that the proposed solution will be a self-contained system which includes both on-board charging and discharging devices for the

thermal battery as well as mechanism for deploying the thermal energy (e.g. fans, etc.). ARPA-E seeks highly innovative applications in this area.

The technology target specification for this area of interest is given in Section I.B.4 d and e. Proposed technology development plans must have well justified, realistic potential to meet or exceed the stated "Primary Technology Target Specification" by the end of the period of performance of the proposed project in order to be considered for award. Proposed technologies will secondarily be evaluated against their well-justified, realistic potential to approach the "Secondary Technology Target Specification" by the end of the period of performance of the proposed project. Proposed technologies will still be considered for award if they fall short of one or more of the Secondary Technical Targets below, but will be evaluated and compared to one another according to their ability to address these targets. For purpose of target evaluation, the storage system is intended to describe the full system i.e. it includes all components such as charging and discharging devices, pumps, storage container, insulation, and storage material.

An ideal team for this area of interest should comprise materials, thermal, mechanical and automotive engineers/scientists. It's important that the team should include expertise in every aspect of the system and good understanding of automotive HVAC systems. Space is a big constraint in automobile, and while total volume of the system is specified in the specifications it is expected that different components will be distributed throughout the vehicle as is the practice today. Therefore it is important to have an automotive expert in the team who is familiar with integration and space challenges in automobiles.

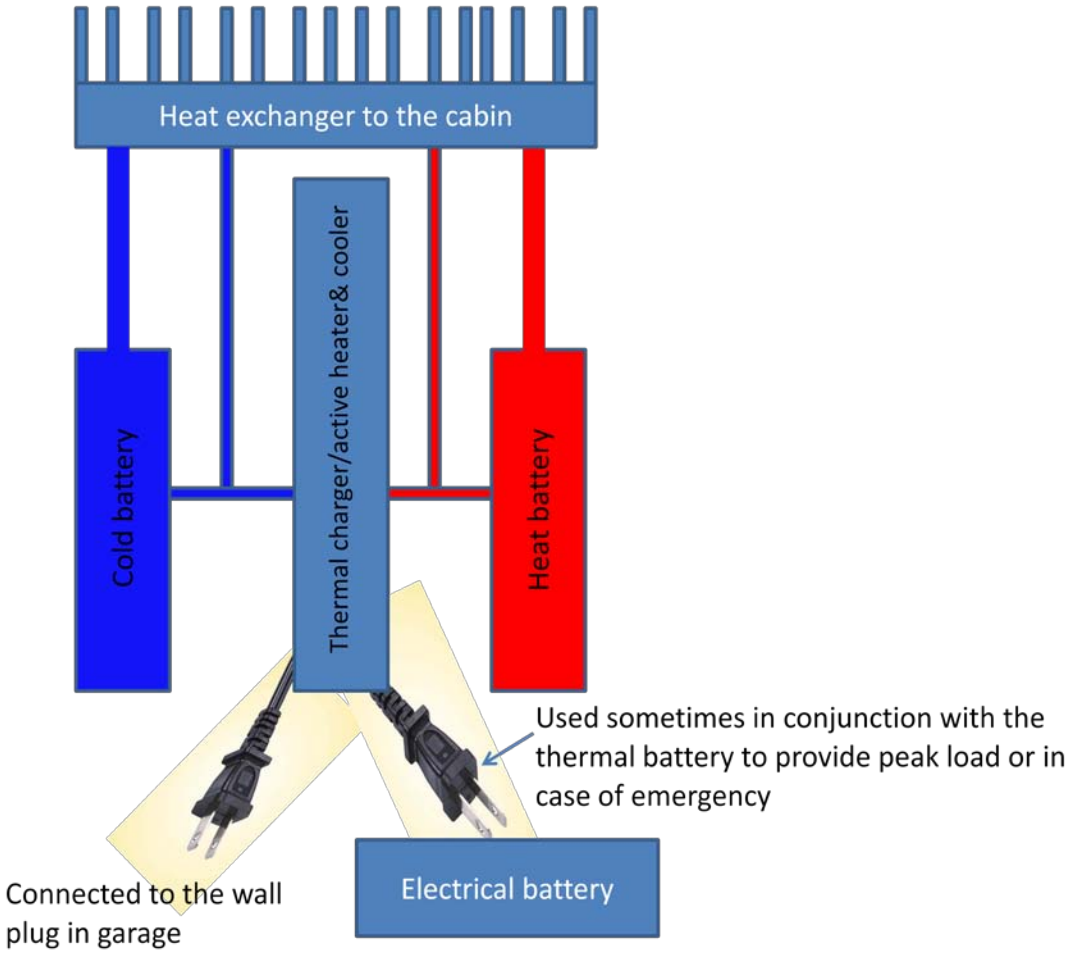

Figure 2: *A schematic demonstrating the concept of hybrid cabin climate control system*

Area of Interest 4 Seedling / Proof of concept for partial solutions or very novel, unexplored thermal storage concepts

ARPA-E recognizes that there may be new high-impact ideas related to the Areas of Interest above for which a novel thermal storage concept has been envisioned, but the concept has not yet been proven. In these cases, developing a system with the full specifications given in Areas of Interest 1 through 3 may not be realistic due to limitations in scale. For instance, a candidate may be interested in developing a very novel new material or approach for high-temperature CSP storage, but may not expect to be able to demonstrate that concept at >30kWh$_t$ scale. For such unproven and yet promising ideas, ARPA-E seeks small 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 suggest possible paths to approach the full system level specifications given in one of the areas discussed above.

- **Areas Specifically Not of Interest:**
  - Incremental improvements to, or combinations of, existing products and technologies, wherein no significant advances in understanding or reductions in technical uncertainty are achieved; and
  - Demonstration projects that do not involve a significant degree of technical risk.

Any Concept Papers or Full Applications that focus on "Areas Specifically Not of Interest" will be rejected as nonresponsive and will not be reviewed or considered.

4. TECHNICAL PERFORMANCE TARGETS

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 by the end of the period of performance for the proposed project.

Applications will receive favorable consideration if they meet or exceed at least one of the Secondary Technical Targets. Preference will be given to applications that have a well-justified, realistic potential to meet or exceed most, if not all, of the Secondary Technical Targets.

The Primary Technical Targets and Secondary Technical Targets for **utility scale electricity generation from solar or nuclear source** are stated below:

a. PRIMARY TECHNICAL TARGETS FOR UTILITY SCALE ELECTRICITY GENERATION FROM SOLAR OR NUCLEAR SOURCE

ID Number	Category	Value (Units)
1.1.1	Temperature for power generation in the down-stream power cycle	$\geq 600\ ^{o}C$
1.1.2	Exergetic efficiency (Eq. 2)	$\geq 95\%$
1.1.3	Charging time for storage	≤ 6 hours for full charge
1.1.4	Stored energy for Technology demonstration	$\geq 30\ kWh_t$ * (Minimum capacity to deliver 6 hours of stored energy at peak thermal power)

1.1.5	Technology demonstration	Peak delivered thermal power from storage ≥ 5 kW_t *

(See Section I.B.3 for details on Area of Interest 1 to which these Primary Targets apply)

* Note that subscript **t** denotes thermal.

b. SECONDARY TECHNICAL TARGETS FOR UTILITY SCALE ELECTRICITY GENERATION FROM SOLAR OR NUCLEAR SOURCE

ID Number	Category	Value (Units)
1.2.1	Cost of storage system including charging and discharging devices	$\leq \$15/kWh_t$
1.2.2	Volumetric energy density	≥ 25 kWh_t/m^3
1.2.3	Operational Lifetime	20+ years, 10,000+ cycles

(See Section I.B.3 for details on Area of Interest 1 to which these Secondary Targets apply)

The Primary Technical Targets for **solar thermochemical fuel generation** are stated below:

c. PRIMARY TECHNICAL TARGETS FOR SOLAR THERMOCHEMICAL FUEL GENERATION

ID Number	Category	Value (Units)
2.1.1	Solar-to-fuel efficiency (Eq. 4)	$\geq 10\%$
2.1.2	Highest temperature in the system	≤ 1500 °C

(See Section I.B.3 for details on Area of Interest 2 to which these Primary Targets apply)

The Primary Technical Targets and Secondary Technical Targets for **climate control thermal battery for EVs and PHEVs** are stated below:

d. PRIMARY TECHNICAL TARGETS FOR CLIMATE CONTROL THERMAL BATTERY FOR EVS AND PHEVS

ID Number	Category	Value (Units)
3.1.1	Air temperature delivered to the cabin for heating	40 – 60 °C
3.1.2	Air temperature delivered to the cabin for cooling	3 – 10 °C
3.1.3	Maximum air delivery flow volume	675 m^3/hr

3.1.4	Minimum power capability of thermal battery (storage)	Cooling – 2.5 kW_t * Heating – 2.5 kW_t
3.1.5	Minimum capacity of thermal battery (storage)	Cooling – 2.5 kWh_t * Heating – 2.5 kWh_t
3.1.6	Minimum active power capability from electrical battery (must be available on demand at any time)	Cooling - 2.5 kW_t * Heating – 2.5 kW_t
3.1.7	Maximum System Volume (including active component(s), thermal charger, thermal batteries (storage)(s), blower(s), and any other components)	30 Liters
3.1.8	Charging time	<=4 hrs
3.1.9	Self discharge allowance	<10% per day

(See Section I.B.3 for details on Area of Interest 3 to which these Primary Targets apply)

* Note that subscript **t** denotes thermal.

e. SECONDARY TECHNICAL TARGETS FOR CLIMATE CONTROL THERMAL BATTERY FOR EVS AND PHEVS

ID Number	Category	Value (Units)
3.2.1	Coefficient of performance (COP)	>2 for **cooling** (assuming 38 °C ambient temperature and 10 °C delivered air temperature > 1.5 for **heating** (assuming 0 °C ambient temperature and 40 °C delivered air temperature)
3.2.2	Total weight of the system	< 35 kg
3.2.3	Manufacturing cost of the whole system	< $250/kW
3.2.4	Lifetime	10 years, 5000 on/off cycles

(See Section I.B.3 for details on Area of Interest 3 to which these Secondary Targets apply)

II. AWARD INFORMATION

A. AWARD OVERVIEW

Approximately $30 million is expected to be available for new awards under this FOA, subject to the availability of appropriated funds. ARPA-E anticipates making 10-20 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 would prefer to support only rare applications with significant technology risk and aggressive timetables for support at the upper ranges, with careful management and mitigation of the associated risks. ARPA-E may make individual awards up to $10 million in rare and exceptional cases.

