

**FINANCIAL ASSISTANCE
FUNDING OPPORTUNITY ANNOUNCEMENT**



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

***METHANE OBSERVATION NETWORKS WITH INNOVATIVE
TECHNOLOGY TO OBTAIN REDUCTIONS (MONITOR)***

Announcement Type: **Initial Announcement Modification 01**
Funding Opportunity No. DE-FOA-0001128
CFDA Number 81.135

FOA Issue Date:	April 29, 2014
First Deadline for Questions to ARPA-E-CO@hq.doe.gov:	5 PM ET, June 6, 2014
Submission Deadline for Concept Papers:	5 PM ET, June 13, 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).*

MODIFICATIONS

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

Mod. No.	Date	Description of Modifications
01	06/04/2014	<ul style="list-style-type: none">• Inserted additional information in Section I.B.4 regarding the types of data that would be relevant to sensing systems.

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REQUIRED DOCUMENTS CHECKLIST

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

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

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

SUBMISSION	COMPONENTS	OPTIONAL/ MANDATORY	FOA SECTION	DEADLINE
Concept Paper	<ul style="list-style-type: none">• Each Applicant must submit a Concept Paper in Adobe PDF format by the stated deadline. The Concept Paper must include the following:<ul style="list-style-type: none">○ Technology Description (2 pages max.)○ System Diagram (1 page max.)○ Cost Table (1 page max.)○ Addendum (2 pages max.)	Mandatory	IV.C	5 PM ET, June 13, 2014
Full Application	[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]	Mandatory	IV.D	5 PM ET, TBD
Reply to Reviewer Comments	[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]	Optional	IV.E	5 PM ET, TBD

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I. FUNDING OPPORTUNITY DESCRIPTION

A. AGENCY OVERVIEW

The Advanced Research Projects Agency – Energy (ARPA-E), an organization within the Department of Energy, is chartered by Congress in the America COMPETES Act of 2007 (P.L. 110-69), as amended by the America COMPETES Reauthorization Act of 2010 (P.L. 111-358), to support the creation of transformational energy technologies and systems through funding and managing Research and Development (R&D) efforts. Originally chartered in 2007, the Agency was first funded through the American Recovery and Reinvestment Act of 2009. Since that time, the Agency has invested over \$900 million across 362 projects through 18 focused programs and two open funding solicitations across the entire technology landscape.¹

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. To date, 22 ARPA-E projects have attracted more than \$625 million in private-sector follow-on funding after ARPA-E's investment of approximately \$95 million. In addition, at least 24 ARPA-E project teams have formed new companies to advance their technologies, and more than 16 ARPA-E projects have partnered with other government agencies for further development.

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

¹ Information on ARPA-E's projects is available at <http://arpa-e.energy.gov/?q=projects>.

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.

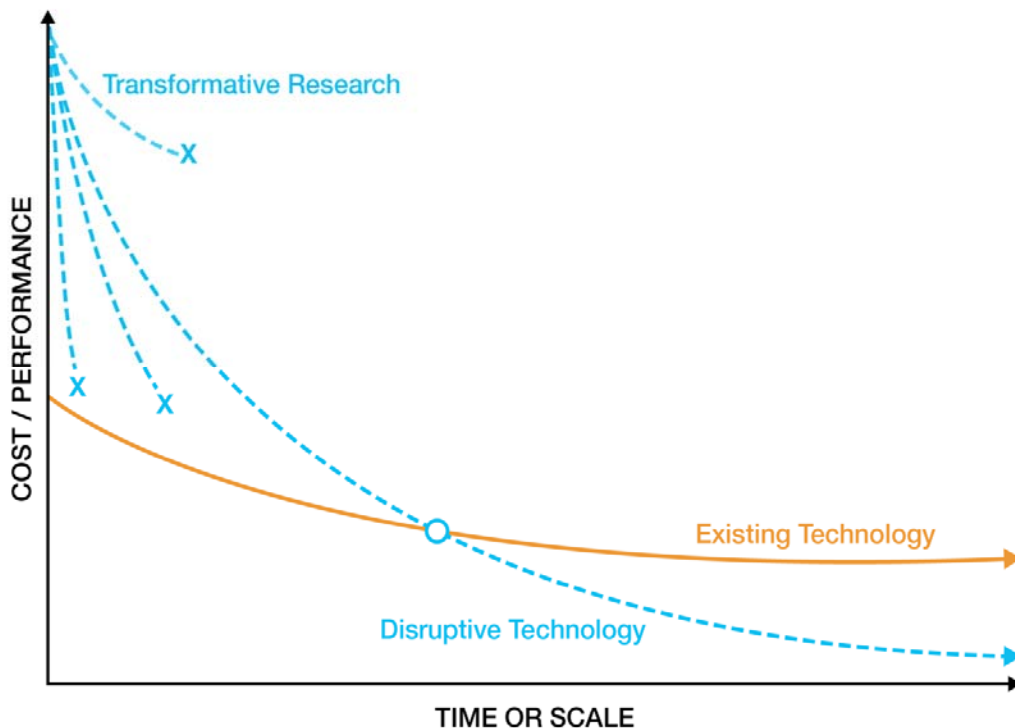


Figure 1: Description of transformational and disruptive technologies in terms of cost per unit performance versus time or scale. ARPA-E seeks to support research that establishes new learning curves that lead to disruptive technologies.

