FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT

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

ACCELERATING LOW-COST PLASMA HEATING AND ASSEMBLY (ALPHA)

Announcement Type: Initial Announcement
Funding Opportunity No. DE-FOA-0001184
CFDA Number 81.135

FOA Issue Date:	August 28, 2014
First Deadline for Questions to ARPA-E-CO@hq.doe.gov:	5 PM ET, October 7, 2014
Submission Deadline for Concept Papers:	5 PM ET, October 14, 2014
Second Deadline for Questions to ARPA-E-CO@hq.doe.gov:	5 PM ET, TBD
Submission Deadline for Full Applications:	5 PM ET, TBD
Submission Deadline for Replies to Reviewer Comments:	5 PM ET, TBD
Expected Date for Selection Notifications:	TBD
Total Amount to Be Awarded	Approximately $30 million, subject to the availability of appropriated funds.
Anticipated Awards	ARPA-E may issue one, multiple, or no awards under this FOA. Awards may vary between $250,000 and $10 million.

- For eligibility criteria, see Section III.A of the FOA.
- For cost share requirements under this FOA, see Section III.B of the FOA.
- To apply to this FOA, Applicants must register with and submit application materials through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/Registration.aspx). For detailed guidance on using ARPA-E eXCHANGE, see Section IV.H.1 of the FOA.
- Applicants are responsible for meeting each submission deadline. Applicants are strongly encouraged to submit their applications at least 48 hours in advance of the submission deadline.
- ARPA-E will not review or consider noncompliant or nonresponsive applications. For detailed guidance on compliance and responsiveness criteria, see Sections III.C.1 and III.C.2 of the FOA.

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

TABLE OF CONTENTS

REQUIRED DOCUMENTS CHECKLIST

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

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

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

SUBMISSION	COMPONENTS	OPTIONAL/ MANDATORY	FOA SECTION	DEADLINE
Concept Paper	• Each Applicant must submit a Concept Paper in Adobe PDF format by the stated deadline. The Concept Paper must not exceed 4 pages in length and must include the following: o Concept Summary o Innovation and Impact o Proposed Work o Team Organization and Capabilities • The Concept Paper must be accompanied by: o Summary Slide (1 page limit, Microsoft PowerPoint format) –A Summary Slide template is available on ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov).	Mandatory	IV.C	5 PM ET, October 14, 2014
Full Application	[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]	Mandatory	IV.D	5 PM ET, TBD
Reply to Reviewer Comments	[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]	Optional	IV.E	5 PM ET, TBD

I. FUNDING OPPORTUNITY DESCRIPTION

A. AGENCY OVERVIEW

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

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

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

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

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

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

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

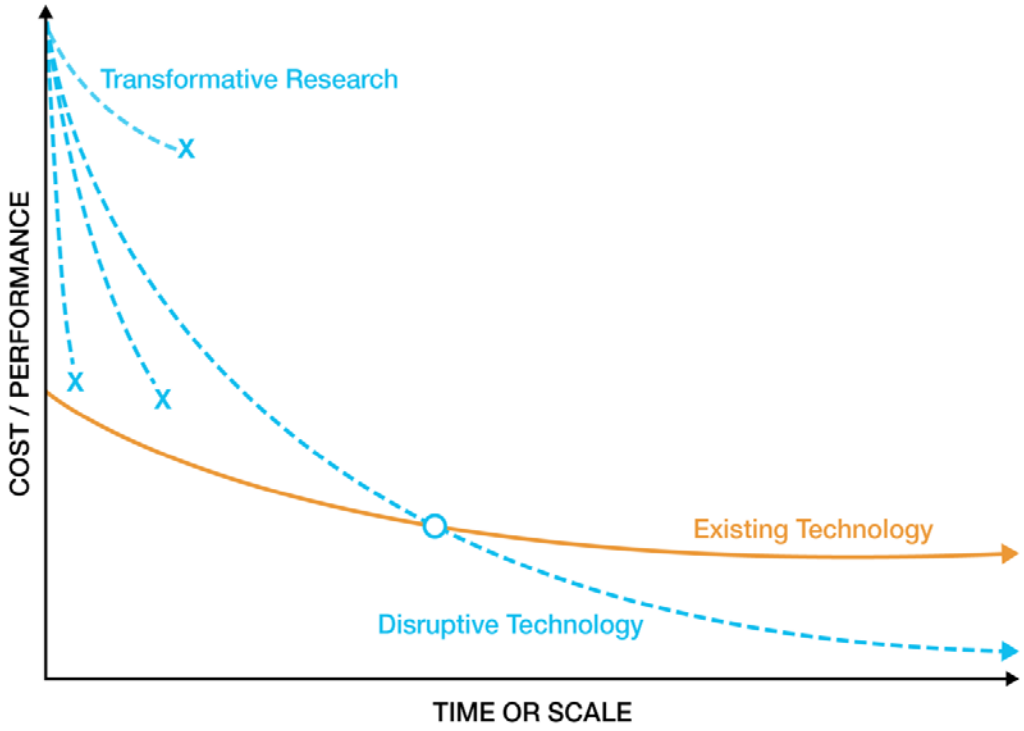

Figure 1: Description of transformational and disruptive technologies in terms of cost per unit performance versus time or scale. ARPA-E seeks to support research that establishes new learning curves that lead to disruptive technologies.

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

ARPA-E funded technology has the potential to be disruptive in the marketplace. The mere creation of a new learning curve does not ensure market penetration. Rather, the ultimate value of a technology is determined by the marketplace, and impactful technologies ultimately become disruptive – that is, they are widely adopted and displace existing technologies from the marketplace or create entirely new markets. Energy technologies typically become disruptive at maturity rather than close to inception and the maturation of nascent technologies often require significant incremental development to drives the technology down its natural learning curve to its ultimate equilibrium (see Figure 1 above). Such development

might include modification of the technology itself, the means to produce and distribute that technology, or both. Thus, while early incarnations of the automobile were transformational in the sense that they created a fundamentally new learning curve for transportation, they were not disruptive, because of the unreliability and high cost of early automobiles. Continuous, incremental refinement of the technology ultimately led to the Ford Model T: as the first affordable, reliable, mass-produced vehicle, the Model T had a disruptive effect on the transportation market.

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

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

ARPA-E will not support basic research aimed at discovery and fundamental knowledge generation, nor will it undertake large-scale demonstration projects of existing technologies. ARPA-E is not a substitute for existing R&D organizations within the Department of Energy, but rather complements existing organizations by supporting R&D objectives that are transformational and translational. Applicants interested in receiving basic research financial assistance should work with the Department of Energy's Office of Science (http://science.energy.gov/). Similarly, projects focused on the improvement of existing technology platforms may be appropriate for support by the applied programs – for example, the Office of Energy Efficiency and Renewable Energy (http://www.eere.energy.gov/), the Office of Fossil Energy (http://fossil.energy.gov/), the Office of Nuclear Energy (http://nuclear.energy.gov/), and the Office of Electricity Delivery and Energy Reliability (http://energy.gov/oe/office-electricity-delivery-and-energy-reliability).