The period of performance for funding agreements may range between 12 and 36 months. ARPA-E expects the start date for funding agreements to be November 2011.

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 categories: "seedling / proof of concept" and "early stage device prototyping."

- Seedling / Proof of Concept awards focus on early-stage, proof-of-concept level research and development. Applicants should submit evidence of an idea, described in sufficient technical detail to allow Reviewers to meaningfully evaluate the proposed project's potential for meeting the necessary Primary Technical Targets and Secondary Technical Targets. ARPA-E may issue approximately 5-10 awards in this category, with an average award amount of $500k.

- Early Stage Device Prototyping awards 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 the proposed project will meet the necessary Primary Technical Targets and Secondary Technical Targets. ARPA-E may issue approximately 5-10 awards in this category, with an average award amount of $2-3 million.

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."[22] Accordingly, ARPA-E has substantial involvement in the management and 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,[23] unless one of the following conditions apply:

- The Prime Recipient is a Federally Funded Research and Development Center (FFRDC) or U.S. Government-Owned Government-Operated laboratory (GOGO), or
- The Prime Recipient requests and qualifies for a Technology Investment Agreement.

Like Grants, Cooperative Agreements involve the provision of financial or other support to accomplish a public purpose of support or stimulation authorized by Federal statute. However, Cooperative Agreements differ from Grants in terms of agency involvement, supervision, and intervention in the project. Grants restrict Government involvement to the minimum necessary to achieve program objectives. Under Cooperative Agreements, the Government and Prime Recipients share responsibility for the management, control, direction, and performance of projects.

ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement, which is available at http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx, in advance of award negotiations. ARPA-E created the Model Cooperative Agreement to facilitate

[22] U.S. Congress, Conference Report to accompany the 21st Century Competitiveness Act of 2007, H. Rpt. 110-289 at 171-172 (Aug. 1, 2007).
[23] The Prime Recipient is the signatory to the funding agreement with ARPA-E.

and expedite award negotiations. ARPA-E generally does not modify the terms and conditions of the ARPA-E Model Cooperative Agreement unless there is a demonstrated need.

2. FUNDING AGREEMENTS WITH FFRDCS AND GOGOS[24]

When a FFRDC or non-DOE/NNSA GOGO is the *lead organization* for 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 FFRDC or non-DOE/NNSA GOGO 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.

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 and GOGOs 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).

3. TECHNOLOGY INVESTMENT AGREEMENTS AND "OTHER TRANSACTIONS" AGREEMENTS

ARPA-E may use its "other transactions authority" under the America COMPETES Reauthorization Act of 2010 to enter into "other transactions" agreements with Prime Recipients. Alternatively, ARPA-E may use DOE's "other transactions authority" under the Energy Policy Act of 2005 to enter into Technology Investment Agreements (TIAs) with Prime Recipients. ARPA-E uses TIAs and "other transactions" agreements to broaden the U.S. technology base and to foster within the technology base new relationships and practices that

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

advance U.S. economic and energy security and promote scientific and technological innovation.

ARPA-E may negotiate a TIA or "other transactions" agreement in order:

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

In a TIA or "other transactions" agreement, ARPA-E may modify standard Government terms and conditions, including but not limited to:

- 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.
- 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. For example, ARPA-E may modify the definition of "subject invention" or Government rights attaching to inventions developed under the ARPA-E funding agreement (e.g., Government purpose license).

If Applicants are seeking to negotiate a TIA or "other transactions" agreement, they are required to include an explicit request in their Full Applications. Please refer to Section IV.C.1 of the FOA 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 and "other transactions" agreements.

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. CONTRACTS

Although ARPA-E has the authority to contract with Applicants, ARPA-E generally does not fund projects through Contracts.

C. STATEMENT OF SUBSTANTIAL INVOLVEMENT

ARPA-E generally has substantial involvement in the management and direction of its projects from inception to completion.

- ARPA-E shares responsibility with Prime Recipients for the management, control, direction, and performance of projects.

- Prime Recipients must adhere to ARPA-E technical direction and comply with agency-specific and programmatic requirements.

- ARPA-E may intervene at any time in 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/CooperativeAgreements.aspx).

- ARPA-E Program Directors share responsibility with Prime Recipients for the management, control, direction, and performance 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.[25] Upon request, Prime Recipients are required to provide additional information and documentation to support claimed expenditures. Prime Recipients are required to adhere to ARPA-E's direction and comply with agency-specific and programmatic requirements. Please refer to Section VI.B.4-5 of the FOA for guidance on cost share payments and 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 partnerships with private and public entities to provide continued support for the development and deployment of ARPA-E-funded technologies.

[25] To request reimbursement, Prime Recipients must submit: (1) an SF-270, available at http://www.whitehouse.gov/sites/default/files/omb/grants/sf270.pdf; (2) a spreadsheet showing cumulative expenditures for the invoice period and cumulative expenditures to date (whether paid by ARPA-E or the Project Team) for the following SF-424A categories: Personnel (i.e., salaries and wages), Fringe Benefits, Travel, Equipment, Supplies, Contractual, Construction, Other, and Indirect Charges; and, (3) Supporting documentation for the claimed expenditures, which may consist of summary information (e.g., printouts from internal financial systems) or detailed documentation (e.g., invoices on appropriate letterhead, equipment purchase acquisitions, and travel vouchers).

III. ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS

1. DOMESTIC ENTITIES

For-profit entities, educational institutions, and nonprofits[26] that are incorporated or otherwise headquartered in the United States are eligible to apply for funding as a Standalone Applicant,[27] as the lead organization for a Project Team,[28] 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.

2. 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. However, all work by foreign entities must be performed by subsidiaries or affiliates incorporated or otherwise headquartered in the United States.

[26] 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.

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

[28] 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.

If Applicants are seeking to perform certain work overseas, they are required to include an explicit waiver request in their Full Applications. Please refer to Section IV.C.1 of the FOA for guidance on the content and form of the request.

3. 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 or otherwise headquartered in the United States. The eligibility of the consortium will be determined by reference to the eligibility of the consortium representative under Sections III.A of the FOA. Each consortium entity 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 ARPA-E Contracting Officer (ARPA-E-CO@hq.doe.gov).

B. COST SHARING OR MATCHING[29]

1. GENERAL COST SHARE REQUIREMENT

By law, every Project Team is required to provide greater than or equal to 20% of the Total Project Cost[30] as cost share, except as described below.[31]

2. INCREASED COST SHARE REQUIREMENT

Under Technology Investment Agreements and "other transaction" agreements, Prime Recipients are required to pay greater than or equal to 50% of the Total Project Cost as cost share.

[29] Please refer to Section VI.B.4-5 of the FOA for guidance on cost share payments and reporting.
[30] 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.
[31] Energy Policy Act of 2005, Pub.L. 109-58, sec. 988.

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 greater than or equal to 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 greater than or equal to 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 greater than or equal to 10% of the Total Project Cost as cost share.

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 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 pay 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, so 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.G.1 of the FOA.

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

Project Teams may not use the following sources to meet their 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.

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 ARPA-E 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 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 COMMITMENT

Applicants are required to describe their proposed cost share contributions in their Concept Papers and Full Applications. Please refer to Sections IV.B and IV.C.1 of the FOA for guidance on the requisite cost share information.

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.3 of the FOA for guidance on the requisite cost share information and documentation.

C. OTHER

1. COMPLIANT CRITERIA

ARPA-E performs a preliminary review of Concept Papers to determine whether:

- The Applicant meets the eligibility and compliance requirements in Sections III.A and III.C.3 of the FOA;
- The Applicant meets the cost share requirements in Section III.B of the FOA;
- The Concept Paper conforms to the content and form requirements in Section IV.B of the FOA; and
- The Concept Paper was timely submitted via ARPA-E eXCHANGE by the applicable deadline. See Section IV.E of the FOA for guidance on the timely submission of Concept Papers.

Concept Papers that meet these requirements are deemed compliant.