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. SUMMARY

The goal of the MONITOR² program is to support the development of disruptive approaches for methane emission detection and measurement that will enable widespread utilization and facilitate reductions in methane emissions. The program implementation focus is on “oil and gas systems” from the wellhead to the end-user. Cost-effective measurement of methane emissions will facilitate detection and early mitigation of leaks and process upsets, thus reducing the overall emissions of methane from the production of natural gas.

2. MOTIVATION

ARPA-E’s authorizing statute directs the agency to support the development of technology that could result in “reduction of energy-related emissions, including greenhouse gases”, which this program addresses directly. The statute also promotes the development of technologies that could result in “reduction of imports of energy from foreign sources”. To the extent that reduction of methane loss preserves the natural gas supply for domestic use, this is also supported.

Methane is estimated to be the second largest contributor to global warming (after CO₂), although there is some debate about the magnitude of its impact due to uncertainties around: 1) the most appropriate global warming potential (GWP)³ for methane, 2) the quantity of methane entering the atmosphere from all sources, and 3) distribution of emissions between anthropogenic and non-anthropogenic sources. GWP values for methane range from 21 to 86⁴ due to varying time periods used for the calculation and developing knowledge about the complex chemistry of methane in the atmosphere. The U.S. Environmental Protection Agency (EPA) estimated that in 2011, methane accounted for 8.8% of the global warming impact from domestic human activity.⁵ This estimate used the 100-year GWP₁₀₀ factor of 21, which is at the lowest end of the GWP spectrum; however, if the higher range value for 20-year GWP₂₀ of 86 is used instead,⁶ the global warming impact from anthropogenic methane in the U.S. would increase to 31.9%.

EPA also estimates that oil and natural gas systems comprise approximately 30% of the U.S. anthropogenic methane emissions. This corresponds to a methane leakage rate of around

² Methane Observation Networks with Innovative Technology to Obtain Reductions

³ Global warming potential (GWP) is a measure of the effectiveness of a gas in trapping heat in the atmosphere, referenced to CO₂.

⁴ From the *Second Assessment Report (SAR) of the Intergovernmental Panel on Climate Change (IPCC)* (1996) and *Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC)* (2014).

⁵ EPA 430-R-13-001. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*. April 12, 2013.

⁶ *Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC)* (2014).

1.65%⁷ of production. While some recent literature, such as Allen’s “bottom up”⁸ analysis generally support this estimate,⁹ other “top down”¹⁰ studies have called these estimates into question. For example, Miller’s top down study proposes that “current inventories from the U.S. Environmental Protection Agency and the Emissions Database for Global Atmospheric Research underestimate methane emissions nationally by 150% and 170%, respectively” — suggesting a leakage rate between 2.5% and 2.8% of production.¹¹ Similarly, Brandt’s recent paper suggests that methane emissions from all sources range from 125% to 175% of EPA estimates.¹² Other studies have indicated that localized emissions in production zones can be much higher, such as a study of the Uintah basin that estimated emissions rates at 6.2%-11.7% of production¹³ and a study of the Los Angeles basin that estimated rates as high as 17% of production.¹⁴

These studies illustrate two important conclusions: 1) methane emissions are a significant contributor to environmental forcing effects, even if the lower range of GWP values are assumed; and 2) there is a bona fide need to improve the measurement of anthropogenic methane emissions. These conclusions provide the motivation for this FOA’s focus on the development of technological solutions that facilitate improved, cost effective detection and measurement of methane emissions.

3. STATE-OF-THE-ART

There are numerous technologies available that allow the measurement of methane levels. These technologies include, but are not limited to gas chromatography (GC), flame ionization detection (FID), Fourier transform infrared spectroscopy (FTIR), tunable laser diode absorption spectroscopy (TLDS), cavity ring-down spectroscopy, electrochemical sensors, and catalytic sensors. These systems have different degrees of selectivity, sensitivity, accuracy, and cost. For example, catalytic sensors can be quite inexpensive, but their relatively low sensitivity requires that they be deployed in close proximity to potential leakage points, requiring a relatively high

⁷ Calculated from data presented in EPA 430-R-13-001. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*. April 12, 2013. (see <http://static.berkeleyearth.org/memos/epa-report-reveals-lower-methane-leakage-from-natural-gas.pdf>)

⁸ “Bottom up” estimates attempt to estimate methane emissions by combining inventories of potential sources (natural gas wells, compressor engines, field processing equipment, etc.) with estimates of their “typical” emissions and “snapshot” measurements to estimate total emissions from the system.

