

**FINANCIAL ASSISTANCE  
FUNDING OPPORTUNITY ANNOUNCEMENT**



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

**Traveler Response Architecture using Novel Signaling for Network  
Efficiency in Transportation (TRANSNET)**

Announcement Type: ~~Modification 02~~ **Modification 03**

Funding Opportunity No. DE-FOA-0001199

CFDA Number 81.135

<b>FOA Issue Date:</b>	November 10, 2014
<b>First Deadline for Questions to <a href="mailto:ARPA-E-CO@hq.doe.gov">ARPA-E-CO@hq.doe.gov</a>:</b>	5 PM ET, December 15, 2014
<b>Submission Deadline for Concept Papers:</b>	5 PM ET, December 22, 2014
<b>Second Deadline for Questions to <a href="mailto:ARPA-E-CO@hq.doe.gov">ARPA-E-CO@hq.doe.gov</a>:</b>	5 PM ET, April 7, 2015
<b>Submission Deadline for Full Applications:</b>	5 PM ET, April 14, 2015
<b>Submission Deadline for Replies to Reviewer Comments:</b>	5 PM ET, May 28, 2015
<b>Expected Date for Selection Notifications:</b>	June 2015
<b>Total Amount to Be Awarded</b>	Approximately \$10 million, subject to the availability of appropriated funds.
<b>Anticipated Awards</b>	ARPA-E may issue one, multiple, or no awards under this FOA. Awards may vary between \$250,000 and \$5 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](mailto:ARPA-E-CO@hq.doe.gov) (with FOA name and number in subject line); see FOA Sec. VII.A.  
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## MODIFICATIONS

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

Mod. No.	Date	Description of Modifications
01	11/25/2014	<ul style="list-style-type: none"> <li>Updated Section Reference of “Applications Specifically Not of Interest,” from I.F to I.E. See Section III.C.2 of the FOA.</li> </ul>
02	3/03/2015	<ul style="list-style-type: none"> <li>Inserted certain deadlines, including the deadlines for submitting questions and Full Applications. See Cover Page and Required Documents Checklist.</li> <li>Inserted information concerning incentives. See Section I.C of the FOA.</li> <li>Inserted information concerning “Characteristics of the System Model”. See Table 1 in Section I.C of the FOA.</li> <li>Clarified “PERSONALIZED DATA AND PARTICIPATION IN CONROL STRUCTURE”, see Table 2 in Section I.C of the FOA.</li> <li>Updated funding agreement start date, see Section II. A of the FOA.</li> <li>Provided C.F.R. citation, see Section II.B.3 of the FOA.</li> <li>Clarified Cost Sharing, see Section III.B of the FOA.</li> <li>Revised the following sections of the FOA to provide guidance on required application forms and the content and form of Full Applications and Replies to Reviewer Comments: Required Documents Checklist and Sections IV.D, IV.E, IV.G of the FOA. Applicants are strongly encouraged to use the templates provided on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>).</li> <li>Inserted criteria that ARPA-E will use to evaluate Full Applications. See Section V.A.2 of the FOA.</li> <li>Inserted criteria that ARPA-E will use to evaluate Replies to Reviewer Comments in Section V.A.3 of the FOA.</li> <li>Inserted Program Policy Factors. See Section V.B.1 of the FOA.</li> <li>Inserted information concerning Full Application Notifications. See Section VI.A.3 of the FOA.</li> <li>Inserted Administrative and National Policy Requirements. See Section VI.B of the FOA.</li> <li>Inserted Reporting Requirements. See Section VI.C of the FOA.</li> <li>Inserted information concerning Class Waivers. See Section VIII.F of the FOA.</li> <li>Inserted regulations applicable to resulting awards. See Section VIII.I of the FOA.</li> </ul>
03	3/24/2015	<ul style="list-style-type: none"> <li>Clarified Model Performance, See Table 1 in Section I.C of the FOA.</li> </ul>

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## **REQUIRED DOCUMENTS CHECKLIST**

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

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

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

SUBMISSION	COMPONENTS	OPTIONAL/ MANDATORY	FOA SECTION	DEADLINE
Concept Paper	<ul style="list-style-type: none"> <li>Each Applicant must submit a Concept Paper in Adobe PDF format by the stated deadline. The Concept Paper must not exceed 4 pages in length and must include the following: <ul style="list-style-type: none"> <li>Concept Summary</li> <li>Innovation and Impact</li> <li>Proposed Work</li> <li>Team Organization and Capabilities</li> </ul> </li> </ul>	Mandatory	IV.C	5 PM ET, December 22, 2014
Full Application	<p>Each Applicant must submit a Technical Volume in Adobe PDF format by the stated deadline. Applicants may use the Technical Volume template available on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>). The Technical Volume must include the following:</p> <ul style="list-style-type: none"> <li>Executive Summary (1 page max.)</li> <li>Sections 1-5 (30 pages max.) <ul style="list-style-type: none"> <li>1. Innovation and Impact</li> <li>2. Proposed Work</li> <li>3. Team Organization and Capabilities</li> <li>4. Technology to Market</li> <li>5. Budget</li> </ul> </li> <li>Bibliographic References (no page limit)</li> <li>Personal Qualification Summaries (each PQS limited to 3 pages in length, no cumulative page limit)</li> <li>The Technical Volume must be accompanied by: <ul style="list-style-type: none"> <li>SF-424 (no page limit, Adobe PDF format);</li> <li>Budget Justification Workbook/SF424A (no page limit, Microsoft Excel format)</li> <li>Summary for Public Release (250 words max., Adobe PDF format);</li> <li>Summary Slide (1 page limit, Microsoft PowerPoint format) – Applicants may use the Summary Slide template available on ARPA-E eXCHANGE (<a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a>); and</li> <li>Completed and signed Business Assurances &amp; Disclosures Form (no page limit, Adobe PDF format).</li> </ul> </li> </ul>	Mandatory	IV.D	5 PM ET, April 14, 2015
Reply to Reviewer Comments	<ul style="list-style-type: none"> <li>Each Applicant may submit a Reply to Reviewer Comments in Adobe PDF format. This submission is optional. Applicants may use the Reply to Reviewer Comments</li> </ul>	Optional	IV.E	5 PM ET, May 28, 2015

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

	template available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ). The Reply may include:		
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- Up to 2 pages of text; and
- Up to 1 page of images.

## **I. FUNDING OPPORTUNITY DESCRIPTION**

### **A. AGENCY OVERVIEW**

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

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

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

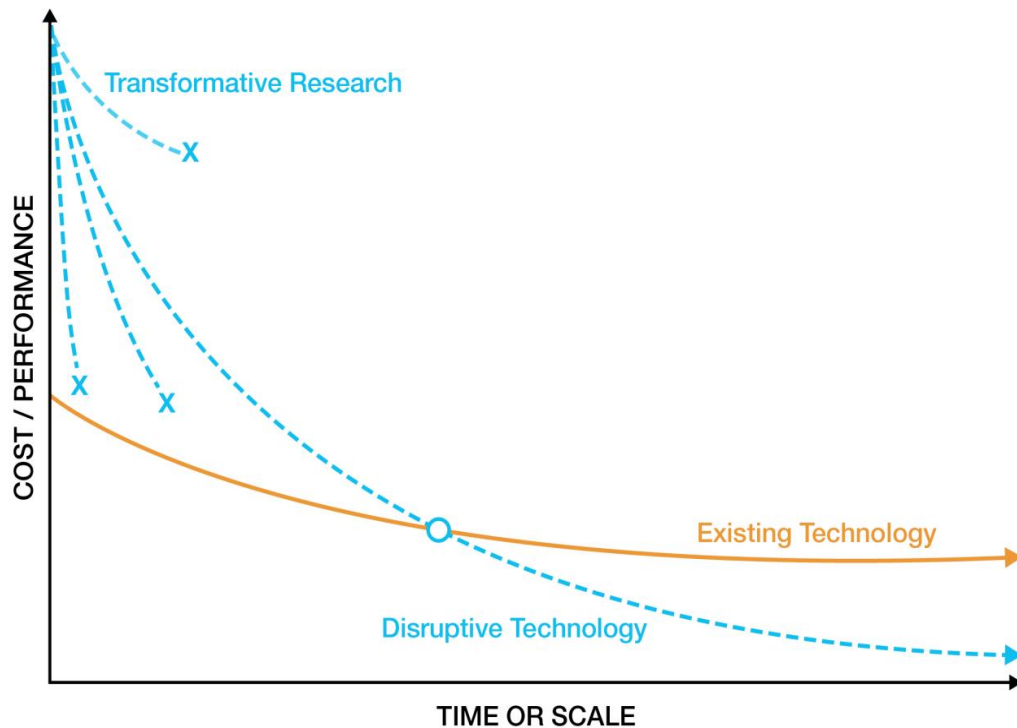
1. Enhance the economic and energy security of the United States through the development of energy technologies that result in:
  - a. reductions of imports of energy from foreign sources;
  - b. reductions of energy-related emissions, including greenhouse gases; and
  - c. improvement in the energy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

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



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

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



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

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

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

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

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

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

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

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

## **B. PROGRAM OVERVIEW**

The Traveler Response Architecture using Novel Signaling for Network Efficiency in Transportation (TRANSNET) program seeks solutions that minimize energy consumption in America's surface transportation network through the use of network control mechanisms that operate through personalized signals directed at individual travelers.

In 2013, the United States used more than 25% of its energy supply for the purpose of moving people and goods from one place to another, i.e., in the transportation sector.<sup>1</sup> Even modest improvements that reduce transportation energy consumption can reduce energy imports and greenhouse gas emissions, two of ARPA-E's primary goals. To date, technologies directed at transportation have focused primarily on the diversification of energy supplies (e.g., the production of alternative liquid fuels and electrification) or on improvements in vehicle fuel efficiency (e.g., combustion efficiency, weight reduction, and aerodynamic design).<sup>2</sup> The TRANSNET program takes an alternative, complementary approach through the development of technologies that target both the factors that drive energy consumption and the overall energy efficiency of personal transportation, without changing the mechanical efficiency of each mode (car, bus, train, etc.) within the network.

The time is ripe for this new approach. Today, personal transportation is entering a period of rapid change, enabled by the introduction of new technologies. Such technologies apply not only to the vehicles themselves (e.g., autonomous/semiautonomous vehicles, vehicle-to-vehicle (V2V)/vehicle-to-infrastructure (V2I) communications, and electric/natural gas fueled vehicles), but also to a number of approaches that enable transportation information to be collected and disseminated by wireless communication and the Internet (e.g., Waze, Uber, Zipcar, and Lyft, as well as social networks such as Facebook, Twitter, etc.). How can these innovative technologies be used to reduce energy use in transportation networks? The answer is not completely clear. But ARPA-E envisions significant opportunities for new and emerging technologies, with deliberate and thoughtful development, to create a framework for a practical system with real-time response to make energy efficiency an integral part of the optimized transportation network of the future.

In the context of this opportunity, several descriptive and common terms require accurate definitions, which may be found in the Technical Glossary in Section I.D of the FOA. Please review these definitions so that the intent of this funding opportunity is clear.