B. PROGRAM OVERVIEW

1. INTRODUCTION

This program seeks to develop and demonstrate low-cost tools to aid in the development of fusion power, with a focus on approaches to produce thermonuclear plasmas in the final density range of 10^{18}-10^{23} ions/cm^3. The program goal is to create a toolset that will allow a significant reduction in facilities costs for fusion development and to enable rapid learning through a high shot rate at a low cost-per-shot.

2. BACKGROUND

Fusion has been pursued for decades because it is perhaps the ideal power source, with abundant fuel, effectively zero emissions, manageable waste, and minimal proliferation risk.[1] Significant resources have been devoted to fusion research in the US and internationally. To date, the largest fusion research efforts have focused on magnetic confinement of plasmas at densities of approximately 10^{14} ions/cm^3 and on inertial confinement of plasmas at densities exceeding 10^{25} ions/cm^3. Advances in scientific understanding and engineering of high energy density plasmas resulting from these research campaigns have been remarkable, but the ultimate goal of self-sustaining, controlled, thermonuclear fusion remains elusive. This reflects the extraordinary technical challenges of high energy plasma physics, which are compounded by the high cost of fusion research. In this FOA, ARPA-E pursues focused investments to develop tools for fusion approaches in the intermediate density regime, between 10^{18} -10^{23} ions/cm^3. This intermediate density regime has been highlighted in recent analyses as a potential low-cost route to fusion power, and because it sits between the operating densities of pure magnetic confinement and inertial confinement, developments in this regime will complement mainline fusion programs.

3. MOTIVATION

A key motivation for this program is to address some of the practical challenges that have slowed progress in fusion research. In addition to the unique scientific challenges of producing a thermonuclear plasma, there are two major, interrelated, practical challenges that make progress in fusion research especially difficult: (1) fusion research facilities have significant capital costs and (2) the shot rate, or number of experiments per day, at existing fusion research facilities is limited by high operating costs and low equipment repetition rate. As a result, there is a transformational opportunity for low cost development and rapid learning

[1] (a) *An Assessment of the Prospects for Inertial Fusion Energy,* The National Research Council, The National Academies Press: Washington, DC (2013); (b) *Program on Technology Innovation: Assessment of Fusion Energy Options for Commercial Electricity Production,* Electric Power Research Institute: Palo Alto, CA (2012); (c) Jones, S. and F. von Hippel. The Question Of Pure Fusion Explosions Under the CTB, *Science & Global Security* (1998), *7*, 129-150; (d) Glaser, A and R. Goldston. Proliferation risks of magnetic fusion energy: clandestine production, covert production and breakout, *Nuclear Fusion* (2012), *52*, 043004

enabled by investment in new tools for fusion research. *First*, recent analyses suggest low-cost pathways to fusion in the intermediate density regime[2-3] and recent experimental work, though preliminary, lends support to this analysis.[4] *Second*, improving the shot rate and reducing the cost of shots should directly improve the learning rate and speed progress along new fusion learning curves. To create low-cost tools with improved shot rate, ARPA-E seeks to leverage recent innovations in several areas: pulsed power;[5] MEMS particle acceleration;[6] plasma formation, plasma acceleration, and liner technologies;[7] and other areas. By funding the development of low-cost tools capable of high shot rates, ARPA-E seeks to open the field of fusion research to a broader range of approaches by a variety of institutions, both public and private, thereby facilitating more rapid progress along new learning curves towards economical fusion power.

The Department of Energy and others have made previous investments into intermediate density fusion experiments, including work over the past decade on magneto-inertial fusion (MIF, or alternatively magnetized target fusion, MTF). While many MIF/MTF approaches fall in the density range of interest for this program, this program's technical goals and anticipated research tool development differ from previous efforts. Principally, this program focuses on technologies that can achieve a high shot rate at low cost, with the goal of enabling rapid experimentation and learning in intermediate density regimes both within the program and in future research. This focus distinguishes the current program from previous work exploring intermediate density plasmas, much of which has focused on solid liner implosions. The use of high energy pulsed power or chemical explosives to drive implosions of solid liners has yielded

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[2] Lindemuth, I. and R. Siemon. The fundamental parameter space of controlled thermonuclear fusion, *Am. J. Phys*. (2009), *77*, 407-416

[3] (a) Thio, Y. C. F. Status of the U.S. program in magneto-inertial fusion, IFSA2007, *Journal of Phys.: Conf. Series 112* (2008), 042084; (b) Rosner, R. (chair) and D. Hammer (co-chair). "Basic Research Needs for High Energy Density Laboratory Physics," Report of the Workshop on High Energy Density Laboratory Physics Research Needs, November 15-18, 2009, U.S. Department of Energy (Chapter 2); (c) "Advancing the Science of High Energy Density Laboratory Plasmas," Report of the FESAC Panel on High Energy Density Laboratory Plasmas, U.S. Department of Energy, January 2009, (Sections 7.1.6, 9.1.4)

[4] (a) Hohenberger, M. et al. Inertial confinement fusion implosions with imposed magnetic field compression using the OMEGA Laser, *Phys. of Plasmas* (2012), *19*, 056306; (b) Herrmann, M. Update on Magnetized Liner Inertial Fusion, *Fusion Energy: Visions of the Future, 32nd Annual Meeting and Symposium*: Washington, DC. December 10, 2013. http://fire.pppl.gov/fpa_annual_meet.html (accessed May 22, 2014)

[5] (a) Saddow, S.E. and A. Agarwal, eds. Pulsed Power Applications. In *Advances in Silicon Carbide Processing and Applications*, Artech House/ Massachusetts (2004), 93-95; (b) Anderson, D.E. Recent Developments in Pulsed High Power Systems. *Proceedings of LINAC*: Knoxville, TN (2006), 541-545; (c) Hegeler, F. et al. A Durable Gigawatt Class Solid State Pulsed Power System, *IEEE Trans. on Dielectrics and Electrical Insulation* (2011), *18*, 1205

[6] Shi, Y. and A. Lal. Integrated all-electric high energy ion beam guidance on chip: Towards miniature particle accelerator, *24th IEEE International Conference on Micro Electro Mechanical Systems (MEMS 2011)*: Cancun, Mexico. January 23-27, 2011

[7] (a) Hsu, S.C. et al. Spherically Imploding Plasma Liners as a Standoff Driver for Magnetoinertial Fusion, *IEEE Trans. on Plasma Sci.* (2012), 40, 1287; (b) Slough, J.; Votroubek, G.; Pihl, C. Creation of a high temperature plasma through merging and compression of supersonic field reversed configuration plasmoids, *Nuclear Fusion* (2011), *51,* 053008

valuable insights and identified significant technical challenges.[8] While such systems are perhaps the only currently available tools that can provide the performance required in target-implosion approaches in these regimes, the destructive nature of these drivers makes it difficult to conduct a large number of experiments in a short amount of time. Plasma liner approaches have been explored as a possible solution, but plasma liner compression has not yet been demonstrated and significant technical challenges remain. [9] The ALPHA program posits that a large number of experiments can greatly accelerate learning in the intermediate density regime, and the focus on low-cost, high shot rate technologies is intended to lay the groundwork for that rapid experimentation and development. The goal of this program is to address the significant technical challenges in developing low-cost, high shot rate tools capable of accessing the intermediate density regime and demonstrating that these tools provide a path to Lawson conditions and beyond after the program.

