

**DEPARTMENT OF ENERGY (DOE)**  
**OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (EERE)**

**HYDROGEN AND FUEL CELL TECHNOLOGIES RESEARCH,  
DEVELOPMENT, AND DEMONSTRATIONS**  
**AREA OF INTEREST 3: CONSORTIUM TOPICS**

**Funding Opportunity Announcement (FOA) Number: DE-FOA-0001412**

**FOA Type: Initial**

**CFDA Number: 81.087**

<b>FOA Issue Date:</b>	12/10/2015
<b>Submission Deadline for Concept Papers:</b>	01/15/2016 5:00pm ET
<b>Submission Deadline for Full Applications:</b>	03/28/2016 5:00pm ET
<b>Expected Submission Deadline for Replies to Reviewer Comments:</b>	04/18/2016 5:00pm ET
<b>Expected Date for EERE Selection Notifications:</b>	Summer 2016
<b>Expected Timeframe for Award Negotiations</b>	August/September 2016

- Applicants must submit a Concept Paper by 5:00pm ET the due date listed above to be eligible to submit a Full Application.
- To apply to this FOA, applicants must register with and submit application materials through EERE Exchange at <https://eere-Exchange.energy.gov>, EERE's online application portal.
- Applicants must designate primary and backup points-of-contact in EERE Exchange with whom EERE will communicate to conduct award negotiations. If an application is selected for award negotiations, it is not a commitment to issue an award. It is imperative that the applicant/selectee be responsive during award negotiations and meet negotiation deadlines. Failure to do so may result in cancellation of further award negotiations and rescission of the Selection.

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# I. FUNDING OPPORTUNITY DESCRIPTION

## A. DESCRIPTION/BACKGROUND

The Fuel Cell Technologies Office (FCTO) is a key component of the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) portfolio. Fuel cells powered by hydrogen from renewable or low-carbon resources can lead to substantial energy savings and reductions in imported petroleum and carbon emissions. The FCTO aims to provide clean, safe, secure, affordable, and reliable energy from diverse domestic resources, providing the benefits of increased energy security and reduced criteria pollutants and green-house gas (GHG) emissions by adopting a technology-neutral approach toward research, development and demonstration (RD&D) to address both key technical challenges for fuel cells and hydrogen fuels (i.e. hydrogen production, delivery and storage) and institutional barriers such as hydrogen codes and standards.

The DOE's goals for hydrogen and fuel cells are driven by the following legislation:

- Energy Policy Act of 2005 (EPAAct 2005) Public Law 109-58, Section 801 et seq.
- Energy Independence and Security Act (EISA) of 2007 (Public Law 110-140)

Section 805, Activities, of EPAAct 2005 states:

The Secretary of Energy, in partnership with the private sector, shall conduct programs to address -

6) Development of safe, durable, affordable, and efficient fuel cells, including fuel-flexible fuel cell power systems, improved manufacturing processes, high-temperature membranes, cost-effective fuel processing for natural gas, fuel cell stack and system reliability, low temperature operation, and cold start capability;

Section 805, Program Goals, of EPAAct states:

3) FUEL CELLS — The goals for fuel cells and their portable, stationary, and transportation applications are to enable —

- A) safe, economical, and environmentally sound hydrogen fuel cells;
- B) fuel cells for light duty and other vehicles; and
- C) other technologies consistent with the Department's plan.

The central mission of FCTO is to enable the widespread commercialization of a portfolio of hydrogen and fuel cell technologies through applied research, technology development and demonstration, and diverse efforts to overcome institutional and market challenges. Fuel cells can address our critical energy challenges in all sectors - commercial, residential, industrial, and transportation. They can use diverse fuels, including biomass-based fuels, natural gas, and hydrogen produced from renewable resources. Fuel cells can be used in a wide range of applications, including near-term markets such as distributed primary and backup power, lift trucks, and portable power; mid-term markets such as residential combined-heat-and-power

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(CHP) systems, auxiliary power units, and fleet vehicles; and longer-term markets such as wide-scale commercialization of light-duty passenger vehicles.

This Funding Opportunity Announcement (FOA) will provide funding up to \$35M in to meet FCTO's goals for Hydrogen Production and Delivery, Hydrogen Storage, Fuel Cell Technologies, Technology Validation, Manufacturing, and Analysis Programs.

This FOA supports two FCTO general objectives:

- (1) To address Research and Development (R&D) technology gaps, drive down cost and improve the performance of fuel cell and hydrogen fuel systems and technologies. This objective will be accomplished by supporting R&D projects focusing on advanced high-temperature water splitting (HTWS) for hydrogen production, advanced compression technologies for delivery infrastructure, and advanced insulation for cryogenic fuel storage for automotive applications. Further, this FOA will support the National Laboratory Consortia Strategy being launched by FCTO. The FOA will support projects that will work with Lab Consortia already established in the areas of fuel cell performance and durability, and advanced hydrogen storage materials. Further efforts in the areas of cost and performance analysis for Fuel Cells, Hydrogen Storage and Hydrogen Production and Delivery will be supported also. More detailed descriptions of the FCTO Program, including technical and cost targets, can be found in the Multi-Year Research, Development and Demonstration Plan (MYRD&D) at <http://www1.eere.energy.gov/hydrogenandfuelcells/mypp/>.
- (2) To encourage early adoption of hydrogen and fuel cell technologies through development, demonstration, and deployment of hydrogen delivery infrastructure and fuel cell electric vehicle (FCEV) technologies. To support this objective the FOA will develop and demonstrate hydrogen infrastructure technologies through component manufacturing. To further encourage early adoption of hydrogen and fuel cell technologies, the FOA will recognize America's Climate Action Champions that are implementing hydrogen and fuel cell technologies.

## **B. TOPIC AREAS/TECHNICAL AREAS OF INTEREST**

### ***Area of Interest 3 (AOI 3): Consortium Topics***

To accelerate the rate of progress in developing technologies to improve the performance and durability of PEM fuel cell systems and to develop advanced hydrogen storage materials for light-duty fuel cell vehicle applications, FCTO has established two collaborative research consortia: Fuel Cell – Performance and Durability (FC-PAD) and Hydrogen Materials – Advanced Research Consortium (HyMARC). Each consortium is comprised of a core team of DOE national laboratories and competitively selected individual projects. Applications submitted in response to topics under this area of interest are for participation in either of two collaborative consortia efforts established by FCTO.

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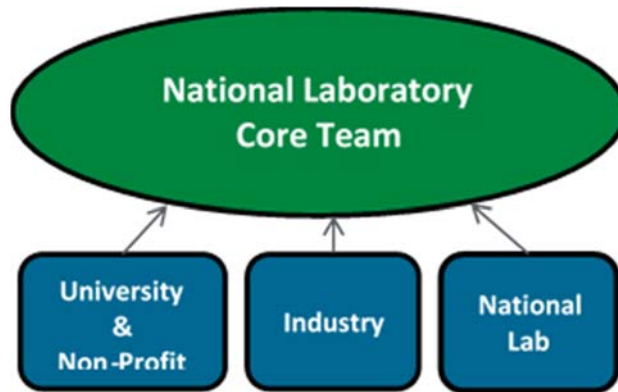


Figure 1: Research Consortia Model

The national laboratory core teams have the responsibility to carry out foundational research and capabilities development, and provide support for the individual projects' research efforts. As a collaborative effort, it is expected that the national laboratory core team will have substantial involvement with each individual project's research effort. Further information about each national lab core team's research program and capabilities are included in the topic descriptions that follow.

Since all projects selected under the topics for this Area of Interest are expected to participate in the relevant consortia, obtaining and including letters of commitment from the national laboratory core team is not required. The core national laboratories for FC-PAD and HyMARC have been funded through the AOP process and are not expected to apply to this FOA as prime or subrecipient applicants.

At a minimum, each selectee under this topic will be required to agree to a non-disclosure agreement with its relevant consortium. For each individual project, the national lab core team and selectee are encouraged to negotiate a Cooperative Research and Development Agreement (CRADA) or Strategic Partnership Project (SPP) agreement if the parties want to address issues beyond those addressed in the non-disclosure agreement.

In addition to standard reporting requirements, projects selected will be required to participate in mandatory meetings of the consortium and provide annual project updates to relevant U.S. DRIVE Technical Teams.

All work under EERE funding agreements must be performed in the United States. See Section IV.J.3 and Appendix C.

### AOI 3, Topic 1: Fuel Cell - Performance and Durability (FC-PAD)

#### Program Background

The goal of the Fuel Cells Program<sup>1</sup> in FCTO is to enable the widespread commercialization of hydrogen and fuel cell technologies through the development of advanced fuel cell technologies with a focus on transportation, as well as enabling stationary and early market applications. The program's R&D efforts address the major challenges to fuel cell commercialization, namely cost and durability.

For fuel cells and fuel cell systems to be commercially viable, significant reduction in cost is required. Materials and manufacturing costs for fuel cell stack, as well as for balance-of-plant (BOP) components and subsystems including air handling and water management, need to be reduced. Low-cost, high-performance ion-exchange membrane electrolytes, high-performance catalysts enabling ultra-low precious metal loading, and lower cost, lighter, corrosion-resistant bipolar plates are required to make fuel cell stacks competitive. Platinum represents one of the largest cost components of a fuel cell, so much of the R&D focuses on approaches that will increase activity and utilization of current platinum group metal (PGM) and PGM-alloy catalysts, as well as PGM-free catalyst approaches for long-term applications.

Fuel cell and fuel cell system performance and efficiency must meet or exceed that of competing technologies to allow for market penetration and the inherent environmental benefits of the technology. To improve fuel cell performance, R&D focuses on the development of materials and components with enhanced efficiency and durability at reduced cost, as well as improving membrane electrode assemblies (MEAs) through integration of state-of-the-art MEA components. R&D also seeks to improve transport in and performance of the MEA by improving the understanding of critical transport issues in the MEA. This includes the development of transport models and in-situ and ex-situ experiments to provide data for model validation. Improvements in fuel cell performance can lead to fuel cell system simplification and elimination or downsizing of BOP components and subsystems and hence to cost reduction.

A key factor in enabling fuel cell commercialization is durability, in terms of a fuel cell system lifetime that will meet application expectations. R&D work funded by DOE and others over the last decade has enabled substantial improvements in fuel cell durability. DOE independent validation of on-road vehicles showed nearly a four-fold increase in the maximum projected durability of fuel cell systems, increasing from 950 hours in 2006 to 3,900 hours in 2015.<sup>2</sup> DOE durability targets for transportation fuel cells are 5,000 hours (equivalent to 150,000 miles of driving) under realistic operating conditions. In the most demanding applications, realistic operating conditions include impurities in the fuel and air, starting and stopping, freezing and thawing, and humidity and load cycles that result in stresses on the chemical and mechanical stability of the fuel cell system materials and components. R&D focuses on understanding the

<sup>1</sup> DOE Fuel Cell Program website: <http://energy.gov/eere/fuelcells/fuel-cells>

<sup>2</sup> Jennifer Kurtz et. al., "Spring 2015 Fuel Cell Vehicle Evaluation Results", CDP#21: "Operation Hours and Projected Hours to 10% Voltage Drop", [http://www.nrel.gov/hydrogen/images/cdp\\_fcev\\_21.jpg](http://www.nrel.gov/hydrogen/images/cdp_fcev_21.jpg)

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fuel cell degradation mechanisms and developing materials and strategies that will mitigate them.

Fuel cell vehicles can lead to substantial energy savings and reductions in imported petroleum and carbon emissions. To realize these benefits, DOE has established technical targets in the Fuel Cells section (3.4) of the FCTO MYRD&D Plan.<sup>3</sup> The DOE targets and testing protocols for automotive applications were developed in collaboration with automotive manufacturers, such as the U.S. DRIVE Partnership. 2020 targets will allow light-duty hydrogen FCEV platforms to meet customer expectations and to compete with incumbent and alternative technologies on a lifecycle cost basis in the respective timeframe. The Fuel Cells program's objective is to develop, by 2020, a 65% peak-efficient, 5,000 hour durable, direct hydrogen fuel cell power system for transportation that can be mass produced at a cost of \$40/kW. Currently, the cost of an 80-kW<sub>net</sub> automotive PEM fuel cell system based on next-generation laboratory technology and operating on direct hydrogen is projected to be \$53/kW<sub>net</sub> when manufactured at a volume of 500,000 units/year and \$60/kW<sub>net</sub> at a volume of 100,000 units/year.<sup>4</sup> The expected cost of automotive PEM fuel cell systems based on current technology, planned for commercialization in the 2016 time frame, is approximately \$280/kW when manufactured at a volume of 20,000 units/year.<sup>5</sup>

To meet all customer expectations across the full range of light-duty hydrogen fuel cell vehicle platforms, DOE has established an ultimate cost target for direct-hydrogen fuel cell power systems to be mass-produced at \$30/kW.

### **FC-PAD Consortium Background**

The existing FC-PAD consortium consists of a consortium Lead (Los Alamos National Laboratory), a Deputy Lead (Lawrence Berkeley National Laboratory), and several Technical Partners (Argonne National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory) that will conduct the foundational technical scope of work of the consortium. This topic will incorporate innovations from the broader R&D community into the FC-PAD consortium, aiding in the understanding of – and leading to significant improvements in – fuel cell performance and durability. Updated targets and protocols relevant to FC-PAD are shown in Appendix F. These include:

- Table 3.4.3 Technical Targets: 80-kW<sub>e</sub> (net) Integrated Transportation Fuel Cell Power Systems Operating on Direct Hydrogen
- Table 3.4.5 Technical Targets: Membrane Electrode Assemblies
- Table 3.4.7 Technical Targets: Electrocatalysts for Transportation Applications
- Table 3.4.8 Technical Targets: Bipolar Plates

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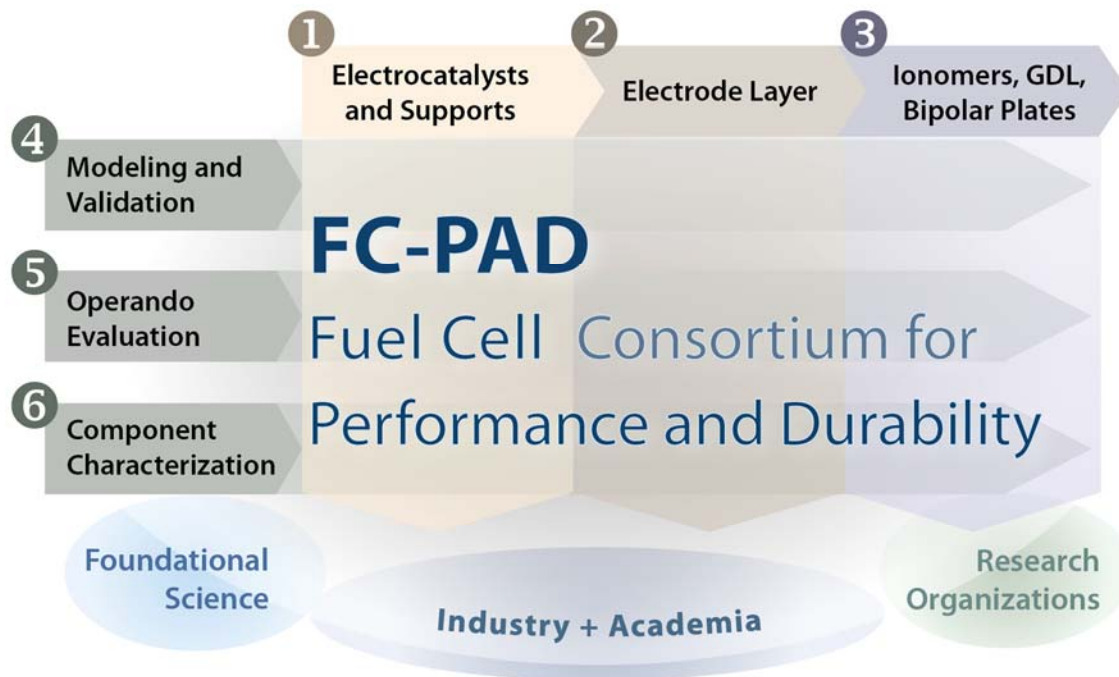
<sup>3</sup> FCTO MYRD&D Plan website: <http://energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22>

<sup>4</sup> [http://www.hydrogen.energy.gov/pdfs/15015\\_fuel\\_cell\\_system\\_cost\\_2015.pdf](http://www.hydrogen.energy.gov/pdfs/15015_fuel_cell_system_cost_2015.pdf)

<sup>5</sup> D. Green, "Status and Prospects of the Global Automotive Fuel Cell Industry and Plans for Deployment of Fuel Cell Vehicles and Hydrogen Refueling Infrastructure," 2013.

- Table 3.4.17 Testing Protocol: Electrocatalyst Cycle and Metrics
- Table 3.4.18 Testing Protocol: Catalyst Support Cycle and Metrics
- Table 3.4.19 Testing Protocol: MEA Chemical Stability and Metrics (Test Using a MEA)
- Table 3.4.20 Testing Protocol: Membrane Mechanical Cycle and Metrics (Test Using a MEA)
- Table 3.4.21 Testing Protocol: Polarization Protocol
- Table 3.4.22 Testing Protocol: Drive Cycle Durability Protocol
- Table 3.4.23 Testing Protocol: Unmitigated Startup/Shutdown Durability Protocol

FC-PAD's activities are coordinated across six different thrust areas: three component-specific areas and three cross-cutting efforts between subject areas, as shown in Figure 2. The component thrusts are shown as 1 through 3: (1) electrocatalysts and supports, (2) electrode layers, and (3) ionomer, gas diffusion layers, and bipolar plates. The cross-cutting 'technique' thrusts are shown as 4 through 6: (4) modeling and validation, (5) operando evaluation and benchmarking, including accelerated stress tests and contaminant testing/tolerance, and (6) component characterization and diagnostics. These cross-cutting technique thrusts will be developed within FC-PAD and applied to the component thrusts as innovation in those thrusts are brought forth.



Lead: Rod Borup (LANL)

Deputy Lead: Adam Z. Weber (LBNL)



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Figure 2. FC-PAD Thrust Areas

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Each thrust area will be coordinated by a senior technical staff scientist, with representation from each of the participating laboratories, as shown in Table 1.

Table 1. National Lab involvement within thrust areas of FC-PAD

Thrust Areas	ANL	LBNL	LANL	NREL	ORNL
1. Electrocatalysts and Supports	X		X		
2. Electrode Layers	X	X	X	X	
3. Ionomers, Gas Diffusion Layers, Bipolar Plates, Interfaces		X	X		
4. Modeling and Validation	X	X			
5. Operando Evaluation: Benchmarking, ASTs, and Contaminants			X		
6. Component Characterization and Diagnostics	X	X	X		X

**In order to understand more about FC-PAD, including the capabilities of the FC-PAD core consortium that are available to applicants for partnering with under this FOA, PowerPoint slides are available.**<sup>6</sup> A webinar will also be conducted so that applicants can more fully understand the resources that are available.