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<sup>1</sup> In 2013, the US consumed 97.534 quadrillion BTUs (Quads) of energy, 26.990 Quads of this were associated with transportation. Source: DOE/EIA-0035 (2014/07), U. S. Energy Information Agency, Monthly Energy Review, July 2014. 17 August 2014. <http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf>

<sup>2</sup> For example, see the ARPA E programs Electrofuels, BEEST, PETRO, REMOTE, RANGE, MOVE, and METALS. <http://arpa-e.energy.gov/?q=arpa-e-site-page/view-programs>

### ***Summary of the Opportunity***

ARPA-E believes that the transportation network can be made more efficient, without substantial investment in new infrastructure, improvements in modal efficiency, or perceptible reduction in either the quality-of-service or the reliability of the system. While the size of the impact is difficult to quantify precisely, given the human element, significant energy is wasted in personal transportation: Occupancy is only 40% of nominal capacity for passenger vehicles,<sup>3</sup> driving styles contribute to a 45% reduction in the on-road fuel economy (per driver),<sup>4</sup> and congestion (which is related to non-optimal route choice) increases the energy used in transportation up to 33%,<sup>5</sup> even before soft factors such as lost productivity and lower quality of life are accounted for.

Applicants are challenged to develop mechanisms for individual travelers that both signal and guide them toward improvement of the energy efficiency of the transportation network in multimodal urban areas. Because a purely experimental, complete analysis of the transportation network would be prohibitively expensive and time consuming, ARPA-E seeks the development of simulated network control models of energy use in personal transportation, based on real-world data, that incorporate personalized signaling and guiding mechanisms. A suitable model will need not only to describe the current state of the personal transportation network but also to predict the impact of changes to the network, both from travelers' choices, such as mode and departure time, and from network changes, such as those that result from incidents and lane closures. The model must also be robust with respect to inaccuracies that stem from incomplete and noisy sensor data. Optimization will require development of a high fidelity system model that allows guidance and control hypotheses to be tested, refined, or discarded in full view of this uncertainty. These hypotheses will be embodied through simulation to achieve ARPA-E's core objective, a control architecture that enables the practical network control through personalized guidance. The design of this control architecture defines the central challenge of the TRANSNET program.

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<sup>3</sup> The National Highway Transportation Survey reports average occupancy of 1.67 persons over all types of trips. The average number of seats is assumed to be 4.

<sup>4</sup> Sivak, M. & Schoettle, B. "Eco-driving: Strategic, tactical, and operational decisions of the driver that influence vehicle fuel economy", Transport Policy 22 (2012) 96–99. See also LeBlanc, D., Sivak, M., and Bogard, S. "Using Naturalistic Driving Data to Assess Variations in Fuel Efficiency among Individual Drivers" University of Michigan Transportation Institute Report UMTRI-2010-34, December 2010.

<sup>5</sup> This is an approximation of the maximum effect. See Roughgarden, T., "The Price of Anarchy in Games of Incomplete Information", <http://theory.stanford.edu/~tim/papers/inc.pdf>.

### ***Challenges in Signaling and Control Mechanisms***

In today's transportation network, guidance and control mechanisms are, for the most part, impersonal. For example, in private vehicles, every traveler experiences speed limits, traffic signals, and tolls identically.<sup>6</sup> However, over the past ten years, digital technology has altered the landscape dramatically. Personal, wireless technologies combined with low-cost sensors are ubiquitous and these technologies possess an intrinsic transformational potential<sup>7</sup> to change how to move people from one place to another efficiently. Software advances complement these hardware and communications network technologies, fueling computational approaches that help process the data to both predict and influence the choices made by individuals.<sup>8</sup>

Here, we seek the development of a control architecture that acts to reduce energy use in transportation through personalized signaling, guidance, and control mechanisms. This architecture is subject to the physical constraints imposed by existing infrastructure (e.g., highways, arterials, rail lines, etc.). Because such a structure also needs to be practical for, and implemented by, travelers themselves, it must not reduce either the individual's quality-of-service or the network's system reliability.

Figure 2 shows energy use at the level of the individual traveler (expressed both as total energy consumed, in quadrillion BTUs or quads, and in consumer-friendly, miles-per-gallon-equivalent per traveler, MPGe). Personal transportation is dissected by mode, and plotted in order of increasing efficiency. We see that the least efficient choices, cars and trucks, consume most of the energy in personal transportation. Further, we see that, on a per person basis, all forms of road transportation are less efficient than air or rail; this is largely the consequence of occupancy, which is about 33% for cars and trucks, and 30-40% for city buses,<sup>9</sup> but exceeds 80% for commercial airlines. The relatively low occupancy of Amtrak (about 25%) is more than offset

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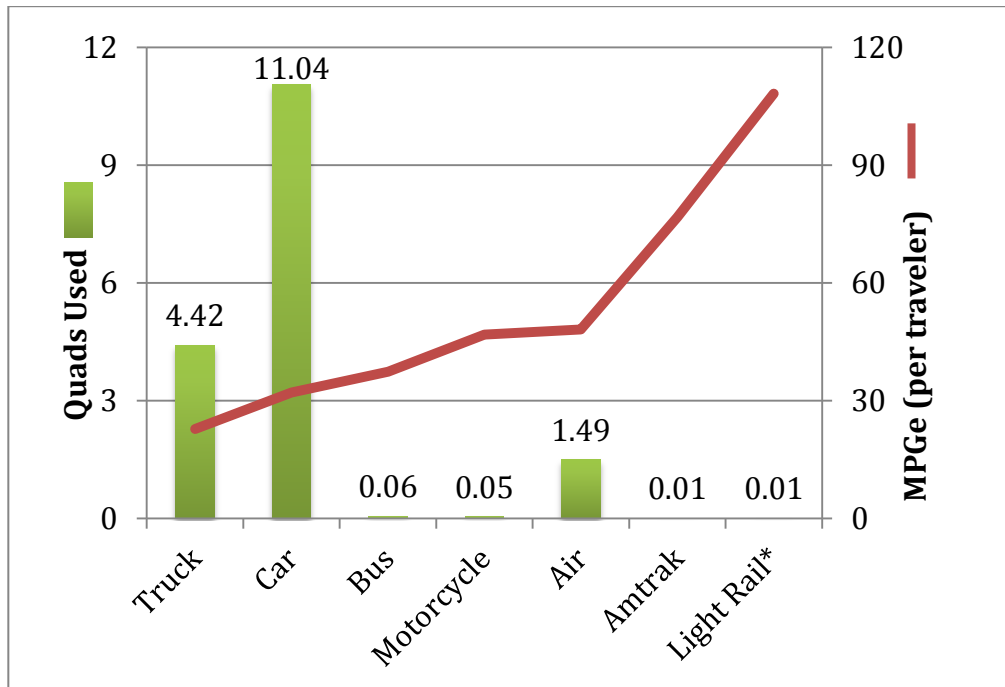
<sup>6</sup> Note that even rudimentary differentiation by vehicle class can be a remarkably effective control mechanism. For example, the use of single-occupancy HOV lane stickers in California for alternative vehicles is considered to have been successful in reducing both emissions and congestion, with sticker-bearing Priuses valued thousands of dollars more than their sticker-free siblings.

<sup>7</sup> In 2014, the International Telecommunications Union reported that the cellular telephone market is approaching saturation, that is, one phone per person over the entire planet! [See <http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.] In this same report, mobile broadband adoption appears to trail cellular adoption by about 10 years. Assuming these trends persist, nearly every person on the planet will be connected to the Internet via wireless devices within the next decade.

<sup>8</sup> Lohr, "Sizing Up Big Data, Broadening Beyond the Internet", New York Times Blog. August 23, 2014. <http://bits.blogs.nytimes.com/2013/06/19/sizing-up-big-data-broadening-beyond-the-internet/> See also Thaler, R. H. & Sunstein, C. R. "Nudge: Improving Decisions About Health, Wealth, and Happiness", Penguin, 2009, and Ariely, D. "Predictably Irrational: The Hidden Forces That Shape Our Decisions", HarperCollins, 2008.

<sup>9</sup> The average occupancy of a city bus is about 9 (Table 2.12, Transportation Energy Data Book, Edition 33, 2014, <http://cta.ornl.gov/data/index.shtml>), the average capacity of a city bus is about 30 (seated).

by the extraordinary energy efficiency of rail,<sup>10</sup> a factor that is also captured in Light Rail efficiency.<sup>11</sup>



**Figure 2:** Energy used in personal transportation by mode and efficiency. For each mode, values are based on CY2011. Except for Light Rail, data is derived from USDOT RITA BTS “National Transportation Statistics”, 2014 Tables 4-20, 4-21, 4-22, 4-24, and 4-26. MPGe is calculated based on the energy used and the energy content of gasoline, rather than the customary fuels used by each mode of transportation. \*For Light Rail, value is derived from the National Transit Database (<http://www.ntdprogram.gov/>) as a ratio of total passenger miles to energy consumed, from Tables 17 and 19 respectively.

Of course, different modes are not ideal substitutes for one another, and mode choice is only one factor that influences transportation energy efficiency. For a large number of travelers, while shifting to mass transit would lead to energy savings, it also provides lower quality-of-service. Figure 2 also illustrates the importance, in energy terms, of targeting individual travelers. Today, travelers operate more or less independently under a control architecture comprised of uniformly displayed signals and controls and highly variable drivers. Cars and trucks are wasteful, but they are flexible modes that operate at low occupancy, addressing unique personal needs for transportation. In the TRANSNET program, we seek a way to leverage this feature of today’s transportation network to provide both better control and improved network energy efficiency.

<sup>10</sup> This is derived from the limited access character of railroad, which results in fewer stops, and the low rolling friction of steel-on-steel. For more information, see the Association of American Railroads at <https://www.aar.org/keyissues/Pages/Energy-And-Environment.aspx>. The rolling resistance of automobile tires is approximately 15-fold higher than rail.

<sup>11</sup> For light rail, which is exclusively electric-powered, energy units were converted as 1 kWh = 3,412 Btu. This does not consider system losses in electrical generation; if those losses are considered, Light Rail efficiency drops to a less dramatic 34.9 MPGe.

Technologies based on significantly improved computational capabilities, personalized signals, and control mechanisms will be needed in order to realize this opportunity. The strategic advantage of network control architecture lies in its ability to adjust both the schedule and routing of individual elements, such that optimization becomes both possible and predictable. In transportation networks, the components of such a control architecture are already in place:

- Microscopic simulation models at different scales have been<sup>12</sup>, or are being, developed<sup>13</sup> but dynamic, personalized signaling, guidance and control mechanisms have not been considered.
- The behavior of controlled dynamical systems can be predicted in advance of experiment using modern computational methods (Computational Fluid Dynamics, for example), so modeling and flow control in transportation networks needn't be a purely descriptive exercise.
- Model based network optimization is widely accepted practice, for example, in power systems and in air traffic control.

Consequently, ARPA-E believes that there are components in related fields of investigation that provide an opportunity for innovation, if these fields can be successfully integrated and the combined technology reduced to practice.

The first step is to develop a high fidelity system-level model of an urban multimodal network. This is expected to be a new effort that may build upon existing transportation models, which in many cases treat individual travelers as agents whose choices are independent, made largely before travel commences. The result of these uncorrelated choices is not optimal for the whole network, as first noted by economist A. C. Pigou in 1920.<sup>14</sup> The model must answer the central question: "What fraction of travelers must communicate directly, and in real time, both with each other and with a control network, to provide significant overall energy savings?" Such a model must not only take into account what happens when travelers communicate and the system is optimized based on personalized signaling and network control mechanisms, but also must be able to be grounded in (and tested by) real world data.