ARPA-E performs a preliminary review of Full Applications to determine whether:

- The Applicant meets the eligibility and compliance requirements in Sections III.A and III.C.3 of the FOA;
- The Applicant meets the cost share requirements in Section III.B of the FOA;
- The Full Application conforms to the content and form requirements in Section IV.C of the FOA;
- The Full Application was timely submitted via ARPA-E eXCHANGE by the applicable deadline (see Section IV.E of the FOA for guidance on the timely submission of Full Applications); and
- The Applicant submitted a compliant and responsive Concept Paper. (Only Applicants that submitted a compliant and responsive Concept Paper are eligible to submit a Full Application.)

Full Applications that meet these requirements are deemed compliant.

ARPA-E performs a preliminary review of Replies to Reviewer Comments to determine whether:

- The Reply to Reviewer Comments conforms to the content and form requirements in Section IV.D; and
- The Reply to Reviewer Comments was timely submitted via ARPA-E eXCHANGE by the applicable deadline. See Section IV.E of the FOA for guidance on the timely submission of Replies to Reviewer Comments.

Replies to Reviewer Comments that meet these requirements are deemed compliant.

Please refer to Section VI.A of the FOA for guidance on notifications of noncompliant submissions.

2. RESPONSIVENESS CRITERIA

ARPA-E performs a preliminary technical review of Concept Papers and Full Applications to determine whether the proposed project falls within the technical parameters described in Section I.B of the FOA.

- Any Concept Papers or Full Applications that focus on "Areas Specifically Not of Interest" in Section I.B.3 of the FOA are rejected as nonresponsive and are not reviewed or considered.

- Other submissions that do not fall within the technical parameters described in Section I.B of the FOA are also rejected as nonresponsive and are not reviewed or considered.

Please refer to Section VI.A of the FOA for guidance on notifications of nonresponsive submissions

3. INELIGIBILITY FOR AWARD

Applicants are required to disclose in their Full Applications if any of the following conditions exist:

- The Applicant (or a member of the Project Team) is under investigation for or has been convicted of fraud or similar acts, violations of U.S. export controls laws and regulations, or violations of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701, et seq.);

- The Applicant (or a member of the Project Team) is debarred, suspended, proposed for debarment, or otherwise declared ineligible from receiving Federal contracts, subcontracts, and financial assistance and benefits; and

- The Applicant (or a member of the Project Team) is insolvent.

The ARPA-E Contracting Officer may reject a Full Application if any of the above conditions exist. If the ARPA-E Contracting Officer rejects the Full Application, it will not be reviewed or considered.

Please refer to Sections IV.C.1 and VIII.C of the FOA for guidance on submitting a full and complete disclosure of the requested information.

4. 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 (SF-424, SF-424A, Budget Justification Workbook, and Environmental Impact Questionnaire) are available at https://arpa-e-foa.energy.gov.

B. CONTENT AND FORM OF CONCEPT PAPERS

The Concept Paper must conform to the following requirements:

- The Concept Paper must be submitted as an Adobe PDF.
- The Concept Paper 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 an Arial, Helvetica, Palatino Linotype, or Georgia 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; the font size requirement still applies.) Type density, including characters and spaces, must be no more than 12-15 characters per inch.
- The control number[32] 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.

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

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

[32] Once you login to ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx), you may access your submissions to ARPA-E FOAs by clicking the "My Submissions" link in the navigation on the left side of the page. Every application that you have submitted to ARPA-E and the corresponding control number is displayed on this page. If you submit more than one application to this FOA, a unique control number is assigned to each application.

SECTION	PAGE LIMIT	DESCRIPTION
Abstract	1 page maximum	• Describe succinctly: o The essence of the transformative concept; o How the proposed project will develop this concept; and o The potential impact that the proposed project would have on the relevant field and application.
Technical Description	4 pages maximum	• Describe in detail: o How the proposed project is consistent with ARPA-E's Mission Areas: ▪ To enhance the economic and energy security of the United States through the development of energy technologies that result in: • Reductions of energy imports from foreign sources, • Reductions of energy-related emissions, and • Improvement in the energy efficiency of all economic sectors; and ▪ To ensure that the United States maintains a technological lead in developing and deploying advanced energy technologies; o The current technology readiness level (TRL) of the proposed technology and the anticipated TRL at project completion. o The proposed technology, including its basic operating principles and how it is unique and innovative; o The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; o The proposed technology's target level of performance (Applicants should provide technical data or other support to show how the proposed target could be met); o How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; o The key technical risks/issues associated with the proposed technology development plan; o The manufacturing approach anticipated for scaling the proposed technology and the scalability/cost issues related to this approach; o The Project Team and why they are uniquely suited to successfully execute the proposed project; and o The impact that ARPA-E funding would have on the proposed project. Applicants should specifically explain how ARPA-E funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Transition/ Commercialization Strategy	0.5 page maximum	• Describe succinctly: o The phases of development required for the proposed technology, starting from its current stage of development and continuing to commercial deployment,

		○ The specific phase of development that will be executed during the proposed ARPA-E project, ○ Why a successful project outcome will result in commercial development, ○ How the technology will be transitioned at the end of the ARPA-E project to the next source of private or public funding, and ○ The subsequent investment that will be required to achieve full commercial deployment.
Cost Summary	1.5 pages maximum	• Describe succinctly: ○ Each person or position (e.g., senior scientist, technician, graduate student) that would be funded under the proposed project; ○ Approximate number of hours to be worked by each person or position during the period of performance; ○ Any major equipment purchases that would be made, in whole or in part, with ARPA-E funding; ○ If multiple organizations will perform work on the proposed project, Applicants must include an approximate breakdown of costs by Project Team member; and ○ Sources and types of proposed cost share,[33] including: ▪ The name of entities contributing cost share, ▪ The type of cost share to be provided (cash or in kind), ▪ For in-kind contributions, a detailed description of each proposed contribution and its relevance to the project objectives, and ▪ The value of each cost share contribution in U.S. dollars and as a percentage of the Total Project Cost.
End of Project Targets Table	1 page maximum	• Describe succinctly, in table format: ○ End of project targets for all Primary Technical Targets and Secondary Technical Targets, and ○ Any other end of project targets required by Section I.B of the FOA.
FFRDC Authorization *(FFRDCs only)*	1 page maximum	• Before submitting a Concept Paper, DOE/NNSA FFRDCs are required to obtain written authorization from the cognizant DOE/NNSA contracting officer, and non-DOE/NNSA FFRDCs are required to obtain written authorization from the cognizant Federal agency sponsoring the FFRDC. This written authorization must be submitted with the Concept Paper. The following wording is acceptable for the written authorization: "Authorization is granted for [FFRDC Name] to participate in the proposed project. The work proposed for [FFRDC Name] is consistent with or complementary 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." Additionally, non-DOE/NNSA FFRDCs are required to provide in the

[33] Cost share proposed in the Concept Paper is non-binding, but cost share proposed in the Full Application is binding on Applicants.

		written authorization the statutory authority (statute name, citation, and section) that authorizes them to perform the work proposed in their Concept Paper.
Field Work Proposal *(DOE/NNSA FFRDCs only)*	2 pages maximum	• DOE/NNSA FFRDCs are required to submit a Field Work Proposal with their Concept Paper. The Field Work Proposal must conform to the instructions in DOE O 412.1, "Work Authorization System" (http://management.energy.gov/business_doe/business_forms.htm).

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 an Arial, Helvetica, Palatino Linotype, or Georgia 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; the font size requirement still applies.) Type density, including characters and spaces, must be no more than 12-15 characters per inch.
- The control number, which is the same number used for the Concept Paper,[34] 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.

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 technical description of the project, proposed milestones, Project Team overview, etc.
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)

[34] Once you login to ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx), you may access your submissions to ARPA-E FOAs by clicking the "My Submissions" link in the navigation on the left side of the page. Every application that you have submitted to ARPA-E and the corresponding control number is displayed on this page. If you submit more than one proposal to this FOA, a unique control number is assigned to each proposal.

Budget Justification Workbook	XLS	Budget Justification Workbook for SF424A Budget (https://arpa-e-foa.energy.gov)
NEPA Compliance Questionnaire	PDF	Questionnaire regarding the potential environmental impacts of the proposed project (https://arpa-e-foa.energy.gov)
Summary for Public Release	PDF	Public (non-confidential) project summary, in paragraph format
Summary Slide	PPT	A four-panel project summary on a single PowerPoint slide detailing various aspects of the project

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. 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.