⁹ D.T. Allen, et al. Measurements of methane emissions at natural gas production sites in the United States. *PNAS* 110(44):17768–17773 (2013).

¹⁰ “Top down” estimates attempt to estimate emissions through measurements in the atmosphere, typically from tall towers or aircraft.

¹¹ S.M. Miller, et al. Anthropogenic emissions of methane in the United States. *PNAS* 110(50):20018-20022 (2013).

¹² A.R. Brandt, et al. Methane leaks from North American natural gas system. *Science* 343(6172):733-735 (2014).

¹³ A. Karion, et al. Methane emissions estimate from airborne measurements over a western United States natural gas field. *Geophys. Res. Lett.* 40(16):4393–4397 (2013).

¹⁴ J. Peischl, et al. Quantifying sources of methane using light alkanes in the Los Angeles basin, California. *J. Geophys. Res. Atmos.* 118(10):4974-4990 (2013).

number of sensors for complete coverage of a site. At the other end of the spectrum, TLDAS systems have demonstrated very high sensitivity with detection levels of 1 ppb or below that potentially allow the use of fewer sensors, albeit with higher cost per sensor. Regardless of sensitivity, many measurement systems require transport of either the methane to the sensor or the sensor to the methane plume. Moreover, systems can make measurements from a single point, along an open path line, or over an area (as in the case of imaging detectors). The primary barrier to widespread utilization of continuous or semi-continuous methane measurement is cost. Current high-resolution methane measurement approaches (e.g.; cavity ring-down, TLDAS) have initial capital costs of \$75,000-\$100,000 as well as additional installation, calibration, and operating costs—yielding an annual measurement cost in excess of \$25,000 per site, assuming a 3-5 year equipment life. Lower cost electrochemical or IR approaches are used in safety systems to monitor for flammability that typically do not require sensitivity below 100 ppm.

4. PROGRAM APPROACH

There are numerous approaches to reduce the cost of methane sensing and measurement. Among others, one can reduce the cost of the sensor itself or transport the sensor so that it performs sensing at a number of different sites. With this in mind, ARPA-E is soliciting applications for the development of “sensing systems” rather than focusing solely on sensors. Potential measurement solutions could consist of, **but are not limited to**:

1. Single high-sensitivity fixed sensor;
2. Network consisting of a number of lower sensitivity fixed sensors;
3. Systems incorporating imaging technology;
4. Sensor(s) mounted on vehicles that drive prescribed or random routes and uses both concentration and wind data to estimate the location of leaks;
5. Sensors mounted in conventional or unmanned aircraft;
6. Satellite imaging; and
7. Biological solutions in which plants might “signal” (change of color, release of chemicals) the presence of methane.

Each of these would require not only the physical sensing component (laser spectrometer, catalytic sensor, imaging sensor, biological sensor), but also **wind environmental** data (e.g., **wind speed and direction**) and potentially other weather data (e.g., temperature, precipitation). The concentration and **wind environmental**/weather data would be used with an inverse dispersion model to estimate the location and magnitude of a leak. **Please note that the specific**

environmental data described here (such as wind, for example) are not a requirement. Alternative methods of estimating the location and magnitude of a leak are acceptable. Please note that use of specific environmental and weather data is not required; all data-based methods of estimating the location and magnitude of a leak are acceptable.

C. PROGRAM OBJECTIVES

The goal of the MONITOR program is to support the development of disruptive approaches for methane emission detection and measurement that will enable widespread utilization and facilitate reductions in methane emissions. The specific objective of the FOA is to *detect and measure methane leaks as small as 1 ton per year from a site 10 m x 10 m in area with a certainty that would allow 90% reduction in methane loss for an annual site cost of \$3,000*. The system should be capable of estimating the location and mass flow rate of a leak, should be able to transmit results wirelessly to a remote receiver, and should incorporate data processing to minimize false positive events. Additional cost will be allowed for systems that demonstrate enhanced measurement capabilities, as discussed in Section I.C.4 below.

1. TARGET LEAK SIZE

This FOA establishes a detection threshold of 1 ton/year. This corresponds to 1.9 grams/minute, which is approximately 6 standard cubic feet per hour (scfh). Significant stochastic uncertainty may be present in field measurements; these should be considered when reporting the presence and/or magnitude of a leak in order to minimize reporting of false positive events. Finally, applicants to this FOA should include strategies to account for the local background level of methane because inaccurate background assumptions could lead to significant errors in leak detection and determination of leakage rates.

2. TARGET FACILITY

This FOA seeks detection solutions that can be applied at facilities of all sizes, including individual wellpads, gathering and field compression sites, gas processing plants, and compressor stations, and local distribution systems. In order to bound the problem, a production well pad has been selected as the focus of this FOA; however, systems approaches to other segments of natural gas infrastructure will be considered.