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<sup>12</sup> Treiber, M. & Kesting, A. "Traffic Flow Dynamics", Springer, 2013.

<sup>13</sup> There are a number of academic and private modeling efforts. See for example "POLARIS", <https://www.tracc.anl.gov/index.php/polaris>, a project under development at Argonne National Laboratories with funding from FHWA, and Zhang et al "Integrating an Agent-Based Travel Behavior Model with Large-Scale Microscopic Traffic Simulation for Corridor-Level and Subarea Transportation Operations and Planning Applications", J. Urban Plann. Dev. 2013.139:94-103.

<sup>14</sup> Pigou, A. C., *The Economics of Welfare*, Macmillan, 1920. A pithy, transportation-relevant treatment is given in Roughgarden, T. "Selfish Routing and the Price of Anarchy", MIT Press, 2005, Chapter 1.



As a second, more important step, personalized signaling and guidance strategies need to be embodied in a control architecture that reflects the incomplete and inaccurate sampling environment of the physical world. This architecture is intended to provide the basis for implementing personalized signaling and guidance in actual urban environments.

### ***Challenges in Measurement***

Particularly with the widespread deployment of low cost sensors, the energy used in transportation can certainly be measured with a high degree of accuracy—there is little technological challenge implicit in the development of new energy meters at the level of the mode (car, bus, train, etc.). In practice, however, energy use data is not collected effectively or at the level of the individual traveler, and conceptualizing the problem from the traveler’s viewpoint exposes several technological shortfalls. The problem can be reduced to one of mapping the energy used by the mode to the energy used by the traveler.

To illustrate this problem, consider an individual commuter in the Washington (DC) metropolitan area, an area with many different transportation options. Suppose, for the purpose of illustration, that our traveler is a commuter who lives in the suburbs, but works downtown, and uses public transit to get to work. On a particular day, our traveler drives from home to the transit station, parks, rides the DC Metro rail system into work, attends a business lunch across town, and returns home by reversing the steps of the morning commute. During the first leg of the journey, our traveler drives (alone) from home to the train station. Modern automobiles have computer-controlled fuel injectors, such that the precise amount of fuel (and hence energy) used by the vehicle is readily measured, from data available on the On-Board Diagnostics (OBD-II) port that has been mandated in all new vehicles since 1996. During the second leg of the journey, our traveler boards the DC Metro. While the total amount of energy used by the train is certainly known, this data and the *occupancy* of the train is difficult to obtain by any individual traveler, especially in real time. The energy used by the traveler is, of course, the *pro rata* portion of the total energy used by the train, in other words, the total energy use for the mode divided by the occupancy. Next, our traveler arrives at work, ending the first part of the transportation day. Then, at lunch, our traveler has a cross-town business lunch and decides to take a taxi both ways. The OBD-II sensor in the cab can certainly provide precise energy use data to our traveler, with suitable connectivity, but there are additional unknowns. For example, how far away did the cab need to travel (without a passenger) to pick up our traveler?<sup>15</sup> Finally, the energy used in reversing each of these steps is not equivalent to that used in the forward steps, even though the distances traveled may be identical, due to factors such as modal occupancy, local traffic, and parking.

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<sup>15</sup> Personalized controls may eventually seek to reward specific choices made by travelers who are also drivers, so, another question is, can the technology differentiate passenger and driver? Note that the traveler occupancy of the cab is 0 when it is not engaged. The traveler and the driver are separate in this case, unlike the first car trip. This example exposes data collection problems associated with vehicle to passenger/driver communication.



Collecting data at the level of the individual traveler is another part of this conceptually simple yet technically challenging problem, even though the overall answers are known: Average daily traffic speeds, fuel sales, vehicle miles traveled, transit ridership, and taxi trips are all tabulated (in principle). But, these data are not without issue: In the real world, sensor reliability and manual reporting reduces the quality of the data.<sup>16</sup> Personal data collection is, of course, treacherous due to privacy concerns,<sup>17</sup> such that it is unrealistic to expect the availability of a comprehensive data set to support any real world system model or control architecture. Fortunately, we believe that the proliferation of sensors in recent years will oversample the transportation network, and redundant data sources (from different sensors) will serve to mitigate at least some of the noise and inconsistency.<sup>18</sup> Regardless, the knowledge of aggregate numbers allows various models to be calibrated using real world data.

### C. PROGRAM OBJECTIVES AND STRUCTURE

This funding opportunity solicits the development and testing of new network optimization approaches entirely in a simulation environment. The primary objectives are twofold: (1) To demonstrate that energy efficiency gains are possible through implementable control architectures, and (2) To identify key technology gaps that limit such implementation. A second phase program (if pursued) would involve real-world validation of the system model and trial implementation of the network control architecture developed in the initial phase of TRANSNET. **However, a second phase will only be considered if significant positive impact is demonstrated during the course of the awards made through this FOA.**

Each applicant must develop two interdependent modules: (1) a system model and (2) a control architecture. A system model is a fully parameterized model of a multimodal urban personal transportation network, and must functionally represent the real world. A control architecture is a detailed, comprehensive approach to network control and will be implemented within the system model in the same way it could be implemented in the real world, with the objective to reduce system level energy use by providing signals to individual travelers.

Each applicant should clearly define the incentive structure and the nature of the individual choices to be influenced by the incentives. The applicant must clearly describe how the control architecture will identify the preferred choices and how the response to incentivizing those choices will be introduced as changes in the model system.

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<sup>16</sup> See for example El Faouzi, NE et al. "Data fusion in intelligent transportation systems: Progress and challenges – A survey", Information Fusion 12 (2011) 4–10

<sup>17</sup> For a transportation-related example, see de Montjoye, Y.-A., Hidalgo, C.A., Verleysen, M. & Blondel, V.D. "Unique in the Crowd: The privacy bounds of human mobility". Sci. Rep. **3**, 1376.

<sup>18</sup> See for example, Bachmann, C. et al., "A comparative assessment of multi-sensor data fusion techniques for freeway traffic speed estimation using microsimulation modeling", Transportation Research Part C 26 (2013) 33–48

## The System Model

The system model must have two broad capabilities, (1) the ability to simulate a complete set of data that could be measured/obtained from the real world and (2) the ability to describe traveler behaviors and responses to guidance and control signals in a realistic way. The characteristics of system models that deliver these capabilities are provided in

**Table 1** Applications should propose a model that addresses each of these characteristics; however, ARPA-E recognizes that flexibility in the model is required and that model development and refinement will continue during the course of the award.

**Table 1.**

Characteristics of the System Model	
DATA & DATA QUALITY	<p><u>To be defined by applicant.</u> Data must be based on the requirements of the control architecture. Applicants should estimate data accuracy and quality for each source to help with sensitivity evaluation of the model. Sources fall into three classes, public, private, and personal. DATA STREAMS MUST BE CURRENTLY ACCESSIBLE. Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) data and communications, while likely to be widely deployed in the future, are <i>not</i> widely available in today's fleet. However, Traveler-to-Traveler (T2T) and Traveler-to-Infrastructure (T2I) are omnipresent through wireless devices, and may provide an opportunity to simulate these data.</p> <p>Public: These data will serve as the ground truth for the system model and must be comprehensive. Data outside the training set must also be available.</p> <p>Private: If used, data providers must be involved, ideally with the data provider as a member of the project team. Privacy features must be incorporated up front, and should be highlighted, where necessary to protect both private and personal data.</p> <p>Personal: It is assumed that individual wireless devices associated with each participating traveler will provide this data. Consequently, the applicant should clearly define what data is needed from each traveler and incorporate it into the system model. Real-world parameterization of this specification is expected. Personal data should be collected as needed, rather than as a continual stream, to minimize privacy and bandwidth concerns, but may include a zone around each traveler that is collected using peer-to-peer wireless technologies. See the Control Architecture section for further guidance.</p>
REPORTING	<p>In addition to energy use, other aggregate data, e.g., average vehicle speed and density on key highways and arterials, must be reported for model validation. These data are expected to closely approximate actual measurements, particularly during peak conditions. For transit, similar aggregate measures might include, for example, hourly ridership on public transit. Reporting should also include metrics of quality of service and system reliability (See Definitions).</p>

Characteristics of the System Model (continued)	
MODEL PERFORMANCE	<ul style="list-style-type: none"> <li>• Fast enough to support the testing of a real time control architecture, but need not be “real time” itself</li> <li>• Modular, and developed and available under an open software standard.<sup>19</sup> If commercial software is used, the commercial software must be widely and readily available, and the source code for the module(s) developed under this award must be made publicly available.</li> <li>• Written in a widely-available computer language</li> </ul> <p>To promote wide dissemination of the model, the standard intellectual property provisions of an award may be modified.</p>
REGION OF INTEREST	US urban region of greater than 3 million inhabitants, based on the 2010 Census and metropolitan statistical areas defined the Office of Management and Budget <sup>20</sup> using a region that has robust multimodal options
DESCRIPTORS FOR PARTICIPANTS	Descriptors for both travelers and drivers should approximate the natural population. Models that employ individualized unique driver or probe data as descriptors will be strongly preferred. See Control Architecture section for suggested implementation of driver behavior in the absence of control.
VALIDATION AND SENSITIVITY ANALYSIS	Performance should be validated using historic data from anonymous sources (e.g., loop detectors) both during normal conditions and after actual incidents. Error rates and missing data parameters should be explicit.
CALCULATION OF ENERGY USED PER TRAVELER	Ability to calculate energy used by each traveler at any given time, and to re-calculate it dynamically as changes occur in traveler’s choices and in the network.
CALCULATION OF AGGREGATE ENERGY USED	Aggregate energy use for travelers in the selected region should be calculated to within ±10% of overall estimates published by, or derived from, public sources such as the region's Metropolitan Planning Organization, as well as ±10% within each subcategory as defined by these sources.
DEMONSTRATION OF IMPACT	Determination of how energy reduction depends upon the fraction of participating travelers.
EXPANDABILITY	The model should be constructed to anticipate future technologies. These should be able to be incorporated in a modular fashion.

#### Supplementary Information:

Teams that expect to employ private data must explicitly involve data providers, with letters of support (at a minimum). Personal data should be assumed to be transmitted by individual wireless devices, but may include data that could be collected locally, including external sources (such as the automobile’s OBD-II port) outside the devices themselves. Applicants may propose the use of additional data collection hardware in addition to smart phones and other personal

<sup>19</sup> See for example <http://opensource.org/osd>

<sup>20</sup> See <http://www.whitehouse.gov/sites/default/files/omb/bulletins/2013/b13-01.pdf>

wireless devices, but the applicant must discuss in detail the estimated cost and proposed deployment strategy for this data collection technology.

The system model must have the capability for sensitivity analysis, a process that is intended to simulate imperfections and uncertainties found in real world data, including erroneous, noisy, or missing data (for example, imperfect communications systems), as well as emergent situations such as road closures and traffic incidents.

The model must also report metrics associated with the traveler's quality-of-service and overall system reliability (see Definitions), such that no individual traveler or group of travelers is forced to bear a disproportionate burden. The system model must identify and account for the measurement of difficult-to-measure aspects associated with individual participants, such as modal occupancy, openness to mode switching, and personal driving style.

The system model must also be a virtual test bed, capable of an authentic response to realistic personalized signals (see below). These signals will target participants to adjust behavior of travelers and drivers according to modern behavioral theories.<sup>21</sup> The description of both travelers and drivers in this model should thus explicitly factor in their human characteristics.