ARPA-E acknowledges that the path to commercial fusion power will be exceptionally difficult, and that the risk of failure is substantial. However, the potential for reliable, low-cost power generation with abundant fuel resources and zero emissions is unparalleled. The ARPA-E mission is to seek opportunities for transformational energy technologies, and developing tools for fusion power is an appropriate, if high risk, piece of the agency's portfolio. It is also important to note that the technologies pursued in this program will draw on expertise from a broad range of communities, and the tools developed will likely find a number of high value applications outside of fusion, e.g. medical treatment, materials processing and characterization, and space propulsion. While these spinoff technologies are not the main motivation for the program, the potential value to areas outside of fusion energy research will be helpful in finding first markets, reducing costs, and ultimately pushing the newly developed tools towards economical fusion power.

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[8] (a) Degnan, J. et al. Recent magneto-inertial fusion experiments on the field reversed configuration heating experiment, *Nucl. Fusion*, (2013), *53*, 093003; (b) Cuneo, M. et al. Magnetically Driven Implosions for Inertial Confinement Fusion at Sandia National Laboratories, *IEEE Trans. On Plasma Sci*., (2012), *40*, 3222-3245; (c) Richardson, D. MTF Progress Update and Compression Heating of Spheromaks, *Fusion Energy: Visions of the Future, 32nd Annual Meeting and Symposium*: Washington, DC. December 11, 2013. http://fire.pppl.gov/FPA13_Richardson_Gen_Fusion.pdf (accessed August 7, 2014); (d) Garanin, S. et al. The MAGO System: Current Status, IEEE Trans. On Plasma Sci., (2006), 34, 2273-2278; (e) Sefkow, A. et al. Design of magnetized liner inertial fusion experiments using the Z facility, *Phys. Of Plasmas*, (2014), *21*, 072711; (f) Laberge, M. Sustained Spheromak at General Fusion, *Workshop on Exploratory Topics in Plasma and Fusion Research (EPR) and US-Japan Compact Torus (CT) Workshop:* Madison, WI August 5-8, 2014. http://www.iccworkshops.org/epr2014/proceedings.php (accessed August 7, 2014)

[9] (a) Kim, H. et al. On the structure of plasma liners for plasma jet induced magnetoinertial fusion, *Phys. Of Plasmas,* (2013), *20*, 022704-1-10 ; (b) Merritt, E.C. et al., Experimental characterization of the stagnation layer between two obliquely merging supersonic plasma jets, *Phys. Rev. Lett.*, (2013), *111*, 085003-1-5.

C. PROGRAM OBJECTIVES

The purpose of this funding opportunity is to create new tools for the low-cost development of fusion energy. By program completion, performers will be expected to demonstrate prototype tools that help enable a path to economical fusion power through low-cost, high shot rate development. This program focuses on the intermediate ion density regime (10^{18}-10^{23} ions/cm^3), which may open up new pathways to economical fusion power[2]. Working in the intermediate ion density regime also avoids duplication of effort with mainline fusion research programs. Participants will not be expected to build a complete fusion reactor. Rather, performers are expected to demonstrate prototype tools to form, heat, and/or confine plasmas at performance levels that establish the viability for low-cost fusion approaches in the intermediate density regime. These tools will also achieve the high shot rates required to enable continued rapid development towards economical fusion power. Tools that can leverage existing equipment to enhance technological progress within the project timeframe are of interest.

D. TECHNICAL CATEGORIES OF INTEREST

This program will develop tools in two broadly defined categories, "targets" and "drivers," that may in certain cases overlap. While these terms are commonly used in the context of inertial confinement fusion, their use in this FOA is not intended to limit applications to target-implosion approaches. Instead, the two categories are intended to ground discussion to a common set of challenges across diverse fusion approaches.

Within the context of this FOA, "target" is defined as the plasma that is heated to reach Lawson conditions, and "driver" is defined as the device that provides the necessary energy to the target to achieve Lawson conditions. Applicants may submit ideas that address one or both Categories:

Category 1: Drivers

Systems to deliver energy to plasma targets with sufficient power density, symmetry, and mitigation of instabilities to achieve Lawson conditions at a final density of 10^{18}-10^{23} ions/cm^3.

Category 2: Targets

Plasma formation technologies to produce plasmas with sufficient lifetime, transport properties, and geometry to pair with a driver and achieve Lawson conditions at a final density of 10^{18}-10^{23} ions/cm^3.

As noted above, there may be areas of overlap where a single system can both form a plasma target and drive it to fusion conditions. These systems are within the scope of this FOA. Applicants submitting "combined" approaches where target formation and driver technologies

overlap are required to clearly define their system requirements according to the terms outlined in Section E.

Applicants for a single Category must state assumptions on performance levels and constraints on the rest of the system. That is, a Category 1 (Drivers) application must define the parameters for the plasma target (at a minimum: density, temperature, lifetime, size, magnetic field, and transport properties) for which the driver will be designed. A Category 2 (Targets) application must define the performance of the driver (at a minimum: the power, intensity, precision, timing jitter, and symmetry) that will take the proposed plasma target to Lawson conditions. All applications (i.e. for Category 1, Category 2, or both) must describe conceptually how the intended target and driver technologies will work together in future development. Applicants are strongly encouraged to support the performance estimates for complementary drivers or targets with references or preliminary modeling.

ARPA-E will consider innovative partial solutions/proof of concept for plasma formation technologies or low-cost drivers that are not yet fully integrated into a conceptual fusion approach. For partial solutions, Applicants will not be required to fully quantify the performance levels and constraints on all components of the conceptual fusion system. However, applications for partial solutions will be limited to proof of concept funding.

E. TECHNICAL PERFORMANCE TARGETS

This section describes goals, metrics and performance requirements for the ALPHA program. Applicants will be required to address these items in detail in the full application, and the information is provided here for Applicants' consideration as they prepare Concept Papers. However, space is limited for Concept Papers and Applicants, therefore, should prioritize the content requirements outlined in Section IV.C.