A square production well pad has been chosen as the “model site,” with dimensions of 10 meters by 10 meters; leakage is possible from anywhere on the site, and time varying winds of 2.75 m/s (average wind speed) are typical. For systems that depend on or are affected by wind, the reference wind profile chosen for this analysis is a 2 meter data set (taken 2 meters above ground) from the National Wind Technology Center.¹⁵ Respondents are allowed full latitude in positioning the components of their monitoring system on, or outside of, the site. Details

¹⁵ http://www.nrel.gov/midc/nwtc_m2/

about the model site and additional criteria will be provided in the instructions for Full Applications.

3. REDUCTION CRITERION

Although the property of primary interest for gas sensors is concentration, design of the entire system is needed to determine the required sensitivity of the sensors. For example, a single high-sensitivity sensor may be replaced with an array of lower cost, lower sensitivity sensors. Similarly, sensors for use in mobile sensing (from ground vehicles, airplanes, UAVs, etc.) may require high sensitivity but may be able to tolerate higher sensor costs since the system allows measurement of multiple sites. This diversity of approaches makes it impractical to establish sensitivity criteria for sensors *a priori*. Instead, ARPA-E has established a system goal of reducing methane leakage from the model site by 90%. The base case assumes that site inspections are performed on an annual basis. Statistically, it is also assumed that leaks that occur between the annual inspections are evenly distributed throughout the year. For simplicity, it is assumed that any leak that is detected by a monitoring system is repaired instantly. Therefore, when a leak is detected (and repaired) before the next annual inspection, a reduction in leakage is achieved.

Respondents who submit Full Applications will be required to document the expected performance of their system, including calculation of the lower detection limit required for their sensors. Additional instructions on performance modeling will be provided in the instructions for submitting a Full Application.

Quantifying system performance will require an estimate of the natural gas savings that can be facilitated by a particular measurement system; this requires assumptions about maintenance and repair practices. For the purpose of this FOA, it is assumed that:

1. An annual leak inspection will be conducted and would detect any leaks (above the 6 scfh threshold) at the site. It is assumed that all leaks at or above 6 scfh will be detected and repaired at the time of the annual inspection.
2. A leak can occur at any time between annual inspections.
3. The initiation times of leaks are evenly distributed throughout the year; thus, the starting time of the “average” (mean and median are the same in this case) leak occurs at the midpoint of the year. This implies that the average leak would persist for $365/2 = 182.5$ days. Consequently, a 90% reduction in average leakage requires detection of a leak within 10% of the time between its start and the annual inspection, so within 18.25 days on average.

4. If a leak is detected, it is “instantly” considered repaired.¹⁶
5. The “gas saved” is the amount of gas that would have otherwise been emitted between detection and the annual inspection.

4. COST AND ENHANCED FUNCTIONALITY

The primary goal of this FOA is for early detection of methane or natural gas leakage and establishes a cost metric of \$3,000 / site / year for basic functionality, i.e. the ability to measure methane within a time period (18.25 days) sufficient to produce a 90% reduction of methane loss from leakage. However, there are other considerations which can increase or reduce the value of the system, and can therefore influence the allowable annual cost of measurement. Additional capabilities of interest include:

1. Methane selectivity: Defined as a system that has the ability to discriminate between methane and longer chain hydrocarbons.
2. Speciation capability: Similar to methane selectivity, but with additional ability to quantify the primary constituents of the natural gas stream.
3. Thermogenic / biogenic differentiation: Defined as a system that can differentiate between methane from thermogenic sources (i.e., natural gas) and methane from biogenic sources (i.e. cattle, landfills, wastewater treatment, etc.). This could include, but is not limited to, analysis of higher hydrocarbons, carbon isotope analysis, and hydrogen isotope analysis.
4. Continuous measurement: Defined as a system that continuously measures methane (or natural gas) concentration at a site. A system will be deemed to make continuous measurements if it measures the concentration at least once every 10 minutes.
5. Enhanced stability: The increasing concerns about atmospheric levels of methane suggest the need for sensing systems that may have higher precision and stability than required for leak detection. These sensors could be deployed for long-term ambient baseline studies, for “ground verification” of satellite or aerial imaging, or for scientific studies of methane emissions from sources as varied as tundra and alpine lakes.
6. Other functionality: Other enhanced functionality may be of interest. Applications for systems with other enhanced functionality should describe the expected capabilities.

¹⁶ The unrealistically optimistic assumption of maintenance practice is acknowledged. Detecting a leak is only the first step in repairing it. An inspection and repair crew must be mobilized; with mobilization assumed to be prioritized by the magnitude of the leak. Although many leaks can be quickly fixed while the system is pressurized, others may require “blowdown” of piping components.

Enhanced functionality is generally expected to allow additional cost. The number of combinations and permutations prevents a prescriptive specification cost for each of these capabilities and/or combination of capabilities. It is unlikely that applications for systems with a cost of over \$10,000 / year would be competitive, even if they combine multiple categories of enhanced functionality as described above. Applications for systems with enhanced capabilities should document the expected cost of the system; in cases where the enhanced functionality is additive to the system (rather than built into the basic structure of the system and therefore inseparable), it may be useful to describe the costs with and without the enhanced capability.