Model validation protocols are currently envisioned as a set of realistic scenarios (and extreme scenarios) that are intended to determine under what circumstances the system model "breaks". Tests will be designed in coordination with each awardee, to confirm that the model represents a fair and accurate test bed for the control architecture. Further, we anticipate that the system models may become useful tools either for transportation planners or for future transportation control simulations. Consequently, models that are modular and developed under public, open software standards, in commonly used computer languages are preferred. To facilitate this extension, once the program is underway, awardees that have similar approaches will be encouraged to collaborate on their system models, to provide added resources, perspectives, and robustness.

The system model and control architecture described below are strongly coupled. Because it may be easier for applicants to envision a control architecture that relies on a complete parameterized model of the transportation system, one approach is to construct a reduced complexity model based on sampling specific information from the system model. In this case, the development and validation of the reduced complexity model against the system model will be an important deliverable. Further, if this approach is taken, the control architecture and the reduced complexity model must be able to run concurrently with the system model itself, such that decisions and control outputs can be fed back into the high fidelity system model to evaluate the impact of the control architecture in a real-world, real-time setting.

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<sup>21</sup> There are many examples of this type of approach, too numerous for this document. For a concise guide to possible approaches, see [http://peec.stanford.edu/docs/energybehavior/Data Jam - 5 Behavioral Techniques Guide.pdf](http://peec.stanford.edu/docs/energybehavior/Data%20Jam%20-%205%20Behavioral%20Techniques%20Guide.pdf)

## The Control Architecture

The control architecture is a key deliverable. Developing a control architecture that interacts with the system model will allow ARPA-E to assess the usefulness of personalized control for energy savings in transportation. The control architecture should be scalable, thus capable of quantifying micro-, meso-, and macro-scale impacts of control on real-time reduction of energy use.

The characteristics of the control architecture are provided in Table 2. Applications should devise an architecture that addresses each of these characteristics; however, ARPA-E recognizes that the specifics of the architecture will evolve during the course of an award as tested via simulation using the model system.

**Table 2.**

Characteristics of the Control Architecture	
EVENT HORIZON	Successful controls will show statistically significant reduction in energy use based on predicted state, mode, and energy use of the system at least 15 minutes into the future.
PERSONALIZED DATA AND PARTICIPATION IN CONTROL STRUCTURE	Control scenarios should assume that only a small portion of those eligible participate, but may include a zone around each participant that utilizes peer-to-peer wireless technologies as presently embodied. The impact of the approach needs to be evaluated at varying degrees of technological penetration, so this is essentially a sensitivity analysis based on the number of control nodes in the network.
RESPONSE TO NETWORK CHANGES	Capable of rapid response to traffic incidents, providing relevant, wireless signals to travelers within 30 seconds of the time of the incident (and updated thereafter as the extent of the disruption caused by the incident becomes clearer). This constraint will affect data collection frequency and density.
DIMENSIONAL SCALES OF ENERGY EFFECTS	Micro-: <sup>22</sup> At this scale, individual travelers are observable as individuals, and naturalistic variations are evident. Meso-: <sup>23</sup> At this scale, traveler demand is aggregated across a region. Mesoscale zones should be no larger than 0.5 mile in radius. Microsimulated zones interact with one another in an open fashion, but interaction is limited to exchange of individual travelers between zones. Macro-: <sup>24</sup> This is the entire scale of the transportation simulation. Mesoscale zones interact with one another in a closed fashion to describe the entire region.

<sup>22</sup> Hollander, Y. & Liu, R., "The principles of calibrating traffic microsimulation models", Transportation 35: 347-362 (2008)

<sup>23</sup> In mesoscale transportation systems, the statistical nature of local traffic can be used to develop a fluid-like conservation model of traveler flow, with average characteristics such as traffic velocity and vehicle density taking the place of individual travelers. See Horowitz, Roberto. (2003). Development of Integrated Meso/Microscale Traffic Simulation Software for Testing Fault Detection and Handling Algorithms in AHS: Final Report. California Partners for Advanced Transit and Highways (PATH). UC Berkeley: California Partners for Advanced Transit and Highways (PATH). Retrieved from: <http://www.escholarship.org/uc/item/61z020hf>

<sup>24</sup> The macroscale simulation is essentially the entire simulation described by the virtual test bed.

Characteristics of the Control Architecture (continued)	
QUALITY OF SERVICE	Based on travel time (with expected statistical uncertainty) for <u>each</u> traveler in the uncontrolled model, an increase in travel time upon control is never statistically significant ( $p < 0.05$ )
SYSTEM RELIABILITY	Based on travel time (with expected statistical uncertainty) for <u>all</u> travelers in the uncontrolled model, the distribution of travel time upon control is never statistically broader ( $p < 0.05$ )
WIRELESS DELIVERY OF SIGNALS	Required. Signals should be provided after an incident to affected travelers within 30 seconds.
INTENT	Patterns and historical data should be incorporated, but, for sensitivity analysis, applicants should assume that a variable fraction of the participants are willing to enter detailed trip information (e.g., destination).
CONTROL STRATEGIES	Applicants should employ individualized control strategies that are grounded in modern behavioral science, rather than those based on broad economic principles. Active control should influence energy use at the system level, and impact of control must be quantifiable in energy terms.
TRAVELER DECISION CRITERIA	In the absence of a control signal, model should assume that traveler decisions are essentially independent of all other travelers (i.e., a Nash equilibrium), based on anticipated total travel time. In the presence of a control signal, participants are expected to respond in a probabilistic way, providing an alternative response when a personalized control signal is presented.
CAPABILITY FOR EXPERIMENTAL OPTIMIZATION	Personalized controls should incorporate intrinsic variables that can be adjusted to optimize participant responses when presented with a control signal. It is understood that each participant will not be individually predictable, but will instead show reproducible statistical tendencies are a population.
IDENTIFICATION OF KEY TECHNOLOGY GAPS	Applicants should identify key gaps in hardware or software that would be required to implement the proposed control architecture in the real world. Anticipated gaps in hardware and software might include: occupancy meters, driving style meters, <sup>25</sup> intent sensors (e.g., two-way turn signals), hands-free delivery of diverse personalized signals, traveler-to-traveler or traveler-to-infrastructure communication, and intent prediction algorithms.

<sup>25</sup> See Progressive Insurance SnapShot, <http://www.progressive.com/auto/snapshot-common-questions/>

## Supplementary Information:

The control architecture should facilitate interactions with other micro- and mesoscale zones and routing infrastructure (e.g., traffic lights) and should query modes of transportation using a common protocol, where feasible. A personalized control architecture with partial adoption is important because, in contrast to today's dominant traveler control mechanisms (i.e., road signs, signals, etc.), new individualized controls are unlikely to be adopted immediately and universally. Therefore, applicants must objectively assess the participation level for personalized guidance and control where they begin to have a measurable impact on energy use. This architecture must therefore use incomplete data sampled in a realistic way.<sup>26</sup> The control architecture should be designed to overcome bandwidth, privacy, and analysis issues generated by the now dominant "collect first, interpret later" strategy.<sup>27</sup> Further, the control architecture must assume that individual (personal) information will be available from a wireless app primarily from opt-in participants and thus will provide data only on an as needed basis, rather than as a continuous stream. This is not a rigid requirement: Simulations that rely on large amounts of largely anonymous (or anonymized) cell phone tower data are entirely appropriate and will be considered.<sup>28</sup> The intent is to provide for system-wide information acquisition from anonymous (or anonymized) data sources (which must be available today), supplemented and enhanced by personal data collected from a subset of participants, who will have opted both to provide more granular data and to be network control points. One approach to this is a query-response architecture that has direct or indirect access to data commonly collected by commercial transportation apps on a mobile device such as Google Maps and Inrix. Applicants should assume that data from all travelers would be fed into the control architecture through wireless communications.

Optimization algorithms should assume that the data, particularly from travelers, is of variable quality. The practical capacity to sample in the real world depends on the (limited) bandwidth of the network. Thus, while sampling of wireless sensors (as embodied in the wireless devices that individual travelers carry) will be limited both by penetration and bandwidth, the use of aggregate data streams based in the cloud (such as those available from the Google Maps "traffic" feature) is encouraged. Disproportional leverage by small groups of participating travelers is not unprecedented, since computational studies of congestion behavior show that the re-routing of only a few percent of the vehicles can lead to substantial reduction in congestion for all travelers.<sup>29</sup> For example, during periods of congestion, numerous analyses indicate that an improvement in efficiency is possible in theory through a more informed route

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<sup>26</sup> For many examples, see Roughgarden, T. "Selfish Routing and the Price of Anarchy", MIT Press, 2005.

<sup>27</sup> See Bertolucci, J. "Big Data Fans: Don't Boil The Ocean", Information Week, May 12, 2014.  
<http://www.informationweek.com/big-data/big-data-analytics/big-data-fans-dont-boil-the-ocean/>

<sup>28</sup> See for example Wang, P., Hunter, T., Bayen, A.M., Schechtner, K. & Gonzalez, M.C. Understanding Road Usage Patterns in Urban Areas. *Sci. Rep.* **2**, 1001

<sup>29</sup> See for example Robert A. Johnston, Jay R. Lund, and Paul P. Craig (1995). "Capacity-Allocation Methods for Reducing Urban Traffic Congestion." *J. Transp. Eng.*, 121(1), 27–39.



selection:<sup>30</sup> The control architecture should attempt to quantify this expected improvement using practical personalized controls and real world data.

Unforeseen events such as traffic incidents, as well as foreseeable events such as road closures or anomalous traffic due to specific occasions, occur frequently, so the control architecture must lead to accurate and timely predictions of resulting changes in traffic patterns. The control strategy should predict changes in patterns as needed for control computation, but the system model should be able to represent/capture any non-nominal behaviors. Because the responsiveness to unforeseen events is crucial during periods of high volume, in particular, the model must be capable of rapid control and readjustment to enable rerouting of responsive travelers in a timely fashion.

Because the control architecture will be benchmarked against the system model also specified by the applicant, the two must be closely aligned. Key data needed for the control architecture must be gathered and processed in a timely fashion, both from the system model and in the real world. The control architecture will be evaluated as a predictable response of the system to differential, personalized controls.

ARPA-E seeks control strategies that are grounded in modern behavioral science.<sup>30</sup> The use of broad, non-personalized economic incentives as controls will not be considered adequate for this solicitation. Examples of these discouraged incentives include variable tolls tied to a group of travelers (rather than the individual traveler) and collective incentives such as preferential lanes.

Personalized signals should be targeted at selected participants, including both travelers and drivers, but these signals must intentionally influence energy-related transportation choices (e.g., mode, departure time, etc.) by travelers. Selection of these participants must be justified, where possible, through market adoption analysis based on the diversity and variation of Americans, rather than simply assuming statistically random participation. Thus, potential participants should be grouped based on their likelihood of adoption of the technology (e.g., a smartphone app combined with a particular personalized signal approach) and the probability of their affirmative response to a positive guidance and control signal—this can be approached essentially as a market segmentation exercise. Signals should not presume that the traveler is, or wishes to be, particularly energy aware or influenced by potential savings, either in energy or in cost. It will be more important to anticipate systemic energy reduction through personalized control signals than to make more participants aware of their energy choices.