This program will develop tools to enable low-cost development and rapid learning toward fusion reactors with final densities between 10^{18}-10^{23} ions/cm^3. It is beyond the scope of this program to build a complete fusion reactor, but Applicants should include a conceptual plan of the envisioned fusion reactor that their tool(s) will enable.

Partial solution/proof-of-concept applications are required only to provide quantitative analysis on the specific Category (Targets or Drivers) for which they are applying. However, partial solution/proof-of-concept Applicants are strongly encouraged to provide complete system analysis as outlined below in order to provide a more complete accounting of the impact for their component technology.

Overall Goals:

Each Applicant must present a final set of metrics for drivers and/or targets that can meet the set of parameters described below for a fusion reactor. Please note that these metrics do not need to be met within the Period of Performance of the ARPA-E award, but Applicants should

present an aggressive and logical development path to achieve these performance goals in a fusion reactor based on the team's technology.

Table 1 outlines the long-term objectives for the envisioned fusion reactors. Each proposal must include quantitative analysis, with supporting calculations and references, to demonstrate that the envisioned reactor with the proposed new tool(s) developed in this program will meet the metrics described below.

Parameter	**Requirement**	**Motivation**
Ion density at Lawson conditions (ions/cm^3)	10^{18}-10^{23}	ARPA-E seeks to catalyze research in the intermediate density regime to open up a new potential pathway for economical fusion power.
$\eta_d G_d$ (product of driver efficiency and gain)	> 5	Modest recirculating power is needed for a practical power plant. The product $\eta_d G_d$ represents the ratio of fusion energy out to wall-plug electricity input to the drivers.
Driver cost (amortized over full lifetime of driver)	< $0.05/MJ (MJ measured as delivered by driver over its full life)	A low-cost driver is required for economical fusion power. Cost per MJ delivered by the driver must include capital expenses (amortized over full lifetime of driver) and operating expenses (cost of electricity and driver maintenance).
Target cost	< 0.05 ¢/MJ (MJ measured as energy content of fuel. Note that this corresponds to 0.2 ¢/kWh.)	Low cost targets are required for economical fusion power. Target cost must include capital expenses for hardware (amortized over its full life) and operating expenses.
Repetition rate	≥ 1 Hz	Moderate to high rep rate allows lower energy per pulse and enables more compact power reactors

All applications, except those for partial solution/proof of concept efforts, should present a conceptual development plan to move from the prototype tools in the ARPA-E program to

demonstration of a power reactor (beyond the ARPA-E program). This should include a brief discussion of the costs, timeframe, and approximate number of shots required for each of the following steps:

- Scale-up from prototype tools developed under the ARPA-E award to reactor-scale components;
- Integrated experimental reactor with plasma formation, driver, and confinement vessel;
- Demonstration of scientific breakeven;
- Demonstration of engineering gain required for competitive power reactor; and
- Prototype power reactor.

Maintenance and materials compatibility issues (e.g., first wall materials, replacement schedule for other components exposed to neutron flux, etc.) should also be addressed in this discussion. All assumptions about the required components must be supported with references, including tools/components that will be developed under the ALPHA program and those that are expected to be available to integrate with the new tools. Applications should quantitatively describe low-cost, fast development pathways to breakeven and beyond. Please note that this program is not intended to fund a power reactor or to address maintenance and materials issues, but Applicants are expected to give thoughtful consideration to these issues at the time of their application.

Category 1: Drivers

Table 2 outlines the minimum performance requirements for driver technologies in this program:

Parameter	**Requirement**	**Motivation**
η_d (efficiency from wall-plug to useful energy delivered)	>20%	High efficiency drivers allow greater flexibility in fusion gain and an easier path to economical power.
Number of successful* shots in program	>100 shots	Practical shot rate and low cost per shot are required for rapid learning and development
Total number of shots in program (including development, testing, and demonstration)	>500 shots	Practical shot rate and low cost per shot are required for rapid learning and development
Power or intensity	Defined by Applicant	See discussion below
Precision, timing jitter, and symmetry	Defined by Applicant	See discussion below

*A 'successful' shot is one that meets or exceeds the performance requirements to demonstrate and validate physics of tools for scale up and integration beyond the ARPA-E program. See Section I.G for further details on driver performance requirements.

Driver requirements in power, intensity, precision, timing jitter, symmetry, and other relevant parameters will be dictated by the conceptual design of the reactor, and Applicants must define the performance requirements of the driver to achieve fusion conditions in the envisioned reactor. Proposals must address:

1. State-of-the-art performance for the proposed driver technology.
2. Performance level required to achieve Lawson conditions.
3. Performance level that will be demonstrated in prototype tool (i.e. a hardware demonstration, not just a simulation) under the ARPA-E program, and a quantitative discussion of how this performance level is sufficient to establish the pathway to (2) upon scale-up.
4. Envisioned plasma target for proposed driver technology, including quantification of the size, density, magnetic field, temperature, and lifetime of the target plasma, and note whether the stated properties of the target are measured, modeled, or calculated (e.g., assuming Bohm transport), using references where possible.
5. What other components (separate from the proposed ARPA-E driver development) are required for an integrated reactor and continued development towards a power reactor. Specifically:
    a. Identify other components that are known, demonstrated technologies.
    b. Identify other components that are likely to require significant development.

Category 2: Targets

Table 3 outlines the minimum performance requirements for plasma target formation technologies developed in this program:

Parameter	Requirement	Motivation
Number of successful* target preparation shots in program	>50 shots	Practical shot rate and low cost per shot are required for rapid learning and development. Note: ARPA-E will consider lower shot numbers for approaches requiring access to external or user facilities, provided the proposed effort provides exceptionally high impact in validating the physics and defining the path forward for a low-cost pathway approach.

Total number of shots (including development, testing, and demonstration)	>500 shots	Practical shot rate and low cost per shot required for rapid learning and development Note: ARPA-E will consider lower shot numbers for approaches requiring access to external or user facilities, provided the proposed effort provides exceptionally high impact in validating the physics and defining the path forward for a low-cost pathway approach.
Plasma lifetime	$\text{Max}(\tau_{\text{Lawson}}, \tau_{\text{driver}}) < \text{Min}(\tau_{\text{thermal losses}}, \tau_{\text{lifetime}})$	All loss mechanisms must be considered and quantified to establish a viable path to Lawson conditions within the timescale of the driver action.
Plasma parameters	n, T, τ, r, B defined by Applicant and measured within ±20% for each shot	A diagnostic suite capable of greater precision is preferred where existing diagnostics can provide better measurements.
Modeling	Plasma codes defined by Applicant	See discussion below

*A successful shot is one that meets all the required plasma parameters (within diagnostic error) to demonstrate and validate physics of tools for scale up and integration beyond the ARPA-E program.