SECTION	PAGE LIMIT	DESCRIPTION
Abstract	1 page maximum	• Provide a concise summary of the proposed RD&D project. The summary should be written for a technically literate, but non-specialist, audience.
RD&D Tasks	1 page maximum	• Describe succinctly: (1) the purpose of the proposed RD&D project, (2) the underlying hypothesis(es)/technical concept(s) guiding the approach, and (3) a list of the tasks the research team will undertake and accomplish to achieve this purpose.
RD&D Strategy	20 pages maximum	• Applicants are <u>required</u> to address the following factors: (1) <u>Innovation</u> – Describe specifically: (a) the performance of the current state of the art in the specific technology area of the application, (b) 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, (c) how the proposed approach differs from others under investigation in the field, and (d) how the work, if successful, could leapfrog today's approaches and significantly impact both technology and business. (2) <u>Approach</u> – Provide detailed experimental plans for the completion of the tasks and goals specified in the RD&D Tasks section above. The plans should allow specialists in the field to understand and evaluate each and every relevant step. (3) <u>Preliminary Results</u> – Provide preliminary data and results (if available) that support the feasibility of the application. (4) <u>Significance With Respect to FOA Requirements and Targets</u> – Describe specifically: (a) how the proposed effort is responsive to each aspect of the detailed FOA topic description, and (b) the impact that successful completion of the proposed work would have on the FOA target areas. (5) <u>Performance Team</u> – Describe succinctly: (a) the members of the proposed research team, and (b) 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	1 page maximum	The Statement of Project Objectives will be incorporated into the funding agreement and may be released to the public. • 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 RD&D Tasks above. Please do not include any confidential, proprietary, or privileged information in the Objectives. • 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 RD&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.
Technical Milestones and Deliverables	5 pages maximum	• 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). Annual/End of Project milestones may be subject to independent measurement or verification. Aggressive technical milestones and deliverables are required for all projects. Technical milestones and deliverables help focus effort and resources on critical path technology components. ARPA-E Program Directors may 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 agreed upon technical milestones and deliverables. • Applicants are required to provide a set of detailed technical milestones and deliverables based on the tasks described in the RD&D Tasks section above. The milestones and deliverables should provide a clear path to completion of the RD&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. Sample technical milestones and deliverables are provided in Appendix 2 to this FOA. These technical milestones and deliverables may be incorporated, in whole or in part, into the Statement of Project Objectives in the funding agreement.
Literature Citations	No page limit	• 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).

Qualifications, Experience, and Capabilities	For each PQS, 3 page maximum	• Applicants are required to provide a Personal Qualification Summary (PQS) for the Principal Investigator and a PQS for each Key Participant.[35] Each PQS is limited to 3 pages maximum. Curriculum vitae will not be considered. Each PQS must include: (1) Education/training, (2) Employment history, (3) Awards and honors, (4) Up to 10 peer-reviewed publications specifically related to the proposed RD&D project, (5) Up to 10 other peer-reviewed publications demonstrating capabilities in the broad field, and (6) Up to 10 non-peer reviewed publications and patents demonstrating capabilities in the broad field.
Participating Organizations	1 page maximum	• Describe succinctly why each proposed organization is qualified to accomplish their portion of the proposed RD&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 maximum	• Describe succinctly: (1) any prior projects, programs, and initiatives on which the Project Team has collaborated; (2) the roles of each Project Team member in the project, program, or initiative; (3) whether the project, program, or initiative was ultimately successful; and (4) any management, intellectual property, or other issues that arose within the Project Team and how they were resolved.
Management Plan	1 page maximum	• An effective management plan is essential to ensure continuous effective communication between performance members. Describe succinctly: (1) the roles of each Project Team member; (2) any critical handoffs/interdependencies between Project Team members; (3) 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 Principal Investigator.
Multi-Investigator Projects	2 pages maximum	• Roles of Participants: For multi-organizational or multi-investigator projects, describe succinctly: (1) the roles and the work to be performed by each Principal Investigator and Key Participant; (2) business agreements between the Applicant and each Principal Investigator and Key Participant; and

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

		(3) how the various efforts will be integrated and managed. • Multiple Principal Investigators: Standalone Applicants and Project Teams are required to disclose if the project will include multiple Principal Investigators. If multiple Principal Investigators will be designated, identify the Contact Principal Investigator/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 Principal Investigators. This plan should include: (1) process for making decisions on scientific/technical direction; (2) publication arrangements; (3) intellectual property issues; (4) communication plans; (5) procedures for resolving conflicts; and (6) Principal Investigators' roles and administrative, technical, and scientific responsibilities for the project.
Budget Summary	2 pages maximum	• Applicants are required to provide a two-page budget summary, broken down by milestones. The summaries must conform to the following guidelines: (1) The budget summary should be clearly associated with the milestones outlined as part of the Technical RD&D Plan and reflect quarterly progress on the proposed project. (2) All major equipment purchases must be included in the budget summary. For equipment acquired as part of the proposed RD&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. (3) If costs are less than would normally be expected due to large amounts of previous RD&D done by one or more members of the research team, please describe and explain accordingly. (4) 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.
Transition/ Commercialization Strategy	2 pages maximum	• ARPA-E supports energy technology RD&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: (1) High-level milestones for development that follow the end of the proposed project;

		(2) the path by which the proposed technology is expected to transition from its current stage of development and continuing through to ultimate commercial deployment; (3) specific organizations (partners, customers, etc.) expected to be involved in transition of the technology from research to commercial deployment and their anticipated involvement; and (4) resource needs for the next phase of development that follows the end of the ARPA-E project ; (5) why the proposed research is not being pursued by industry today; and (6) 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 Technology Transfer & Outreach (TT&O) expenditures in their SF424A and Budget Justification unless they submit an accompanying waiver request. See Section IV.G.8 of the FOA for guidance on TT&O expenditures
Intellectual Property Strategy	No page limit	• Describe specifically: (1) existing intellectual property that will be used to develop the new intellectual property (2) new intellectual property and data that will be created as part of this effort; (3) 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 the plan for disposition/ownership of the intellectual property, including intellectual property agreements or memorandums of understanding between Project Team members.
Additionality and Risk	2 pages maximum	• ARPA-E funds high-risk, high-reward projects that have significant market impact potential if the technology development plan is successful. Describe specifically: (1) the technical, market, and organizational risks associated with the proposed RD&D project; (2) why the proposing organization needs ARPA-E funding for the proposed RD&D project, relative to other funding sources; (3) how the proposed RD&D project may lead to increased employment and manufacturing in the United States; (4) if the proposing organization is a large business, why this RD&D project is not being sponsored internally; (5) if the proposing organization is a small business sponsored by private investors, why this RD&D project is not being supported by your investors; (6) if the proposing organization is a startup not sponsored by private investors, why this RD&D project has been unable to attract private financing; and (7) if the proposing 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.

Cost Share Verification	No page limit	• Applicants are required to provide written assurance of their cost share commitments. Applicants are bound by the cost share proposed in their Full Applications. Describe specifically: (1) the name of the entities contributing cost share; (2) the type of cost share to be provided (cash or in-kind); (3) for in-kind contributions, a detailed description of each proposed contribution and its relevance to the project objectives; (4) the value of each cost share contribution in U.S. dollars and as a percentage of the Total Project Cost; and (5) the cost share amount being contributed in each budget category specified in the SF-424A. • Please refer to Sections III.B and VI.B.3-5 of the FOA for guidance on cost share requirements.
Other Sources of Funding	No page limit	• Describe in detail: (1) All financial assistance that is currently being received by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (Including Co-PIs), ~~or~~ and Key Participants from any United States Government agency or instrumentality. • For each project, please provide (i) the name of each government entity or instrumentality, (ii) the title of each project, (iii) the funding amount for each project, (iv) the beginning and end dates for each project, (v) an abstract of each project, (vi) the specific aims of each project, and (vii) the Federal program manager for each project and his/her contact information (email, telephone, and address). (2) All pending applications for financial assistance submitted by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (Including Co-PIs), ~~or~~ and Key Participants to any United States Government agency or instrumentality within the last 24 months. • For each project, please provide (i) the name of each government entity or instrumentality, (ii) the title of each project, (iii) the requested funding amount for each project, (iv) the proposed beginning and end dates for each project, (v) an abstract of each project, (vi) the proposed aims of each project, and (vii) the Principal Investigator for the proposed project and his/her contact information (email, telephone, and address). (3) All financial assistance that is currently being received or was previously received (within the past 5 years) by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (Including Co-PIs), ~~or~~ and Key Participants from, and any pending applications submitted within the last 24 months to, any governmental entity or instrumentality (Federal, state, local, or foreign) to support the proposed project or work that relates directly or indirectly to the proposed project. • For each project, please provide (i) the name of each government entity, (ii) the title of each

		project, (iii) the funding amount for each project, (iv) the beginning and end dates for each project, (v) an abstract of each project, (vi) the specific aims of each project, and (vii) the governmental program manager for each project and his/her contact information (email, telephone, and address). (4) All financial assistance that is currently being received or was previously received (within the past 5 years) by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (Including Co-PIs), ~~or~~ and Key Participants from, and any pending applications submitted within the last 24 months to, any private or non-governmental entity to support the proposed project or work that relates directly or indirectly on the proposed project. • For each project, please provide: (i) the name of each private or non-governmental entity, (ii) technical point of contact for the private or non-governmental entity and his/her contact information (email, telephone, and address), (iii) a description of how the project(s) funded by the private entities are different than the proposed project, and (iv) a description of efforts made to secure funding for the proposed project from private or non-governmental entities.
Conflicts of Interest within Project Team	No page limit	• Describe in detail any actual or apparent personal, organizational, financial, and other conflicts of interest within the Project Team. • Examples of potential conflicts of interest may include but are not limited to: (1) The Principal Investigator for the Prime Recipient may have an equity stake in a Subrecipient; (2) The Principal Investigator for a Subrecipient may have a consulting arrangement with the Prime Recipient; or (3) A Subrecipient may be a subsidiary or otherwise affiliated with the Prime Recipient.
Ineligibility Criteria	No page limit	• Applicants are required to disclose if: (1) the Applicant (or a member of the Project Team) is under investigation for or has been convicted of fraud or similar acts, violations of U.S. export controls laws and regulations, or violations of the Drug-Free Workplace Act of 1988 (Pub. L. 100-690, Title V, Subtitle D; 41 U.S.C. 701, et seq.); (2) the Applicant (or a member of the Project Team) is debarred, suspended, proposed for debarment, or otherwise declared ineligible from receiving Federal contracts, subcontracts, and financial assistance and benefits; and/or (3) the Applicant (or a member of the Project Team) is insolvent. • Applicants are required to provide all relevant facts relating to the above circumstances so as to facilitate a determination of eligibility by ARPA-E.