### Applications

Applications are sought in the areas of fuel cell performance and durability, with focus on low platinum group metal (PGM) containing PEMFCs, by expanding the existing national laboratory consortium FC-PAD (See Figure 1 above for Research Consortia Model). Project teams will collaborate with the FC-PAD national laboratory core team, which was formed to bring together national laboratories with demonstrated leadership in the topic area, creating a high-functioning team to advance both fundamental understanding and applied research, leading to improved designs and better performing fuel cell systems. Applicants should propose 2-4 year projects for up to \$3,000,000 DOE share. Applications should be at Technology Readiness Levels of 2-4, and the funding request should be commensurate with the level of work proposed. For additional information on TRLs please see Appendix E.

Applicants must address include how FC-PAD's core consortium team will be engaged, specifically including which thrust area(s) of FC-PAD the application is addressing, and which national labs and capabilities are necessary for the project.

Applicants are expected to provide data and materials to support FC-PAD activities. As part of the project, each applicant will be required to agree to a non-disclosure agreement with the FC-PAD Core Consortium that will govern the treatment of information shared between the applicant and the consortium. Quantitative metrics must be included in the application in the form of annual go/no-go decision points. A final deliverable of the project is to deliver materials to the FC-PAD core consortium for testing. The applicant should propose the deliverable that

<sup>6</sup> FC-PAD website: <http://energy.gov/eere/fuelcells/fc-pad>

makes the most sense for their specific project, but DOE prefers an MEA of at least 50 cm<sup>2</sup>. Applicants are also expected to participate in person at bi-annual FC-PAD working group meetings.

**Performance:** Fuel cell performance at high power defines system size requirements and, therefore, greatly impacts cost. Performance of polymer electrolyte membrane fuel cells (PEMFCs) at high power is limited by inefficient mass transport, especially for systems with the low catalyst loadings necessary to approach DOE cost targets. Mass transport issues can also limit performance at other points in the operation cycle, such as during cold operation and during some transients. However, it is difficult to predict or model the local transport due to an inadequate understanding of the structure and properties of the components of interest (catalyst layers, gas diffusion layers (GDLs), and micro-porous layers (MPLs)). A better understanding of the local structures and conditions and how they affect mass transport in the fuel cell can lead to improved designs and better performing systems. FCTO seeks applications that will improve understanding of critical transport issues in the membrane electrode assembly (MEA) and improve transport in and performance of the MEA. Topics of interest include:

- Research on electrode structure-function relationships through characterization of electrode ink structure and properties and correlation with resulting electrode microstructure and performance, as well as through characterization of ionomer/catalyst interactions, including site blocking, local transport phenomena at the interface, and effect of relative humidity on transport properties.
- Development of electrode structures that have high performance during operation at high current density
- Integration of advanced materials and components into high-performance, durable MEAs

Improvements may include faster O<sub>2</sub> transport, increased protonic conductivity, improved dispersion on catalyst surfaces, decreased catalyst active site blockage by ionomer or ionomer degradation products, and improved durability. Applicants are also encouraged to propose new electrode structures, with or without ionomer, that have improved transport properties. Electrode integration issues and risks, along with risk mitigation strategies, should be described. Applicants should address any known mass transport issues that may arise (e.g., flooding issues that decrease access to catalysts at low temperature). MEA cost and durability should also be addressed.

**Durability:** Durability of PEMFCs, especially of those with catalyst loadings that have potential to simultaneously meet the DOE cost and performance targets, is still insufficient to meet the DOE targets of 5,000 hours for transportation and 60,000 - 80,000 hours for stationary applications (under realistic operating conditions). In the most demanding applications, these conditions include operation in the presence of fuel and air impurities, starting and stopping, freezing and thawing, and humidity and load cycling that result in mechanical and chemical stresses on fuel cell materials, components, and interfaces. MEA durability decreases with

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decreasing PGM loading, making it all the more difficult to meet durability targets while also meeting cost and PGM loading targets. Proposed approaches should increase understanding of degradation in new and state-of-the-art material sets and improve durability of lower-cost fuel cells under realistic conditions. R&D is needed to improve understanding of degradation of advanced fuel cell materials and components. The results are intended to guide component, cell, and stack development efforts to improve durability by identifying degradation mechanisms and developing mitigation strategies.

Topics of interest include:

- The effect of low PGM loading on durability and methods to improve the durability of low-PGM MEAs
- Component microstructure stability in the three-phase region of reactant gas, electrolyte, and catalyst and the impact of microstructure on durability
- Catalyst layer stability, including support stability and methods to decrease support corrosion and compaction while maintaining appropriate pore structure
- Correlation of durability to local cell operating conditions
- Durability/aging and evolution of transport properties and phenomena
- Materials-based solutions to decrease degradation during stop/start and cell reversal events
- Characterization of degradation phenomena in state-of-the-art membranes

Improvements may include reduced electrode layer degradation, including improved durability from catalyst/support and catalyst/membrane interactions. MEA durability is a primary concern, but durability of other stack components is of interest as well. Applications should describe any issues and risks, along with risk mitigation strategies, that may arise from their approach. MEA cost and performance should also be addressed.

### **AOI 3, Topic 2: Hydrogen Storage Materials Discovery (HyMARC)**

#### **Program Background**

The goal of the DOE Hydrogen Storage Program<sup>7</sup> is to enable the widespread commercialization of hydrogen and fuel cell technologies through the development of advanced hydrogen storage technologies that can provide adequate hydrogen storage to meet the application demands. Full commercialization of hydrogen-fueled FCEVs will require development of lightweight, compact, and cost-competitive hydrogen storage technologies that enable longer driving ranges while meeting other performance requirements, including not restricting passenger and cargo space. While hydrogen has the highest energy content per unit weight of any fuel, it has very low energy content per unit volume. This poses a challenge as increasing the energy content per unit volume for gaseous hydrogen storage requires either very high pressures or low temperatures. However, materials that bond to, or adsorb hydrogen, have potential to enable storage at high density in a compact container and at lower pressures. While the energy

<sup>7</sup> DOE Hydrogen Storage Program website: <http://www.energy.gov/eere/fuelcells/hydrogen-storage>

density challenge exists for all fuel cell installations that use hydrogen, the problem is most acute for light-duty vehicles where the storage systems must: operate within stringent size, weight and cost constraints; enable a driving range of more than 300 miles (generally regarded as the minimum for widespread driver acceptance based on the performance of today's gasoline vehicles); and refuel at ambient temperatures in less than five minutes to meet drivers' expectations. Commercial FCEVs are being released today that use high-pressure 700 bar hydrogen storage onboard, and the hydrogen fuel infrastructure is being installed to support fast fueling of 700 bar onboard hydrogen storage. The high-pressure tanks are significantly more expensive, larger and heavier than conventional gasoline or diesel fuel tanks. While some vehicles have achieved a 300-mile range, high-pressure hydrogen storage systems may not be able to provide the driving range and costs consumers will accept across the full range of light-duty vehicle platforms. In addition, the costs associated with high-pressure fast fueling adds significant costs to the hydrogen fuel. Therefore, to maximize the use of hydrogen as a zero-carbon fuel for transportation, advanced hydrogen storage technologies are sought. To meet the objectives for light-duty FCEVs, DOE has developed, in collaboration with automotive manufacturers, such as through the U.S. DRIVE partnership, a comprehensive set of technical targets for onboard hydrogen storage systems. The full set of technical targets is included in Appendix G and available online.<sup>8</sup> Interim 2020 targets will allow some light-duty hydrogen FCEV platforms to meet customer expectations. To meet all customer expectations across the full range of light-duty hydrogen fuel cell vehicle platforms, the Ultimate Full Fleet targets will be required.

Three overarching performance targets for onboard hydrogen storage systems noted in Appendix G are: gravimetric capacity; volumetric capacity; and system cost. For 2020, the targets are 1.8 kWh/kg (5.5 wt.% H<sub>2</sub>), 1.3 kWh/L (40 g H<sub>2</sub>/L), and \$10/kWh (\$333/kg H<sub>2</sub> stored) and the Ultimate Full Fleet targets are 2.5 kWh/kg (7.5 wt.% H<sub>2</sub>), 2.3 kWh/L (70 g H<sub>2</sub>/L), and \$8/kWh (\$267/kg H<sub>2</sub> stored). As an example of the challenges these system targets represent, hydrogen gas alone (not including the tank) at 700 bar pressure and ambient temperature has a density of approximately 40 g/L, and thus is theoretically not able to meet the 2020 system level volumetric target when the volume of the tank and rest of the system is included. Additionally, liquid hydrogen alone at its normal boiling point of 20 K has a density of 71 g/L, and consequently, when the volume contribution of the remainder of the system is included, liquid hydrogen is theoretically not able to meet the Ultimate Full Fleet volumetric target for the full system. For these reasons, the program is focused on the development of advanced materials-based storage technologies which have the theoretical potential to meet all onboard storage system targets simultaneously. Especially those that might also ease the burden imposed on and the cost of the emerging hydrogen fueling infrastructure. Previous efforts included three material-based "Centers of Excellence," which operated from 2005 through

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<sup>8</sup> Onboard storage targets for light-duty vehicles: <http://energy.gov/eere/fuelcells/doe-hydrogen-storage-technical-performance-targets-light-duty-vehicles>

2010, each focusing on a specific material class.<sup>9,10,11</sup> The program also advanced the state-of-the-art of hydrogen storage systems through the Hydrogen Storage Engineering Center of Excellence (HSECoE)<sup>12</sup>, which operated between 2009 and 2015. These efforts provided a solid foundation for defining the minimum balance-of-plant (BOP) requirements for material-based storage systems, identifying performance gaps of each type of system, and developing and refining models that enable the hydrogen storage community to determine the basic material properties required for hydrogen storage materials to meet all of the DOE onboard targets simultaneously. Results from the efforts of “reverse engineering” the material property requirements from full system performance models have been publically disseminated.<sup>13,14,15,16</sup> Applications for R&D projects under this topic are expected to address these requirements, including but not limited to the necessary thermodynamic, kinetic, and capacity properties, in their proposals for the development of advanced onboard rechargeable hydrogen storage materials.

As an example, “reverse engineering” analyses from full system performance has shown that an onboard rechargeable metal hydride with an enthalpy of hydrogen release of around 27 kJ/mol of H<sub>2</sub> and sufficient kinetics at a temperature less than the waste heat of a PEM fuel cell (i.e., ≤80 °C), must have a usable material gravimetric capacity of at least 11 wt.%. If either the hydrogen release thermodynamics is greater, or the kinetics are slower (such that consuming some of the stored hydrogen is required to provide additional heat/temperature), then even higher gravimetric capacities are required.<sup>16</sup> At a minimum, all applications must include targeted material property metrics for volumetric and gravimetric capacity, kinetics, and thermodynamics in addition to other key performance targets, regardless of material type. Applications focused on a single material property (e.g., material’s gravimetric capacity) will be deemed unresponsive.

### Consortium Background

The HyMARC national laboratory core team, composed of Sandia, Lawrence Livermore and Lawrence Berkeley National Laboratories, is tasked with carrying out foundational research to understand the interaction of hydrogen with materials in relation to the formation and release of hydrogen from hydrogen storage materials. This effort includes the development of computational material design tools, synthetic and characterization methodologies, and online

<sup>9</sup> Metal Hydride Center of Excellence Final Report:

[http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/metal\\_hydride\\_coe\\_final\\_report.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/metal_hydride_coe_final_report.pdf)

<sup>10</sup> Chemical Hydrogen Storage Center of Excellence Final Report:

[http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/chemical\\_hydrogen\\_storage\\_coe\\_final\\_report.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/chemical_hydrogen_storage_coe_final_report.pdf)

<sup>11</sup> Hydrogen Sorption Center of Excellence Final Report:

[http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/hydrogen\\_sorption\\_coe\\_final\\_report.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/hydrogen_sorption_coe_final_report.pdf)

<sup>12</sup> Hydrogen Storage Engineering Center of Excellence website: <http://hsecoe.srs.gov/>

<sup>13</sup> R.K. Ahluwalia, et al. IJHE, 2015 <http://www.sciencedirect.com/science/article/pii/S0360319915005935>

<sup>14</sup> R.K. Ahluwalia, et al. IJHE, 2014 <http://www.sciencedirect.com/science/article/pii/S0360319914020114>

<sup>15</sup> T.A. Semelsberger, et al. J. Power Sources, 2015

<http://www.sciencedirect.com/science/article/pii/S0378775315000415>

<sup>16</sup> J.M. Pasini, et. al. IJHE, in press, 2013 <http://www.sciencedirect.com/science/article/pii/S0360319912019623>

databases of hydrogen storage materials properties and computational data. Further information on the national laboratory core team's work plans and capabilities can be found on the DOE Hydrogen Storage Program website.<sup>17</sup> Projects selected under this topic will work with the national laboratory core team on the development and characterization of the proposed hydrogen storage material systems.

In addition to the HyMARC national laboratory core team, the DOE Hydrogen Storage Program has other resources to assist the research efforts of the selected project teams. To aid researchers in employing reliable material property measurement techniques, researchers are referred to DOE's "Recommended Best Practices for the Characterization of Storage Properties of Hydrogen Storage Materials" document.<sup>18</sup> This document provides an introduction and overview of the recommended best practices in making measurements of hydrogen storage material properties and is suggested reading prior to initiating hydrogen storage materials development activities. The DOE has established a searchable online hydrogen storage materials database as repository for the comprehensive collection of hydrogen storage material properties developed through DOE supported R&D efforts and is part of the President's Materials Genome Initiative.<sup>19</sup> Additionally, DOE is supporting a team of Federally Funded Research and Development Centers (FFRDCs) that have advanced characterization capabilities so that they are readily accessible to research teams supported by the Program. The FFRDCs include the National Renewable, Pacific Northwest and Lawrence Berkeley National Laboratories and the NIST Center for Neutron Research. The available characterization capabilities available are described on the DOE Hydrogen Storage Program's website.<sup>20</sup> These capabilities can be available for validation measurements, unique measurements that are not readily available outside the FFRDCs and when critical for the supported research effort. These capabilities are not for performance of routine measurements for a supported research project.

The HyMARC national laboratory core team's efforts and the FFRDC characterization capabilities are available to all supported research projects selected under this topic and therefore applicants do not need to contact or request letters of commitment for inclusion in their proposals.

### **Applications**

FCTO solicits applications for the discovery of novel, advanced onboard-rechargeable hydrogen storage materials so that complete systems have the potential to meet the DOE 2020 and Ultimate Full Fleet onboard vehicle storage targets specified in Appendix G. Project teams will collaborate with the HyMARC national laboratory core team. As part of the project, each applicant will be required to agree to a non-disclosure agreement with the HyMARC Consortium that will govern the treatment of information shared between the applicant and the national laboratory core team. Projects should be planned as multi-phase efforts,

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<sup>17</sup> <http://energy.gov/eere/fuelcells/hymarc>

<sup>18</sup> DOE's "Recommended Best Practices for the Characterization of Storage Properties of Hydrogen Storage Materials," [http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/best\\_practices\\_hydrogen\\_storage.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/best_practices_hydrogen_storage.pdf)

<sup>19</sup> About the Materials Genome Initiative: <http://www.whitehouse.gov/mgi>

<sup>20</sup> <http://energy.gov/eere/fuelcells/downloads/hydrogen-storage-rd-core-characterization-capabilities>

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\$1,000,000 maximum funding and for a two to three year total duration, with a quantitative Go/No-Go decision point between each phase. **Phase 1 should be planned for a maximum of \$250,000 and for a 12-18 month duration to demonstrate the feasibility of the proposed material concept. The DOE will initially commit to fund phase 1 only; commitment to fund subsequent phases will only be made after the project team has demonstrated meeting the agreed upon quantitative phase 1 Go/No-Go criteria.** The DOE is looking for innovative, high-risk, high-payoff concepts for hydrogen storage materials development to meet the challenging demands of automotive applications. As a result, it is expected that a substantial percentage of selected projects will not achieve their phase 1 Go/No-Go criteria and will not continue to be supported beyond phase 1.

Applications must describe novel research on innovative materials to address the needs for onboard rechargeable hydrogen storage. The applications should also describe in detail the material concepts and include targeted performance metrics for the materials that address the critical properties identified through “reverse engineering” from the system level performance.<sup>15,16,15,16</sup> The work plan should be multi-phase, with phase 1 planned for 12-18 months to demonstrate the feasibility of the materials concept. Quantitative metrics must be included for a Go/No-Go decision at the end of phase 1 that provide confidence that the proposed materials concept has reasonable potential to result in a hydrogen storage material capable of meeting automotive performance requirements. DOE will initially commit to only fund phase 1 of all projects selected under this topic. Projects will need to demonstrate they meet the agreed upon quantitative performance criteria for the phase 1 Go/No-Go decision before support for additional phases will be committed. The DOE is looking for novel, high-risk, high-payoff proposals and anticipates that only a small percentage will meet their phase 1 Go/No-Go criteria and be supported for additional phases.

The first phase of the project must include synthesis and characterization of the proposed materials, following guidance provided through computational efforts with the national laboratory core team. Materials must demonstrate the potential to meet several specified metrics, which may include reversible volumetric and gravimetric capacities, (de)sorption kinetics within reasonable pressure and temperature ranges, and thermodynamics, to have the potential to meet the overall set of material property metrics and function within the operating conditions onboard FCEVs. DOE may require that samples of materials developed be sent to a third party laboratory specified by DOE for independent material evaluation and testing.

The following technologies will not be accepted under this topic based on previous No-Go decisions by FCTO: hydrolysis of sodium borohydride<sup>21</sup>; pure, undoped single-walled carbon nanotubes<sup>22</sup>; and onboard fuel processing (hydrocarbon fuels that are reformed onboard to

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<sup>21</sup> Go/No-Go Decision: Sodium Borohydride for Onboard Vehicular Hydrogen Storage:  
<http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/42220.pdf>

<sup>22</sup> Go/No-Go Decision: Pure, Undoped Single Wall carbon nanotubes for Vehicular Hydrogen Storage:  
[http://www.hydrogen.energy.gov/pdfs/go\\_no\\_go\\_nanotubes.pdf](http://www.hydrogen.energy.gov/pdfs/go_no_go_nanotubes.pdf)

produce hydrogen and carbon dioxide).<sup>23</sup> In addition, DOE is not interested in concepts relying *solely* on hydrogen storage enhancement via the weak-chemisorption or “spillover” mechanism.<sup>24</sup> Applications in these areas will be deemed non-responsive and will not be reviewed. Systems that were discontinued for investigation by the three DOE Hydrogen Storage Material Centers of Excellence (final reports referenced above)<sup>9,10,11</sup> are also not solicited unless a new approach has been developed that addresses the reasons why the subject material was discontinued for R&D.