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<sup>30</sup> Wardrop, J. G.; Whitehead, J. I. *op cit*. For a more recent treatment that suggests even more improvement is possible, see Kerner, BS, *J. Phys. A: Math. Theor.* 44 (9) [2011].



Applicants will be asked to numerically estimate the impact of deployment of the proposed technology at various levels of participation and responsiveness and thereby determine, among other things, what fraction of participation is needed for impact. If implemented in the real world, signal strategies are expected to be refined experimentally (based on responsiveness and predictability), such that a direct feedback of the effectiveness of the signal must be implicit in the signaling architecture. Consequently, this control architecture must be designed to allow for trials and evaluation of different signal approaches to measure the effectiveness of different incentives strategies.

The response to a signal must be relevant to energy use by the traveler, e.g., changes in route, departure time, and mode, etc. While specific, punitive financial controls such as congestion pricing are excluded (as being known strategies), specific non-punitive financial controls such as coupons, tax relief, etc., will all be considered, provided they are personalized.

ARPA-E is interested in identifying key technology gaps allow that enable the control architecture to interact with the real world more effectively without extensive human input or interaction. In some instances, like the OBD-II connector mentioned previously, the essential technology is already deployed and Bluetooth® connectivity to wireless devices is already commercially available.<sup>31</sup> In other instances, however, technologies for measuring crucial parameters (such as modal occupancies) in a seamless, automatic fashion are more challenging. An applicant's concept may show significantly better performance when data that is currently unavailable from already-deployed sensors, either from modes or from personalized devices, becomes available. Applicants should identify both the new technologies (hardware or software) required and the data these will provide.

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<sup>31</sup> See for example the OBDLink LX Bluetooth Scan Tool, <http://www.scantool.net/obdlink-lx.html>

## D. TECHNICAL GLOSSARY

<b>Participant</b>	Either a traveler or a driver who opts-in voluntarily to participate in the control architecture
<b>Traveler</b>	The individual who has a need to move from one place to another
<b>Driver</b>	The individual who controls the mode. For the predominant mode, single-occupancy vehicles, the driver and the traveler are identical.
<b>Mode</b>	The specific transportation vehicle (car, bus, train, etc.) by which a traveler is moved
<b>Route</b>	The path by which the traveler moves. This is the traveler's personal choice.
<b>Personal transportation network</b>	The segment of the transportation sector that is involved in moving travelers in and around an urban center.
<b>Personalized Signals</b>	Information and incentives provided to individual travelers and drivers intended to affect their decisions while participating in the personal transportation network. <i>[Note: Only a limited number of participants will be available for personalized signaling.]</i>
<b>Network Control</b>	A predictable response of the personal transportation network to personalized signaling
<b>New infrastructure</b>	Deployment of additional resources, in the form of new roadways, new signals, or new sensor networks independent of personal mobile devices, as a prerequisite for real-world implementation.
<b>Quality-of-service</b>	Referenced to today's travel experience, primarily in terms of departure and arrival times. It is the overall measured or perceived performance of transit service from the traveler's point of view. <sup>32</sup> It has long been known that the efficiency of the transportation network during times of congestion is suboptimal (see Wardrop's Principles). <sup>33</sup> This can be framed as a shift from a selfish, Nash equilibrium (where individuals make independent choices that lead to a suboptimal solution) toward a more efficient system optimal equilibrium (where collaboration among individuals leads to a better situation for all).
<b>System Reliability</b>	The consistency of on-time arrival, <sup>34</sup> based on the expectation of the traveler. These are primarily related to travel time reliability: the consistency or dependability in travel times, as measured from day-to-day and/or across different times of the day.

<sup>32</sup> See: <http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp100/part3.pdf>

<sup>33</sup> Wardrop, J. G.; Whitehead, J. I. (1952). "Correspondence. Some Theoretical Aspects of Road Traffic Research". *ICE Proceedings: Engineering Divisions* 1 (5): 767.

<sup>34</sup> See: [http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/Reliability\\_159.aspx](http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/Reliability_159.aspx)

## **E. 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.C 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 solely at discovery and/or fundamental knowledge generation.
- Applications for large-scale demonstration projects of existing technologies.
- Applications for proposed technologies that represent incremental improvements to existing technologies.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates a law of thermodynamics).
- Applications 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:
  - Applications that propose examining only a single transportation corridor or sub-region with limited population (< 3 million inhabitants).
  - Applications that focus primarily on freight demand and goods movements.

## **II. AWARD INFORMATION**

### **A. AWARD OVERVIEW**

ARPA-E expects to make approximately \$10 million available for new awards under this FOA, subject to the availability of appropriated funds. ARPA-E anticipates making approximately 5-10 awards under this FOA. ARPA-E may issue one, multiple, or no awards.

Individual awards may vary between \$250,000 and \$5 million.

The period of performance for funding agreements may not exceed 30 months. ARPA-E expects the start date for funding agreements to be October, 2015, or as negotiated.

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

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

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

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

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

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

Congress directed ARPA-E to "establish and monitor project milestones, initiate research projects quickly, and just as quickly terminate or restructure projects if such milestones are not achieved."<sup>35</sup> 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.<sup>36</sup>

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

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

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<sup>35</sup> U.S. Congress, Conference Report to accompany the 21<sup>st</sup> Century Competitiveness Act of 2007, H. Rpt. 110-289 at 171-172 (Aug. 1, 2007).

<sup>36</sup> The Prime Recipient is the signatory to the funding agreement with ARPA-E.

## **2. FUNDING AGREEMENTS WITH FFRDCs, GOGOs, AND FEDERAL INSTRUMENTALITIES<sup>37</sup>**

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

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

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

Non-DOE GOGOs and Federal agencies may be proposed as supporting project team members on an applicant’s project. The Non-DOE GOGO/Agency support would be obtained via an Interagency Agreement between ARPA-E and the non-DOE GOGO/Agency, and provided as part of ARPA-E’s standard substantial involvement in its funded projects.

## **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.

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<sup>37</sup> DOE/NNSA GOGOs are not eligible to apply for funding, as described in Section III.A of the FOA.

A TIA is more flexible than a traditional financial assistance agreement. In using a TIA, ARPA-E may modify standard Government terms and conditions. See 10 C.F.R. § 603.105 for a description of a TIA.

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

#### **4. GRANTS**

Although ARPA-E has the authority to provide financial support to Prime Recipients through Grants, ARPA-E generally does not fund projects through Grants. ARPA-E may fund a limited number of projects through Grants, as appropriate.

#### **C. STATEMENT OF SUBSTANTIAL INVOLVEMENT**

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

- ARPA-E does not limit its involvement to the administrative requirements of the ARPA-E funding agreement. Instead, ARPA-E has substantial involvement in the direction and redirection of the technical aspects of the project as a whole. Project teams must adhere to ARPA-E technical direction and comply with agency-specific and programmatic requirements.
- ARPA-E may intervene at any time to address the conduct or performance of project activities.
- During award negotiations, ARPA-E Program Directors and Prime Recipients mutually establish an aggressive schedule of quantitative milestones and deliverables that must be met every quarter. Prime Recipients document the achievement of these milestones and deliverables in quarterly technical and financial progress reports, which are reviewed and evaluated by ARPA-E Program Directors (see Attachment 4 to ARPA-E's Model Cooperative Agreement, available at <http://arpa-e.energy.gov/arpa-e-site-page/award-guidance>). ARPA-E Program Directors visit each Prime Recipient at least twice per year, and hold periodic meetings, conference calls, and webinars with Project Teams. ARPA-E Program Directors may modify or terminate projects that fail to achieve predetermined technical milestones and deliverables.

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

### **III. ELIGIBILITY INFORMATION**

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

##### **1. INDIVIDUALS**

U.S. citizens or permanent residents may apply for funding in their individual capacity as a Standalone Applicant,<sup>38</sup> as the lead for a Project Team,<sup>39</sup> or as a member of a Project Team.

##### **2. DOMESTIC ENTITIES**

For-profit entities, educational institutions, and nonprofits<sup>40</sup> 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.

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<sup>38</sup> A Standalone Applicant is an Applicant that applies for funding on its own, not as part of a Project Team.

<sup>39</sup> The term "Project Team" is used to mean any entity with multiple players working collaboratively and could encompass anything from an existing organization to an ad hoc teaming arrangement. A Project Team consists of the Prime Recipient, Subrecipients, and others performing or otherwise supporting work under an ARPA-E funding agreement.

<sup>40</sup> Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995 are not eligible to apply for funding as a Prime Recipient or Subrecipient.

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.

### **3. FOREIGN ENTITIES**

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

### **4. CONSORTIUM ENTITIES**

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

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

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



## **B. COST SHARING**<sup>41</sup>

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

### **1. BASE COST SHARE REQUIREMENT**

ARPA-E generally uses Cooperative Agreements to provide financial and other support to Prime Recipients (see Section II.B.1 of the FOA). Under a Cooperative Agreement or Grant, the Prime Recipient must provide at least 20% of the Total Project Cost<sup>42</sup> as cost share, except as provided in Sections III.B.2 or III.B.3 below.<sup>43</sup>

### **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 when selecting applications for award negotiations (see Section V.B.1 of the FOA).

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

### **3. REDUCED COST SHARE REQUIREMENT**

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

- A domestic educational institution or domestic nonprofit applying as a Standalone Applicant is required to provide at least 5% of the Total Project Cost as cost share.
- Small businesses – or consortia of small businesses - will provide 0% cost share from the outset of the project through the first 12 months of the project (hereinafter the “Cost Share Grace Period”).<sup>44</sup> If the project is continued beyond the Cost Share Grace Period, then at least 10% of the Total Project Cost (including the costs incurred during the Cost Share Grace Period) will be required as cost share over the remaining period of performance.

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<sup>41</sup> Please refer to Section VI.B.3-4 of the FOA for guidance on cost share payments and reporting.

<sup>42</sup> The Total Project Cost is the sum of the Prime Recipient share and the Federal Government share of total allowable costs. The Federal Government share generally includes costs incurred by GOGOs and FFRDCs.

<sup>43</sup> Energy Policy Act of 2005, Pub.L. 109-58, sec. 988.

<sup>44</sup> Small businesses are generally defined as domestically incorporated entities that meet the criteria established by the U.S. Small Business Administration’s (SBA) “Table of Small Business Size Standards Matched to North American Industry Classification System Codes” (NAICS) (<http://www.sba.gov/content/small-business-size-standards>).

- Project Teams where a small business is the lead organization and small businesses perform greater than or equal to 80%, but less than 100%, of the total work under the funding agreement (as measured by the Total Project Cost) the Project Team are entitled to the same cost share reduction and Cost Share Grace Period as provided above to Standalone small businesses or consortia of small businesses.<sup>45</sup>
- 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, small businesses and/or FFRDCs perform greater than or equal to 80%, of the total work under the funding agreement (as measured by the Total Project Cost) are required to provide at least 10% of the Total Project Cost as cost share. However, any entity (such as a large business) receiving patent rights under a class waiver, or other patent waiver, that is part of a Project Team receiving this reduction must continue to meet the statutory minimum cost share requirement (20%) for its portion of the Total Project Cost.
- Projects that do not meet any of the above criteria are subject to the minimum cost share requirements described in Sections III.B.1 and III.B.2 of the FOA.

#### **4. LEGAL RESPONSIBILITY**

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

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

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<sup>45</sup> See the information provided in previous footnote.