D. TECHNICAL CATEGORIES OF INTEREST

FOA Applicants must convincingly demonstrate that the proposed system has the potential to meet the detection, measurement, and cost metrics required for widespread deployment. ARPA-E is primarily interested in applications that propose *complete systems* that combine methane detection and measurement with data analytics in order to estimate methane emission rates and location of leaks; the systems should also include provisions for data quality control and digital communication. ARPA-E will also consider for awards transformational *partial solutions* that demonstrate promising new approaches to sensing, but are too early in their development to warrant incorporation into a complete system.

CATEGORY 1: COMPLETE MEASUREMENT SYSTEMS

The primary focus of this FOA is the development of *complete methane measurement systems*, which will include 1) methane emission sensing, 2) methane leakage characterization and data analytics in order to estimate the leakage rates and approximate location of leaks, 3) provisions for data quality control, 4) digital communication, and 5) enhanced functionality.

Technologies of Interest

ARPA-E is particularly interested in applications that incorporate one or more of the following technological advances into their systems solution:

- Reduced-cost TLDAS systems that incorporate either an internal absorption path or an external absorption path;
- Reduced-cost long-path spectroscopic approaches which are configured to provide sensing along one side or potentially around the entire perimeter of a site of interest;
- Hyperspectral approaches with an ambient thermal radiation infrared source;

- Absorption approaches in which the sun or sky provide the reference source;
- Low-cost approaches to mid-infrared (IR) detectors, particularly uncooled detectors;
- Reduced cost and/or increased resolution methane imaging systems, particularly with non-cryogenic detectors;
- Single-point sensors or imaging systems using plasmonic detectors, with particular interest in uncooled plasmonic detectors;
- LIDAR or laser backscatter approaches;
- Mobile sensing from dedicated and non-dedicated ground vehicles and aerial vehicles;
- Highly automated deployment of unmanned aerial vehicles (UAVs), using any combination of single-point, open-path, or imaging detectors;
- Multiple UAVs with long-path sensing, or combinations involving ground-based and aerial sensing;
- Low-cost approaches to mid-IR lasers, including quantum cascade lasers(QCLs), inter-sub-band gap lasers (ISBs), vertical cavity surface emission lasers (VCSELs), or other novel/emerging concepts;
- Other novel concepts and technologies that would be enabling for low-cost gas monitoring; and
- Advanced data analytics that aggregate localized methane measurement with wider area atmospheric and dispersion models in order to estimate regional flux rates, including, but not limited to: 1) GIS integration, 2) reinforcement learning, 3) inversion modeling, 4) micro-climate modeling, and 5) site flux apportionment.

CATEGORY 2: PARTIAL MEASUREMENT SOLUTIONS

The second category of interest is the development of *partial measurement solutions*. Although ARPA-E is primarily interested in applications for complete sensing systems, it is understood that some nascent technologies may be too early in the development process for incorporation into a complete sensing systems. ARPA-E will support the development of such potentially transformational new technologies that could significantly contribute to progress towards the system level objectives in this FOA. Partial solutions are primarily envisioned as advances in detector technology or data analytics.

Technologies of Interest

ARPA-E is particularly interested in partial solutions that include:

- Novel spectrometers;
- Novel electrochemical sensors;
- Critical sensor components, such as reduced cost mid-infrared lasers or detectors;
- Advanced dispersion models;
- Data-processing algorithms; and
- Other technologies that would be enabling for low-cost gas monitoring.

E. TECHNICAL PERFORMANCE TARGETS

As discussed in Section IV.A, this FOA will use a two-stage application approach: 1) Concept Paper Stage and 2) Full Application Stage. After a review of the Concept Papers, Applicants will either be “encouraged” or “not encouraged” to submit a Full Application. Concept papers are expected to provide a description of a system that would be “reasonably expected” to meet the technical performance targets in this section, but are not required to provide detailed supporting analysis. Full Applications will be expected to include a sufficient level of analysis to document that the system can achieve the system level goals of:

- Detecting a leak of 6 SCFH (1 ton/year) on a 10 m x 10 m well pad, within a time period that will allow a 90% reduction of leakage, with a 90% confidence level;
- Validating the data so that the rate of “false positive” indications is no more than 1%;
- Estimating the mass flow rate of each leak, to within 20% error;
- Estimating the location of each leak to within 1 meter;
- Communicating the results wirelessly to a remote receiver;
- Total system cost (amortized capital cost + operating cost) is less than \$3,000 / year for basic functionality; additional cost is allowed for enhanced functionality.

- Finally, if a system with enhanced functionality is proposed, the enhanced functionality must be documented.