### C. APPLICATIONS SPECIFICALLY NOT OF INTEREST

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

Applications that fall outside the technical parameters specified in Section I.B of AOI 3 of this FOA, including but not limited to non-PGM catalyst durability and performance R&D; phosphoric and phosphoric-acid-based fuel cells, alkaline membrane fuel cells, direct methanol fuel cells, solid oxide fuel cells, and molten carbonate fuel cells for Topic 1; catalyst and membrane R&D for Topic 1 as the DOE funds separate activities in these areas; hydrolysis of sodium borohydride ; pure, undoped single-walled carbon nanotubes ; and onboard fuel processing (hydrocarbon fuels that are reformed onboard to produce hydrogen and carbon dioxide); concepts relying solely on hydrogen storage enhancement via the weak-chemisorption or “spillover” mechanism; systems that were discontinued for investigation by the three DOE Hydrogen Storage Material Centers of Excellence (final reports referenced above) for AOI 3 Topic 2.

- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).

### D. AUTHORIZING STATUTES

The programmatic authorizing statute is EPACT 2005, Title VIII – Hydrogen, Public Law 109-58 (Aug. 8, 2005).

Awards made under this announcement will fall under the purview of 2 CFR Part 200 as amended by 2 CFR Part 910.

<sup>23</sup> Go/No-Go Decision: Onboard Fuel Processing:

[http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/committee\\_report.pdf](http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/committee_report.pdf)

<sup>24</sup> H. Oh, et. al., Micorpor. Mesopor. Mater., 2013

<http://www.sciencedirect.com/science/article/pii/S1387181113002229>

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## II. AWARD INFORMATION

### A. AWARD OVERVIEW

#### 1. ESTIMATED FUNDING

EERE expects to make approximately \$13 million of Federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 7-16 awards under this FOA. EERE may issue one, multiple, or no awards.

Individual awards may vary between \$1 million (\$250 thousand maximum for phase 1 for topic 2 awards) and \$3 million.

EERE may issue awards in one, multiple, or none of the topic areas addressed in Table 2 below:

**Table 2: Anticipated Funding and Award Details**

Topic Area	Anticipated Number of Awards	Max. Federal Funding per Award	Maximum Project Duration (years)	Minimum Required non-Federal Cost Share %
<b>Topic 1:</b> Fuel Cell - Performance and Durability (FC-PAD)	2-6	\$3,000,000	4	20%*
<b>Topic 2:</b> Hydrogen Storage Materials Discovery (HyMARC)	5-10	\$1,000,000 (\$250,000 phase 1)	3	20%*

\*A special cost share reduction determination is available for domestic institutions of higher education, domestic nonprofit entities, FFRDCs, and U.S. State, local, and tribal government entities

EERE may establish more than one budget period for each award and fund only the initial budget period(s). Funding for all budget periods, including the initial budget period, is not guaranteed.

Projects awarded through topic 2 will be funded for a single 12-18 month budget period at a maximum amount of \$250,000, continuation for additional phases will be contingent on meeting agreed upon quantitative go/no-go criteria for budget period 1.

#### 2. PERIOD OF PERFORMANCE

EERE anticipates making awards with durations that vary by topic, as shown in Table 2 above. Project continuation will be contingent upon satisfactory performance and go/no-go decision review. At the go/no-go decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, EERE will make a determination to continue the project, re-direct the project, or discontinue

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funding the project. Only those projects demonstrating a high probability of successfully meeting the program targets will be continued. Projects for AOI 3 Topic 2 will be funded for a single 12-18 month phase, continuation for additional phases will be contingent on meeting agreed upon quantitative go/no-go criteria for budget period 1.

### **3. NEW APPLICATIONS ONLY**

EERE will accept only new applications under this FOA. EERE will not consider applications for renewals of existing EERE-funded awards through this FOA.

## **B. EERE FUNDING AGREEMENTS**

Through Cooperative Agreements and other similar agreements, EERE provides financial and other support to projects that have the potential to realize the FOA objectives. EERE does not use such agreements to acquire property or services for the direct benefit or use of the United States Government.

### **1. COOPERATIVE AGREEMENTS**

EERE generally uses Cooperative Agreements to provide financial and other support to Prime Recipients.

Through Cooperative Agreements, EERE provides 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.

EERE has substantial involvement in all projects funded via Cooperative Agreement. See Section VI.B.9 of the FOA for more information on what substantial involvement may involve.

### **2. FUNDING AGREEMENTS WITH FFRDCs**

In most cases, Federally Funded Research and Development Centers (FFRDC) are funded independently of the remainder of the Project Team. The FFRDC then executes an agreement with any non-FFRDC Project Team members to arrange work structure, project execution, and any other matters. Regardless of these arrangements, the entity that applied as the Prime Recipient for the project will remain the Prime Recipient for the project.

### **3. GRANTS**

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

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#### 4. TECHNOLOGY INVESTMENT AGREEMENTS

In rare cases and if determined appropriate, EERE will consider awarding a Technology Investment Agreement (TIA) to a non-FFRDC applicant. TIAs, governed by 10 CFR Part 603, are assistance instruments used to increase the involvement of commercial entities in the Department's research, development, and demonstration programs. A TIA may be either a type of cooperative agreement or an assistance transaction other than a cooperative agreement, depending on the intellectual property provisions. In both cases, TIAs are not necessarily subject to all of the requirements of 2 CFR Part 200 as amended by 2 CFR Part 910.

In a TIA, EERE may modify the standard Government terms and conditions, including but not limited to:

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

EERE will be more amenable to awarding a TIA in support of an application from a consortium or a team arrangement that includes cost sharing with the private sector, as opposed to an application from a single organization. Such a consortium or teaming arrangement could include a FFRDC. If a DOE/NNSA FFRDC is a part of the consortium or teaming arrangement, the value of, and funding for the DOE/NNSA FFRDC portion of the work will be authorized and funded under the DOE field work authorization system and performed under the laboratory's Management and Operating contract. Funding for a non-DOE/NNSA FFRDC would be through an interagency agreement under the Economy Act or other statutory authority. Other appropriate contractual accommodations, such as those involving intellectual property, may be made through a "funds in" agreement to facilitate the FFRDCs participation in the consortium or teaming arrangement. If a TIA is awarded, certain types of information described in 10 CFR 603.420(b) are exempt from disclosure under the Freedom of Information Act for five years after DOE receives the information.

An applicant may request a TIA if it believes that using a TIA could benefit the RD&D objectives of the program (see section 603.225) and can document these benefits. If an applicant is seeking to negotiate a TIA, the applicant must include an explicit request in its Full Application. After an applicant is selected for award negotiation, the Contracting Officer will determine if awarding a TIA would benefit the RD&D objectives of the program in ways that likely would not happen if another type of assistance agreement (e.g., cooperative agreement subject to the requirements of 2 CFR Part 200 as amended by 2 CFR Part 910). The Contracting Officer will use the criteria in 10 CFR 603, Subpart B, to make this determination.

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### **III. ELIGIBILITY INFORMATION**

To be considered for substantive evaluation, an applicant's submission must meet the criteria set forth below. If the application does not meet these initial requirements, it will be considered non-responsive, removed from further evaluation, and ineligible for any award.

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

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

U.S. citizens and lawful permanent residents are eligible to apply for funding as a Prime Recipient or Subrecipient.

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

For-profit entities, educational institutions, and nonprofits that are incorporated (or otherwise formed) under the laws of a particular State or territory of the United States are eligible to apply for funding as a Prime Recipient or Subrecipient. 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.

State, local, and tribal government entities are eligible to apply for funding as a Prime Recipient or Subrecipient.

DOE/NNSA Federally Funded Research and Development Centers (FFRDCs) are eligible to apply for funding as a Prime Recipient or Subrecipient.

Non-DOE/NNSA FFRDCs are eligible to apply for funding as a Subrecipient, but are not eligible to apply as a Prime Recipient.

Federal agencies and instrumentalities (other than DOE) are eligible to apply for funding as a Subrecipient, but are not eligible to apply as a Prime Recipient.

##### **3. FOREIGN ENTITIES**

Foreign entities, whether for-profit or otherwise, are eligible to apply for funding under this FOA. Other than as provided in the "Individuals" or "Domestic Entities" sections above, all Prime Recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. If a foreign entity applies for funding as a Prime Recipient, it must designate in the Full Application a subsidiary or affiliate incorporated (or otherwise formed) under the laws of a State or territory of the United States to be the Prime Recipient. The Full Application must state the nature of the corporate relationship between the foreign entity and domestic subsidiary or affiliate.

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Foreign entities may request a waiver of the requirement to designate a subsidiary in the United States as the Prime Recipient in the Full Application (i.e., a foreign entity may request that it remains the Prime Recipient on an award). To do so, the Applicant must submit an explicit written waiver request in the Full Application. Appendix C lists the necessary information that must be included in a request to waive this requirement. The applicant does not have the right to appeal EERE's decision concerning a waiver request.

In the waiver request, the applicant must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to have a foreign entity serve as the Prime Recipient. EERE may require additional information before considering the waiver request.

A foreign entity may receive funding as a Subrecipient. However, see section IV. D. parts 12 and 13 on performance of work in the United States and Manufacturing Plans.

#### **4. INCORPORATED CONSORTIA**

Incorporated consortia, which may include domestic and/or foreign entities, are eligible to apply for funding as a Prime Recipient or Subrecipient. For consortia incorporated (or otherwise formed) under the laws of a State or territory of the United States, please refer to "Domestic Entities" above. For consortia incorporated in foreign countries, please refer to the requirements in "Foreign Entities" above.

Each incorporated consortium must have an internal governance structure and a written set of internal rules. Upon request, the consortium must provide a written description of its internal governance structure and its internal rules to the EERE Contracting Officer.

#### **5. UNINCORPORATED CONSORTIA**

Unincorporated Consortia, which may include domestic and foreign entities, must designate one member of the consortium to serve as the Prime Recipient/consortium representative. The Prime Recipient/consortium representative must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. The eligibility of the consortium will be determined by the eligibility of the Prime Recipient/consortium representative under Section III.A of the FOA.

Upon request, unincorporated consortia must provide the EERE 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;

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- Provisions for members' cost sharing contributions; and
- Provisions for ownership and rights in intellectual property developed previously or under the agreement.

## **B. COST SHARING**

For AOI 3 of this FOA, Cost Share 20%, Cost Share Waiver Utilized

### *i. Cost Sharing Generally*

The cost share must be at least 20% of the total allowable costs for research and development projects (i.e., the sum of the Government share, including FFRDC costs if applicable, and the recipient share of allowable costs equals the total allowable cost of the project) and must come from non-Federal sources unless otherwise allowed by law. (See 2 CFR 200.306 and 2 CFR 910.130 for the applicable cost sharing requirements.)

### *ii. Special Cost Share Waiver for Domestic Institutions of Higher Education, Domestic Nonprofit Entities, FFRDCs, or U.S. State, Local, or Tribal Government Entity*

The Assistant Secretary for the Office of Energy Efficiency and Renewable Energy has issued a Cost Share Reduction determination pursuant to Section 988(b)(3) of the Energy Policy Act of 2005 that is applicable to certain entities applying under AOI 3 of this FOA. The cost share waiver only applies to FY16 funds. If an award is selected from this FOA using FY17 funds, non-federal cost share of 20% is required, unless the waiver is extended. Specifically, recipient cost share requirement for applied research and development activities projects is reduced from 20% to 10% where:

1. The Prime Recipient is a domestic institution of higher education; domestic nonprofit entity; FFRDC; or U.S. State, local, or tribal government entity; and
2. The Prime Recipient performs more than 50% of the project work, as measured by the Total Project Cost.

Applicants who believe their project qualifies for the reduced recipient cost share must be able to provide verification that the above requirements are satisfied.

To assist applicants in calculating proper cost share amounts, EERE has included a cost share information sheet and sample cost share calculation as Appendices B and C to this FOA.

### **1. LEGAL RESPONSIBILITY**

Although the cost share requirement applies to the project as a whole, including work performed by members of the project team other than the Prime Recipient, the Prime Recipient is legally responsible for paying the entire cost share. The Prime Recipient's cost share

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obligation is expressed in the Assistance 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 obligation assumed by Project Team members in subawards or related agreements.

## **2. COST SHARE ALLOCATION**

Each Project Team is free to determine how best to allocate the cost share requirement among the team members. 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.

## **3. COST SHARE TYPES AND ALLOWABILITY**

Every cost share contribution must be allowable under the applicable Federal cost principles, as described in Section IV.J.1 of the FOA. In addition, cost share must be verifiable upon submission of the Full Application.

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 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 including, but not limited to:

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

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

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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. As all sources of cost share are considered part of total project cost, the cost share dollars will be scrutinized under the same Federal regulations as Federal dollars to 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 are encouraged to refer to 2 CFR 200.306 as amended by 2 CFR 910.130 & 10 CFR 603.525-555 for additional guidance on cost sharing.

#### **4. COST SHARE CONTRIBUTIONS BY FFRDCS**

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 another non-Federal source.

#### **5. COST SHARE VERIFICATION**

Applicants are required to provide written assurance of their proposed cost share contributions in their Full Applications.

Upon selection for award negotiations, applicants are required to provide additional information and documentation regarding their cost share contributions. Please refer to Appendix A of the FOA.

#### **6. COST SHARE PAYMENT**

EERE requires Prime Recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the Prime Recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a minimum, the cost sharing percentage negotiated).

In limited circumstances, and where it is in the government's interest, the EERE Contracting Officer may approve a request by the Prime Recipient to meet its cost share requirements on a less frequent basis, such as monthly or quarterly. Regardless of the interval requested, the Prime Recipient must be up-to-date on cost share at each interval. Such requests must be sent to the Contracting Officer during award negotiations and include the following information: (1) a detailed justification for the request; (2) a proposed schedule of payments, including amounts and dates; (3) a written commitment to meet that schedule; and (4) such evidence as necessary to demonstrate that the Prime Recipient has complied with its cost share obligations to date. The Contracting Officer must approve all such requests before they go into effect.

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## C. COMPLIANCE CRITERIA

**Concept Papers and Full Applications must meet all Compliance criteria listed below or they will be considered noncompliant. EERE will not review or consider noncompliant submissions,** including Concept Papers, Full Applications, and Replies to Reviewer Comments that were: submitted through means other than EERE Exchange; submitted after the applicable deadline; and/or submitted incomplete. EERE will not extend the submission deadline for applicants that fail to submit required information due to server/connection congestion.

### 1. COMPLIANCE CRITERIA

#### *i. Concept Papers*

Concept Papers are deemed compliant if:

- The Concept Paper complies with the content and form requirements in Section IV.C of the FOA; and
- The applicant successfully uploaded all required documents and clicked the “Submit” button in EERE Exchange by the deadline stated in this FOA.

#### *ii. Full Applications*

Full Applications are deemed compliant if:

- The applicant submitted a compliant Concept Paper;
- The Full Application complies with the content and form requirements in Section IV.D of the FOA; and
- The applicant successfully uploaded all required documents and clicked the “Submit” button in EERE Exchange by the deadline stated in the FOA.

#### *iii. Replies to Reviewer Comments*

Replies to Reviewer Comments are deemed compliant if:

- The Reply to Reviewer Comments complies with the content and form requirements in Section IV.E of the FOA; and
- The applicant successfully uploaded all required documents to EERE Exchange by the deadline stated in the FOA.

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## D. RESPONSIVENESS CRITERIA

All “Applications Specifically Not of Interest,” as described in Section I.C of the FOA, are deemed nonresponsive and are not reviewed or considered.

## E. OTHER ELIGIBILITY REQUIREMENTS

### 1. **REQUIREMENTS FOR DOE/NNSA FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS (FFRDC) LISTED AS THE APPLICANT**

A DOE/NNSA FFRDC is eligible to apply for funding under this FOA if its cognizant Contracting Officer provides written authorization and this authorization is submitted with the application. If a DOE/NNSA FFRDC is selected for award negotiation, the proposed work will be authorized under the DOE work authorization process and performed under the laboratory’s Management and Operating (M&O) contract.

The following wording is acceptable for the authorization:

Authorization is granted for the \_\_\_\_\_ Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or complementary to the missions of the laboratory, and will not adversely impact execution of the DOE assigned programs at the laboratory.

### 2. **REQUIREMENTS FOR DOE/NNSA AND NON-DOE/NNSA FEDERALLY FUNDED RESEARCH AND DEVELOPMENT CENTERS INCLUDED AS A SUBRECIPIENT**

DOE/NNSA and non-DOE/NNSA FFRDCs may be proposed as a Subrecipient on another entity’s application subject to the following guidelines:

#### *i. Authorization for non-DOE/NNSA FFRDCs*

The Federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The use of a FFRDC must be consistent with its authority under its award.

#### *ii. Authorization for DOE/NNSA FFRDCs*

The cognizant Contracting Officer for the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The following wording is acceptable for this authorization:

Authorization is granted for the \_\_\_\_\_ Laboratory to participate in the proposed project. The work proposed for the laboratory is consistent with or

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complementary to the missions of the laboratory, and will not adversely impact execution of the DOE assigned programs at the laboratory.

*iii. Value/Funding*

The value of and funding for the FFRDC portion of the work will not normally be included in the award to a successful applicant. Usually, DOE will fund a DOE/NNSA FFRDC contractor through the DOE field work proposal system and non-DOE/NNSA FFRDC through an interagency agreement with the sponsoring agency.

*iv. Cost Share*

Although the FFRDC portion of the work is usually excluded from the award to a successful applicant, the applicant's cost share requirement will be based on the total cost of the project, including the applicant's and the FFRDC's portions of the project.

*v. Responsibility*

The Prime Recipient will be 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 the FFRDC contractor.

*vi. Limit on FFRDC Effort*

The scope of work to be performed by the FFRDC may not be more significant than the scope of work to be performed by the applicant.

**F. LIMITATION ON NUMBER OF CONCEPT PAPERS AND FULL APPLICATIONS ELIGIBLE FOR REVIEW**

Applicants may submit more than one Full Application to this FOA, provided that each application describes a unique, scientifically distinct project.

**G. QUESTIONS REGARDING ELIGIBILITY**

EERE will not make eligibility determinations for potential applicants prior to the date on which applications to this FOA must be submitted. The decision whether to submit an application in response to this FOA lies solely with the applicant.

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## IV. APPLICATION AND SUBMISSION INFORMATION

### A. APPLICATION PROCESS

The application process will include two phases: a Concept Paper phase and a Full Application phase. **Only applicants who have submitted an eligible Concept Paper will be eligible to submit a Full Application.** At each phase, EERE performs an initial eligibility review of the applicant submissions to determine whether they meet the eligibility requirements of Section III of the FOA. EERE will not review or consider submissions that do not meet the eligibility requirements of Section III. All submissions must conform to the following form and content requirements, including maximum page lengths (described below) and must be submitted via EERE Exchange at <https://eere-exchange.energy.gov/>, unless specifically stated otherwise. **EERE will not review or consider submissions submitted through means other than EERE Exchange, submissions submitted after the applicable deadline, and incomplete submissions.** EERE will not extend deadlines for applicants who fail to submit required information and documents due to server/connection congestion. A control number will be issued when an applicant begins the Exchange application process. This control number must be included with all Application documents, as described below.