## 5. COST SHARE ALLOCATION

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

## 6. COST SHARE TYPES AND ALLOWABILITY

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

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

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

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

In addition, Project Teams may not use independent research and development (IR&D) funds<sup>46</sup> 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.

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<sup>46</sup> As defined in Federal Acquisition Regulation Section 31.205-18.

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

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

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

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

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

## **8. COST SHARE VERIFICATION**

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

### **C. OTHER**

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

Concept Papers are deemed compliant if:

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

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

Full Applications are deemed compliant if:

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

ARPA-E will not review or consider noncompliant Full Applications, including Full Applications submitted through other means, Full Applications submitted after the applicable deadline, and incomplete Full Applications. A Full Application is incomplete if it does not include required information and documents, such as Forms SF-424 and SF-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.E of the FOA, are deemed nonresponsive and are not reviewed or considered.

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

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

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

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

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

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

#### **2. CONCEPT PAPERS**

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

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

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

### **3. FULL APPLICATIONS**

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

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

### **4. REPLY TO REVIEWER COMMENTS**

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

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

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

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

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

## 6. SELECTION FOR AWARD NEGOTIATIONS

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

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

## 7. MANDATORY WEBINAR

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

### B. APPLICATION FORMS

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

- The Concept Paper must not exceed 4 pages in length including figures, footnotes and/or tables.



- 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. Single space all text and use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures and tables).
- The ARPA-E assigned Control Number, the Lead Organization Name, and the Principal Investigator's Last Name must be prominently displayed on the upper right corner of the header of every page. Page numbers must be included in the footer of every page.

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

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

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

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

## **1. CONCEPT PAPER**

### **a. CONCEPT SUMMARY**

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

### **b. INNOVATION AND IMPACT**

- Describe how the proposed effort represents an innovative and potentially transformational solution to the technical challenges posed by the FOA.
- Discuss the concept in terms of each of the two main elements described in Section I.C of the FOA: The System Model (Table 1) and the Control Architecture (Table 2). In particular, respond to the question, "How will the Control Architecture function in the

real world, and what control strategies will be enabled and/or limited by this choice of architecture?”

**c. PROPOSED WORK**

- Describe the data sources, and simulation/modeling approaches that will be used in the proposed work. Provide supporting examples of precedents. Cite the scientific and technical literature as appropriate.
- Discuss alternative approaches considered, if any, and why the proposed approach is most appropriate for the project objectives.
- Describe the nature of any significant technical challenges, the substance of key technical risks (whether or not they will be mitigated) and the limitations inherent in the proposed approach. [NOTE: ARPA-E expects that all successful proposals will contain significant technical uncertainty.]
- If applicable, describe any key technology gaps that are needed to enable the Control Architecture to function in the real world without extensive human input or interaction.

**d. TEAM ORGANIZATION AND CAPABILITIES**

- Identify key capabilities provided by the organizations comprising the Project Team and how those key capabilities will be used in the proposed effort.
- Identify (if applicable) previous collaborative efforts among team members relevant to the proposed effort.

**D. CONTENT AND FORM OF FULL APPLICATIONS**

Full Applications must conform to the following formatting requirements:

- Each document must be submitted in the file format prescribed below.
- The Full Application must be written in English.
- All pages must be formatted to fit on 8-1/2 by 11 inch paper with margins not less than one inch on every side. Single space all text and use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures and tables).

- The ARPA-E assigned Control Number, the Lead Organization Name, and the Principal Investigator's Last Name must be prominently displayed on the upper right corner of the header of every page. Page numbers must be included in the footer of every page.

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

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

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

Full Applications must conform to the content requirements described below.

Component	Required Format	Description and Information
<b>Technical Volume</b>	PDF	The centerpiece of the Full Application. Provides a detailed description of the proposed R&D project and Project Team. A Technical Volume template is available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ).
<b>SF-424</b>	PDF	Application for Federal Assistance ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ). Applicants are responsible for ensuring that the proposed costs listed in eXCHANGE match those listed on forms SF-424 and SF-424A. Inconsistent submissions may impact ARPA-E's final award determination.
<b>Budget Justification Workbook/SF-424A</b>	XLS	Budget Information – Non-Construction Programs ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> )
<b>Summary for Public Release</b>	PDF	Short summary of the proposed R&D project. Intended for public release. A Summary for Public Release template is available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ).
<b>Summary Slide</b>	PPT	A four-panel project slide summarizing different aspects of the proposed R&D project. A Summary Slide template is available on ARPA-E eXCHANGE ( <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> ).
<b>Business Assurances &amp; Disclosures Form</b>	PDF	Requires the Applicant to make responsibility disclosures and disclose potential conflicts of interest within the Project Team. Requires the Applicant to describe the additionality and risks associated with the proposed project, disclose applications for funding currently pending with Federal and non-Federal entities, and disclose funding from Federal and non-Federal entities for work in the same technology area as the proposed R&D project. If the Applicant is a FFRDC, requires the Applicant to provide written authorization from the cognizant Federal agency and, if a DOE/NNSA FFRDC, a Field Work Proposal. Allows the Applicant to request a waiver or modification of the Performance of Work in the United States

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

		requirement and/or the Technology Transfer & Outreach (TT&O) spending requirement. This form is available on ARPA-E eXCHANGE at <a href="https://arpa-e-foa.energy.gov">https://arpa-e-foa.energy.gov</a> . A sample response to the Business Assurances & Disclosures Form is also available on ARPA-E eXCHANGE.
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ARPA-E provides detailed guidance on the content and form of each component below.

## **1. FIRST COMPONENT: TECHNICAL VOLUME**

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

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

<b><u>PAGE LIMIT</u></b>	<b><u>SECTION</u></b>	<b><u>DESCRIPTION</u></b>
<b>1 page max.</b>	<b>EXECUTIVE SUMMARY</b>	<p>Summarize the objective(s) and technical approach of the proposed effort at a technical level appropriate for scientific and engineering peers.</p> <p><b>INSTRUCTIONS:</b></p> <ol style="list-style-type: none"> <li>(1) The Project Title should be brief and descriptive of the proposed technology.</li> <li>(2) Enter the estimated Total Project Cost in U.S. dollars and percentage cost share in parentheses.</li> <li>(3) Enter the Project Duration in months.</li> <li>(4) The Executive Summary shall not exceed 1 page in length</li> <li>(5) The Executive Summary may contain graphics, figures, or tables as needed to summarize the technical concept.</li> </ol>
<b>Sections 1-5 30 pages max.</b>	<b>Section 1 INNOVATION AND IMPACT</b>	<p>Describe how the proposed work offers an innovative approach to achieve the program objectives of the FOA and how it will impact the mission areas of ARPA-E.</p> <p><b>1.1 Overall Description.</b></p> <ul style="list-style-type: none"> <li>• Describe the conceptual basis for the project and how the proposed technology works with minimal jargon.</li> <li>• Explain the objective(s) and performance characteristics of the proposed effort, including the proposed incentive structure and choices to be influenced by the incentives (See Section I.C of the FOA).</li> </ul> <p><b>1.2 Potential Impact.</b></p> <ul style="list-style-type: none"> <li>• Clearly identify the problem that is being solved with the proposed technology.</li> <li>• Explain the project’s potential to be disruptive relative to the existing technology or how the project establishes a basis for new innovations.</li> <li>• Describe how the individualized “Control Strategies” (see Table 2 in Section I.C of the FOA) can be deployed in the real world, and how energy savings will be quantitatively evaluated based on technological penetration (see “Personalized Data and Participation in Control Structure, Table 2).</li> </ul> <p><b>1.3 Innovativeness.</b></p> <ul style="list-style-type: none"> <li>• Describe how the proposed effort represents a new and innovative solution to the overall program challenge described in the FOA.</li> <li>• Indicate the technical goals and anticipated results, using appropriate metrics, for the project. Provide a description of how the metrics were derived, citing key previous results and/or assumptions.</li> <li>• Include and discuss, as appropriate, a table in which the targeted performance of the proposed technology is compared with Tables 1 and 2 in Section I.C of the FOA and with other competing or</li> </ul>

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

		<p>emerging technologies that might achieve these characteristics.</p> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Innovation and Impact Section may include figures, tables, and graphics.</p> <p>(2) The suggested length of the Innovation and Impact Section is 4 pages.</p>
	<p><b>Section 2 PROPOSED WORK</b></p>	<p>Describe and discuss for the proposed effort the technical background and approach and the key technical risks. This Section should justify the proposed approach as being appropriate to achieve the project’s objective(s).</p> <p><b>2.1 Approach.</b></p> <ul style="list-style-type: none"> <li>• Describe the technical approach and how this approach will achieve the proposed project objective(s). Include a description of the choices to be incentivized and how these are expected to result in reduced energy use in the system (See Section I.C of the FOA).</li> <li>• Discuss alternative approaches considered, if any, and why the selected approach is most appropriate for the identified objective(s).</li> <li>• Describe the background, theory, simulation, modeling, data, or other sound modeling and control practices or principles that support achieving the project objective(s). Provide specific appropriate citations to the scientific and technical literature.</li> <li>• Discuss both the “Data &amp; Data Quality” and “Expandability” characteristics exploited by the “System Model” as described in Table 1 in Section I.C of the FOA.</li> <li>• Discuss both the “Personalized Data &amp; Participation in Control Structure” and the “Capability for Experimental Optimization” by the “Control Architecture” as described in Table 2 in Section I.C of the FOA.</li> </ul> <p><b>2.2 Technical Risk.</b></p> <ul style="list-style-type: none"> <li>• Identify potential technical issues and risks, e.g., the approach requires a never-before-demonstrated algorithm or greater-than-previously-demonstrated computational performance, etc.</li> <li>• Describe appropriate mitigation techniques and plans, if any, for each identified issue and risk.</li> <li>• Discuss limitations of the chosen data as related to the “System Model”, and potential failure modes of the control strategy as related to the “Control Architecture”.</li> </ul> <p><b>2.3 Schedule.</b></p> <ul style="list-style-type: none"> <li>• Provide a schedule for the proposed effort by major tasks, including major milestones or Go/No-Go decision points as appropriate. (<b><u>A Gantt chart is recommended.</u></b>)</li> </ul>