Applicants that receive funding under this FOA will be held to development-specific technical milestones and objectives throughout the course of their project. By the end of Year 1, the performer is expected to demonstrate the performance of all system components. By the end of Year 2, the performer is expected to demonstrate the performance of a complete system. By the end of Year 3, the performer is expected to demonstrate the performance of a mature system that can operate over an extended period and demonstrates acceptable levels of sensitivity and with an acceptable number of “false alarms” (false positives).

F. INSTRUCTIONS

CATEGORY 1: COMPLETE MEASUREMENT SYSTEMS

Concept Papers must show a well-justified, realistic potential for a novel technology to meet the technical performance targets summarized in the previous section. In the Concept Paper, applications for Category of Interest 1 (Complete Measurement System) should describe their concept, including all of the following elements:

1. A system level diagram that includes all major system components and displays how they would be deployed on the well site;
2. A discussion of the value of the technology compared to state-of-the-art
3. A description of technical maturity of the concept, highlighting novel and high-risk elements
4. A description of the gas sensing technology, including any novel features, sensitivity, and selectivity;
5. A table which estimates the annual operating cost of the system. This should include a breakdown of the system’s capital cost, annual operating cost, and system life; these should then be combined to estimate the annual cost of measurement.

In the Concept Paper, applications for Category of Interest 1 (Complete Measurement System) should also include all of the following elements, if relevant to the proposed measurement system:

6. A description of any other sensors required (wind speed, wind direction, etc.), including a description of any novel features.

7. A description of the data analytics approach to estimate the leakage rate and approximate location of the leak.
8. A description of the approach to data quality control, with the intent of maximizing detection while minimizing reporting of false positive alarms.
9. A description of the approach to wireless digital communication of results to a remote receiver.
10. A description of the approach to any “enhanced capability”, which may include: methane selectivity, speciation capability, thermogenic / biogenic differentiation, continuous measurement, enhanced stability, etc.

CATEGORY 2: PARTIAL MEASUREMENT SYSTEMS

In the Concept Paper, applications for Category of Interest 2 (Partial Measurement Solutions) should describe their partial solution, including the following elements:

1. A description of the partial solution proposed;
2. A discussion of how the partial solution would be enabling to the overall goals of the MONITOR program;
3. A discussion of the value of the technology compared to state-of-the-art;
4. A description of technical maturity of the concept, highlighting novel and high-risk elements;
5. A table that estimates the annual operating cost of a complete system that utilizes the partial solution; this will require specification of a hypothetical complete system that takes advantage of the partial solution. This should include a breakdown of the system’s capital cost, annual operating cost, and system life; these should then be combined to estimate the annual cost of measurement. If a partial solution does not support this direct cost estimation, the benefits and their potential impact on the cost of measurement should be discussed as completely as possible; and
6. A discussion of any “enhanced capability” that the solution would provide to a measurement system.

G. APPLICATIONS SPECIFICALLY NOT OF INTEREST

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

- Applications that fall 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 technologies:
 - UAV platform development (development of detector systems that are intended for deployment from UAV platforms are of interest, but development of the UAV platform itself is not);

- Routine application of preexisting technology;
- Studies that are primarily focused on documenting natural gas leakage or on “reconciling top-down and bottom-up” data discrepancies; and
- Economic and/or policy studies related to methane leakage.

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 12-18 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 in September 2014, 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 extremely creative but partial solutions. 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 may establish more than one budget period for each award and fund only the initial budget period(s). Applicants are not guaranteed funding beyond the initial budget period(s). Before the expiration of the initial budget period(s), ARPA-E may perform a down-select among different recipients and provide additional funding only to a subset of recipients.

B. ARPA-E FUNDING AGREEMENTS

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

Congress directed ARPA-E to "establish and monitor project milestones, initiate research projects quickly, and just as quickly terminate or restructure projects if such milestones are not achieved."¹⁷ 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.¹⁸

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/?q=project-guidance/award>.

2. FUNDING AGREEMENTS WITH FFRDCs, GOGOs, AND FEDERAL INSTRUMENTALITIES¹⁹

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

When a FFRDC is the *lead organization* for a Project Team, ARPA-E executes a funding agreement directly with the FFRDC and a single, separate Cooperative Agreement with the rest

¹⁷ U.S. Congress, Conference Report to accompany the 21st Century Competitiveness Act of 2007, H. Rpt. 110-289 at 171-172 (Aug. 1, 2007).

¹⁸ The Prime Recipient is the signatory to the funding agreement with ARPA-E.

¹⁹ DOE/NNSA GOGOs are not eligible to apply for funding, as described in Section III.A of the FOA.

of the Project Team. Notwithstanding the use of multiple agreements, the FFRDC is the lead organization for the entire project, including all work performed by the FFRDC and the rest of the Project Team.