FFRDC Authorization *(FFRDCs only)*	1 page maximum	• Before submitting a Full Application, DOE/NNSA FFRDCs are required to obtain written authorization from the cognizant DOE/NNSA contracting officer, and non-DOE/NNSA FFRDCs are required to obtain written authorization from the cognizant Federal agency sponsoring the FFRDC. This written authorization must be submitted with the Full Application. The following wording is suggested (but not mandatory) for the written authorization. FFRDCs may use other wording for the written authorization, as appropriate. "Authorization is granted for [FFRDC Name] to participate in the proposed project. The work proposed for [FFRDC Name] is consistent with or complementary 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."
Field Work Proposal *(DOE/NNSA FFRDCs only)*	No page limit	• DOE/NNSA FFRDCs are required to submit a Field Work Proposal with their Full Application. The Field Work Proposal must conform to the instructions in DOE O 412.1, "Work Authorization System" (http://management.energy.gov/business_doe/business_forms.htm). • DOE/NNSA FFRDCs are required to submit a Field Work Proposal, SF-424A and a Budget Justification Workbook with their Full Application, as described in Sections IV.C.3 and 4 of the FOA.
Foreign Work Waiver Request *(Optional)*	2 pages maximum	• ARPA-E requires 100% of the Total Project Cost to be expended in the United States. Applicants may request a waiver of this requirement if they wish to perform some work overseas. Such waivers are granted where there is a demonstrated need. Describe specifically: (1) Any work to be performed outside of the United States, (2) The foreign entities that would perform the work and the type of work to be performed by the foreign entities, (3) The reasons for their participation in the project, and (4) The availability of alternate sources of scientific and engineering expertise and facilities in the United States, (5) The importance of foreign participation to the initiation and successful completion of the project, (6) Whether the project, if successful, would enhance the energy and economic security of the United States; and (7) Whether the project, if successful, would establish or maintain a U.S. technological lead in one or more energy industries or sectors.
Technology Transfer and Outreach Waiver Request	1 page maximum	• Every Project Team is required to spend at least 5% of ARPA-E funding on Technology Transfer and Outreach activities. Applicants may request a waiver of this requirement in whole or in part. In their request, Applicants must describe the proposed technology's stage of development (i.e., early-stage or late-stage) with reference to Technology Readiness Levels (TRLs). In addition, Applicants must describe in detail why the Technology Transfer

(Optional)		and Outreach requirement should not be applied to their project or why they are proposing less than the required 5%.
Request for Technology Investment Agreement or "Other Transactions" Agreement *(Optional)*	4 pages maximum	• Applicants may request a TIA or "other transactions" agreement in their Full Applications. In their request, Applicants are required to: (1) Briefly explain why they would prefer to negotiate a TIA or "other transactions" agreement instead of using ARPA-E's Model Cooperative Agreement (http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx); (2) Briefly describe the specific objectives that they are seeking to accomplish through the TIA or "other transactions" agreement; (3) Briefly describe any special rights they are seeking and any special clauses that they wish to include in the TIA or "other transactions" agreement; (4) Briefly compare the proposed technology to the state-of-the-art and describe the technical and financial risks involved in developing and deploying this technology; (5) Briefly describe the benefits of the proposed technology, especially its potential to enhance U.S. energy and economic security and maintain U.S. technological leadership in key energy sectors; (6) Briefly describe how the proposed technology fits within the Applicant's existing business line(s) or technology area(s); and (7) Briefly describe the Applicant's financial and other incentives to successfully develop and deploy the proposed technology. • In addition, Applicants are required to address the following questions: (1) Will the use of a TIA permit the involvement of for-profit entities that would not otherwise participate in the project? If so: • Why would the for-profit entities not participate if ARPA-E used its Model Cooperative Agreement (http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx)? • What are the expected benefits of the for-profit entities' participation (e.g., is there a specific technology that could be better, more readily available, or less expensive)? (2) Will the use of a TIA or "other transactions" agreement allow the creation of new relationships among participants in a team, among for-profit entities, or between Federal agencies and non-Federal entities that

		will foster better technology? If so: • Which provisions of the TIA or "other transactions" agreement would enable these relationships to form? • Why do these new relationships have the potential for fostering technology that is better, more affordable, or more readily available? (3) Will the use of a TIA or "other transactions" agreement allow for-profit entities to use new business practices in the execution of the RD&D project that will foster better technology, new technology more quickly or less expensively, or facilitate partnering with for-profit entities? If so: • What specific benefits result from the use of these new practices? • Are there provisions of the TIA or "other transactions" agreement that enable the use of the new practices? (4) Are there any other benefits of the use of a TIA that could help ARPA-E achieve its statutory mission to enhance U.S. economic and energy security and maintain U.S. technological leadership in key energy sectors?

2. SECOND COMPONENT: SF-424

Please refer to ARPA-E's website (https://arpa-e-foa.energy.gov) for the SF-424 form. The SF-424 includes instructions for completing the form. Applicants are required to complete all required fields in accordance with the instructions. The SF-424 must be submitted in Adobe PDF format.

Prime Recipients and Subrecipients are required to complete SF-LLL (Disclosure of Lobbying Activities), which is 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 November 1, 2011.
- 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

Please refer to ARPA-E's website (https://arpa-e-foa.energy.gov) for the SF-424A form. 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.

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 Audit costs and Patent costs are requested, they must be included in the Applicant's proposed budget.

- All Technology Transfer and Outreach (TT&O) costs requested must be included in the Applicant's proposed budget and identified as TT&O costs in the SF424A and the Budget Justification Workbook 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 ARPA-E 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 ARPA-E Contracting Officer (Section IV.G.8 of the FOA) .

- For pricing purposes, assume a project start date of November 1, 2011.

4. FOURTH 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-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.

5. FIFTH COMPONENT: NEPA COMPLIANCE QUESTIONNAIRE

By law, ARPA-E is required to evaluate the potential environmental impact of projects that it is considering for funding.[36] In particular, ARPA-E must determine before a project begins 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).

Please refer to ARPA-E's website (https://arpa-e-foa.energy.gov) for the Environmental Impact Questionnaire. To facilitate and expedite ARPA-E's environmental review, Applicants are required to complete an Environmental Impact Questionnaire. The Environmental Impact Questionnaire must be submitted in Adobe PDF format.

Applicants 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. Applicants may not limit their responses to work performed by the Prime Recipient.

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

Upon selection for award negotiations, the Prime Recipient or Subrecipients may be requested to provide additional information to the ARPA-E NEPA Compliance Officer.

6. SIXTH 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.

[36] National Environmental Policy Act (NEPA), Pub L. No. 91-190, 42 U.S.C. § 4321 et seq.; Department of Energy NEPA Implementing Regulations, 10 C.F.R. part 1021.

7. SEVENTH COMPONENT: SUMMARY SLIDE

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. The slide must be submitted in Microsoft PowerPoint format. This slide is used during the evaluation process. 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 Key Participants.

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.

Applicants are not required to submit a Reply to Reviewer Comments. Submitting a Reply to Reviewer Comments is optional. Each compliant and responsive Full Application will be considered on the merits regardless of whether a Reply to Reviewer Comments is submitted.

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 an Arial, Helvetica, Palatino Linotype, or Georgia 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; the font size requirement still applies.) Type density, including characters and spaces, must be no more than 12-15 characters per inch.

- The control number, which is the same number used for the Concept Paper and Full Application,[37] 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.

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

SECTION	PAGE LIMIT	DESCRIPTION
Text	2 pages maximum	• Applicants may respond to one or more Reviewer comments or supplement their Full Application.
Images	1 page maximum	• Applicants may provide graphs, charts, or other data to respond to Reviewer Comments or supplement their Full Application.

E. SUBMISSION DATES AND TIMES

Applicants must complete the following actions before the submission deadline in order for their Concept Papers and Full Applications to be considered timely submitted:

- Applicants must provide the requested information in ARPA-E eXCHANGE;
- Applicants must upload their Concept Papers or Full Applications to ARPA-E eXCHANGE; and
- Applicants must click the "Submit" button under the "Upload and Submit" tab in ARPA-E eXCHANGE for this FOA.

Applicants must successfully upload their Reply to Reviewer Comments to ARPA-E eXCHANGE before the submission deadline in order for it to be considered timely submitted.

Concept Papers, Full Applications, and Replies to Reviewer Comments that are not timely submitted are deemed noncompliant and are not reviewed or considered, as described in Section III.C.1 of the FOA.

[37] Once you login to ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx), you may access your submissions to ARPA-E FOAs by clicking the "My Submissions" link in the navigation on the left side of the page. Every proposal that you have submitted to ARPA-E and the corresponding control number is displayed on this page. If you submit more than one proposal to this FOA, a unique control number is assigned to each proposal.

Please refer to Section IV.H.1 of the FOA and the eXCHANGE User Guide (https://arpa-e-foa.energy.gov/Manuals.aspx) for guidance on submitting Concept Papers, Full Applications, and Replies to Reviewer Comments to ARPA-E eXCHANGE.