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

		<p>technology toward commercial adoption.</p> <p><b>4.1 Technology to Market Strategy.</b></p> <ul style="list-style-type: none"> <li>Describe how the proposed technology is expected to transition from the lab to commercial deployment, including a description of potential near- and long-term market entries, likely commercialization approach (startup, license, etc.), specific organizations expected to be involved in the transition (partners, customers, etc.), and the commercialization timeline.</li> <li>Describe anticipated resource needs for the next phase of development following the end of the ARPA-E project.</li> <li>Explain why the proposed research is not being pursued by industry today.</li> <li>Discuss the anticipated roles for the proposed research team in the commercialization of the technology.</li> </ul> <p><b>4.2 Intellectual Property.</b></p> <ul style="list-style-type: none"> <li>Describe existing intellectual property, if any, that will be used to develop the new intellectual property; and</li> <li>Discuss new intellectual property and data that is anticipated to be created as part of this effort, if any.</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Technology to Market Section may include figures, tables, and graphics.</p> <p>(2) The suggested length of the Technology to Market Section is 4 pages.</p>																																										
	<p><b>Section 5 BUDGET</b></p>	<p>Indicate the budget, in US dollars, and provide a high-level budget summary, demonstrating that the budget is reasonable and appropriate for the proposed effort.</p> <p><b>5.1 Budget Breakdown.</b></p> <p>Provide in tabular form following the template give below, a breakdown of the project budget by entity and major task in US dollars.</p> <table border="1"> <thead> <tr> <th>Task Name</th> <th>[Prime]</th> <th>[Sub #1]</th> <th>[Sub #2]</th> <th>[Sub #3]</th> <th>[Sub #4]</th> <th>Total</th> </tr> </thead> <tbody> <tr> <td>[Task #1]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>[Task #2]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>[Task #3]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>[Task #4]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td><b>Total</b></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	Task Name	[Prime]	[Sub #1]	[Sub #2]	[Sub #3]	[Sub #4]	Total	[Task #1]							[Task #2]							[Task #3]							[Task #4]							<b>Total</b>						
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		<p>Replace “Prime” with name of the primary (lead) entity and “Sub #n” with the name of the sub-recipient or sub-contractor entities, if applicable. Task names should clearly correspond to major tasks listed in Section 2.4. Expand or contract the table as needed to add/subtract entities (columns) or tasks (rows).</p> <p><b>5.2 Budget Summary.</b></p> <p>Provide a high-level summary for the project by major budget category, including at least these three:</p> <ul style="list-style-type: none"> <li>• Key Personnel and technical staff to be utilized (e.g., scientists, engineers, technicians, postdocs, graduate students, etc.)</li> <li>• Equipment</li> <li>• Materials and Supplies</li> </ul> <p><b>5.3 Cost Share.</b></p> <p>Provide a description of the cost share by value of the contribution (in dollars) and percentage of the Total Project Cost (TPC):</p> <ul style="list-style-type: none"> <li>• List each source of cost share, the type of contribution (cash or in-kind), the value of the contribution (in dollars), and the value as a percentage of TPC.</li> <li>• For all in-kind contributions, provide a detailed description of the contribution and its relevance to the project objectives</li> </ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) The Budget Section may include figures, tables, and graphics.  (2) The suggested length of the Budget Section is 4 pages.</p>
<b>No page limit</b>	<b>REFERENCES</b>	<p>Provide a list of references appropriate to Sections 1-5.</p> <p><b>INSTRUCTIONS:</b></p> <p>(1) Only bibliographic information may be contained in the references. No additional text or commentary is allowed.  (2) There is no page limit for the Bibliographic References Section, which is outside of the overall 30-page limit for Sections 1-5.</p>
<b>Each PQS limited to 3 pages in length, no cumulative page limit</b>	<b>PERSONAL QUALIFICATION SUMMARIES</b>	<p>A Personal Qualification Summary (PQS) is required for the PI and all other Key Personnel. Each PQS must include a description of the following only:</p> <ul style="list-style-type: none"> <li>• Education and training</li> <li>• Employment history</li> <li>• Awards and honors</li> <li>• A list of no more than 10 peer-reviewed publications related to the proposed project</li> <li>• A list of no more than 10 other peer-reviewed publications</li> </ul>

		<p>demonstrating capabilities in the broad field</p> <ul style="list-style-type: none"><li>• A list of no more than 10 non-peer-reviewed publications and patents demonstrating capabilities in the broad field</li></ul> <p><b>INSTRUCTIONS:</b></p> <p>(1) Each Personal Qualification Summary is limited to 3 pages in length and there is no page limit for this Section, which is outside of the 30-page limit for Sections 1-5.</p> <p>(2) Curriculum Vitae should not be submitted.</p>
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## 2. SECOND COMPONENT: SF-424

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

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

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

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

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

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

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

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

Subrecipient information must be submitted as follows:

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

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

- Applicants may request funds under the appropriate object class category tabs as long as the item and amount requested are necessary to perform the proposed work, meet all the criteria for allowability under the applicable Federal cost principles, and are not prohibited by the funding restrictions described herein.
- If Patent costs are requested, they must be included in the Applicant’s proposed budget (see Section IV.G.3 of the FOA for more information on Patent Costs).
- Unless a waiver is granted by the Contracting Officer, each Project Team must spend at least 5% of the Federal funding (i.e., the portion of the award that does not include the recipient’s cost share) on Technology Transfer & Outreach (TT&O) activities to promote and further the development and deployment of ARPA-E-funded technologies. In addition, Project Teams may not expend more than 5% of the Total Project Cost on

TT&O activities without the prior approval of the Contracting Officer (see Section IV.G.8 of the FOA).

- All TT&O costs requested must be included in the Applicant’s proposed budget and identified as TT&O costs in the Budget Justification Workbook/SF-424A with the costs being requested under the “Other” budget category. All budgeted activities must relate to achieving specific objectives, technical milestones and deliverables outlined in Section 2.4 Task Descriptions of the Technical Volume.
- For pricing purposes, assume a project start date of [date], or as negotiated.
- For more information, please refer to the ARPA-E Budget Justification Guidance document at <https://arpa-e-foa.energy.gov>.

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

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

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

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

- A Technology Summary;
  - A description of the types of choices to be incentivized and the proposed incentive methods.
  - Bullet points that describe data sources and modeling approaches to both the System Model and Control Architecture;
- A description of Key Features of both the System Model and the Control Architecture;
  - Quantitative description (through text or graphic) of the proposed System Model and Control Architecture, highlighting distinctive features of the approach;
  - The description should explain how the preferred choices will be determined and how the results of the incentivized behaviors will be introduced into the model system;
- Proposed Geography and Modes;
  - Describe/indicate the region to be modeled;
  - List the modes to be modeled;
  - List the data to be used in the modeling and controls
  - Describe the control signals to be used and how they will be transmitted to travelers
- The project's key idea/takeaway;
- Project title and Principal Investigator information; and
- Requested ARPA-E funds and proposed applicant cost share.

## 6. SIXTH COMPONENT: BUSINESS ASSURANCES & DISCLOSURES FORM

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

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

- Disclose conditions bearing on responsibility, such as criminal convictions and Federal tax liability;
- Disclose potential conflicts of interest within the Project Team;

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

In addition, ARPA-E is required by statute to “accelerat[e] transformational technological advances in areas that industry is by itself not likely to undertake because of technical and financial uncertainty.”<sup>47</sup> In accordance with ARPA-E’s statutory mandate, the Applicant is required to:

- Describe the additionality and risks associated with the proposed R&D project;
- Disclose any applications for the same project or related work currently pending with any Federal or non-Federal entities; and
- Disclose all funding for work in the same technology area as the proposed project received from any Federal or non-Federal entity within the last 5 years.

Finally, the Applicant may use the Business Assurances & Disclosures Form to:

- Request authorization to perform some work overseas; and
- Request a waiver of the TT&O spending requirement.

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

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

Replies to Reviewer Comments must conform to the following requirements:

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

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<sup>47</sup> America COMPETES Act, Pub. L. No. 110-69, § 5012 (2007), as amended (codified at 42 U.S.C. § 16538).

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

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

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

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

## **F. INTERGOVERNMENTAL REVIEW**

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

## **G. FUNDING RESTRICTIONS**

### **1. ALLOWABLE COSTS**

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

### **2. PRE-AWARD COSTS**

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

Upon selection for award negotiations, Applicants may incur pre-award costs at their own risk, consistent with the requirements 2 C.F.R. Part 200, as modified by 2 C.F.R. Part 910, and other

Federal laws and regulations. ARPA-E generally does not accept budgets as submitted with the Full Application. Budgets are typically reworked during award negotiations. ARPA-E is under no obligation to reimburse pre-award costs if, for any reason, the Applicant does not receive an award or the award is made for a lesser amount than the Applicant expected, or if the costs incurred are not allowable, allocable, or reasonable.

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

Please refer to the “Applicants’ Guide to ARPA-E Award Negotiations” ([http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award\\_Negotiations\\_Guide081613.pdf](http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award_Negotiations_Guide081613.pdf)) for additional guidance on pre-award costs.

### **3. PATENT COSTS**

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

The Prime Recipient may request a waiver of the \$30,000 cap. Because all patent costs are considered to be Technology Transfer & Outreach (TT&O) costs (see Section IV.G.8 of the FOA below), the waiver request is subject to review by the ARPA-E Program Director and approval by the Contracting Officer.

### **4. CONSTRUCTION**

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

### **5. FOREIGN TRAVEL**

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



## **6. PERFORMANCE OF WORK IN THE UNITED STATES**

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

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

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

## **7. PURCHASE OF NEW EQUIPMENT**

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

## **8. TECHNOLOGY TRANSFER AND OUTREACH**

By law, ARPA-E is required to contribute a percentage of appropriated funds to Technology Transfer and Outreach (TT&O) activities. In order to meet this mandate every Project Team must spend at least 5% of the Federal funding (i.e., the portion of the award that does not include the recipient's cost share) provided by ARPA-E on TT&O activities to promote and further the development and deployment of ARPA-E-funded technologies. Project Teams may not expend more than 5% of the Total Project Cost on TT&O activities without the prior approval of the Contracting Officer. Project Teams must also seek a waiver from the Contracting Officer to spend less than the minimum 5% TT&O expenditure requirement.

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

- Documented travel and registration for the ARPA-E Energy Innovation Summit and other energy-related conferences and events;
- Documented travel to meet with potential suppliers, partners, or customers;

- Documented work by salaried or contract personnel to develop technology-to-market models or plans;
- Documented costs of acquiring industry-accepted market research reports; and
- Approved patent costs.

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

- Meals or entertainment;
- Gifts to potential suppliers, partners, or customers;
- TT&O activities that do not relate to the ARPA-E-funded technologies;
- Undocumented TT&O activities; and
- TT&O activities unrelated and/or unallocable to the subject award.

Applicants may seek a waiver of the TT&O requirement by including an explicit request in the Business Assurances & Disclosures Form. Please refer to the Business Assurances & Disclosures Form for guidance on the content and form of the waiver request. ARPA-E may waive or modify the TT&O requirement, as appropriate.

For information regarding incorporation of TT&O costs into budget documentation, see Section IV.D.3 of the FOA.

Please refer to the “Applicants’ Guide to ARPA-E Award Negotiations” ([http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award\\_Negotiations\\_Guide081613.pdf](http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award_Negotiations_Guide081613.pdf)) for additional guidance on TT&O requirements.

## **9. LOBBYING**

Prime Recipients and Subrecipients may not use any Federal funds, directly or indirectly, to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. § 1913. This restriction is in addition to those prescribed elsewhere in statute and regulation.

Prime Recipients and Subrecipients are required to complete and submit SF-LLL, “Disclosure of Lobbying Activities” (<http://www.whitehouse.gov/sites/default/files/omb/grants/sflllin.pdf>) if

any non-Federal funds have been paid or will be paid to any person for influencing or attempting to influence any of the following in connection with your application:

- An officer or employee of any Federal agency,
- A Member of Congress,
- An officer or employee of Congress, or
- An employee of a Member of Congress.

## **10. CONFERENCE SPENDING**

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

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

## **H. OTHER SUBMISSION REQUIREMENTS**

### **1. USE OF ARPA-E eXCHANGE**

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

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

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

Applicants are responsible for meeting each submission deadline in ARPA-E eXCHANGE.