The Concept Paper, Full Application, and Reply to Reviewer Comments must conform to the following requirements:

- Each must be submitted in Adobe PDF format unless stated otherwise.
- Each must be written in English.
- All pages must be formatted to fit on 8.5 x 11 inch paper with margins not less than one inch on every side. Use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures or tables, which may be 10 point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies. References must be included as footnotes or endnotes in a font size of 10 or larger. Footnotes and endnotes are counted toward the maximum page requirement.
- 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.
- Each submission must not exceed the specified maximum page limit, including cover page, charts, graphs, maps, and photographs when printed using the formatting requirements set forth above and single spaced. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages.

Applicants are responsible for meeting each submission deadline. **Applicants are strongly encouraged to submit their Concept Papers and Full 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, Full

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Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE Exchange, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline.

EERE urges applicants to carefully review their Concept Papers, and Full Applications and to allow sufficient time for the submission of required information and documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V.A.2 of the FOA.

### **1. ADDITIONAL INFORMATION ON EERE EXCHANGE**

EERE Exchange is designed to enforce the deadlines specified in this FOA. The “Apply” and “Submit” buttons will automatically disable at the defined submission deadlines. Should applicants experience problems with Exchange, the following information may be helpful.

Applicants that experience issues with submission PRIOR to the FOA deadline: In the event that an applicant experiences technical difficulties with a submission, the Application should contact the Exchange helpdesk for assistance ([EERE-ExchangeSupport@hq.doe.gov](mailto:EERE-ExchangeSupport@hq.doe.gov)). The Exchange helpdesk and/or the EERE Exchange system administrators will assist Applicants in resolving issues.

Applicants that experience issue with submissions that result in late submissions: In the event that an applicant experiences technical difficulties so severe that they are unable to submit their application by the deadline, the applicant should contact the Exchange helpdesk for assistance ([EERE-ExchangeSupport@hq.doe.gov](mailto:EERE-ExchangeSupport@hq.doe.gov)). The Exchange helpdesk and/or the EERE Exchange system administrators will assist the applicant in resolving all issues (including finalizing submission on behalf of and with the applicant’s concurrence). PLEASE NOTE, however, those applicants who are unable to submit their application on time due to their waiting until the last minute when network traffic is at its heaviest to submit their materials will not be able to use this process.

### **B. APPLICATION FORMS**

The application forms and instructions are available on EERE Exchange. To access these materials, go to <https://eere-Exchange.energy.gov> and select the appropriate funding opportunity number.

Note: The maximum file size that can be uploaded to the EERE Exchange website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the FOA, it must be broken into parts and denoted to that effect. For example:

**ControlNumber\_LeadOrganization\_Project\_Part\_1**

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ControlNumber\_LeadOrganization\_Project\_Part\_2, etc.

### C. CONTENT AND FORM OF THE CONCEPT PAPER

To be eligible to submit a Full Application, applicants must submit a Concept Paper by the specified due date and time.

#### 1. CONCEPT PAPER CONTENT REQUIREMENTS

EERE will not review or consider ineligible Concept Papers (see Section III of the FOA).

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

The Concept Paper must conform to the following content requirements:

SECTION	PAGE LIMIT	DESCRIPTION
<b>Cover Page</b>	1 page maximum	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
<b>Technology Description</b>	3 pages maximum	Applicants are required to describe succinctly: <ul style="list-style-type: none"> <li>• The proposed technology, including its basic operating principles and how it is unique and innovative;</li> <li>• The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target could be met);</li> <li>• The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges;</li> <li>• How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application;</li> <li>• The potential impact that the proposed project would have on the relevant field and application;</li> <li>• The key technical risks/issues associated with the proposed technology development plan; and</li> <li>• The impact that EERE funding would have on the proposed project.</li> </ul>
<b>Addendum</b>	1 pages maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: <ul style="list-style-type: none"> <li>• Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan;</li> </ul>

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		<ul style="list-style-type: none"> <li>• Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity;</li> <li>• Whether the applicant has worked together with its teaming partners on prior projects or programs; and</li> <li>• Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities.</li> </ul> <p>Applicants may provide graphs, charts, or other data to supplement their Technology Description.</p>
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EERE makes an independent assessment of each Concept Paper based on the criteria in Section V.A.1 of the FOA. EERE will encourage a subset of applicants to submit Full Applications. Other applicants will be discouraged from submitting a Full Application. An applicant who receives a “discouraged” notification may still submit a Full Application. EERE will review all eligible Full Applications. However, by discouraging the submission of a Full Application, EERE intends to convey its lack of programmatic interest in the proposed project in an effort to save the applicant the time and expense of preparing an application that is unlikely to be selected for award negotiations.

EERE may include general comments provided from reviewers on an applicant’s Concept Paper in the encourage/discourage notification sent to applicants at the close of that phase.

**D. CONTENT AND FORM OF THE FULL APPLICATION**

Applicants must submit a Full Application by the specified due date and time to be considered for funding under this FOA. Applicants must complete the following application forms found on the EERE Exchange website at <https://eere-Exchange.energy.gov/>, in accordance with the instructions.

Applicants will have approximately 30 days from receipt of the Concept Paper Encourage/Discourage notification to prepare and submit a Full Application. Regardless of the date the applicant receives the Encourage/Discourage notification, the submission deadline for the Full Application remains the date and time stated on the FOA cover page.

All Full Application documents must be marked with the Control Number issued to the applicant. Applicants will receive a control number upon submission of their Concept Paper, and should include that control number in the file name of their Full Application submission (i.e., Control number\_Applicant Name\_Full Application).

**1. FULL APPLICATION CONTENT REQUIREMENTS**

EERE will not review or consider ineligible Full Applications (see Section III of the FOA).

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Problems with EERE Exchange? Email EERE- [EERE-ExchangeSupport@hq.doe.gov](mailto:EERE-ExchangeSupport@hq.doe.gov) Include FOA name and number in subject line.*

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

Full Applications must conform to the following requirements:

SUBMISSION	COMPONENTS	FILE NAME
<b>Full Application (PDF, unless stated otherwise)</b>	Technical Volume (See Chart in Section IV.D.2)	ControlNumber_LeadOrganization_Technical Volume
	Statement of Project Objectives (Microsoft Word format) (5 page limit)	ControlNumber_LeadOrganization_SOPO
	SF-424	ControlNumber_LeadOrganization_App424
	Budget Justification (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Budget_Justification
	Summary for Public Release (1 page limit)	ControlNumber_LeadOrganization_Summary
	Summary Slide (1 page limit, Microsoft PowerPoint format)	ControlNumber_LeadOrganization_Slide
	Subaward Budget Justification (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Subaward ee_Budget_Justification
	Budget for FFRDC, if applicable	ControlNumber_LeadOrganization_FWP
	Authorization from cognizant Contracting Officer for FFRDC, if applicable	ControlNumber_LeadOrganization_FFRDCAuth
	SF-LLL Disclosure of Lobbying Activities	ControlNumber_LeadOrganization_SF-LLL
	Foreign Entity and Performance of Work in the United States waiver requests, if applicable	ControlNumber_LeadOrganization_Waiver
	U.S. Manufacturing Plans	ControlNumber_LeadOrganization_USMP

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**ControlNumber\_LeadOrganization\_TechnicalVolume\_Part\_1**  
**ControlNumber\_LeadOrganization\_TechnicalVolume\_Part\_2**, etc.

**EERE will not accept late submissions that resulted from technical difficulties due to uploading files that exceed 10MB.**

EERE provides detailed guidance on the content and form of each component below.

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## 2. TECHNICAL VOLUME

The Technical Volume must be submitted in Adobe PDF format. The Technical Volume must conform to the following content and form requirements, including maximum page lengths. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages. This volume must address the Merit Review Criteria as discussed in Section V.A.2 of the FOA. Save the Technical Volume in a single PDF file using the following convention for the title: "ControlNumber\_LeadOrganization\_TechnicalVolume".

Applicants must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical Volume. However, EERE and reviewers are under no obligation to review cited sources.

The Technical Volume to the Full Application may not be more than 15 pages, including the cover page, table of contents, and all citations, charts, graphs, maps, photos, or other graphics, and must include all of the information in the table below. The applicant should consider the weighting of each of the evaluation criteria (see Section V.A.2 of the FOA) when preparing the Technical Volume.

SECTION/PAGE LIMIT	DESCRIPTION
<b>Cover Page</b>	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
<b>Project Overview</b> (This section should constitute approximately 10% of the Technical Volume)	<p>The Project Overview should contain the following information:</p> <ul style="list-style-type: none"> <li>• <b>Background:</b> The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application.</li> <li>• <b>Project Goal:</b> The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal.</li> <li>• <b>DOE Impact:</b> The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.</li> </ul>

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<p><b>Technical Description, Innovation, and Impact</b> (This section should constitute approximately 40% of the Technical Volume)</p>	<p>The Technical Description should contain the following information:</p> <ul style="list-style-type: none"> <li>• <b>Relevance and Outcomes:</b> The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project.</li> <li>• <b>Feasibility:</b> The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results.</li> <li>• <b>Innovation and Impacts:</b> The applicant should describe the current state of the art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state of the art/technical baseline if the project is successful.</li> </ul>
<p><b>Workplan and Market Transformation Plan</b> (This section should constitute approximately 35% of the Technical Volume)</p>	<p>The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure, Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed Statement of Project Objectives (SOPO) is separately requested. The Workplan should contain the following information:</p> <ul style="list-style-type: none"> <li>• <b>Project Objectives:</b> The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes.</li> <li>• <b>Technical Scope Summary:</b> The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on go/no-go decision points). The applicant should describe the specific expected end result of each performance period.</li> <li>• <b>Work Breakdown Structure (WBS) and Task Description Summary:</b> The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard work breakdown structure (WBS) for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as “we will then complete a proprietary process” is unacceptable). It is the applicant’s responsibility to prepare an adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this FOA. The summary provided should be consistent with the SOPO. The SOPO will contain a more detailed description of the WBS and tasks.</li> <li>• <b>Milestone Summary:</b> The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success,</li> </ul>

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	<p>where success is defined as technical achievement rather than simply completing a task. To ensure that milestones are relevant, applicants should follow the SMART rule of thumb, which is that all milestones should be <b>Specific, Measurable, Achievable, Relevant, and Timely</b>. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO.</p> <ul style="list-style-type: none"> <li>• <b>Go/No-Go Decision Points:</b> The applicant should provide a summary of project-wide go/no-go decision points at appropriate points in the Workplan. A go/no-go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one project-wide go/no-go decision point for each budget period (12 to 18-month period) of the project. The Applicant should also provide the specific technical criteria to be used to make the go/no-go decision. The summary provided should be consistent with the SOPO.</li> <li>• <b>Project Schedule (Gantt Chart or similar):</b> The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and go/no-go decision points.</li> <li>• <b>Project Management:</b> The applicant should discuss the team’s proposed management plan, including the following: <ul style="list-style-type: none"> <li>○ The overall approach to and organization for managing the work</li> <li>○ The roles of each Project Team member</li> <li>○ Any critical handoffs/interdependencies among Project Team members</li> <li>○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices</li> <li>○ The approach to project risk management</li> <li>○ A description of how project changes will be handled</li> <li>○ If applicable, the approach to Quality Assurance/Control</li> <li>○ How communications will be maintained among Project Team members</li> </ul> </li> <li>• <b>Market Transformation Plan:</b> The applicant should provide a market transformation plan, including the following: <ul style="list-style-type: none"> <li>○ Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan</li> <li>○ Identification of a product development and/or service plan, commercialization timeline, financing, product marketing,</li> </ul> </li> </ul>
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	<p>legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. manufacturing plan etc., and product distribution.</p>
<p><b>Technical Qualifications and Resources</b> (Approximately 15% of the Technical Volume)</p>	<p>The Technical Qualifications and Resources should contain the following information:</p> <ul style="list-style-type: none"> <li>• Describe the Project Team’s unique qualifications and expertise, including those of key Subrecipients.</li> <li>• Describe the Project Team’s existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project.</li> <li>• This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives.</li> <li>• Describe the time commitment of the key team members to support the project.</li> <li>• Attach one-page resumes for key participating team members as an appendix. Resumes do not count towards the page limit. Multi-page resumes are not allowed.</li> <li>• Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable.</li> <li>• Attach letters of commitment from all Subrecipient/third party cost share providers as an appendix. Letters of commitment do not count towards the page limit.</li> <li>• Attach any letters of support from partners/end users as an appendix (1 page maximum per letter). Letters of support do not count towards the page limit.</li> <li>• For multi-organizational or multi-investigator projects, describe succinctly:             <ul style="list-style-type: none"> <li>○ The roles and the work to be performed by each PI and Key Participant;</li> <li>○ Business agreements between the applicant and each PI and Key Participant;</li> <li>○ How the various efforts will be integrated and managed;</li> <li>○ Process for making decisions on scientific/technical direction;</li> <li>○ Publication arrangements;</li> <li>○ Intellectual Property issues; and</li> <li>○ Communication plans</li> </ul> </li> </ul>

**3. STATEMENT OF PROJECT OBJECTIVES**

Applicants are required to complete a Statement of Project Objectives (SOPO). A SOPO template is available on EERE Exchange at <https://eere-Exchange.energy.gov/>. The SOPO, including the Milestone Table, must not exceed 5 pages when printed using standard 8.5 x 11

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paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point. Save the SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber\_LeadOrganization\_SOPO".

#### **4. SF-424: APPLICATION FOR FEDERAL ASSISTANCE**

Complete all required fields in accordance with the instructions on the form. The list of certifications and assurances in Field 21 can be found at <http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms>, under Certifications and Assurances. Note: The dates and dollar amounts on the SF-424 are for the complete project period and not just the first project year, first phase or other subset of the project period. Save the SF-424 in a single PDF file using the following convention for the title "ControlNumber\_LeadOrganization\_App424".

#### **5. BUDGET JUSTIFICATION WORKBOOK (EERE 335)**

Applicants are required to complete the Budget Justification Workbook. This form is available on EERE Exchange at <https://eere-Exchange.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 rate agreement, vendor quotes). Applicants should include costs associated with required annual audits and incurred cost proposals in their proposed budget documents. The "Instructions and Summary" included with the Budget Justification Workbook will auto-populate as the applicant enters information into the Workbook. Applicants must carefully read the "Instructions and Summary" tab provided within the Budget Justification Workbook. Save the Budget Justification Workbook in a single Microsoft Excel file using the following convention for the title "ControlNumber\_LeadOrganization\_Budget\_Justification".

#### **6. SUMMARY/ABSTRACT FOR PUBLIC RELEASE**

Applicants are required to submit a one-page summary/abstract of their project. The project summary/abstract must contain a summary of the proposed activity suitable for dissemination to the public. It should be a self-contained document that identifies the name of the applicant, the project director/principal investigator(s), the project title, the objectives of the project, a description of the project, including methods to be employed, the potential impact of the project (e.g., benefits, outcomes), and major participants (for collaborative projects). This document must not include any proprietary or sensitive business information as DOE may make it available to the public after selections are made. The project summary must not exceed 1 page when printed using standard 8.5 x 11 paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point. Save the Summary for Public Release in a single PDF file using the following convention for the title "ControlNumber\_LeadOrganization\_Summary".

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## **7. SUMMARY SLIDE**

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. The slide must be submitted in Microsoft PowerPoint format. This slide is used during the evaluation process. Save the Summary Slide in a single file using the following convention for the title “ControlNumber\_LeadOrganization\_Slide”.

The Summary Slide template requires the following information:

- A technology Summary;
- A description of the technology’s impact;
- Proposed project goals;
- Any key graphics (illustrations, charts and/or tables);
- The project’s key idea/takeaway;
- Project title, Prime Recipient, Principal Investigator, and Key Participant information; and
- Requested EERE funds and proposed applicant cost share.

## **8. SUBAWARD BUDGET JUSTIFICATION (EERE 335)**

Applicants must provide a separate budget justification, EERE 335 (i.e., budget justification for each budget year and a cumulative budget) for each subawardee that is expected to perform work estimated to be more than \$250,000 or 25 percent of the total work effort (whichever is less). The budget justification must include the same justification information described in the “Budget Justification” section above. Save each subaward budget justification in a Microsoft Excel file using the following convention for the title “ControlNumber\_LeadOrganization\_Subawardee\_Budget\_Justification”.

## **9. BUDGET FOR DOE/NNSA FFRDC (IF APPLICABLE)**

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE Field Work Proposal (FWP) in accordance with the requirements in DOE Order 412.1, Work Authorization System. DOE Order 412.1 and DOE O 412.1 (Field Work Proposal form) area available at the following link, under “DOE Budget Forms”:  
<https://www.directives.doe.gov/directives/0412.1-BOrder-a/view>. Save the FWP in a single PDF file using the following convention for the title “ControlNumber\_LeadOrganization\_FWP”.

## **10. AUTHORIZATION FOR NON-DOE/NNSA OR DOE/NNSA FFRDCs (IF APPLICABLE)**

The Federal agency sponsoring the FFRDC must authorize in writing the use of the FFRDC on the proposed project and this authorization must be submitted with the application. The use of a FFRDC must be consistent with the contractor’s authority under its award. Save the Authorization in a single PDF file using the following convention for the title “ControlNumber\_LeadOrganization\_FFRDCAuth”.

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### **11. SF-LLL: DISCLOSURE OF LOBBYING ACTIVITIES**

Prime Recipients and Subrecipients may not use any Federal funds to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters.

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/sfillin.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.

Save the SF-LLL in a single PDF file using the following convention for the title “ControlNumber\_LeadOrganization\_SF-LLL”.

### **12. WAIVER REQUESTS: FOREIGN ENTITIES AND PERFORMANCE OF WORK IN THE UNITED STATES**

#### *i. Foreign Entity Participation:*

As set forth in Section III.A.3, all Prime Recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. To request a waiver of this requirement, the applicant must submit an explicit waiver request in the Full Application. Appendix C lists the necessary information that must be included in a request to waive this requirement.

#### *ii. Performance of Work in the United States*

As set forth in Section IV.J.3, all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the Prime Recipient should make every effort to purchase supplies and equipment within the United States. Appendix C lists the necessary information that must be included in a request to waive the Performance of Work in the United States requirement.

### **13. U.S. MANUFACTURING COMMITMENTS**

As part of the application, applicants are required to submit a U.S. Manufacturing Plan. The U.S. Manufacturing Plan represents the applicant’s measurable commitment to support U.S. manufacturing as a result of its award.

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The weight given to the U.S. Manufacturing Plans during the review and selection process varies based on the particular FOA. Applicants should review Section V.A.2 of this FOA to determine the weight given to the U.S. Manufacturing Plans under this FOA.