Required plasma parameters will be dictated by the conceptual design of the reactor, and Applicants seeking funding for development of target formation technologies must define the required plasma attributes to achieve fusion conditions in the envisioned reactor. Proposals must address:

1. State of the art performance for the proposed target formation technology, including a discussion of the modeling approach to guide and validate experimental measurements of the target plasma.
2. Performance level required to achieve Lawson conditions.
3. Performance level that will be demonstrated in prototype tool under this program and a quantitative discussion of how this performance level is sufficient to establish the pathway to (2) upon scale-up.
4. Envisioned driver for proposed plasma target technology, including quantification of the power, intensity, precision, timing jitter, and symmetry of the driver (using references where possible)

5. What other components (separate from the proposed target formation technology development) are required for an integrated reactor and continued development towards a power reactor. Specifically:
    a. Identify other components that are known, demonstrated technologies.
    b. Identify other components that are likely to require significant development.

Applicants are strongly encouraged to include preliminary plasma simulations to demonstrate the viability of the proposed approach in their proposals. Consideration will be given to the impact of the proposed research to validate the theoretical and computational models to guide future development, including scaling laws for scale-up and integrated demonstration beyond the ARPA-E program. In the course of this program, teams will be required to verify their simulation results. Any limitations of code should be clearly noted in the proposal, and an experimental or modeling strategy to overcome these challenges, perhaps through collaboration, should be presented.

F. APPLICATIONS SPECIFICALLY NOT OF INTEREST

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

- Applications that fall outside the technical parameters specified in Section I.E of the FOA
- Applications that were already submitted to pending ARPA-E FOAs.
- Applications that are not scientifically distinct from applications submitted to pending ARPA-E FOAs.
- Applications for basic research aimed at discovery and fundamental knowledge generation.
- Applications for large-scale demonstration projects of existing technologies.
- Applications for proposed technologies that represent incremental improvements to existing technologies.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates a law of thermodynamics).
- Applications that do not address at least one of ARPA-E's Mission Areas (see Section I.A of the FOA).
- Applications for proposed technologies that are not transformational, as described in Section I.A of the FOA and as illustrated in Figure 1 in Section I.A of the FOA.
- Applications for proposed technologies that do not have the potential to become disruptive in nature, as described in Section I.A of the FOA. Technologies must be scalable such that they could be disruptive with sufficient technical progress (see Figure 1 in Section I.A of the FOA).
- Applications that are not scientifically distinct from existing funded activities supported elsewhere, including within the Department of Energy.
- Applications that propose the following:
    - Approaches based on low-energy nuclear reactions (e.g., cold fusion)

- Technologies that cannot be used or scaled to access the intermediate density regime of 10^{18}-10^{23} ions/cm^3 at Lawson conditions.
- Incremental improvements to existing fusion devices.
- Fusion-fission hybrids.
- Devices without a plausible pathway to electricity production.
- Approaches requiring chemical explosives for drivers.
- Efforts that do not include target and/or driver development and a hardware demonstration, such as: purely conceptual power-plant designs; efforts devoted to materials solutions or balance of plant issues for an existing reactor design; or purely theoretical work.

G. TECHNICAL SYMBOLS AND GLOSSARY

n	Density, principally ion density n_i [#/cm^3]
T	Temperature, principally ion temperature T_i [K]
τ_{Lawson}	Lawson time [s]
$\tau_{lifetime}$	Lifetime of plasma target to maintain its structure [s]
$\tau_{thermal\ losses}$	Timescale for thermal (or particle) losses in plasma [s]
τ_{driver}	Timescale for driver to input energy into target to achieve Lawson conditions [s]
χ	Thermal diffusivity of plasma target [m^2/s]
r	Radius of plasma target [m]
B	Magnetic field [Tesla]
β	Ratio of plasma pressure to magnetic pressure [unitless]
η_d	Driver efficiency (wall-plug to useful energy delivered by driver) [unitless]
G	Fusion gain, typically driver gain G_d (ratio of fusion energy to energy from driver) [unitless]

Driver: The device that delivers energy to the target in order to achieve fusion conditions. The power and intensity provided by a driver must be sufficiently high to overcome thermal losses in the plasma target. Fig. 1a and 1b are derived from data presented at the ARPA-E workshop and Lindemuth and Siemon[2, 10] to show minimum driver intensity to reach Lawson conditions (at 10 keV) for plasma targets with 20% thermal losses.

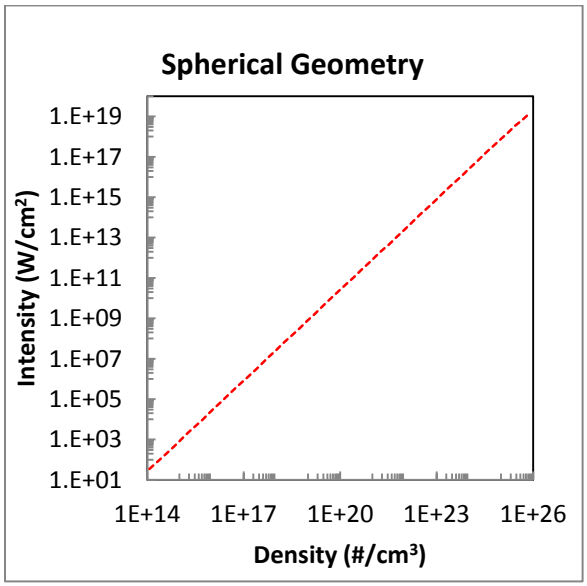

Fig. 1.a – Minimum driver intensity (W/m^2) for (10 keV) D-T targets in spherical geometry[10]

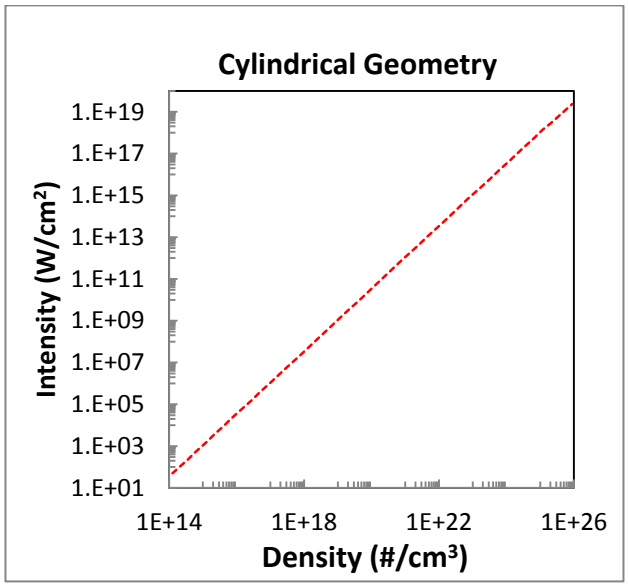

Fig. 1.b – Minimum driver intensity (W/m^2) for (10 keV) D-T targets in cylindrical geometry[10]

Driver efficiency (η_d): The efficiency of the driver should be measured as the ratio of the driver's useful energy output (e.g. kinetic energy of liner used to compress plasma) to the initial wall-plug electricity input.