Applicants are responsible for meeting the submission deadline. ARPA-E strongly encourages Applicants to submit their Concept Papers, Full Applications, and Replies to Reviewer Comments at least 24 hours in advance of the submission deadline. Applicants should not wait until the last minute—Internet and data server traffic can be heavy in the last hours before the submission deadline, which may affect Applicants' ability to successfully submit their Concept Papers, Full Applications, or Replies to Reviewer Comments.

ARPA-E uses ARPA-E eXCHANGE to determine whether Concept Papers, Full Applications, and Replies to Reviewer Comments are timely submitted. Following the expiration of the applicable deadline, Applicants are no longer able to click the "Submit" button under the "Upload and Submit" tab in ARPA-E eXCHANGE for this FOA.

F. INTERGOVERNMENTAL REVIEW

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

G. FUNDING RESTRICTIONS

1. ALLOWABLE COSTS

All expenditures must be allowable, allocable, and reasonable in accordance with the applicable Federal cost principles.

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 ARPA-E 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 up to 90 days before the effective date of the funding agreement.

Prime Recipients are required to obtain written authorization from the ARPA-E Contracting Officer (ARPA-E-CO@hq.doe.gov) before submitting any reimbursement requests for (i) insignificant costs (i.e., $20,000 or less in total aggregate costs) incurred more than 90 days before the effective date of the funding agreement, or (ii) significant costs (i.e., more than $20,000 in total aggregate costs) incurred before the effective date of the funding agreement.

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 $15,000 in expenditures incurred under the funding agreement for costs and fees relating to the filing and prosecution of U.S. patent applications on subject inventions disclosed to ARPA-E and DOE in accordance with Attachment 2 to the funding agreement. Prime Recipients may use costs and fees in excess of $15,000 to meet their cost share obligations under the funding agreement.

ARPA-E will not reimburse any costs and fees relating to the filing and prosecution of foreign patent applications on subject inventions disclosed to ARPA-E and DOE in accordance with

Attachment 2 to the funding agreement. However, Prime Recipients may use such costs and fees to meet their cost share obligations.

4. CONSTRUCTION

ARPA-E generally does not fund projects that involve major construction. Recipients are required to obtain written authorization from the ARPA-E Contracting Officer before incurring any major construction costs (i.e., construction costs in excess of $2,500).

5. FOREIGN TRAVEL

ARPA-E generally does not fund projects that involve major foreign travel. Recipients are required to obtain written authorization from the ARPA-E 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 are required to 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 their Full Application. Please refer to Section IV.C.1 of the FOA for guidance on the content and form of the waiver request. 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 Commercialization Plan with the ARPA-E Program Director, as described in Section VI.B.6 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.G.1 of the FOA and must not adversely affect the scientific integrity of ARPA-E.

Examples of TT&O expenditures that comply with Federal cost principles include but are not limited to:

- 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.

Examples of TT&O expenditures that do not comply with Federal cost principles include but are not limited to:

- 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 their Full Application. Please refer to Section IV.C.1 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.[38]

As described in Section IV.C.2 of the FOA, Prime Recipients and Subrecipients are required to complete and submit SF-LLL (Disclosure of Lobbying Activities), which is 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.

H. OTHER SUBMISSION REQUIREMENTS

1. USE OF ARPA-E EXCHANGE

To apply to this FOA, please register with ARPA-E's online application portal, ARPA-E eXCHANGE, at https://arpa-e-foa.energy.gov/Registration.aspx. Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted to ARPA-E through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx). ARPA-E eXCHANGE is the exclusive means by which Applicants may submit Concept Papers, Full Applications, and Replies to Reviewer Comments for this FOA. Concept Papers, Full Applications, and Replies to Reviewer Comments submitted through other means (e.g., email, fax, mail, hand delivery) are deemed noncompliant and are not reviewed or considered. The eXCHANGE User Guide is available at https://arpa-e-foa.energy.gov/Manuals.aspx.

See Section IV.E of the FOA for guidance on the timely submission of Concept Papers, Full Applications, and Replies to Reviewer Comments.

[38] 18 U.S.C. § 1913.

V. APPLICATION REVIEW INFORMATION

A. CRITERIA

ARPA-E performs a preliminary review of Concept Papers and Full Applications to determine whether they are compliant and responsive, as described in Sections III.C.1 and III.C.2 of the FOA. ARPA-E also performs a preliminary review of Replies to Reviewer Comments to determine whether they are compliant, as described in Section III.C.1 of the FOA.

ARPA-E considers a mix of quantitative and qualitative criteria in determining whether to encourage or discourage the submission of a Full Application and to select or not select a Full Application 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 Concept Paper and Full Application based on the criteria and program policy factors in Sections V.A and V.B.1.

1. CRITERIA FOR CONCEPT PAPERS

Concept Papers are evaluated based on the following criteria:

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

- Whether the Applicant proposes quantitative material and/or technology metrics that demonstrate the potential for a transformational and disruptive (not incremental) advancement in one or more energy-related fields;
- Whether 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
- Whether the Applicant demonstrates an 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* (50%) - This criterion involves consideration of the following factors:

- Whether the Applicant proposes work that is unique and innovative;

- Whether the Applicant proposes work that is high risk but feasible;

- Whether the Applicant demonstrates a sound technical approach to accomplish the proposed RD&D objectives;

- Whether the Applicant envisions a project outcome and deliverables that 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 and Secondary Technical Targets in Section I.B.4 of the FOA; and

- Whether 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 RD&D or directly into industrial development and deployment.

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	50%
Overall Scientific and Technical Merit	50%

2. 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* (25%) - This criterion involves consideration of the following factors:

- Whether the Applicant proposes quantitative material and/or technology metrics that demonstrate the potential for a transformational and disruptive (not incremental) advancement in one or more energy-related fields;

- Whether 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

- Whether the Applicant demonstrates an 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* (25%) - This criterion involves consideration of the following factors:

- Whether the Applicant proposes work that is unique and innovative;
- Whether the Applicant proposes work that is high risk but feasible;
- Whether the Applicant demonstrates a sound technical approach to accomplish the proposed RD&D objectives;
- Whether the Applicant envisions a project outcome and deliverables that 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 and Secondary Technical Targets in Section I.B.4 of the FOA; and
- Whether 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 RD&D or directly into industrial development and deployment.

(3) *Qualifications, Experience, and Capabilities of the Proposed Project Team* (25%) - This criterion involves consideration of the following factors**:**

- Whether the Principal Investigator and proposed technical team have the skill and expertise needed to successfully execute the project plan;
- Whether the Applicant has prior experience which demonstrates an ability to perform RD&D of similar risk and complexity;
- Whether the Applicant has worked together with its teaming partners on prior projects or programs; and
- Whether the Applicant has adequate access to equipment and facilities necessary to accomplish the RD&D effort and/or clearly explain how it intends to obtain access to necessary equipment and facilities.

(4) *Soundness of Management Plan* (25%) - This criterion involves consideration of the following factors:

- Whether the Applicant presents a workable plan to manage people and resources;

- Whether the Applicant proposes to allocate appropriate levels of people and resources to tasks;

- Whether the Applicant identifies major technical RD&D risks and clearly defines feasible, adequately planned mitigation efforts; and

- 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	25%
Overall Scientific and Technical Merit	25%
Qualifications, Experience, and Capabilities	25%
Sound Management Plan	25%

3. 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 encourage to submit Full Applications and which Full Applications 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 cost of and budget for the proposed project;

- Whether the proposed cost share is above the minimum established by the DOE program 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 RD&D project;
- Whether the project has a well-justified, realistic potential to meet or exceed most, if not all, of the Secondary Technical Targets;
- If the lead organization is a large business, why this RD&D project is not being sponsored internally;
- If the lead organization is a small business sponsored by private investors, why this RD&D project is not being supported by its investors;
- If the lead organization is a startup not sponsored by private investors, why this RD&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 TT&O expenditures; and

- Whether the Applicant has submitted a credible proposal for a TIA or "other transaction" agreement.

2. APPLICATION PROCESS OVERVIEW

a. CONCEPT PAPERS

The first step in applying for funding under the FOA is the submission of a Concept Paper. The Concept Paper describes the essence and novelty of the proposed technology and its ability to meet or exceed the Primary Technical Targets and Secondary Technical Targets in Section I.B.4 of the FOA.

Concept Papers must be submitted to ARPA-E through its online application portal, ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx), as described in Section IV.H.1 of the FOA.

ARPA-E performs a preliminary review of Concept Papers to determine whether they are compliant and responsive, as described in Sections III.C of the FOA. Noncompliant and/or nonresponsive Concept Papers are rejected by the ARPA-E Contracting Officer and are not reviewed or considered.

ARPA-E makes an independent assessment of each Concept Paper based on the criteria and program policy factors in Sections V.A.1 and V.B.1. Applicants are promptly notified of ARPA-E's determination, as described in Section VI.A of the FOA.

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

b. FULL APPLICATIONS

The next step in applying for funding under the FOA is the submission of a Full Application. The Full Application provides detailed information on the proposed project, including, among other items, an in-depth discussion of various aspects of the proposed project, a detailed budget, an environmental impact questionnaire, and a publically releasable summary of the project.

Full Applications must be submitted to ARPA-E through its online application portal, ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx), as described in Section IV.H.1 of the FOA.