A U.S. Manufacturing Plan should contain the following or similar preamble: “If selected for funding, the applicant agrees to the following commitments as a condition of that funding:” and, after the preamble, the plan should include one or more specific and measurable commitments. For example, an applicant may commit particular types of products to be manufactured in the U.S. In addition to or instead of making a commitment tied to a particular product, the applicant may make other types of commitments still beneficial to U.S. manufacturing. An applicant may commit to a particular investment in a new or existing U.S. manufacturing facility, keep certain activities based in the U.S. (i.e., final assembly) or support a certain number of jobs in the U.S. related to the technology and manufacturing. For an applicant which is likely to license the technology to others, especially universities for which licensing may be the exclusive means of commercializing the technology, the U.S. manufacturing plan may indicate the applicant’s plan and commitment to use a licensing strategy that would likely support U.S. manufacturing.

When an applicant that is a domestic small business, domestic educational institution, or nonprofit organization is selected for an award, the U.S. Manufacturing Plan submitted by the applicant becomes part of the terms and conditions of the award. The applicant/awardee may request a waiver or modification of the U.S. Manufacturing Plan from DOE upon a showing that the original U.S. Manufacturing Plan is no longer economically feasible.

When an applicant that is a domestic large business is selected for an award, a class patent waiver applies as set forth in Section VIII. L. Under this class patent waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class patent waiver, a domestic large business must agree that any products embodying or produced through the use of an invention conceived or first actually reduced to practice under the award will be substantially manufactured in the United States, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan are sufficient.

For other entity types that are selected for award, please see Section VIII.L regarding U.S. manufacturing commitments.

#### **14. DATA MANAGEMENT PLAN**

Applicants who’s Full Applications are selected for award negotiations will be required to submit a Data Management Plan during the award negotiations phase. The Data Management Plan is a document that outlines the proposed plan for data sharing or preservation. Submission of this plan is required, and failure to submit the plan may result in the termination of award negotiations. As a courtesy, guidance for preparing a Data Management Plan is provided in Appendix D.

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

EERE will provide applicants with reviewer comments following evaluation of all eligible Full Applications. Applicants will have a brief opportunity to review the comments and to prepare a short Reply to Reviewer Comments responding to comments however they desire or supplementing their Full Application. The Reply to Reviewer Comments is an optional submission; applicants are not required to submit a Reply to Reviewer Comments. EERE will notify applicants via email when the Reviewer Comments are available for reply. The expected submission deadline is on the cover page of the FOA; however, it is the applicant's responsibility to monitor email in the event that the expected date changes. The deadline will not be extended for applicants who are unable to timely submit their reply due to failure to check email or relying on the expected date alone. Applicants should anticipate having approximately three (3) business days to submit Replies to Reviewer Comments.

EERE will not review or consider ineligible Replies to Reviewer Comments (see Section III of the FOA). EERE will review and consider each eligible Full Application, even if no Reply is submitted or if the Reply is found to be ineligible.

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, EERE will review only the first three (3) pages and disregard any additional pages.

SECTION	PAGE LIMIT	DESCRIPTION
Text	3 pages max	Applicants may respond to one or more reviewer comments or supplement their Full Application.

## F. POST-AWARD INFORMATION REQUESTS

If selected for award, EERE reserves the right to request additional or clarifying information for any reason deemed necessary, including but not limited to:

- Indirect cost information
- Other budget information
- Commitment Letters from Third Parties Contributing to Cost Share, if applicable
- Name and phone number of the Designated Responsible Employee for complying with national policies prohibiting discrimination (See 10 CFR 1040.5)
- Representation of Limited Rights Data and Restricted Software, if applicable
- Environmental Questionnaire

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## **G. DUN AND BRADSTREET UNIVERSAL NUMBERING SYSTEM NUMBER AND SYSTEM FOR AWARD MANAGEMENT**

Each applicant (unless the applicant is an individual or Federal awarding agency that is excepted from those requirements under 2 CFR §25.110(b) or (c), or has an exception approved by the Federal awarding agency under 2 CFR §25.110(d)) is required to: (i) Be registered in the System for Award Management (SAM) at <https://www.sam.gov> before submitting its application; (ii) provide a valid Dun and Bradstreet Universal Numbering System (DUNS) number in its application; and (iii) continue to maintain an active SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by a Federal awarding agency. DOE may not make a Federal award to an applicant until the applicant has complied with all applicable DUNS and SAM requirements and, if an applicant has not fully complied with the requirements by the time DOE is ready to make a Federal award, the DOE may determine that the applicant is not qualified to receive a Federal award and use that determination as a basis for making a Federal award to another applicant.

## **H. SUBMISSION DATES AND TIMES**

Concept Papers, Full Applications, and Replies to Reviewer Comments must be submitted in EERE Exchange no later than 5 p.m. Eastern on the dates provided on the cover page of this FOA.

## **I. INTERGOVERNMENTAL REVIEW**

Technology Office not subject to Executive Order 12372

This FOA is not subject to Executive Order 12372 – Intergovernmental Review of Federal Programs.

## **J. FUNDING RESTRICTIONS**

### **1. ALLOWABLE COSTS**

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

Refer to the following applicable Federal cost principles for more information:

- FAR Part 31 for For-Profit entities; and
- 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

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## 2. PRE-AWARD COSTS

Selectees must request prior written approval to charge pre-award costs. Pre-award costs are those incurred prior to the effective date of the Federal award directly pursuant to the negotiation and in anticipation of the Federal award where such costs are necessary for efficient and timely performance of the scope of work. Such costs are allowable only to the extent that they would have been allowable if incurred after the date of the Federal award and **only** with the written approval of the Federal awarding agency, through the Contracting Officer assigned to the award.

Pre-award costs cannot be incurred prior to the Selection Official signing the Selection Statement and Analysis. Pre-award costs can only be incurred if such costs would be reimbursable under the agreement if incurred after award.

Pre-Award expenditures are made at the Selectee's risk; EERE is not obligated to reimburse costs: (1) in the absence of appropriations; (2) if an award is not made; or (3) if an award is made for a lesser amount than the Selectee anticipated.

### *i. Pre-Award Costs Related to National Environmental Policy Act (NEPA) Requirements*

EERE's decision whether and how to distribute Federal funds under this FOA is subject to NEPA. Applicants should carefully consider and should seek legal counsel or other expert advice before taking any action related to the proposed project that would have an adverse effect on the environment or limit the choice of reasonable alternatives prior to EERE completing the NEPA review process.

EERE does not guarantee or assume any obligation to reimburse costs where the Prime Recipient incurred the costs prior to receiving written authorization from the Contracting Officer. If the applicant elects to undertake activities that may have an adverse effect on the environment or limit the choice of reasonable alternatives prior to receiving such written authorization from the Contracting Officer, the applicant is doing so at risk of not receiving Federal funding and such costs may not be recognized as allowable cost share. Likewise, if a project is selected for negotiation of award, and the Prime Recipient elects to undertake activities that are not authorized for Federal funding by the Contracting Officer in advance of EERE completing a NEPA review, the Prime Recipient is doing so at risk of not receiving Federal Funding and such costs may not be recognized as allowable cost share. Nothing contained in the pre-award cost reimbursement regulations or any pre-award costs approval letter from the Contracting Officer override these NEPA requirements to obtain the written authorization from the Contracting Officer prior to taking any action that may have an adverse effect on the environment or limit the choice of reasonable alternatives.

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

a. Requirement.

All work performed under EERE Awards must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment; however, the Prime Recipient should make every effort to purchase supplies and equipment within the United States. The Prime Recipient must flow down this requirement to its Subrecipients.

b. Failure to Comply.

If the Prime Recipient fails to comply with the Performance of Work in the United States requirement, EERE may deny reimbursement for the work conducted outside the United States and such costs may not be recognized as allowable recipient cost share. The Prime Recipient is responsible should any work under this Award be performed outside the United States, absent a waiver, regardless of if the work is performed by the Prime Recipient, Subrecipients, contractors or other project partners.

c. Waiver.

There may be limited circumstances where it is in the interest of the project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit a written waiver request to EERE. Appendix C lists the necessary information that must be included in a request to waive the Performance of Work in the United States requirement.

The applicant must demonstrate to the satisfaction of EERE that a waiver would further the purposes of the FOA and is in the economic interests of the United States. EERE may require additional information before considering a waiver request. Save the waiver request(s) in a single PDF file titled "ControlNumber\_PerformanceofWork\_Waiver". The applicant does not have the right to appeal EERE's decision concerning a waiver request.

### **4. CONSTRUCTION**

Recipients are required to obtain written authorization from the Contracting Officer before incurring any major construction costs.

### **5. FOREIGN TRAVEL**

If international travel is proposed for your project, please note that your organization must comply with the International Air Transportation Fair Competitive Practices Act of 1974 (49 USC 40118), commonly referred to as the "Fly America Act," and implementing regulations at 41 CFR 301-10.131 through 301-10.143. The law and regulations require air transport of people or property to, from, between, or within a country other than the United States, the cost of which

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is supported under this award, to be performed by or under a cost-sharing arrangement with a U.S. flag carrier, if service is available.

## **6. EQUIPMENT AND SUPPLIES**

To the greatest extent practicable, all equipment and supplies purchased with funds made available under this FOA should be American-made. This requirement does not apply to used or leased equipment.

Property disposition will be required at the end of a project if the current fair market value of property exceeds \$5,000. The rules for property disposition are set forth in 2 CFR 200.310 – 200.316 as amended by 2 CFR 910.360.

## **7. LOBBYING**

Recipients and Subrecipients may not use any Federal funds to influence or attempt to influence, directly or indirectly, congressional action on any legislative or appropriation matters.

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.

## **8. RISK ASSESSMENT**

Prior to making a Federal award, the DOE is required by 31 U.S.C. 3321 and 41 U.S.C. 2313 to review information available through any OMB-designated repositories of government-wide eligibility qualification or financial integrity information, such as SAM Exclusions and “Do Not Pay.”

In addition, DOE evaluates the risk(s) posed by applicants before they receive Federal awards. This evaluation may consider: results of the evaluation of the applicant's eligibility; the quality of the application; financial stability; quality of management systems and ability to meet the management standards prescribed in this part; history of performance; reports and findings from audits; and the applicant's ability to effectively implement statutory, regulatory, or other requirements imposed on non-Federal entities.

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In addition to this review, DOE must comply with the guidelines on government-wide suspension and debarment in 2 CFR 180, and must require non-Federal entities to comply with these provisions. These provisions restrict Federal awards, subawards and contracts with certain parties that are debarred, suspended or otherwise excluded from or ineligible for participation in Federal programs or activities.

## **V. APPLICATION REVIEW INFORMATION**

### **A. TECHNICAL REVIEW CRITERIA**

#### **1. CONCEPT PAPERS**

Concept Papers are evaluated based on consideration the following factors. All sub-criteria are of equal weight.

#### **Concept Paper Criterion: Overall FOA Responsiveness and Viability of the Project (Weight: 100%)**

- The applicant clearly describes the proposed technology, describes how the technology is unique and innovative, and how the technology will advance the current state-of-the-art.
- The applicant has identified risks and challenges, including possible mitigation strategies, and has shown the impact that EERE funding and the proposed project would have on the relevant field and application;
- The applicant has the qualifications, experience, capabilities and other resources necessary to complete the proposed project; and
- The proposed work, if successfully accomplished, would clearly meet the objectives as stated in the FOA.

#### **2. FULL APPLICATIONS**

Applications will be evaluated against the merit review criteria shown below. All sub-criteria are of equal weight.

#### **Criterion 1: Technical Merit, Innovation, and Impact (50%)**

##### **Technical Merit and Innovation**

- Extent to which the proposed technology or process is innovative and has the potential to advance the state of the art;
- Degree to which the current state of the technology and the proposed advancement are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state of the art to the proposed advancement; and

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- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work.

#### Impact of Technology Advancement

- Extent to which the project supports the topic area objectives and target specifications and metrics; and
- The potential impact of the project on advancing the state-of-the-art.

### **Criterion 2: Project Research and Market Transformation Plan (35%)**

#### Research Approach, Workplan and SOPO

- Degree to which the approach and critical path have been clearly described and thoughtfully considered; and
- Degree to which the task descriptions are clear, detailed, timely, and reasonable, resulting in a high likelihood that the proposed Workplan and SOPO will succeed in meeting the project goals.

#### Identification of Technical Risks

- Discussion and demonstrated understanding of the key technical risk areas involved in the proposed work and the quality of the mitigation strategies to address them.

#### Baseline, Metrics, and Deliverables

- The level of clarity in the definition of the baseline, metrics, and milestones; and
- Relative to a clearly defined experimental baseline, the strength of the quantifiable metrics, milestones, and mid-point deliverables defined in the application, such that meaningful interim progress will be made.

#### Market Transformation Plan

- Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including mitigation plan; and
- Discussion of commercialization strategy including but not limited to product development plan, commercialization timeline, , product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. manufacturing plan etc., and product distribution.

### **Criterion 3: Team and Resources (15%)**

- The capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. The qualifications, relevant expertise, and time commitment of the individuals on the team;
- The sufficiency of the facilities to support the work;

- The degree to which the proposed consortia/team demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies;
- The level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan; and
- The reasonableness of the budget and spend plan for the proposed project and objectives.

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

EERE has not established separate criteria to evaluate Replies to Reviewer Comments. Instead, Replies to Reviewer Comments are attached to the original applications and evaluated as an extension of the Full Application.

## **B. STANDARDS FOR APPLICATION EVALUATION**

Applications that are determined to be eligible will be evaluated in accordance with this FOA, by the standards set forth in EERE's Notice of Objective Merit Review Procedure (76 Fed. Reg. 17846, March 31, 2011) and the guidance provided in the "Department of Energy Merit Review Guide for Financial Assistance," which is available at: <http://energy.gov/sites/prod/files/meritrev.pdf>.

## **C. OTHER SELECTION FACTORS**

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

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

- The degree to which the proposed project, including proposed cost share, optimizes the use of available EERE funding to achieve programmatic objectives;
- The level of industry involvement and demonstrated ability to commercialize energy or related technologies;
- Technical, market, organizational, and environmental risks associated with the project;
- Whether the proposed project is likely to lead to increased employment and manufacturing in the United States;
- Whether the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty; and
- Whether the proposed project will advance the goals of the Climate Action Champion initiative, as committed to by the designated Champion pursuant to its designation agreement. The Climate Action Champion initiative goals include improving climate resilience and reducing greenhouse gas emissions.

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Note: The Climate Action Champion initiative program policy factor is only applicable to (1) projects proposed by Climate Action Champions<sup>25</sup> as designated under DOE's Request for Applications DE-FOA-0001189; (2) projects proposed by a member of a regional collaboration or consortium designated as a Champion; and (3) projects proposed in a Climate Action Champion community where the applicant submits a letter from the Champion confirming the proposed project would further the Champion's goals under the Climate Action Champion initiative. If an applicant is seeking to receive consideration under (3), the applicant must contact the applicable Champion to obtain a letter of support.

## **D. EVALUATION AND SELECTION PROCESS**

### **1. OVERVIEW**

The evaluation process consists of multiple phases; each includes an initial eligibility review and a thorough technical review. Rigorous technical reviews of eligible submissions are conducted by reviewers that are experts in the subject matter of the FOA. Ultimately, the Selection Official considers the recommendations of the reviewers, along with other considerations such as program policy factors, in determining which applications to select.

### **2. PRE-SELECTION INTERVIEWS**

As part of the evaluation and selection process, EERE may invite one or more applicants to participate in Pre-Selection Interviews. Pre-Selection Interviews are distinct from and more formal than pre-selection clarifications (See Section V.D.3 of the FOA). The invited applicant(s) will meet with EERE representatives to provide clarification on the contents of the Full Applications and to provide EERE an opportunity to ask questions regarding the proposed project. The information provided by applicants to EERE through Pre-Selection Interviews contributes to EERE's selection decisions.

EERE will arrange to meet with the invited applicants in person at EERE's offices or a mutually agreed upon location. EERE may also arrange site visits at certain applicants' facilities. In the alternative, EERE may invite certain applicants to participate in a one-on-one conference with EERE via webinar, videoconference, or conference call.

EERE will not reimburse applicants for travel and other expenses relating to the Pre-Selection Interviews, nor will these costs be eligible for reimbursement as pre-award costs.

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<sup>25</sup> In recognition of the importance of the dual policy goals of reducing greenhouse gas emissions and enhancing climate resilience, the U.S. Department of Energy (DOE) – in close collaboration with other Federal agencies – launched the Climate Action Champion initiative to identify and showcase U.S. local and tribal governments that have proven to be climate leaders through pursuing opportunities to advance both of these goals in their communities. Recently, DOE selected sixteen (16) U.S. local governments and tribal governments – or regional collaborations or consortia thereof – that demonstrated a strong and ongoing commitment to implementing strategies that both reduce greenhouse gas emissions and enhance climate resilience, with a particular emphasis on strategies that further both goals. <http://www.whitehouse.gov/blog/2014/12/03/announcing-first-class-climate-action-champions>

EERE may obtain additional information through Pre-Selection Interviews that will be used to make a final selection determination. EERE may select applications for funding and make awards without Pre-Selection Interviews. Participation in Pre-Selection Interviews with EERE does not signify that applicants have been selected for award negotiations.

### **3. PRE-SELECTION CLARIFICATION**

EERE may determine that pre-selection clarifications are necessary from one or more applicants. Pre-selection clarifications are distinct from and less formal than pre-selection interviews. These pre-selection clarifications will solely be for the purposes of clarifying the application, and will be limited to information already provided in the application documentation. The pre-selection clarifications may occur before, during or after the merit review evaluation process. Information provided by an applicant that is not necessary to address the pre-selection clarification question will not be reviewed or considered. Typically, a pre-selection clarification will be carried out through either written responses to EERE's written clarification questions or video or conference calls with EERE representatives.

The information provided by applicants to EERE through pre-selection clarifications is incorporated in their applications and contributes to the merit review evaluation and EERE's selection decisions. If EERE contacts an applicant for pre-selection clarification purposes, it does not signify that the applicant has been selected for negotiation of award or that the applicant is among the top ranked applications.

EERE will not reimburse applicants for expenses relating to the pre-selection clarifications, nor will these costs be eligible for reimbursement as pre-award costs.

### **4. SELECTION**

The Selection Official may consider the technical merit, the Federal Consensus Board's recommendations, program policy factors, and the amount of funds available in arriving at selections for this FOA.

## **E. ANTICIPATED NOTICE OF SELECTION AND AWARD DATES**

EERE anticipates notifying applicants selected for negotiation of award by [summer 2016](#) and making awards by [August/September 2016](#).

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## **VI. AWARD ADMINISTRATION INFORMATION**

### **A. AWARD NOTICES**

#### **1. INELIGIBLE SUBMISSIONS**

Ineligible Concept Papers and Full Applications will not be further reviewed or considered for award. The Contracting Officer will send a notification letter by email to the technical and administrative points of contact designated by the applicant in EERE Exchange. The notification letter will state the basis upon which the Concept Paper or the Full Application is ineligible and not considered for further review.