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

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

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

In general, TIAs require a cost share of 50%. See Section III.B.3 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 (regardless of the type of funding agreement) 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 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/?q=project-guidance/award>). ARPA-E Program Directors visit each Prime Recipient at least twice per year, and hold periodic meetings, conference calls, and webinars with Project Teams. ARPA-E Program Directors may modify or terminate projects that fail to achieve predetermined technical milestones and deliverables.
- ARPA-E reviews reimbursement requests for compliance with applicable Federal cost principles and Prime Recipients' cost share obligations. Upon request, Prime Recipients are required to provide additional information and documentation to support claimed expenditures. Prime Recipients are required to comply with agency-specific and programmatic requirements. Please refer to Section VI.B.3-4 of the FOA for guidance on proof of cost share commitment and cost share reporting.
- ARPA-E works closely with Prime Recipients to facilitate and expedite the deployment of ARPA-E-funded technologies to market. ARPA-E works with other Government agencies and nonprofits to provide mentoring and networking opportunities for Prime Recipients. ARPA-E also organizes and sponsors events to educate Prime Recipients about key barriers to the deployment of their ARPA-E-funded technologies. In addition, ARPA-E establishes collaborations with private and public entities to provide continued support for the development and deployment of ARPA-E-funded technologies.

- ARPA-E may fund some projects on a fixed-obligation basis.

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,²⁰ as the lead for a Project Team,²¹ or as a member of a Project Team.

2. DOMESTIC ENTITIES

For-profit entities, educational institutions, and nonprofits²² 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.

²⁰ A Standalone Applicant is an Applicant that applies for funding on its own, not as part of a Project Team.

²¹ 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.

²² 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 Form, which is submitted with the Full Application. Please refer to the Business Assurances Form for guidance on the content and form of the request.

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 SHARING²³

Applicants are bound by the cost share proposed in their Full Applications. In the Business Assurances Form accompanying the Full Application, Applicants must provide written assurance

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

of their cost share commitments. Please refer to the Business Assurances Form available on ARPA-E eXCHANGE (<https://arpa-e-foa.energy.gov>) for additional guidance.

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 Cost²⁴ as cost share, except as provided in Sections III.B.2 or III.B.3 below.²⁵

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).

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

3. REDUCED COST SHARE REQUIREMENT

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

- A domestic educational institution or domestic nonprofit applying as a Standalone Applicant is required to provide at least 5% of the Total Project Cost as cost share.
- Project Teams composed exclusively of domestic educational institutions, domestic nonprofits, and/or FFRDCs are required to provide at least 5% of the Total Project Cost as cost share.
- Project Teams where domestic educational institutions, domestic nonprofits, and/or FFRDCs perform greater than or equal to 80%, but less than 100%, of the total work under the funding agreement (as measured by the Total Project Cost) are required to provide at least 10% of the Total Project Cost as cost share. 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

²⁴ 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.

²⁵ Energy Policy Act of 2005, Pub.L. 109-58, sec. 988.

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. ARPA-E requires all recipients to contribute cost share in proportion with each submitted invoice over the life of the program.

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) funds²⁶ to meet their cost share obligations under cooperative agreements. However, Project Teams may use IR&D funds to meet their cost share obligations under Technology investment Agreements.

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

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

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

7. COST SHARE CONTRIBUTIONS BY FFRDCs AND GOGOS

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

8. COST SHARE VERIFICATION

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

²⁶ As defined in Federal Acquisition Regulation Section 31.205-18.

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

C. OTHER

1. COMPLIANT CRITERIA

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.G of the FOA, are deemed nonresponsive and are not reviewed or considered.

3. LIMITATION ON NUMBER OF APPLICATIONS

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

IV. APPLICATION AND SUBMISSION INFORMATION

A. APPLICATION 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 and program policy factors in Sections V.A.1 and V.B.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 noncompliant.

5. “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, perform a “down-select” of Full Applications. Through a down-select, 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. ARPA-E may select or not select a Full Application for award negotiations. ARPA-E may also postpone a final selection determination on one or more Full Applications until a later date, subject to availability of funds and other factors. ARPA-E will enter into award negotiations only with selected Applicants.

Applicants are promptly notified of ARPA-E’s 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, Business Assurances Form, and Other Sources of Funding Disclosure Form. Sample responses to the Other Sources of Funding Disclosure Form and Business Assurances 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 is mandatory (i.e. in order to submit a Full Application, a compliant and responsive Concept Paper must have been submitted) and must conform to the following requirements:

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

ARPA-E will not review or consider noncompliant 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.