ARPA-E performs a preliminary review of Full Applications to determine whether they are compliant and responsive, as described in Sections III.C of the FOA. Noncompliant, nonresponsive, and/or otherwise ineligible Full Applications are rejected by the ARPA-E Contracting Officer and are not reviewed or considered.

c. REPLIES TO REVIEWER COMMENTS

Once ARPA-E has completed its review of Full Applications, Applicants are notified and Reviewer comments on compliant and responsive Full Applications are made available to Applicants via ARPA-E eXCHANGE. Applicants have a brief opportunity to review these comments and prepare a short Reply to Reviewer Comments. Applicants may elect to respond to one or more Reviewer comments or to supplement their Full Application.

Applicants are not required to submit a Reply to Reviewer Comments. Submitting a Reply to Reviewer Comments is optional. Each compliant and responsive Full Application will be considered on the merits regardless of whether a Reply to Reviewer Comments is submitted.

ARPA-E performs a preliminary review of Replies to Reviewer Comments to determine whether they are compliant, as described in Section III.C.1. Noncompliant Replies to Reviewer Comments are rejected by the ARPA-E Contracting Officer and are not reviewed or considered. Compliant and responsive Full Applications are reviewed on the merits even if a Reply to Reviewer Comments is rejected as noncompliant.

d. PRE-SELECTION SITE VISITS

In rare cases, the ARPA-E Contracting Officer may contact Applicants if he/she determines that pre-selection site visits are necessary and appropriate. In such circumstances, one or more ARPA-E personnel, accompanied by the ARPA-E Contracting Officer or his/her designee, may

visit an Applicant's facilities or meet with the Project Team before ARPA-E makes a final selection determination. The purpose of this visit is to assess the Applicant's ability to perform the proposed project.

The ARPA-E Contracting Officer makes appropriate arrangements for pre-selection site visits, and provides guidance on the parameters of interaction during the site visit.

This policy represents a limited exception to ARPA-E's prohibition on communication with Applicants while the application process is ongoing, as described in Section VII.A of the FOA.

e. PRE-SELECTION COMMUNICATIONS

The ARPA-E Contracting Officer may contact Applicants if he/she determines that pre-selection communications are necessary and appropriate. The ARPA-E Contracting Officer has exclusive authority to make this determination. The ARPA-E Contracting Officer may contact one, multiple, or no Applicants at his/her discretion.

The ARPA-E Contracting Officer may communicate with Applicants by telephone, email, or otherwise at his/her discretion.

This policy represents a limited exception to ARPA-E's prohibition on communication with Applicants while the application process is ongoing, as described in Section VII.A of the FOA.

f. SELECTION

ARPA-E carefully considers all of the information obtained through the application process (e.g., Full Applications, Replies to Reviewer Comments, and information obtained through pre-selection correspondence and site visits) and makes an independent assessment of each compliant and responsive Full Application based on the criteria and program policy factors in Sections V.A.2 and V.B.1. 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 the availability of funds or other factors. Applicants are promptly notified of ARPA-E's determination. Please refer to Section VI.A of the FOA for guidance on award notices.

3. 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 Certificate and Nondisclosure Agreement by which they disclose any actual or apparent conflicts and agree to safeguard confidential information contained in Concept Papers, Full Applications, and Replies to Reviewer Comments. In addition, ARPA-E trains its Reviewers in proper evaluation techniques and procedures.

Applicants are not permitted to nominate Reviewers for their applications. Applicants may contact the ARPA-E Contracting Officer by email (ARPA-E-CO@hq.doe.gov) if they have evidence of a potential conflict of interest.

4. 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 September 2011 and to execute funding agreements November 2011.

Please refer to the "Applicant's Guide to ARPA-E Award Negotiations" (http://arpa-e.energy.gov/FundingAgreements/Overview.aspx) for guidance on the award negotiation process.

VI. AWARD ADMINISTRATION INFORMATION

A. AWARD NOTICES

1. REJECTED SUBMISSIONS

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

2. CONCEPT PAPER NOTIFICATIONS

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

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

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

3. FULL APPLICATION NOTIFICATIONS

Applicants are promptly notified of ARPA-E's 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 ARPA-E Contracting Officer executes the funding agreement. ARPA-E may terminate award negotiations at any time for any reason.

Please refer to Section IV.G.2 of the FOA for guidance on pre-award costs. Please also refer to the "Applicant's Guide to ARPA-E Award Negotiations" (http://arpa-e.energy.gov/FundingAgreements/Overview.aspx) for guidance on the award negotiation process.

b. POSTPONED SELECTION DETERMINATIONS

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

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

c. UNSUCCESSFUL APPLICANTS

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

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

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/.[39] Prime Recipients are required to report to FSRS the names and total compensation of each of the Prime Recipient's five most highly compensated executives and the names and total compensation of each Subrecipient's five most highly compensated executives. Please refer to https://www.fsrs.gov/ for guidance on reporting requirements.

ARPA-E may not execute a funding agreement with the Prime Recipient until it has obtained a DUNS number and completed its 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 ARPA-E Contracting Officer

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

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 Fall 2011).

4. COST SHARE PAYMENTS[40]

All proposed cost share contributions must be reviewed and approved in advance by the ARPA-E Contracting Officer and incorporated into the project budget before the expenditures are incurred.

ARPA-E requires Prime Recipients to pay the cost share amount incrementally over the life of the funding agreement.[41] Specifically, every Prime Recipient is required to pay, at a minimum, the cost share percentage of total expenditures incurred during every billing period. For example, a Prime Recipient is required to pay at least 32% of the total expenditures incurred during every billing period if the funding agreement states that the cost share percentage is 32%.

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

If Prime Recipients anticipate difficulty providing the requisite cost share every billing period, they may request authorization from ARPA-E to (1) pay the cost share percentage of total expenditures incurred every quarter (i.e., every three months), or (2) pay the cost share percentage of total expenditures incurred every half-year (i.e., every six months). Such requests must be sent by email to ARPA-E-CO@hq.doe.gov 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. 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[42]

All reimbursement requests must be accompanied by 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.

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. Such reports must be accompanied by 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.

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.

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

6. COMMERCIALIZATION PLAN

During award negotiations, Prime Recipients are required to negotiate and complete a Commercialization 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 Commercialization Plan. Prime Recipients are required to submit updated versions of the plan every six months through the end of the project period.

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

7. 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.

8. FUNDING AGREEMENTS WITH FFRDCS AND GOGOS

Please refer to Section II.B.2 of the FOA for guidance on contracting arrangements with FFRDCs and GOGOs.

9. OTHER SOURCES OF FUNDING

All Project Teams must disclose in their Full Applications and throughout the duration of the project period:

- All current financial assistance received by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (including Co-PIs)~~, or~~ and Key Participants from, and any pending applications submitted to, any Federal agency or instrumentality;

- All prior financial assistance (within the last 5 years) and current financial assistance received by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (including Co-PIs)~~, or~~ and Key Participants from, and any pending applications submitted to, any governmental or quasi-governmental entity (Federal, state, local, or foreign) to support the proposed project or work that relates directly or indirectly on the proposed project; and

- All prior financial assistance (within the last 5 years) and current financial assistance received by the ~~Prime Recipient, Subrecipients~~, Principal Investigator(s) (including Co-PIs)~~, or~~ and Key Participants from, and any pending applications submitted to, any private or non-governmental entity to support the proposed project or work that relates directly or indirectly on the proposed project.

Upon selection and throughout the project period, Project Teams are required to certify their compliance with this requirement in their quarterly progress reports. In addition, the ARPA-E Contracting Officer may require Prime Recipients and Subrecipients to comply with the above-referenced disclosure requirements upon their selection for award negotiations or during the project period.

Please refer to Sections IV.C.1 and VIII.C of the FOA for guidance on submitting a full and complete disclosure of the requested information.

10. CONFLICTS OF INTEREST WITHIN PROJECT TEAM

Project Teams are required to disclose in their Full Applications and throughout the duration of the project period any actual or apparent personal, organizational, financial, and other conflicts of interest within the Project Team.

Please refer to Sections IV.C.1 and VIII.C of the FOA for guidance on submitting a full and complete disclosure of the requested information.

11. 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.

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).[43] 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, exclusive 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 exclusive licensees.

These U.S. Manufacturing requirements do not apply to nonexclusive 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).[44] This requirement applies to products that are manufactured for use or sale in the United States and overseas.

[43] 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).

[44] 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).

Large businesses and foreign entities must apply the same U.S. Manufacturing requirements to their assignees, exclusive licensees, non-exclusive 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 exclusive and nonexclusive 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.

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.

e. Limitation on Scope of U.S. Manufacturing Requirement

U.S. Manufacturing requirements apply to products embodying subject inventions and products produced through the use of subject invention(s). However, U.S. Manufacturing requirements do not apply to downstream products. For example, an integrated circuit may embody a subject invention. In that case, the U.S. Manufacturing requirements would apply to the integrated circuit, but not to downstream products (e.g., telephones, radios, televisions, and computers) that incorporate the integrated circuit.

f. Net Benefits Statement

Upon selection by ARPA-E or subsequent to the execution of an ARPA-E funding agreement, Prime Recipients, Subrecipients, and others subject to U.S. Manufacturing requirements may submit a Net Benefits Statement to the ARPA-E Contracting Officer (ARPA-E-CO@hq.doe.gov). The Net Benefits Statement should describe existing and planned investments in the United States, including new investments that are consistent with ARPA-E's statutory mission. If ARPA-E approves the Net Benefits Statement, the ARPA-E Contracting Officer will modify or waive the applicable U.S. Manufacturing requirements.
The following issues should be addressed in Net Benefits Statements:

- Business Model and Manufacturing: The entity is required to describe its business model and its plans for manufacturing products embodying subject inventions (or products produced through the use of subject inventions) in the United States and overseas. The entity must explain why it needs to manufacture products embodying subject inventions (or products produced through the use of subject inventions) overseas.