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

EERE will notify applicants of its determination to encourage or discourage the submission of a Full Application. EERE will send a notification letter by email to the technical and administrative points of contact designated by the applicant in EERE Exchange.

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, EERE 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.J.2 of the FOA for guidance on pre-award costs.

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

EERE will notify applicants of its determination via a notification letter by email to the technical and administrative points of contact designated by the applicant in EERE Exchange. The notification letter will inform the applicant whether or not its Full Application was selected for award negotiations. Alternatively, EERE 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.

#### **4. SUCCESSFUL APPLICANTS**

Receipt of a notification letter selecting a Full Application for award negotiations does not authorize the applicant to commence performance of the project. If an application is selected for award negotiations, it is not a commitment by EERE to issue an award. Applicants do not

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receive an award until award negotiations are complete and the Contracting Officer executes the funding agreement, accessible by the Prime Recipient in FedConnect.

The award negotiation process will take approximately 60 days. Applicants must designate a primary and a backup point-of-contact in EERE Exchange with whom EERE will communicate to conduct award negotiations. The applicant must be responsive during award negotiations (i.e., provide requested documentation) and meet the negotiation deadlines. If the applicant fails to do so or if award negotiations are otherwise unsuccessful, EERE will cancel the award negotiations and rescind the Selection. EERE reserves the right to terminate award negotiations at any time for any reason.

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

#### **5. ALTERNATE SELECTION DETERMINATIONS**

In some instances, an applicant may receive a notification that its application was not selected for award and EERE designated the application to be an alternate. As an alternate, EERE may consider the Full Application for Federal funding in the future. A notification letter stating the Full Application is designated as an alternate does not authorize the applicant to commence performance of the project. EERE may ultimately determine to select or not select the Full Application for award negotiations.

#### **6. UNSUCCESSFUL APPLICANTS**

EERE shall promptly notify in writing each applicant whose application has not been selected for award or whose application cannot be funded because of the unavailability of appropriated funds.

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

#### **1. REGISTRATION REQUIREMENTS**

There are several one-time actions before submitting an application in response to this FOA, and it is vital that applicants address these items as soon as possible. Some may take several weeks, and failure to complete them could interfere with an applicant's ability to apply to this FOA, or to meet the negotiation deadlines and receive an award if the application is selected. These requirements are as follows:

##### *i. EERE Exchange*

Register and create an account on EERE Exchange at <https://eere-Exchange.energy.gov>. This account will then allow the user to register for any open EERE FOAs that are currently in EERE Exchange. It is recommended that each organization or business unit, whether acting as a team or a single entity, use only one account as the contact point for each submission.

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Applicants should also designate backup points of contact so they may be easily contacted if deemed necessary. **This step is required to apply to this FOA.**

The EERE Exchange registration does not have a delay; however, **the remaining registration requirements below could take several weeks to process and are necessary for a potential applicant to receive an award under this FOA.**

*ii. DUNS Number*

Obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number (including the plus 4 extension, if applicable) at <http://fedgov.dnb.com/webform>.

*iii. System for Award Management*

Register with the System for Award Management (SAM) at <https://www.sam.gov>. Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are important steps in SAM registration. Please update your SAM registration annually.

*iv. FedConnect*

Register in FedConnect at <https://www.fedconnect.net>. To create an organization account, your organization's SAM MPIN is required. For more information about the SAM MPIN or other registration requirements, review the FedConnect Ready, Set, Go! Guide at [https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect\\_Ready\\_Set\\_Go.pdf](https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf).

*v. Grants.gov*

Register in Grants.gov (<http://www.grants.gov>) to receive automatic updates when Amendments to this FOA are posted. However, please note that Concept Papers, and Full Applications will not be accepted through Grants.gov.

*vi. Electronic Authorization of Applications and Award Documents*

Submission of an application and supplemental information under this FOA through electronic systems used by the Department of Energy, including EERE Exchange and FedConnect.net, constitutes the authorized representative's approval and electronic signature.

**2. AWARD ADMINISTRATIVE REQUIREMENTS**

The administrative requirements for DOE grants and cooperative agreements are contained in 2 CFR Part 200 as amended by 2 CFR Part 910.

### **3. FOREIGN NATIONAL ACCESS TO DOE SITES**

All applicants that ultimately enter into an award resulting from this FOA will be subject to the following requirement concerning foreign national involvement. Upon DOE's request, Prime Recipients must provide information to facilitate DOE's responsibilities associated with foreign national access to DOE sites, information, technologies, and equipment. A foreign national is defined as any person who was born outside the jurisdiction of the United States, is a citizen of a foreign government, and has not been naturalized under U.S. law. If the Prime Recipient or Subrecipients, contractors or vendors under the award, anticipate utilizing a foreign national person in the performance of an award, the Prime Recipient is responsible for providing to the Contracting Officer specific information of the foreign national(s) to satisfy compliance with all of the requirements for access approval.

### **4. SUBAWARD AND EXECUTIVE REPORTING**

Additional administrative requirements necessary for DOE grants and cooperative agreements to comply with the Federal Funding and Transparency Act of 2006 (FFATA) are contained in 2 CFR Part 170. Prime Recipients must register with the new FFATA Subaward Reporting System database and report the required data on their first tier Subrecipients. Prime Recipients must report the executive compensation for their own executives as part of their registration profile in SAM.

### **5. NATIONAL POLICY REQUIREMENTS**

The National Policy Assurances that are incorporated as a term and condition of award are located at: <http://www.nsf.gov/awards/managing/rtc.jsp>.

### **6. ENVIRONMENTAL REVIEW IN ACCORDANCE WITH NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)**

EERE's decision whether and how to distribute federal funds under this FOA is subject to the National Environmental Policy Act (42 USC 4321, *et seq.*). NEPA requires Federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website, at <http://nepa.energy.gov/>.

While NEPA compliance is a Federal agency responsibility and the ultimate decisions remain with the Federal agency, all recipients selected for an award will be required to assist in the timely and effective completion of the NEPA process in the manner most pertinent to their proposed project. If DOE determines certain records must be prepared to complete the NEPA review process (e.g., biological evaluations or environmental assessments), the costs to prepare the necessary records may be included as part of the project costs.

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## 7. APPLICANT REPRESENTATIONS AND CERTIFICATIONS

### *i. Lobbying Restrictions*

By accepting funds under this award, the Prime Recipient agrees that none of the funds obligated on the award shall be expended, directly or indirectly, to influence Congressional action on any legislation 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.

### *ii. Corporate Felony Conviction and Federal Tax Liability Representations*

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

(1) It is **not** a corporation that has been convicted of a felony criminal violation under any Federal law within the preceding 24 months, and

(2) 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.

For purposes of these representations the following definitions apply:

A Corporation includes any entity that has filed articles of incorporation in any of the 50 states, the District of Columbia, or the various territories of the United States [but not foreign corporations]. It includes both for-profit and non-profit organizations.

### *iii. Nondisclosure and Confidentiality Agreements Representations*

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

(1) It **does not and will not** require its employees or contractors to sign internal nondisclosure or confidentiality agreements or statements prohibiting or otherwise restricting its employees or contractors from lawfully reporting waste, fraud, or abuse to a designated investigative or law enforcement representative of a Federal department or agency authorized to receive such information.

(2) It **does not and will not** use any Federal funds to implement or enforce any nondisclosure and/or confidentiality policy, form, or agreement it uses unless it contains the following provisions:

a. *“These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing*

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*statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this agreement and are controlling.”*

- b. The limitation above shall not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.
- c. Notwithstanding the provision listed in paragraph (a), a nondisclosure or confidentiality policy form or agreement that is to be executed by a person connected with the conduct of an intelligence or intelligence-related activity, other than an employee or officer of the United States Government, may contain provisions appropriate to the particular activity for which such document is to be used. Such form or agreement shall, at a minimum, require that the person will not disclose any classified information received in the course of such activity unless specifically authorized to do so by the United States Government. Such nondisclosure or confidentiality forms shall also make it clear that they do not bar disclosures to Congress, or to an authorized official of an executive agency or the Department of Justice, that are essential to reporting a substantial violation of law.

#### **8. STATEMENT OF FEDERAL STEWARDSHIP**

EERE will exercise normal Federal stewardship in overseeing the project activities performed under EERE Awards. Stewardship Activities include, but are not limited to, conducting site visits; reviewing performance and financial reports, providing assistance and/or temporary intervention in usual circumstances to correct deficiencies that develop during the project; assuring compliance with terms and conditions; and reviewing technical performance after project completion to ensure that the project objectives have been accomplished.

#### **9. STATEMENT OF SUBSTANTIAL INVOLVEMENT**

EERE has substantial involvement in work performed under Awards made as a result of this FOA. EERE does not limit its involvement to the administrative requirements of the Award. Instead, EERE has substantial involvement in the direction and redirection of the technical aspects of the project as a whole. Substantial involvement includes, but is not limited to, the following:

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1. EERE shares responsibility with the recipient for the management, control, direction, and performance of the Project.
2. EERE may intervene in the conduct or performance of work under this Award for programmatic reasons. Intervention includes the interruption or modification of the conduct or performance of project activities.
3. EERE may redirect or discontinue funding the Project based on the outcome of EERE's evaluation of the Project at that the Go/No Go decision point(s).
4. EERE participates in major project decision-making processes.

#### **10. SUBJECT INVENTION UTILIZATION REPORTING**

In order to ensure that Prime Recipients and Subrecipients holding title to subject inventions are taking the appropriate steps to commercialize subject inventions, EERE may require that each Prime Recipient holding title to a subject invention submit annual reports for 10 years from the date the subject invention was disclosed to EERE on the utilization of the subject invention and efforts made by Prime Recipient or their licensees or assignees to stimulate such utilization. The reports must include information regarding the status of development, date of first commercial sale or use, gross royalties received by the Prime Recipient, and such other data and information as EERE may specify.

#### **11. INTELLECTUAL PROPERTY PROVISIONS**

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at <http://energy.gov/gc/standard-intellectual-property-ip-provisions-financial-assistance-awards>.

#### **12. REPORTING**

Reporting requirements are identified on the Federal Assistance Reporting Checklist, DOE F 4600.2, attached to the award agreement. The checklist can be accessed at [http://energy.gov/sites/prod/files/2013/05/f0/Attch\\_FA\\_RepReqChecklist\\_COMBINED\\_FINAL\\_4-23-13%20%283%29\\_0.pdf](http://energy.gov/sites/prod/files/2013/05/f0/Attch_FA_RepReqChecklist_COMBINED_FINAL_4-23-13%20%283%29_0.pdf).

#### **13. Go/No-Go REVIEW**

Each project selected under this FOA will be subject to a periodic project evaluation referred to as a Go/No-Go Review. Federal funding beyond the Go/No Go decision point (continuation funding), is contingent on (1) the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority; (2) meeting the objectives, milestones, deliverables, and decision point criteria of recipient's approved project and

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obtaining approval from EERE to continue work on the project; and (3) the submittal of required reports in accordance with the Statement of Project Objectives.

As a result of the Go/No Go Review, DOE may, at its discretion, authorize the following actions: (1) continue to fund the project, contingent upon the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority; (2) recommend redirection of work under the project; (3) place a hold on federal funding for the project, pending further supporting data or funding; or (4) discontinue funding the project because of insufficient progress, change in strategic direction, or lack of funding.

The Go/No-Go decision is distinct from a non-compliance determination. In the event a recipient fails to comply with the requirements of an award, EERE may take appropriate action, including but not limited to, redirecting, suspending or terminating the award.

#### **14. CONFERENCE SPENDING**

The recipient shall not expend **any** funds on a conference not directly and programmatically related to the purpose for which the grant or cooperative agreement was awarded that would defray the cost to the United States Government of a conference held by any Executive branch department, agency, board, commission, or office for which the cost to the United States Government would otherwise exceed \$20,000, thereby circumventing 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 conference.

## **VII. QUESTIONS/AGENCY CONTACTS**

Upon the issuance of a FOA, EERE personnel are prohibited from communicating (in writing or otherwise) with applicants regarding the FOA except through the established question and answer process as described below. Specifically, questions regarding the content of this FOA must be submitted to: [fy16fctoofficewidefoa@EE.Doe.Gov](mailto:fy16fctoofficewidefoa@EE.Doe.Gov). Questions must be submitted not later than 3 business days prior to the application due date and time.

All questions and answers related to this FOA will be posted on EERE Exchange at: <https://eere-exchange.energy.gov>. **Please note that you must first select this specific FOA Number in order to view the questions and answers specific to this FOA.** EERE will attempt to respond to a question within 3 business days, unless a similar question and answer has already been posted on the website.

Questions related to the registration process and use of the EERE Exchange website should be submitted to: [EERE-ExchangeSupport@hq.doe.gov](mailto:EERE-ExchangeSupport@hq.doe.gov).

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## **VIII. OTHER INFORMATION**

### **A. FOA MODIFICATIONS**

Amendments to this FOA will be posted on the EERE Exchange website and the Grants.gov system. However, you will only receive an email when an amendment or a FOA is posted on these sites if you register for email notifications for this FOA in Grants.gov. EERE recommends that you register as soon after the release of the FOA as possible to ensure you receive timely notice of any amendments or other FOAs.

### **B. GOVERNMENT RIGHT TO REJECT OR NEGOTIATE**

EERE reserves the right, without qualification, to reject any or all applications received in response to this FOA and to select any application, in whole or in part, as a basis for negotiation and/or award.

### **C. COMMITMENT OF PUBLIC FUNDS**

The Contracting Officer is the only individual who can make awards or commit the Government to the expenditure of public funds. A commitment by anyone other than the Contracting Officer, either express or implied, is invalid.

### **D. TREATMENT OF APPLICATION INFORMATION**

In general, EERE will only use data and other information contained in applications for evaluation purposes, unless such information is generally available to the public or is already the property of the Government.

Applicants should not include trade secrets or commercial or financial information that is privileged or confidential in their application unless such information is necessary to convey an understanding of the proposed project or to comply with a requirement in the FOA. Applications containing trade secrets or commercial or financial information that is privileged or confidential, which the applicant does not want disclosed to the public or used by the Government for any purpose other than application evaluation, must be marked as described in this section.

The cover sheet of the application must be marked as follows and identify the specific pages containing trade secrets or commercial or financial information that is privileged or confidential:

Notice of Restriction on Disclosure and Use of Data:  
Pages [list applicable pages] of this document may contain trade secrets or commercial or financial information that is privileged or confidential,

and 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.  
[End of Notice]

The header and footer of every page that contains trade secrets or commercial or financial information that is privileged must be marked as follows: “May contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure.”

In addition, each line or paragraph containing trade secrets or commercial or financial information that is privileged or confidential must be enclosed in brackets.

The above markings enable EERE to follow the provisions of 10 CFR 1004.11(d) in the event a Freedom of Information Act (FOIA) request is received for information submitted with an application. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under a FOIA request 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.

Subject to the specific FOIA exemptions identified in 5 U.S.C. 552(b), all information submitted to EERE by a FOA applicant is subject to public release under the Freedom of Information Act, 5 U.S.C. §552, as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175. It is the applicant’s responsibility to review FOIA and its exemptions to understand (1) what information may be subject to public disclosure and (2) what information applicants submit to the Government that are protected by law. In some cases, DOE may be unable to make an independent determination regarding which information submitted by an applicant is releasable and which is protected by an exemption. In such cases, DOE will consult with the applicant, in accordance with 10 C.F.R. §1004.11, to solicit the applicant’s views on how the information should be treated.

## **E. EVALUATION AND ADMINISTRATION BY NON-FEDERAL PERSONNEL**

In conducting the merit review evaluation, the Go/No-Go Review and Peer Review, the Government may seek the advice of qualified non Federal personnel as reviewers. The Government may also use non-Federal personnel to conduct routine, nondiscretionary administrative activities. The applicant, by submitting its application, consents to the use of non-Federal reviewers/administrators. Non-Federal reviewers must sign conflict of interest and non-disclosure agreements prior to reviewing an application. Non-Federal personnel conducting administrative activities must sign a non-disclosure agreement.

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## **F. NOTICE REGARDING ELIGIBLE/INELIGIBLE ACTIVITIES**

Eligible activities under this FOA include those which describe and promote the understanding of scientific and technical aspects of specific energy technologies, but not those which encourage or support political activities such as the collection and dissemination of information related to potential, planned or pending legislation.

## **G. NOTICE OF RIGHT TO CONDUCT A REVIEW OF FINANCIAL CAPABILITY**

EERE reserves the right to conduct an independent third party review of financial capability for applicants that are selected for negotiation of award (including personal credit information of principal(s) of a small business if there is insufficient information to determine financial capability of the organization).

## **H. NOTICE OF POTENTIAL DISCLOSURE UNDER FREEDOM OF INFORMATION ACT**

Applicants should be advised that identifying information regarding all applicants, including applicant names and/or points of contact, may be subject to public disclosure under the Freedom of Information Act, whether or not such applicants are selected for negotiation of award.

## **I. REQUIREMENT FOR FULL AND COMPLETE DISCLOSURE**

Applicants are required to make a full and complete disclosure of all information requested. Any failure to make a full and complete disclosure of the requested information may result in:

- 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.

## **J. RETENTION OF SUBMISSIONS**

EERE 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 EERE for funding, applicants consent to EERE's retention of their submissions.

## **K. TITLE TO SUBJECT INVENTIONS**

Ownership of subject inventions is governed pursuant to the authorities listed below.

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- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions.
- All other parties: The Federal Non-Nuclear Energy Act of 1974, 42 U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (see below).
- Class Patent Waiver: DOE has issued a class waiver that applies to this FOA. Under this class waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class waiver, a domestic large business must agree that any products embodying or produced through the use of a subject invention first created or reduced to practice under this program will be substantially manufactured in the United States, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan are sufficient.
- Advance and Identified Waivers: Applicants may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.
- Determination of Exceptional Circumstances (DEC): Each applicant for AOI 3 of this FOA is required to submit a U.S. Manufacturing Plan as part of its application. If selected, the U.S. Manufacturing Plan shall be incorporated into the award terms and conditions for domestic small businesses and nonprofit organizations. DOE has determined that exceptional circumstances exist that warrants the modification of the standard patent rights clause for small businesses and non-profit awardees under Bayh-Dole to the extent necessary to implement and enforce the U.S. Manufacturing Plan. For example, the commitments and enforcement of a U.S. Manufacturing Plan may be tied to subject inventions. Any Bayh-Dole entity (domestic small business or nonprofit organization) affected by this DEC has the right to appeal it.

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

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

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### **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 to a third party. In addition, the Government may grant licenses for use of the subject invention when a Prime Recipient, Subrecipient, or their assignees and exclusive licensees refuse to do so.

DOE may exercise its march-in rights only if it determines that such action is necessary under any of the four following conditions:

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

Any determination that march-in rights are warranted must follow a fact-finding process in which the recipient has certain rights to present evidence and witnesses, confront witnesses and appear with counsel and appeal any adverse decision. To date, DOE has never exercised its march-in rights to any subject inventions.