Driver gain (G_d): The gain should be measured as the ratio of fusion power output to the initial energy supplied by the driver. Driver gain therefore must account for losses in coupling energy from the driver into the plasma. The product of driver efficiency and driver gain therefore represents the ratio of fusion power output to the initial wall-plug electricity input.

Liner: An imploding solid, liquid, or plasma shell used to compress and heat a plasma target.

Target: The fuel to be heated to fusion conditions. Plasma targets must maintain stability with sufficient lifetime to meet the Lawson condition for a given ion density and temperature. The target must also maintain sufficiently low thermal losses to reach fusion temperatures in the τ_{driver} timeframe.

[10] ARPA-E Drivers for Economical Fusion Technologies Workshop. http://arpa-e.energy.gov/arpa-e-events/drivers-economical-fusion-technologies-workshop (accessed May 13, 2014)

II. AWARD INFORMATION

A. AWARD OVERVIEW

ARPA-E expects to make approximately $30 million available for new awards under this FOA, subject to the availability of appropriated funds. ARPA-E anticipates making approximately 12-15 awards under this FOA. ARPA-E may issue one, multiple, or no awards.

Individual awards may vary between $250,000 and $10 million.

The period of performance for funding agreements may not exceed 36 months. ARPA-E expects the start date for funding agreements to be August 2015, or as negotiated.

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

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

Applicants proposing projects for which some initial proof-of-concept demonstration already exists should submit concrete data that supports the probability of success of the proposed project.

ARPA-E will provide support at the highest funding level only for applications with significant technology risk, aggressive timetables, and careful management and mitigation of the associated risks.

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

ARPA-E plans to fully fund your negotiated budget at the time of award.

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."[11] Accordingly, ARPA-E has substantial involvement in the direction of every project, as described in Section II.C below.

1. COOPERATIVE AGREEMENTS

ARPA-E generally uses Cooperative Agreements to provide financial and other support to Prime Recipients.[12]

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

ARPA-E encourages Prime Recipients to review the Model Cooperative Agreement, which is available at http://arpa-e.energy.gov/arpa-e-site-page/award-guidance.

2. FUNDING AGREEMENTS WITH FFRDCS, GOGOS, AND FEDERAL INSTRUMENTALITIES[13]

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

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

[11] U.S. Congress, Conference Report to accompany the 21st Century Competitiveness Act of 2007, H. Rpt. 110-289 at 171-172 (Aug. 1, 2007).
[12] The Prime Recipient is the signatory to the funding agreement with ARPA-E.
[13] DOE/NNSA GOGOs are not eligible to apply for funding, as described in Section III.A of the FOA.

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

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

3. TECHNOLOGY INVESTMENT AGREEMENTS

ARPA-E may use its "other transactions" authority under the America COMPETES Reauthorization Act of 2010 or DOE's "other transactions" authority under the Energy Policy Act of 2005 to enter into Technology Investment Agreements (TIAs) with Prime Recipients. ARPA-E may negotiate a TIA when it determines that the use of a standard cooperative agreement, grant, or contract is not feasible or appropriate for a project.

A TIA is more flexible than a traditional financial assistance agreement. In using a TIA, ARPA-E may modify standard Government terms and conditions.

In general, TIAs require a cost share of 50%. See Section III.B.2 of the FOA.

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. ARPA-E may fund a limited number of projects through Grants, as appropriate.

C. STATEMENT OF SUBSTANTIAL INVOLVEMENT

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

- ARPA-E does not limit its involvement to the administrative requirements of the ARPA-E funding agreement. Instead, ARPA-E has substantial involvement in the direction and redirection of the technical aspects of the project as a whole. Project teams must adhere to ARPA-E technical direction and comply with agency-specific and programmatic requirements.

- ARPA-E may intervene at any time to address the conduct or performance of project activities.

- During award negotiations, ARPA-E Program Directors and Prime Recipients mutually establish an aggressive schedule of quantitative milestones and deliverables that must be met every quarter. Prime Recipients document the achievement of these milestones and deliverables in quarterly technical and financial progress reports, which are reviewed and evaluated by ARPA-E Program Directors (see Attachment 4 to ARPA-E's Model Cooperative Agreement, available at http://arpa-e.energy.gov/arpa-e-site-page/award-guidance). ARPA-E Program Directors visit each Prime Recipient at least twice per year, and hold periodic meetings, conference calls, and webinars with Project Teams. ARPA-E Program Directors may modify or terminate projects that fail to achieve predetermined technical milestones and deliverables.

- ARPA-E works closely with Prime Recipients to facilitate and expedite the deployment of ARPA-E-funded technologies to market. ARPA-E works with other Government agencies and nonprofits to provide mentoring and networking opportunities for Prime Recipients. ARPA-E also organizes and sponsors events to educate Prime Recipients about key barriers to the deployment of their ARPA-E-funded technologies. In addition, ARPA-E establishes collaborations with private and public entities to provide continued support for the development and deployment of ARPA-E-funded technologies.

III. ELIGIBILITY INFORMATION

A. ELIGIBLE APPLICANTS

1. INDIVIDUALS

U.S. citizens or permanent residents may apply for funding in their individual capacity as a Standalone Applicant,[14] as the lead for a Project Team,[15] or as a member of a Project Team.

2. DOMESTIC ENTITIES

For-profit entities, educational institutions, and nonprofits[16] that are incorporated in the United States, including U.S. territories, are eligible to apply for funding as a Standalone Applicant, as the lead organization for a Project Team, or as a member of a Project Team.

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

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

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

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

Federal agencies and instrumentalities (other than DOE) 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.

[14] A Standalone Applicant is an Applicant that applies for funding on its own, not as part of a Project Team.
[15] 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.
[16] 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.

3. FOREIGN ENTITIES

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

4. CONSORTIUM ENTITIES

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

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

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

B. COST SHARING[17]

Applicants are bound by the cost share proposed in their Full Applications.

1. BASE COST SHARE REQUIREMENT

ARPA-E generally uses Cooperative Agreements to provide financial and other support to Prime Recipients (see Section II.B.1 of the FOA). Under a Cooperative Agreement, the Prime Recipient must provide at least 20% of the Total Project Cost[18] as cost share, except as provided in Sections III.B.2 or III.B.3 below.[19]

2. INCREASED COST SHARE REQUIREMENT

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

Under a Technology Investment Agreement, the Prime Recipient must provide at least 50% of the Total Project Cost as cost share. ARPA-E may reduce this minimum cost share requirement, as appropriate.