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

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

SECTION	PAGE LIMIT	DESCRIPTION
Technology Description	2 pages maximum	<ul style="list-style-type: none"> • Applicants should indicate whether they are proposing a complete measurement system or a partial measurement solution • Applicants for Category of Interest 1 (Complete Measurement System) should describe: <ul style="list-style-type: none"> ○ The proposed system solution, including its basic operating principles and how it is unique and innovative; ○ The gas sensing technology, including any novel features, sensitivity, and selectivity; ○ Any other sensors required (wind speed, wind direction, etc.), including a description of any novel features; ○ The system’s target level of performance (Applicants should provide technical data or other support to show how the proposed targets could be met); ○ The current state-of-the-art related to their systems approach, including key shortcomings, limitations, and challenges; ○ How the proposed system will overcome the shortcomings, limitations, and challenges; ○ The technical maturity of the system concept, highlighting novel and high-risk elements; ○ The data analytics approach to estimate the leakage rate and approximate location of the leak; ○ The approach to data quality control; ○ The approach to wireless digital communication; and ○ A description of the approach to any “enhanced capability”. • Applicants for Category of Interest 2 (Partial Measurement Solutions) should describe: <ul style="list-style-type: none"> ○ The partial solution proposed, including its basic operating principles and how it is unique and innovative; ○ How the partial solution would be enabling to the overall goals of the MONITOR program; ○ The technology’s target level of performance (Applicants should

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).

		<p>provide technical data or other support to show how the proposed targets could be met);</p> <ul style="list-style-type: none"> ○ The current state-of-the-art related to the technology, including key shortcomings, limitations, and challenges; ○ How the proposed technology will overcome the shortcomings, limitations, and challenges; ○ The technical maturity of the concept, highlighting novel and high-risk elements; and ○ Any “enhanced capability” that the partial solution would provide to a measurement system.
System Diagram	1 page maximum	<ul style="list-style-type: none"> ● Applicants for Category of Interest 1 (Complete Measurement System) should provide a system level diagram that includes all major system components and displays how they would be deployed on the well site. ● Applicants for Category of Interest 2 (Partial Measurement Solutions) should provide a system level diagram of a hypothetical complete system that takes advantage of the partial solution.
Cost Table	1 page maximum	<ul style="list-style-type: none"> ● Applicants for Category of Interest 1 (Complete Measurement System) should provide a table which estimates the annual operating cost of the system. This should include a breakdown of the system’s capital cost, annual operating cost, and system life; these should then be combined to estimate the annual cost of measurement. ● Applicants for Category of Interest 2 (Partial Measurement Solutions) should provide a table that estimates the annual operating cost of a complete system that utilizes the partial solution; this will require specification of a hypothetical complete system that takes advantage of the partial solution. This should include a breakdown of the system’s capital cost, annual operating cost, and system life; these should then be combined to estimate the annual cost of measurement. If a partial solution does not support this direct cost estimation, the benefits and their potential impact on the cost of measurement should be discussed as completely quantitatively as possible
Addendum	2 pages maximum	<ul style="list-style-type: none"> ● Applicants may provide graphs, charts, or other data to supplement their Technology Description. ● Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: <ul style="list-style-type: none"> ○ Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan; ○ Whether the Applicant has prior experience which demonstrates an ability to perform R&D tasks of similar risk and

		<p>complexity;</p> <ul style="list-style-type: none">○ Whether the Applicant has worked together with its teaming partners on prior projects or programs; and○ Whether the Applicant has adequate access to equipment and facilities necessary to accomplish the R&D effort and/or clearly explain how it intends to obtain access to necessary equipment and facilities.
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D. CONTENT AND FORM OF FULL APPLICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]

E. CONTENT AND FORM OF REPLIES TO REVIEWER COMMENTS

[TO BE INSERTED BY FOA MODIFICATION IN JULY 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 JULY 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.

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).

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 State of the Art* (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 in one or more energy-related fields;
- The extent to which the Applicant demonstrates a profound understanding of the current state-of-the-art and presents an innovative technical approach that significantly improves performance relative to the current state-of-the-art; 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 extent to which the proposed approach is unique and innovative;
- The feasibility of the proposed work;
- The extent to which the Applicant proposes a sound technical approach to accomplish the proposed R&D objectives;
- The extent to which project outcomes and deliverables are clearly defined; and

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

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

Impact of the Proposed Technology Relative to State of the Art	50%
Overall Scientific and Technical Merit	50%

2. CRITERIA FOR FULL APPLICATIONS

[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]

3. CRITERIA FOR REPLIES TO REVIEWER COMMENTS

[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]

B. REVIEW AND SELECTION PROCESS

1. PROGRAM POLICY FACTORS

[TO BE INSERTED BY FOA MODIFICATION IN JULY 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.

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).

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 JULY 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. Due to the anticipated volume of applications, ARPA-E is unable to provide feedback on Concept Papers.

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 or the Applicant. 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 JULY 2014]

B. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]

C. REPORTING

[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]

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).

VII. AGENCY CONTACTS

A. COMMUNICATIONS WITH ARPA-E

Upon the issuance of a FOA, ARPA-E personnel are prohibited from communicating (in writing or otherwise) with Applicants regarding the FOA. This “quiet period” remains in effect until ARPA-E’s public announcement of its project selections.

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

- 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.

*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).*

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

- The rejection of a 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).

J. ANNUAL COMPLIANCE AUDITS FOR FOR-PROFIT ENTITIES

[TO BE INSERTED BY FOA MODIFICATION IN JULY 2014]

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).