### **M. 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.

“Limited Rights Data”: The U.S. Government will not normally require delivery of confidential or trade secret-type 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.

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Government rights in Technical Data Produced Under Awards: The U.S. Government normally retains unlimited 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 EERE awards may be protected from public disclosure for up to five years after the data is generated (“Protected Data”). For awards permitting Protected Data, the protected data must be marked as set forth in the awards intellectual property terms and conditions and a listing of unlimited rights data (i.e., non-protected data) must be inserted into the data clause in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

## **N. COPYRIGHT**

The Prime Recipient and Subrecipients may assert copyright in copyrightable works, such as software, first produced under the award without EERE approval. When copyright is asserted, the Government retains a paid-up nonexclusive, irrevocable worldwide license to reproduce, prepare derivative works, distribute copies to the public, and to perform publicly and display publicly the copyrighted work. This license extends to contractors and others doing work on behalf of the Government.

## **O. PROTECTED PERSONALLY IDENTIFIABLE INFORMATION**

In responding to this FOA, applicants must ensure that Protected Personally Identifiable Information (PII) is not included in the application documents. These documents will be used by the Merit Review Committee in the review process to evaluate each application. PII is defined by the Office of Management and Budget (OMB) and EERE as:

Any information about an individual maintained by an agency, including but not limited to, education, financial transactions, medical history, and criminal or employment history and information that can be used to distinguish or trace an individual’s identity, such as their name, social security number, date and place of birth, mother’s maiden name, biometric records, etc., including any other personal information that is linked or linkable to an individual.

This definition of PII can be further defined as: (1) Public PII and (2) Protected PII.

**Public PII:** PII found in public sources such as telephone books, public websites, business cards, university listing, etc. Public PII includes first and last name, address, work telephone number, email address, home telephone number, and general education credentials.

**Protected PII:** PII that requires enhanced protection. This information includes data that if compromised could cause harm to an individual such as identity theft.

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Listed below are examples of Protected PII that applicants must not include in the files listed above to be evaluated by the Merit Review Committee. This list is not all inclusive.

- Social Security Numbers in any form
- Place of Birth associated with an individual
- Date of Birth associated with an individual
- Mother's maiden name associated with an individual
- Biometric record associated with an individual
- Fingerprint
- Iris scan
- DNA
- Medical history information associated with an individual
- Medical conditions, including history of disease
- Metric information, e.g. weight, height, blood pressure
- Criminal history associated with an individual
- Employment history and other employment information 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
- Security clearance history or related information (not including actual clearances held)

#### **P. ANNUAL COMPLIANCE AUDITS**

If a for-profit entity is a Prime Recipient or Subrecipient and has expended \$750,000 or more of DOE funds during the entity's fiscal year, an annual compliance audit performed by an independent auditor is required. For additional information, please refer to 2 C.F.R. § 910.501 and Subpart F.

If an educational institution, non-profit organization, or state/local government is a Prime Recipient or Subrecipient and has expended \$750,000 or more of Federal funds during the non-Federal entity's fiscal year, then a single or program-specific audit is required. For additional information, please refer to 2 C.F.R. § 200.501 and Subpart F.

Applicants and sub-recipients (if applicable) should propose sufficient costs in the project budget to cover the costs associated with the audit. EERE will share in the cost of the audit at its applicable cost share ratio.

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## **APPENDIX A – COST SHARE INFORMATION**

### **Cost Sharing or Cost Matching**

The terms “cost sharing” and “cost matching” are often used synonymously. Even the DOE Financial Assistance Regulations, 2 CFR 200.306, use both of the terms in the titles specific to regulations applicable to cost sharing. EERE almost always uses the term “cost sharing,” as it conveys the concept that non-federal share is calculated as a percentage of the Total Project Cost. An exception is the State Energy Program Regulation, 10 CFR 420.12, State Matching Contribution. Here “cost matching” for the non-federal share is calculated as a percentage of the Federal funds only, rather than the Total Project Cost.

### **How Cost Sharing Is Calculated**

As stated above, cost sharing is calculated as a percentage of the Total Project Cost. FFRDC costs must be included in Total Project Costs. Following is an example of how to calculate cost sharing amounts for a project with \$1,000,000 in federal funds with a minimum 20% non-federal cost sharing requirement:

- Formula: Federal share (\$) divided by Federal share (%) = Total Project Cost  
Example: \$1,000,000 divided by 80% = \$1,250,000
- Formula: Total Project Cost (\$) minus Federal share (\$) = Non-federal share (\$)  
Example: \$1,250,000 minus \$1,000,000 = \$250,000
- Formula: Non-federal share (\$) divided by Total Project Cost (\$) = Non-federal share (%)  
Example: \$250,000 divided by \$1,250,000 = 20%

### **What Qualifies For Cost Sharing**

While it is not possible to explain what specifically qualifies for cost sharing in one or even a couple of sentences, in general, if a cost is allowable under the cost principles applicable to the organization incurring the cost and is eligible for reimbursement under an EERE grant or cooperative agreement, then it is allowable as cost share. Conversely, if the cost is not allowable under the cost principles and not eligible for reimbursement, then it is not allowable as cost share. In addition, costs may not be counted as cost share if they are paid by the Federal Government under another award unless authorized by Federal statute to be used for cost sharing.

The rules associated with what is allowable as cost share are specific to the type of organization that is receiving funds under the grant or cooperative agreement, though are generally the same for all types of entities. The specific rules applicable to:

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- FAR Part 31 for For-Profit entities, (48 CFR Part 31); and
- 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

In addition to the regulations referenced above, other factors may also come into play such as timing of donations and length of the project period. For example, the value of ten years of donated maintenance on a project that has a project period of five years would not be fully allowable as cost share. Only the value for the five years of donated maintenance that corresponds to the project period is allowable and may be counted as cost share.

Additionally, EERE generally does not allow pre-award costs for either cost share or reimbursement when these costs precede the signing of the appropriation bill that funds the award. In the case of a competitive award, EERE generally does not allow pre-award costs prior to the signing of the Selection Statement by the EERE Selection Official.

### **DOE Financial Assistance Rules 2 CFR Part 200 as amended by 2 CFR Part 910**

As stated above, the rules associated with what is allowable cost share are generally the same for all types of organizations. Following are the rules found to be common, but again, the specifics are contained in the regulations and cost principles specific to the type of entity:

- (A) Acceptable contributions. All contributions, including cash contributions and third party in-kind contributions, must be accepted as part of the Prime Recipient's cost sharing if such contributions meet all of the following criteria:
- (1) They are verifiable from the recipient's records.
  - (2) They are not included as contributions for any other federally-assisted project or program.
  - (3) They are necessary and reasonable for the proper and efficient accomplishment of project or program objectives.
  - (4) They are allowable under the cost principles applicable to the type of entity incurring the cost as follows:
    - a. For-profit organizations. Allowability of costs incurred by for-profit organizations and those nonprofit organizations listed in Attachment C to OMB Circular A-122 is determined in accordance with the for-profit cost principles in 48 CFR Part 31 in the Federal Acquisition Regulation, except that patent prosecution costs are not allowable unless specifically authorized in the award document. (v) Commercial Organizations. FAR Subpart 31.2—Contracts with Commercial Organizations

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- b. Other types of organizations. For all other non-federal entities, allowability of costs is determined in accordance with 2 CFR Part 200 Subpart E.
- (5) They are not paid by the Federal Government under another award unless authorized by Federal statute to be used for cost sharing or matching.
- (6) They are provided for in the approved budget.

(B) Valuing and documenting contributions

- (1) Valuing recipient's property or services of recipient's employees. Values are established in accordance with the applicable cost principles, which mean that amounts chargeable to the project are determined on the basis of costs incurred. For real property or equipment used on the project, the cost principles authorize depreciation or use charges. The full value of the item may be applied when the item will be consumed in the performance of the award or fully depreciated by the end of the award. In cases where the full value of a donated capital asset is to be applied as cost sharing or matching, that full value must be the lesser or the following:
- a. The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation; or
  - b. The current fair market value. If there is sufficient justification, the Contracting Officer may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project. The Contracting Officer may accept the use of any reasonable basis for determining the fair market value of the property.
- (2) Valuing services of others' employees. If an employer other than the recipient furnishes the services of an employee, those services are valued at the employee's regular rate of pay, provided these services are for the same skill level for which the employee is normally paid.
- (3) Valuing volunteer services. Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services must be consistent with those paid for similar work in the recipient's organization. In those markets in which the required skills are not found in the recipient organization, rates must be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, allowable, and allocable may be included in the valuation.

(4) Valuing property donated by third parties.

- a. Donated supplies may include such items as office supplies or laboratory supplies. Value assessed to donated supplies included in the cost sharing or matching share must be reasonable and must not exceed the fair market value of the property at the time of the donation.
- b. Normally only depreciation or use charges for equipment and buildings may be applied. However, the fair rental charges for land and the full value of equipment or other capital assets may be allowed, when they will be consumed in the performance of the award or fully depreciated by the end of the award, provided that the Contracting Officer has approved the charges. When use charges are applied, values must be determined in accordance with the usual accounting policies of the recipient, with the following qualifications:
  - i. The value of donated space must not exceed the fair rental value of comparable space as established by an independent appraisal of comparable space and facilities in a privately-owned building in the same locality.
  - ii. The value of loaned equipment must not exceed its fair rental value.

(5) Documentation. The following requirements pertain to the recipient's supporting records for in-kind contributions from third parties:

- a. Volunteer services must be documented and, to the extent feasible, supported by the same methods used by the recipient for its own employees.
- b. The basis for determining the valuation for personal services and property must be documented.

## APPENDIX B – SAMPLE COST SHARE CALCULATION FOR BLENDED COST SHARE PERCENTAGE

The following example shows the math for calculating required cost share for a project with \$2,000,000 in Federal funds with four tasks requiring different Non-federal cost share percentages:

Task	Proposed Federal Share	Federal Share %	Recipient Share %
Task 1 (R&D)	\$1,000,000	80%	20%
Task 2 (R&D)	\$500,000	80%	20%
Task 3 (Demonstration)	\$400,000	50%	50%
Task 4 (Outreach)	\$100,000	100%	0%

Federal share (\$) divided by Federal share (%) = Task Cost

Each task must be calculated individually as follows:

### Task 1

\$1,000,000 divided by 80% = \$1,250,000 (Task 1 Cost)

Task 1 Cost minus federal share = Non-federal share

\$1,250,000 - \$1,000,000 = \$250,000 (Non-federal share)

### Task 2

\$500,000 divided 80% = \$625,000 (Task 2 Cost)

Task 2 Cost minus federal share = Non-federal share

\$625,000 - \$500,000 = \$125,000 (Non-federal share)

### Task 3

\$400,000 / 50% = \$800,000 (Task 3 Cost)

Task 3 Cost minus federal share = Non-federal share

\$800,000 - \$400,000 = \$400,000 (Non-federal share)

### Task 4

Federal share = \$100,000

Non-federal cost share is not mandated for outreach = \$0 (Non-federal share)

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The calculation may then be completed as follows:

Tasks	\$ Federal Share	% Federal Share	\$ Non-Federal Share	% Non-Federal Share	Total Project Cost
Task 1	\$1,000,000	80%	\$250,000	20%	\$1,250,000
Task 2	\$500,000	80%	\$125,000	20%	\$625,000
Task 3	\$400,000	50%	\$400,000	50%	\$800,000
Task 4	\$100,000	100%	\$0	0%	\$100,000
Totals	\$2,000,000		\$775,000		\$2,775,000

Blended Cost Share %

Non-federal share (\$775,000) divided by Total Project Cost (\$2,775,000) = 27.9% (Non-federal)

Federal share (\$2,000,000) divided by Total Project Cost (\$2,775,000) = 72.1% (Federal)

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## **APPENDIX C – WAIVER REQUESTS: FOREIGN ENTITY PARTICIPATION AS THE PRIME RECIPIENT AND PERFORMANCE OF WORK IN THE UNITED STATES**

### ***1. WAIVER FOR FOREIGN ENTITY PARTICIPATION AS THE PRIME RECIPIENT***

As set forth in Section III.A.3, all Prime Recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a State or territory of the United States. To request a waiver of this requirement, an applicant must submit an explicit waiver request in the Full Application.

Overall, the applicant must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to have a foreign entity serve as the Prime Recipient. A request to waive the *Foreign Entity Participation as the Prime Recipient* requirement must include the following:

- Entity name;
- The rationale for proposing a foreign entity to serve as the Prime Recipient;
- Country of incorporation;
- A description of the project’s anticipated contributions to the US economy;
  - How the project will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
  - How the project will promote domestic American manufacturing of products and/or services;
- A description of how the foreign entity’s participation as the Prime Recipient is essential to the project;
- A description of the likelihood of Intellectual Property (IP) being created from the work and the treatment of any such IP;
- Countries where the work will be performed (Note: if any work is proposed to be conducted outside the U.S., the applicant must also complete a separate request for waiver of the Performance of Work in the United States requirement).

EERE may require additional information before considering the waiver request.

The applicant does not have the right to appeal EERE’s decision concerning a waiver request.

### ***2. WAIVER FOR PERFORMANCE OF WORK IN THE UNITED STATES***

As set forth in Section IV.J.3, all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the Prime Recipient

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should make every effort to purchase supplies and equipment within the United States. There may be limited circumstances where it is in the interest of the project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit an explicit waiver request in the Full Application. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

Overall, a waiver request must demonstrate to the satisfaction of EERE that it would further the purposes of this FOA and is otherwise in the economic interests of the United States to perform work outside of the United States. A request to waive the *Performance of Work in the United States* requirement must include the following:

- The rationale for performing the work outside the U.S. (“foreign work”);
- A description of the work proposed to be performed outside the U.S.;
- An explanation as to how the foreign work is essential to the project;
- A description of the anticipated benefits to be realized by the proposed foreign work and the anticipated contributions to the US economy;
  - The associated benefits to be realized and the contribution to the project from the foreign work;
  - How the foreign work will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
  - How the foreign work will promote domestic American manufacturing of products and/or services;
- A description of the likelihood of Intellectual Property (IP) being created from the foreign work and the treatment of any such IP;
- The total estimated cost (DOE and Recipient cost share) of the proposed foreign work;
- The countries in which the foreign work is proposed to be performed; and
- The name of the entity that would perform the foreign work.

EERE may require additional information before considering the waiver request.

The applicant does not have the right to appeal EERE’s decision concerning a waiver request.

## **APPENDIX D - DATA MANAGEMENT PLAN**

A data management plan (“DMP”) explains how data generated in the course of the work performed under an EERE award will be shared and preserved or, when justified, explains why data sharing or preservation is not possible or scientifically appropriate.

### **DMP Requirements**

In order for a DMP to be considered acceptable, the DMP must address the following:

**At a minimum, the DMP must describe how data sharing and preservation will enable validation of the results from the proposed work, or how results could be validated if data are not shared or preserved.**

**The DMP must provide a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publication.** This includes data that are displayed in charts, figures, images, etc. In addition, the underlying digital research data used to generate the displayed data should be made as accessible as possible in accordance with the principles stated above. This requirement could be met by including the data as supplementary information to the published article, or through other means. The published article should indicate how these data can be accessed.

The DMP should consult and reference available information about data management resources to be used in the course of the proposed work. In particular, a DMP that explicitly or implicitly commits data management resources at a facility beyond what is conventionally made available to approved users should be accompanied by written approval from that facility. In determining the resources available for data management at DOE User Facilities, researchers should consult the published description of data management resources and practices at that facility and reference it in the DMP. Information about other DOE facilities can be found in the additional guidance from the sponsoring program.

The DMP must protect confidentiality, personal privacy, Personally Identifiable Information, and U.S. national, homeland, and economic security; recognize proprietary interests, business confidential information, and intellectual property rights; avoid significant negative impact on innovation, and U.S. competitiveness; and otherwise be consistent with all laws (i.e., export control laws), and DOE regulations, orders, and policies.

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## Data Determination for a DMP

The Principal Investigator should determine which data should be the subject of the DMP and, in the DMP, propose which data should be shared and/or preserved in accordance with the DMP Requirements noted above.

For data that will be generated through the course of the proposed work, the Principal Investigator should indicate what types of data should be protected from immediate public disclosure by DOE (referred to as “protected data”) and what types of data that DOE should be able to release immediately. Similarly, for data developed outside of the proposed work at private expense that will be used in the course of the proposed work, the Principal Investigator should indicate whether that type of data will be subject to public release or kept confidential (referred to as “limited rights data”). Any use of limited rights data or labeling of data as “protected data” must be consistent with the DMP Requirements noted above.

## Suggested Elements for a DMP

The following list of elements for a DMP provides suggestions regarding the data management planning process and the structure of the DMP:

Data Types and Sources: A brief, high-level description of the data to be generated or used through the course of the proposed work and which of these are considered digital research data necessary to validate the research findings or results.

Content and Format: A statement of plans for data and metadata content and format including, where applicable, a description of documentation plans, annotation of relevant software, and the rationale for the selection of appropriate standards. Existing, accepted community standards should be used where possible. Where community standards are missing or inadequate, the DMP could propose alternate strategies for facilitating sharing, and should advise the sponsoring program of any need to develop or generalize standards.

Sharing and Preservation: A description of the plans for data sharing and preservation. This should include, when appropriate: the anticipated means for sharing and the rationale for any restrictions on who may access the data and under what conditions; a timeline for sharing and preservation that addresses both the minimum length of time the data will be available and any anticipated delay to data access after research findings are published; any special requirements for data sharing, for example, proprietary software needed to access or interpret data, applicable policies, provisions, and licenses for re-use and re-distribution, and for the production of derivatives, including guidance for how data and data products should be cited; any resources and capabilities (equipment, connections, systems, software, expertise, etc.) requested in the research proposal that are needed to meet the stated goals for sharing and preservation (this could reference the relevant section of the associated research proposal and budget request); and

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whether/where the data will be preserved after direct project funding ends and any plans for the transfer of responsibilities for sharing and preservation.

**Protection:** A statement of plans, where appropriate and necessary, to protect confidentiality, personal privacy, Personally Identifiable Information, and U.S. national, homeland, and economic security; recognize proprietary interests, business confidential information, and intellectual property rights; and avoid significant negative impact on innovation, and U.S. competitiveness.

**Rationale:** A discussion of the rationale or justification for the proposed data management plan including, for example, the potential impact of the data within the immediate field and in other fields, and any broader societal impact.

### **Additional Guidance**

In determining which data should be shared and preserved, researchers must consider the data needed to validate research findings as described in the Requirements, and are encouraged to consider the potential benefits of their data to their own fields of research, fields other than their own, and society at large.

DMPs should reflect relevant standards and community best practices and make use of community accepted repositories whenever practicable.

Costs associated with the scope of work and resources articulated in a DMP may be included in the proposed research budget as permitted by the applicable cost principles.