3. REDUCED COST SHARE REQUIREMENT

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

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

- Small businesses – or consortia of small businesses - will provide 0% cost share from the outset of the project through the first 12 months of the project (hereinafter the "Cost Share Grace Period"). If the project is continued beyond the Cost Share Grace Period, then at least 10% of the Total Project Cost (including the costs incurred during the Cost Share Grace Period) will be required as cost share over the remaining period of performance.

- Project Teams where a small business is the lead organization and small businesses perform greater than or equal to 80%, but less than 100%, of the total work under

[17] Please refer to Section VI.B.3-4 of the FOA for guidance on cost share payments and reporting.
[18] The Total Project Cost is the sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs, FFRDCs, and GOCOs.
[19] Energy Policy Act of 2005, Pub.L. 109-58, sec. 988.

the funding agreement (as measured by the Total Project Cost) the Project Team are entitled to the same cost share reduction and Cost Share Grace Period as provided above to Standalone small businesses or consortia of small businesses.

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

- Project Teams where domestic educational institutions, domestic nonprofits, and/or FFRDCs perform greater than or equal to 80%, but less than 100%, of the total work under the funding agreement (as measured by the Total Project Cost) are required to provide at least 10% of the Total Project Cost as cost share. However, any entity (such as a large business) receiving patent rights under a class waiver, or other patent waiver, that is part of a Project Team receiving this reduction must continue to meet the statutory minimum cost share requirement (20%) for its portion of the Total Project Cost.

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

4. LEGAL RESPONSIBILITY

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

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

5. COST SHARE ALLOCATION

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

6. COST SHARE TYPES AND ALLOWABILITY

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

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

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

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

In addition, Project Teams may not use independent research and development (IR&D) funds[20] to meet their cost share obligations under cooperative agreements. However, Project Teams may use IR&D funds to meet their cost share obligations under Technology investment Agreements.

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

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

[20] As defined in Federal Acquisition Regulation Section 31.205-18.

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

7. COST SHARE CONTRIBUTIONS BY FFRDCS AND GOGOS

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

8. COST SHARE VERIFICATION

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

C. OTHER

1. COMPLIANT CRITERIA

Concept Papers are deemed compliant if:

- The Applicant meets the eligibility requirements in Section III.A of the FOA;
- The Concept Paper complies with the content and form requirements in Section IV.C of the FOA; and
- The Applicant entered all required information, successfully uploaded all required documents, and clicked the "Submit" button in ARPA-E eXCHANGE by the deadline stated in the FOA.

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

Full Applications are deemed compliant if:

- The Applicant submitted a compliant and responsive Concept Paper;
- The Applicant meets the eligibility requirements in Section III.A of the FOA;

- The Full Application complies with the content and form requirements in Section IV.D of the FOA; and

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

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

Replies to Reviewer Comments are deemed compliant if:

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

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

2. RESPONSIVENESS CRITERIA

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

3. LIMITATION ON NUMBER OF APPLICATIONS

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

IV. APPLICATION AND SUBMISSION INFORMATION

A. APPLICATION PROCESS OVERVIEW

1. REGISTRATION IN ARPA-E eXCHANGE

The first step in applying to this FOA is registration in ARPA-E eXCHANGE, ARPA-E's online application portal. For detailed guidance on using ARPA-E eXCHANGE, please refer to Section IV.H.1 of the FOA and the "ARPA-E eXCHANGE User Guide" (https://arpa-e-foa.energy.gov/Manuals.aspx).

2. CONCEPT PAPERS

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

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

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

3. FULL APPLICATIONS

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

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

4. REPLY TO REVIEWER COMMENTS

Once ARPA-E has completed its review of Full Applications, reviewer comments on compliant and responsive Full Applications are made available to Applicants via ARPA-E eXCHANGE. Applicants may submit an optional Reply to Reviewer Comments, which must be submitted by the deadline stated in the FOA. Section IV.E of the FOA provides instructions on submitting a Reply to Reviewer Comments.

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

5. PRE-SELECTION CLARIFICATIONS AND "DOWN-SELECT" PROCESS

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

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

6. SELECTION FOR AWARD NEGOTIATIONS

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

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

7. MANDATORY WEBINAR

All selected Applicants, including the Principal Investigator and the financial manager for the project, are required to participate in a webinar that is held within approximately one week of the selection notification. During the webinar, ARPA-E officials present important information on the award negotiation process, including deadlines for the completion of certain actions.

B. APPLICATION FORMS

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

C. CONTENT AND FORM OF CONCEPT PAPERS

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

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

corner of the header of every page. Page numbers must be included in the footer of every page.

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

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

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

Concept Papers must conform to the content requirements described below. In Concept Papers, Applicants are encouraged to focus on the technology to be developed in the ARPA-E program effort and place less emphasis on the post-program development path. If Applicants exceed the maximum page length indicated above, ARPA-E will review only the authorized number of pages and disregard any additional pages:

1. FIRST COMPONENT: CONCEPT PAPER

a. CONCEPT SUMMARY

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

b. INNOVATION AND IMPACT

- Clearly identify the problem to be solved with the proposed technology concept.
- Describe how the proposed effort represents an innovative and potentially transformational solution to the technical challenges posed by the FOA.
- Explain the concept's potential to be disruptive compared to existing or emerging technologies.
- Describe how the concept will have a positive impact on at least one of the ARPA-E mission areas in Section I.A of the FOA.
- To the extent possible, provide quantitative metrics in a table that compares the proposed technology concept to current and emerging technologies and to the technical

performance targets in Section I.E of the FOA for the appropriate Technology Category in Section I.D of the FOA.

c. PROPOSED WORK

- Describe the final deliverable(s) for the project and the overall technical approach used to achieve project objectives.

- Discuss alternative approaches considered, if any, and why the proposed approach is most appropriate for the project objectives.

- Describe the background, theory, simulation, modeling, experimental data, or other sound engineering and scientific practices or principles that support the proposed approach. Provide specific examples of supporting data and/or appropriate citations to the scientific and technical literature.

- Describe why the proposed effort is a significant technical challenge and the key technical risks to the project. Does the approach require one or more entirely new technical developments to succeed? How will technical risk be mitigated?

- Identify techno-economic challenges to be overcome for the proposed technology to be commercially relevant.

d. TEAM ORGANIZATION AND CAPABILITIES

- Indicate the roles and responsibilities of the organizations and key personnel that comprise the Project Team.

- Provide the name, position, and institution of each key team member and describe in 1-2 sentences the skills and experience that he/she brings to the team.

- Identify key capabilities provided by the organizations comprising the Project Team and how those key capabilities will be used in the proposed effort.

- Identify (if applicable) previous collaborative efforts among team members relevant to the proposed effort.