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

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

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

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

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

## **V. APPLICATION REVIEW INFORMATION**

### **A. CRITERIA**

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

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

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

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

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

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

- The feasibility of the proposed work, as justified by appropriate background, theory, simulation, modeling, experimental data, or other sound scientific and engineering practices;
- The extent to which the Applicant proposes a sound technical approach to accomplish the proposed R&D objectives, including why the proposed concept is more appropriate than alternative approaches and how technical risk will be mitigated;

- The extent to which project outcomes and final deliverables are clearly defined;
- The extent to which the Applicant identifies techno-economic challenges that must be overcome for the proposed technology to be commercially relevant; and
- The demonstrated capabilities of the individuals performing the project, the key capabilities of the organizations comprising the Project Team, the roles and responsibilities of each organization and (if applicable) previous collaborations among team members supporting the proposed project.

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

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

## 2. CRITERIA FOR FULL APPLICATIONS

Full Applications are evaluated based on the following criteria:

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

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

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

- The extent to which the proposed work is unique and innovative;
- The extent to which project outcomes and deliverables are clearly defined;
- The extent to which the proposed project is likely to satisfy the “Characteristics of the System Model” and “Characteristics of the Control Architecture” identified in Tables 1 and 2, Section I.C this FOA;
- The feasibility of the proposed work based upon preliminary data or other background information and sound scientific and engineering practices and principles;
- The extent to which the Applicant proposes a comprehensive modeling approach, including appropriately defined intermediate milestones and objectives, to accomplish the proposed project objectives; and
- The extent to which the Applicant manages risk, by identifying major technical R&D risks and clearly proposes feasible, effective mitigation strategies.

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

- The extent to which the PI and Project Team have the ability to execute the project plan, evidenced by prior experience that demonstrates an ability to create models and control architectures of similar risk and complexity; and
- The extent to which the Applicant has access to the data, equipment and facilities necessary to accomplish the proposed modeling effort and/or a clear plan to obtain access to necessary data, equipment and facilities.

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

- The extent to which the Applicant presents a plausible plan to manage people and resources;
- The extent to which the Applicant proposes allocation of appropriate levels of effort and resources to proposed tasks;

- Whether the proposed project schedule, including major milestones is reasonable; and
- The appropriateness of the proposed budget to accomplish the proposed project.

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

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

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

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

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

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

- I. **ARPA-E Portfolio Balance.** Project balances ARPA-E portfolio in one or more of the following areas:
  - a. Technological diversity;
  - b. Organizational diversity;
  - c. Geographic diversity;
  - d. Technical or commercialization risk; or
  - e. Stage of technology development.
- II. **Relevance to ARPA-E Mission Advancement.** Project contributes to one or more of ARPA-E's key statutory goals:
  - a. Reduction of US dependence on foreign energy sources;
  - b. Stimulation of domestic manufacturing;
  - c. Reduction of energy-related emissions;
  - d. Increase in U.S. energy efficiency;
  - e. Enhancement of U.S. economic and energy security; or
  - f. Promotion of U.S. advanced energy technologies competitiveness.
- III. **Synergy of Public and Private Efforts.**
  - a. Avoids duplication and overlap with other publicly or privately funded projects;
  - b. Promotes increased coordination with nongovernmental entities for demonstration of technologies and research applications to facilitate technology transfer; or
  - c. Increases unique research collaborations.



- IV. **Low likelihood of other sources of funding.** High technical and/or financial uncertainty that results in the non-availability of other public, private or internal funding or resources to support the project.
- V. **High-Leveraging of Federal Funds.** Project leverages Federal funds to optimize advancement of programmatic goals by proposing cost share above the required minimum or otherwise accessing scarce or unique resources.
- VI. **High Project Impact Relative to Project Cost.**

## **2. ARPA-E REVIEWERS**

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

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

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

## **3. ARPA-E SUPPORT CONTRACTOR**

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

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

### **C. ANTICIPATED ANNOUNCEMENT AND AWARD DATES**

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

## **VI. AWARD ADMINISTRATION INFORMATION**

### **A. AWARD NOTICES**

#### **1. REJECTED SUBMISSIONS**

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

#### **2. CONCEPT PAPER NOTIFICATIONS**

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

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

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

#### **3. FULL APPLICATION NOTIFICATIONS**

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

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

#### ***a. SUCCESSFUL APPLICANTS***

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

Please refer to Section IV.G.2 of the FOA for guidance on pre-award costs. Please also refer to the “Applicants’ Guide to ARPA-E Award Negotiations” ([http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award\\_Negotiations\\_Guide081613.pdf](http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award_Negotiations_Guide081613.pdf)) for guidance on the award negotiation process.

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

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

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

#### ***c. UNSUCCESSFUL APPLICANTS***

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

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

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

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

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

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

By law, Prime Recipients are also required to register with the Federal Funding Accountability and Transparency Act Subaward Reporting System (FSRS) at <https://www.fsrc.gov/>.<sup>48</sup> Prime Recipients are required to report to FSRS the names and total compensation of each of the Prime Recipient's five most highly compensated executives and the names and total compensation of each Subrecipient's five most highly compensated executives. Please refer to <https://www.fsrc.gov/> for guidance on reporting requirements.

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

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

## 2. NATIONAL POLICY ASSURANCES

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

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<sup>18</sup> The Federal Funding Accountability and Transparency Act, P.L. 109-282, 31 U.S.C. 6101 note.

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

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

The Prime Recipient is also required to provide cost share commitment letters from Subrecipients or third parties that are providing cost share, whether cash or in-kind. Each Subrecipient or third party that is contributing cost share must provide a letter on appropriate letterhead that is signed by an authorized corporate representative. Please refer to the “Applicants’ Guide to ARPA-E Award Negotiations” ([http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award\\_Negotiations\\_Guide081613.pdf](http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award_Negotiations_Guide081613.pdf)) for guidance on the contents of cost share commitment letters.

### 4. COST SHARE PAYMENTS<sup>49</sup>

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

ARPA-E generally requires Prime Recipients to contribute the cost share amount incrementally over the life of the funding agreement. Small Businesses see Section III.B.3 of the FOA.

Please refer to the “Applicants’ Guide to ARPA-E Award Negotiations” ([http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award\\_Negotiations\\_Guide081613.pdf](http://www.arpa-e.energy.gov/sites/default/files/documents/files/Award_Negotiations_Guide081613.pdf)) for additional guidance on cost share payment requirements.

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

### 5. ENVIRONMENTAL IMPACT QUESTIONNAIRE

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

To facilitate and expedite ARPA-E’s environmental review, Prime Recipients are required to complete an Environmental Impact Questionnaire during award negotiations. This form is

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<sup>19</sup> Please refer to Section III.B of the FOA for guidance on cost share requirements.

available on ARPA-E eXCHANGE at <https://arpa-e-foa.energy.gov>. The Environmental Impact Questionnaire is due within 21 calendar days of the selection announcement.

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

During award negotiations, Prime Recipients are required to negotiate and submit an initial Technology-to-Market Plan to the ARPA-E Program Director, and obtain the ARPA-E Program Director's approval prior to the execution of the award. Prime Recipients must show how budgeted Technology Transfer and Outreach (TT&O) costs relate to furthering elements of the Technology-to-Market Plan. During the project period, Prime Recipients are required to provide regular updates on the initial Technology-to-Market plan and report on implementation of Technology-to-Market activities. Prime Recipients may be required to perform other actions to further the commercialization of their respective technologies.

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

## **7. INTELLECTUAL PROPERTY MANAGEMENT PLAN**

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

ARPA-E has developed a template for Intellectual Property Management Plans (<http://arpa-e.energy.gov/FundingAgreements/Overview.aspx>) so as to facilitate and expedite negotiations between Project Team members. ARPA-E does not mandate the use of this template. ARPA-E and DOE do not make any warranty (express or implied) or assume any liability or responsibility for the accuracy, completeness, or usefulness of the template. ARPA-E and DOE strongly encourage Project Teams to consult independent legal counsel before using the template.

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

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

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

Small businesses (including Small Business Concerns) that are Prime Recipients or Subrecipients under ARPA-E funding agreements are required to substantially manufacture the following products in the United States for any use or sale in the United States: (1) products embodying subject inventions, and (2) products produced through the use of subject invention(s).<sup>50</sup> This requirement does not apply to products that are manufactured for use or sale outside the U.S. A.

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

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

Large businesses and foreign entities that are Prime Recipients or Subrecipients under ARPA-E funding agreements are required to substantially manufacture the following products in the United States: (1) products embodying subject inventions, and (2) products produced through the use of subject invention(s).<sup>51</sup> This requirement applies to products that are manufactured for use or sale in the United States and outside the United States.

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

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

Domestic educational institutions and nonprofits that are Prime Recipients or Subrecipients under ARPA-E funding agreements must require their exclusive licensees to substantially manufacture the following products in the United States for any use or sale in the United States: (1) articles embodying subject inventions, and (2) articles produced through the use of

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<sup>50</sup> Small businesses are generally defined as domestically incorporated entities that meet the criteria established by the U.S. Small Business Administration's "Table of Small Business Size Standards Matched to North American Industry Classification System Codes" (<http://www.sba.gov/content/small-business-size-standards>).

<sup>51</sup> Large businesses are generally defined as domestically incorporated entities that do not meet the criteria established by the U.S. Small Business Administration's "Table of Small Business Size Standards Matched to North American Industry Classification System Codes" (<http://www.sba.gov/content/small-business-size-standards>).



subject invention(s). This requirement does not apply to articles that are manufactured for use or sale overseas.

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

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

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

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

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

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

- It is not a corporation that has been convicted of a felony criminal violation under any Federal law within the preceding 24 months; and
- It is not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

### **C. REPORTING**

Recipients are required to submit periodic, detailed reports on technical, financial, and other aspects of the project, as described in Attachment 4 to ARPA-E's Model Cooperative Agreement (<http://arpa-e.energy.gov/FundingAgreements/CooperativeAgreements.aspx>).

## **VII. AGENCY CONTACTS**

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

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

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



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

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

ARPA-E will not accept or respond to communications received by other means (e.g., fax, telephone, mail, hand delivery). Emails sent to other email addresses will be disregarded. During the “quiet period,” only the Contracting Officer may authorize communications between ARPA-E personnel and Applicants. The Contracting Officer may communicate with Applicants as necessary and appropriate. As described in Section IV.A of the FOA, the Contracting Officer may arrange pre-selection meetings and/or site visits during the “quiet period.”

## **B. DEBRIEFINGS**

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

## **VIII. OTHER INFORMATION**

### **A. FOAs AND FOA MODIFICATIONS**

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

receive timely notice of any modifications or other announcements. More information is available at <https://www.fedconnect.net>.

**B. OBLIGATION OF PUBLIC FUNDS**

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

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

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

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

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

**D. RETENTION OF SUBMISSIONS**

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

**E. MARKING OF CONFIDENTIAL INFORMATION**

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

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. If the class waiver does not apply, a party may request a waiver in accordance with 10 C.F.R. §784.

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

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

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

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

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

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

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

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

- Social Security Numbers in any form;
- Place of Birth associated with an individual;
- Date of Birth associated with an individual;
- Mother’s maiden name associated with an individual;
- Biometric record associated with an individual;
- Fingerprint;
- Iris scan;
- DNA;
- Medical history information associated with an individual;

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

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

## **IX. GLOSSARY**

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

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

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

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

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

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

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

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

**FOA:** Funding Opportunity Announcement.

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

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

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

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

**PI:** Principal Investigator.

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

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

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

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

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

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

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