- U.S. Investments: The entity is required to describe:
  - Its 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);
  - Its planned investments in the United States with respect to the subject inventions, including staffing, manufacturing, RD&D, and facility usage or buildout;
  - Its business plan for the subject inventions (e.g., initial work in the United States with subsequent global diversification); and
  - Any U.S. jobs that will be created as a result of activities relating to the subject inventions.

- Commitments: The entity 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)).

- Benefits: The entity is required to describe how its investments will further the development and deployment of the technology in the United States. In addition, the entity must describe any other benefits that its work may have for the U.S. economy.

All Net Benefit Statements must be submitted to the ARPA-E Contracting Officer (ARPA-E-CO@hq.doe.gov). The ARPA-E Contracting Officer will consult with the DOE Assistant General Counsel for Intellectual Property and Technology Transfer regarding any Net Benefits Statements. ARPA-E expects to render a decision on Net Benefit Statements within 30-90 days of receipt.

g. Waiver of U.S. Manufacturing Requirement

Upon selection or subsequent to the execution of the ARPA-E funding agreement, Prime Recipients, Subrecipients, and others subject to U.S. Manufacturing requirements may submit a waiver request to the ARPA-E Contracting Officer (ARPA-E-CO@hq.doe.gov). The request must show that manufacturing products embodying subject inventions (or products produced through the use of subject inventions) in the United States would not be commercially feasible. The entity must provide sufficient data and other information to support its request. If ARPA-E approves the waiver request, the ARPA-E Contracting Officer will waive the applicable U.S. Manufacturing requirements.

All waiver requests must be submitted to the ARPA-E Contracting Officer (ARPA-E-CO@hq.doe.gov). The ARPA-E Contracting Officer will consult with the DOE Assistant General Counsel for Intellectual Property and Technology Transfer regarding any waiver requests. ARPA-E expects to render a decision on waiver requests within 30-90 days of receipt.

12. 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 five years after the end of the project period) on the utilization of subject inventions and efforts made by Recipients or their licensees or assignees to stimulate such utilization. The reports must 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.

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 ET. (Questions received after Wednesday at 12 PM ET will be answered the following week.) ARPA-E will cease to accept questions 96 hours in advance of the applicable deadline. Responses to the last questions will be posted at least 24 hours in advance of the applicable deadline. ARPA-E may 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's online application portal, ARPA-E eXCHANGE, 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 FOAs 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 ARPA-E Contracting Officer may authorize communications between ARPA-E personnel and Applicants. As described in Section V.B.2 of the FOA, the ARPA-E Contracting Officer may contact Applicants during the "quiet period" to engage in pre-selection communications or arrange a pre-selection site visit.

B. DEBRIEFINGS

ARPA-E does not offer or provide debriefings to unsuccessful Applicants. However, ARPA-E provides Applicants with feedback on compliant and responsive Concept Papers and Full Applications. Comments on Concept Papers are contained in notification letters sent to Applicants encouraging or discouraging the submission of a Full Application. 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's website (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.

B. OBLIGATION OF PUBLIC FUNDS

The ARPA-E 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 ARPA-E 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 identified in Sections III.C.3, VI.B.9, and VI.B.10 of the FOA. 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 Concept Paper, Full Application, and/or Reply to Reviewer Comments;
- The termination of award negotiations;
- The modification, suspension, and/or termination of a funding agreement;
- The initiation of debarment proceedings, debarment, and/or a declaration of ineligibility for receipt of Federal contracts, subcontracts, and financial assistance and benefits; and
- Civil and/or criminal penalties.

D. RETENTION OF SUBMISSIONS

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

E. MARKING OF CONFIDENTIAL INFORMATION

ARPA-E will use data and other information contained in Concept Papers, Full Applications, and Replies to Reviewer Comments strictly for evaluation purposes. Applicants should not include confidential, proprietary, or privileged information in their Concept Papers, Full Applications, or Replies to Reviewer Comments unless such information is necessary to convey an understanding of the proposed project.

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

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

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

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, nontransferrable, 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.

As reported in a 2009 GAO Report, no Government agency has ever exercised its march-in rights in any circumstance.

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. FOSTERING APPLICANT CONNECTIONS

All Applicants who are encouraged by ARPA-E to submit a Full Application to an ARPA-E FOA but are not selected for funding will be invited to participate in the "Fostering Applicant Connections" initiative (http://arpa-e.energy.gov/ProgramsProjects/ConnectwiththeApplicantCommunity.aspx), which is intended to facilitate communications between encouraged Applicants and potential investors, partners, and customers.

J. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION

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

- Social Security Numbers in any form;
- Place of Birth associated with an individual;
- Date of Birth associated with an individual;
- Mother's maiden name associated with an individual;
- Biometric record associated with an individual;
- Fingerprint;
- Iris scan;
- DNA;
- Medical history information associated with an individual;
- Medical conditions, including history of disease;
- Metric information, e.g. weight, height, blood pressure;
- Criminal history associated with an individual;
- Ratings;
- Disciplinary actions;

- Performance elements and standards (or work expectations) are PII when they are so intertwined with performance appraisals that their disclosure would reveal an individual's performance appraisal;
- Financial information associated with an individual;
- Credit card numbers;
- Bank account numbers; and
- Security clearance history or related information (not including actual clearances held).

K. ANNUAL COMPLIANCE AUDITS FOR FOR-PROFIT ENTITIES

If a for-profit entity is a Prime Recipient or Subrecipient, it is required to have an annual compliance audit performed by an independent auditor. 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 Concept Paper, 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

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.

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

Project Team: 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.

RD&D: Research, Development, and Demonstration.

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.G.8 of the FOA for more information)

APPENDIX 1: TECHNOLOGY READINESS LEVEL SCALE

TRL	Description
1	*Basic principles observed and reported* Scientific research begins with a systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications or products in mind. The knowledge or understanding will later be translated into applied RD&D. Example might include studies of a technology's basic properties.
2	*Technology concept and/or application formulated* Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative and there may be no proof or detailed analysis to support the assumptions.
3	*Analytical and experimental critical function and/or characteristic proof of concept.* Active R&D is initiated. This includes analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.
4	*Component and/or breadboard validation in laboratory environment.* Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.
5	*Component and/or breadboard validation in relevant environment.* Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so it can be tested in a simulated environment. Examples include "high fidelity" laboratory integration of components.
6	*System/subsystem model or prototype demonstration in a relevant environment.* Representative model or prototype system, which is well beyond that of TRL-5, is tested in a relevant environment. This represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.
7	*System prototype demonstration in a operational environment.* It requires the demonstration of an actual system prototype in an operational environment, such as in a light duty vehicle on the road. Examples include testing a prototype battery in an operational hybrid gas-electric vehicle.
8	*Actual system completed and qualified through test and demonstration.* Technology has been proven to work in its final form and under expected conditions. Examples include developmental test and evaluation of the system in its intended parent system to determine if it meets design specifications.
9	*Actual system proven through successful mission operations.* The technology is applied and operated in its final form and under real life conditions, such as those encountered in operational test and evaluation. In almost all cases, this is the end of the last "bug fixing" aspects of true system development. Examples include using the system under various real life conditions.

APPENDIX 2: SAMPLE TECHNICAL MILESTONES AND DELIVERABLES

Program Element		Major Tasks	Key Milestones & Deliverables
Program Element 1: Develop a bioreactor for the energy-efficient production of lipid biomass. The ultimate goal of this program element is to develop a bioreactor system with a measured energy efficiency ≥ 95% ($Energy_{IN}/Energy_{OUT}$).	Q1	1. Complete energy modeling analysis to support development of bioreactor prototype	1. Energy modeling complete 2. Q1 Progress Report complete
	Q2	1. Complete first phase of bioreactor development 2. Operate bioreactor and assess all initial performance metrics over five 10 hour performance runs 3. Select microorganisms to be piloted based on the following criteria (*list criteria*) (e.g. nutrient requirements).	1. Achieve initial bioreactor performance metrics (*list metrics and quantifiable targets*) 2. Selection of microorganisms to be piloted 3. Q2 Progress Report complete
	Q3	1. Complete second phase of bioreactor development 2. Verify all bioreactor performance metrics for all microorganisms over 3, 7, and 14 days of operation	1. Bioreactor performance will achieve the following performance metrics (*list metrics and quantifiable targets*) 2. Q3 Progress Report complete
	Q4	1. Complete experiments to determine optimal conditions for bioreactor operation for the energy efficient production of lipid biomass 2. Complete design report for bioreactor scale-up to *X* liters 3. Construct a cost model for bioreactor operations	1. Finalize bioreactor operational conditions to achieve 95% energy efficiency 2. Finalize methodology and empirically quantify all bioreactor performance metrics 3. Cost model and design report for bioreactor scale up 4. Q4 Final Report complete