2. SECOND COMPONENT: SUMMARY SLIDE

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. This slide will be used during ARPA-E's evaluation of Concept Papers. A summary slide template

and a sample summary slide are available on ARPA-E eXCHANGE (https://arpae-foa.energy.gov). Summary Slides must conform to the content requirements described below:

- Project Title;
- Lead Organization, Principal Investigator, and key personnel names;
- ARPA-E Assigned Control Number;
- Technical Category;
- Estimated Total Project Cost;
- Technology Summary and Impact;
  - Bullet points that describe novel aspects of the technology, approach, and impact on the ALPHA Program goals;
- Proposed Goals;
  - Including any important technical performance metrics;
  - Including quantitative description of the state of the art; and
  - Including quantitiative descriptions of the proposed targets;
- Any key graphics (e.g., illustrations, charts and/or tables that summarize the technology, key innovations, and planned approach);

D. CONTENT AND FORM OF FULL APPLICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

E. CONTENT AND FORM OF REPLIES TO REVIEWER COMMENTS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

F. INTERGOVERNMENTAL REVIEW

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

G. FUNDING RESTRICTIONS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

H. OTHER SUBMISSION REQUIREMENTS

1. USE OF ARPA-E eXCHANGE

To apply to this FOA, Applicants must register with ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/Registration.aspx). Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted through ARPA-E eXCHANGE (https://arpa-e-foa.energy.gov/login.aspx). ARPA-E will not review or consider applications submitted through

other means (e.g., fax, hand delivery, email, postal mail). For detailed guidance on using ARPA-E eXCHANGE, please refer to the "ARPA-E eXCHANGE User Guide" (https://arpa-e-foa.energy.gov/Manuals.aspx).

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

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

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

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

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

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

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

V. APPLICATION REVIEW INFORMATION

A. CRITERIA

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

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

1. CRITERIA FOR CONCEPT PAPERS

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

- The extent to which the proposed quantitative material and/or technology metrics demonstrate the potential for a transformational and disruptive (not incremental) advancement compared to existing or emerging technologies;
- The extent to which the proposed concept will have a positive impact on at least one of ARPA-E's mission areas in Section I.A of the FOA;
- The extent to which the proposed concept is innovative and will achieve the technical performance targets defined in Section 1.E of the FOA for the appropriate technology Category in Section I.D of the FOA; and
- The extent to which the Applicant demonstrates awareness of competing commercial and emerging technologies and identifies how the proposed concept/technology provides significant improvement over existing solutions.

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

- The feasibility of the proposed work, as justified by appropriate background, theory, simulation, modeling, experimental data, or other sound scientific and engineering

practices;

- The extent to which the Applicant proposes a sound technical approach to accomplish the proposed R&D objectives, including why the proposed concept is more appropriate than alternative approaches and how technical risk will be mitigated;

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

- The extent to which the Applicant identifies techno-economic challenges that must be overcome for the proposed technology to be commercially relevant; and

- The demonstrated capabilities of the individuals performing the project, the key capabilities of the organizations comprising the Project Team, the roles and responsibilities of each organization and (if applicable) previous collaborations among team members supporting the proposed project.

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

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

2. CRITERIA FOR FULL APPLICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

3. CRITERIA FOR REPLIES TO REVIEWER COMMENTS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

B. REVIEW AND SELECTION PROCESS

1. PROGRAM POLICY FACTORS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

2. ARPA-E REVIEWERS

By submitting an application to ARPA-E, Applicants consent to ARPA-E's use of Federal employees, contractors, and experts from educational institutions, nonprofits, industry, and governmental and intergovernmental entities as reviewers. ARPA-E selects reviewers based on

their knowledge and understanding of the relevant field and application, their experience and skills, and their ability to provide constructive feedback on applications.

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

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

3. ARPA-E SUPPORT CONTRACTOR

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

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

C. ANTICIPATED ANNOUNCEMENT AND AWARD DATES

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

VI. AWARD ADMINISTRATION INFORMATION

A. AWARD NOTICES

1. REJECTED SUBMISSIONS

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

2. CONCEPT PAPER NOTIFICATIONS

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

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

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

3. FULL APPLICATION NOTIFICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

C. REPORTING

[TO BE INSERTED BY FOA MODIFICATION IN DECEMBER 2014]

VII. AGENCY CONTACTS

A. COMMUNICATIONS WITH ARPA-E

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

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

- ARPA-E will post responses on a weekly basis to any questions that are received. ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.

- ARPA-E will cease to accept questions approximately 5 business days in advance of each submission deadline. Responses to questions received before the cutoff will be posted approximately one business day in advance of the submission deadline. ARPA-E may re-phrase questions or consolidate similar questions for administrative purposes.

- Responses are posted to "Frequently Asked Questions" on ARPA-E's website (http://arpa-e.energy.gov/faq).

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

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

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

B. DEBRIEFINGS

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

VIII. OTHER INFORMATION

A. FOAS AND FOA MODIFICATIONS

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

B. OBLIGATION OF PUBLIC FUNDS

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

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

C. REQUIREMENT FOR FULL AND COMPLETE DISCLOSURE

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

- 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. If they elect to retain title, they must file a patent application in a timely fashion.

- All other parties: The Federal Non Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (*see below)*.

- Class Waiver: Under 42 U.S.C. § 5908, title to subject inventions vests in the U.S. Government and large businesses and foreign entities do not have the automatic right to elect to retain title to subject inventions. However, ARPA-E typically issues "class patent waivers" under which large businesses and foreign entities that meet certain stated requirements may elect to retain title to their subject inventions. If a large business or foreign entity elects to retain title to its subject invention, it must file a patent application in a timely fashion.

G. GOVERNMENT RIGHTS IN SUBJECT INVENTIONS

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

1. GOVERNMENT USE LICENSE

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

2. MARCH-IN RIGHTS

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

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

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

H. RIGHTS IN TECHNICAL DATA

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

- Background or "Limited Rights Data": The U.S. Government will not normally require delivery of technical data developed solely at private expense prior to issuance of an award, except as necessary to monitor technical progress and evaluate the potential of proposed technologies to reach specific technical and cost metrics.
- Generated Data: The U.S. Government normally retains very broad rights in technical data produced under Government financial assistance awards, including the right to distribute to the public. However, pursuant to special statutory authority, certain categories of data generated under ARPA-E awards may be protected from public disclosure for up to five years. Such data should be clearly marked as described in Section VIII.E of the FOA. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

I. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION

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

- Social Security Numbers in any form;
- Place of Birth associated with an individual;

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

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.

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

DOE: U.S. Department of Energy.

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

FFRDCs: Federally Funded Research and Development Centers.

FOA: Funding Opportunity Announcement.

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

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

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

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

PI: Principal Investigator.

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

R&D: Research and development.

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.

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

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

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