To improve the discoverability of and attribution for datasets created and used in the course of research, EERE encourages the citation of publicly available datasets within the reference section of publications, and the identification of datasets with persistent identifiers such as Digital Object Identifiers (DOIs). In most cases, EERE can provide DOIs free of charge for data resulting from DOE-funded research through its Office of Scientific and Technical Information (OSTI) DataID Service.

### **Definitions**

**Data Preservation:** Data preservation means providing for the usability of data beyond the lifetime of the research activity that generated them.

**Data Sharing:** Data sharing means making data available to people other than those who have generated them. Examples of data sharing range from bilateral communications with colleagues, to providing free, unrestricted access to anyone through, for example, a web-based platform.

Digital Research Data: The term digital data encompasses a wide variety of information stored in digital form including: experimental, observational, and simulation data; codes, software and algorithms; text; numeric information; images; video; audio; and associated metadata. It also encompasses information in a variety of different forms including raw, processed, and analyzed data, published and archived data.

Research Data: The recorded factual material commonly accepted in the scientific community as necessary to validate research findings, but not any of the following: preliminary analyses, drafts of scientific papers, plans for future research, peer reviews, or communications with colleagues. This 'recorded' material excludes physical objects (e.g., laboratory samples).

Research data also do not include:

(A) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published, or similar information which is protected under law; and

(B) Personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study.”

Validate: In the context of DMPs, validate means to support, corroborate, verify, or otherwise determine the legitimacy of the research findings. Validation of research findings could be accomplished by reproducing the original experiment or analyses; comparing and contrasting the results against those of a new experiment or analyses; or by some other means.

## **APPENDIX E—TECHNOLOGY READINESS LEVELS**

**Technology Readiness Levels (TRLs):** Identify the readiness level of the technology associated with the project as well as the planned progression during the course of project execution. A detailed explanation of the rationale for the estimated technology readiness level should be provided. Specific entry criteria for the next higher technology readiness level should be identified. The following definitions apply:

**TRL-1.** Basic principles observed and reported: Scientific problem or phenomenon identified. Essential characteristics and behaviors of systems and architectures are identified using mathematical formulations or algorithms. The observation of basic scientific principles or phenomena has been validated through peer-reviewed research. Technology is ready to transition from scientific research to applied research.

**TRL-2.** Technology concept and/or application formulated: Applied research activity. Theory and scientific principles are focused on specific application areas to define the concept. Characteristics of the application are described. Analytical tools are developed for simulation or analysis of the application.

**TRL-3.** Analytical and experimental critical function and/or characteristic proof of concept: Proof of concept validation has been achieved at this level. Experimental research and development is initiated with analytical and laboratory studies. System/integrated process requirements for the overall system application are well known. Demonstration of technical feasibility using immature prototype implementations are exercised with representative interface inputs to include electrical, mechanical, or controlling elements to validate predictions.

**TRL-4.** Component and/or process validation in laboratory environment- Alpha prototype (component) Standalone prototyping implementation and testing in laboratory environment demonstrates the concept. Integration and testing of component technology elements are sufficient to validate feasibility.

**TRL-5.** Component and/or process validation in relevant environment- Beta prototype (component): Thorough prototype testing of the component/process in relevant environment to the end user is performed. Basic technology elements are integrated with reasonably realistic supporting elements based on available technologies. Prototyping implementations conform to the target environment and interfaces.

**TRL-6.** System/process model or prototype demonstration in a relevant environment- Beta prototype (system): Prototyping implementations are partially integrated with existing systems. Engineering feasibility fully demonstrated in actual or high fidelity system applications in an environment relevant to the end user.

**TRL-7.** System/process prototype demonstration in an operational environment- Integrated pilot (system): System prototyping demonstration in operational environment. System is at or near full scale (pilot or engineering scale) of the

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operational system, with most functions available for demonstration and test. The system, component, or process is integrated with collateral and ancillary systems in a near production quality prototype.

**TRL-8.** Actual system/process completed and qualified through test and demonstration-Pre-commercial demonstration: End of system development. Full-scale system is fully integrated into operational environment with fully operational hardware and software systems. All functionality is tested in simulated and operational scenarios with demonstrated achievement of end-user specifications. Technology is ready to move from development to commercialization.

## APPENDIX F – APPLICABLE FC-PAD TARGETS

<b>Table 3.4.3 Technical Targets for Automotive Applications: 80-kW<sub>e</sub> (net) Integrated Transportation Fuel Cell Power Systems Operating on Direct Hydrogen<sup>a</sup></b>			
Characteristic	Units	2015 Status	2020 Targets
Peak energy efficiency <sup>b</sup>	%	60 <sup>c</sup>	65
Power density	W / L	640 <sup>d</sup>	650
Specific power	W / kg	659 <sup>e</sup>	650
Cost <sup>f</sup>	\$ / kW <sub>net</sub>	53 <sup>g</sup>	40
Cold start-up time to 50% of rated power	@-20°C ambient temp	seconds	20 <sup>h</sup>
	@+20°C ambient temp	seconds	<10 <sup>h</sup>
Start up and shut down energy <sup>i</sup>	from -20°C ambient temp	MJ	7.5
	from +20°C ambient temp	MJ	–
Durability in automotive drive cycle	hours	3,900 <sup>j</sup>	5,000 <sup>k</sup>
Startup/shutdown durability <sup>l</sup>	cycles	–	5,000
Assisted start from low temperatures <sup>m</sup>	°C	–	-40
Unassisted start from low temperatures <sup>m</sup>	°C	-30 <sup>n</sup>	-30

- a. Targets exclude hydrogen storage, power electronics and electric drive.
- b. Ratio of DC output energy to the lower heating value of the input fuel (hydrogen). Peak efficiency occurs at less than 25% rated power.
- c. W. Sung, Y. Song, K. Yu, and T. Lim, "Recent Advances in the Development of Hyundai-Kia's Fuel Cell Electric Vehicles," SAE Int. J. Engines 3.1 (2010): 768-772, doi: 10.4271/2010-01-1089.
- d. J.Juriga, Hyundai Motor Group's Development of the Fuel Cell Electric Vehicle, May 10th, 2012, [http://www.hydrogen.energy.gov/pdfs/htac\\_may2012\\_hyundai.pdf](http://www.hydrogen.energy.gov/pdfs/htac_may2012_hyundai.pdf)
- e. U. Eberle, B. Muller, and R von Helmolt, Energy & Environmental Science 5 (2012): 8780.
- f. Cost projected to high-volume production (500,000 systems per year).
- g. Cost at 500,000 systems per year based on an analysis of state-of-the-art components that have been developed and demonstrated primarily through the DOE Program at the laboratory scale. Additional efforts would be needed for integration of components into a complete automotive system that meets durability requirements in real-world conditions. DOE Hydrogen and Fuel Cells Program Record 15015, "Fuel Cell System Cost – 2015." [http://www.hydrogen.energy.gov/program\\_records.html](http://www.hydrogen.energy.gov/program_records.html)
- h. Based on average of status values reported at 2010 SAE World Congress (W. Sung, Y-I. Song, K-H Yu, T.W. Lim, SAE-2-10-01-1089). These systems do not necessarily meet other system-level targets.
- i. H<sub>2</sub> fuel energy (lower heating value) to include the fuel energy required to account for the electrical energy consumed from cold start.

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- j. Average projected time to 10% voltage degradation for the fleet with the highest durability, as reported in J. Kurtz et al., "Fuel Cell Electric Vehicle Evaluation," 2015 Annual Merit Review, [http://www.hydrogen.energy.gov/pdfs/review15/tv001\\_kurtz\\_2015\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review15/tv001_kurtz_2015_o.pdf) (slide 9). Testing reflects real-world driving, not a simulated drive cycle. Catalyst loading was not reported, and did not necessarily match the target value of 0.125 mg<sub>Pt</sub>/cm<sup>2</sup> (Table 3.4.7).
- k. Need to meet or exceed at temperatures of 80°C up to peak temperature. Based on polarization curve and durability testing protocols in Tables 3.4.21 and 3.4.22, with <10% drop in rated power after test.
- l. Measured according to protocol in Table 3.4.23, with less than 5% decrease in voltage at 1.2 A/cm<sup>2</sup>.
- m. 8-hour soak at stated temperature must not impact subsequent achievement of targets.
- n. Press Release: Honda Demonstrates the FCX Concept Vehicle, Sep 25, 2006, <http://www.world.honda.com/news/2006/4060925FCXConcept> and Associated Press, Toyota develops a new fuel cell hybrid, June 6, 2008, <http://www.nbcnews.com/id/25004758/>.

Table 3.4.5 Technical Targets: Membrane Electrode Assemblies			
Characteristic	Units	2015 Status	2020 Targets
Cost <sup>a</sup>	\$ / kW <sub>net</sub>	17 <sup>b</sup>	14
Durability with cycling	Hours	2,500 <sup>c</sup>	5,000 <sup>d</sup>
Startup/shutdown durability <sup>e</sup>	Cycles	–	5,000
Performance @ 0.8 V <sup>f</sup>	mA / cm <sup>2</sup>	240 <sup>g</sup>	300
Performance @ rated power <sup>h</sup> (150 kPa abs)	mW / cm <sup>2</sup>	810 <sup>i</sup>	1,000
Robustness (cold operation) <sup>j</sup>		1.09 <sup>k</sup>	0.7
Robustness (hot operation) <sup>l</sup>		0.87 <sup>k</sup>	0.7
Robustness (cold transient) <sup>m</sup>		0.84 <sup>k</sup>	0.7

- a. Costs projected to high volume production (500,000 80 kW<sub>net</sub> systems per year).
- b. Cost when producing sufficient MEAs for 500,000 systems per year. DOE Hydrogen and Fuel Cells Program Record 15015, “Fuel Cell System Cost – 2015.” [http://www.hydrogen.energy.gov/program\\_records.html](http://www.hydrogen.energy.gov/program_records.html). Cost includes all MEA components, including frames and gaskets.
- c. Time until 10% decrease in voltage at 1.0 – 1.5 A/cm<sup>2</sup> for a Gore MEA using a 510 catalyst (anode/cathode loading of 0.2/0.4 mg<sub>Pt</sub>/cm<sup>2</sup>) operated on durability test protocol in Table 3.4.22. Rod Borup and Rangachary Mukundan (LANL), private communication and 2013 Annual Merit Review presentation ([http://www.hydrogen.energy.gov/pdfs/review13/fc016\\_mukundan\\_2013\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review13/fc016_mukundan_2013_o.pdf)).
- d. Need to meet or exceed at temperatures of 80°C up to peak temperature. Based on polarization curve and durability testing protocols in Tables 3.4.21 and 3.4.22, with <10% drop in rated power after test.
- e. Measured according to protocol in Table 3.4.23, with less than 5% decrease in voltage at 1.2 A/cm<sup>2</sup>.
- f. Measured using polarization curve protocol in Table 3.4.21.
- g. A. Kongkanand et al. (General Motors), “High-Activity Dealloyed Catalysts,” 2014 Annual Progress Report, [http://www.hydrogen.energy.gov/pdfs/progress14/v\\_a\\_9\\_kongkanand\\_2014.pdf](http://www.hydrogen.energy.gov/pdfs/progress14/v_a_9_kongkanand_2014.pdf)
- h. Measured using polarization curve protocol in Table 3.4.21, but any temperature up to maximum operating temperature may be used. Rated power operating point depends on MEA temperature and is defined as the voltage at which  $V = 77.6 / (22.1 + T[°C])$ , based on target of  $Q/\Delta T_i = 1.45$  kW/°C and definition of  $Q/\Delta T_i$  from table 3.4.4, with an approximation of MEA temperature as equal to stack coolant outlet temperature.
- i. Areal power density of 810 mW/cm<sup>2</sup> at 150 kPa<sub>abs</sub> and 1,060 mW/cm<sup>2</sup> At 250 kPa<sub>abs</sub>. A. Steinbach et al. (3M), “High-Performance, Durable, Low-Cost Membrane Electrode Assemblies for Transportation Applications,” 2014 Annual Merit Review, [http://www.hydrogen.energy.gov/pdfs/review14/fc104\\_steinbach\\_2014\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review14/fc104_steinbach_2014_o.pdf)
- j. Ratio of voltage at 30°C to voltage at 80°C during operation at 1.0 A/cm<sup>2</sup>, measured using the protocol for a polarization curve found in Table 3.4.21. A 25°C dew point is used only for 30°C operation.
- k. Based on testing performed at LANL using a Gore MEA with high cathode loading (0.1/0.4 mg<sub>Pt</sub>/cm<sup>2</sup> anode/cathode) and SGL GDLs (25BC/25BC). Rod Borup, presentation to the Fuel Cell Tech Team, July 15, 2015.
- l. Ratio of voltage at 90°C to voltage at 80°C during operation at 1.0 A/cm<sup>2</sup>, measured using the protocol for a polarization curve found in Table 3.4.21. A 59°C dew point is used for both 90°C and 80°C operations.
- m. Ratio of voltage at 30°C transient operation to voltage at 80°C steady-state operation at 1.0 A/cm<sup>2</sup>, measured using the protocol for a polarization curve found in Table 3.4.21. A 25°C dew point is used only for 30°C operation. 30°C transient operation is at 1 A/cm<sup>2</sup> for at least 15 minutes then lowered to 0.1 A/cm<sup>2</sup> for 3 minutes without changing operating conditions. After 3 minutes, the current density is returned to 1 A/cm<sup>2</sup>. The voltage is measured 5 seconds after returning to 1 A/cm<sup>2</sup>.

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Table 3.4.6 Technical Targets: Membranes for Transportation Applications			
Characteristic	Units	2015 Status	2020 Targets
Maximum oxygen cross-over <sup>a</sup>	mA / cm <sup>2</sup>	<1 <sup>b</sup>	2
Maximum hydrogen cross-over <sup>a</sup>	mA / cm <sup>2</sup>	<1.4 <sup>c</sup>	15
Area specific proton resistance at:			
Maximum operating temperature and water partial pressures from 40-80 kPa	Ohm cm <sup>2</sup>	0.072 (120°C,40 kPa) <sup>c</sup>	0.02
80°C and water partial pressures from 25-45 kPa	Ohm cm <sup>2</sup>	0.027 (25 kPa) <sup>c</sup>	0.02
30°C and water partial pressures up to 4 kPa	Ohm cm <sup>2</sup>	0.027 (4 kPa) <sup>c</sup>	0.03
-20°C	Ohm cm <sup>2</sup>	0.1 <sup>b</sup>	0.2
Maximum operating temperature	°C	120 <sup>c</sup>	120
Minimum electrical resistance	Ohm cm <sup>2</sup>	>5,600 <sup>c</sup>	1,000
Cost <sup>d</sup>	\$ / m <sup>2</sup>	17 <sup>e</sup>	20
Durability <sup>f</sup>			
Mechanical	Cycles until >15 mA/cm <sup>2</sup> H <sub>2</sub> crossover <sup>g</sup>	23,000 <sup>c</sup>	20,000
Chemical	Hours until >15 mA/cm <sup>2</sup> crossover or >20% loss in OCV	742 <sup>c</sup>	>500

- a. Tested in MEA at 1 atm O<sub>2</sub> or H<sub>2</sub> at nominal stack operating temperature, humidified gases at 0.5 V DC.
- b. Unreinforced PFIA membrane. S. Hamrock et al. (3M), U.S. Department of Energy Hydrogen and Fuel Cells Program 2011 Annual Progress Report, [http://www.hydrogen.energy.gov/pdfs/progress11/v\\_c\\_1\\_hamrock\\_2011.pdf](http://www.hydrogen.energy.gov/pdfs/progress11/v_c_1_hamrock_2011.pdf).
- c. Reinforced and chemically stabilized PFIA membrane. M. Yandrasits et al. (3M), U.S. Department of Energy Hydrogen and Fuel Cells Program 2015 Annual Progress Report.
- d. Costs projected to high-volume production (500,000 80 kW systems per year).
- e. Cost when producing sufficient membrane for 500,000 systems per year. DOE Hydrogen and Fuel Cells Program Record 15015, "Fuel Cell System Cost – 2015." [http://www.hydrogen.energy.gov/program\\_records.html](http://www.hydrogen.energy.gov/program_records.html)
- f. Measured according to protocols in Tables 3.4.19 and 3.4.20.
- g. For air or N<sub>2</sub> testing, an equivalent crossover metric of 0.1 sccm/cm<sup>2</sup> at a 20 kPa pressure differential, 80°C, and 100%RH may be used as an alternative.

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Table 3.4.7 Technical Targets: Electrocatalysts for Transportation Applications			
Characteristic	Units	2015 Status	2020 Targets
Platinum group metal total content (both electrodes) <sup>a</sup>	g / kW (rated, <sup>b</sup> gross) @ 150 kPa (abs)	0.16 (150 kPa abs) <sup>c,d</sup>	0.125
Platinum group metal (pgm) total loading (both electrodes) <sup>a</sup>	mg PGM / cm <sup>2</sup> electrode area	0.13 <sup>c</sup>	0.125
Mass activity <sup>e</sup>	A / mg PGM @ 900 mV <sub>iR-free</sub>	>0.5 <sup>f</sup>	0.44
Loss in initial catalytic activity <sup>e</sup>	% mass activity loss	66 <sup>c</sup>	<40
Loss in performance at 0.8 A/cm <sup>2,e</sup>	mV	13 <sup>c</sup>	<30
Electro catalyst support stability <sup>g</sup>	% mass activity loss	41 <sup>h</sup>	<40
Loss in performance at 1.5 A/cm <sup>2,g</sup>	mV	65 <sup>h</sup>	<30
Non-PGM catalyst activity <sup>i</sup>	A / cm <sup>2</sup> @ 900 mV <sub>iR-free</sub>	0.024 A/cm <sup>2,i</sup>	>0.044 <sup>i</sup>

- a. PGM content and loading targets may have to be lower to achieve system cost targets.
- b. Rated power operating point depends on MEA temperature and is defined as the voltage at which  $V = 77.6 / (22.1 + T[^\circ\text{C}])$ , based on target of  $Q/\Delta T_i = 1.45 \text{ kW}/^\circ\text{C}$  and definition of  $Q/\Delta T_i$  from table 3.4.4, with an approximation of MEA temperature as equal to stack coolant outlet temperature.
- c. A. Steinbach et al. (3M), "High-Performance, Durable, Low-Cost Membrane Electrode Assemblies for Transportation Applications," 2014 Annual Merit Review, [http://www.hydrogen.energy.gov/pdfs/review14/fc104\\_steinbach\\_2014\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review14/fc104_steinbach_2014_o.pdf)
- d. Based on MEA gross power at 150 kPa abs. Measured at 0.692 V and 90°C, satisfying  $Q/\Delta T < 1.45 \text{ kW}/^\circ\text{C}$ . At 250 kPa abs status is 0.12 g/kW.
- e. Measured using protocol in Table 3.4.17.
- f. A. Kongkanand et al. (General Motors), "High-Activity Dealloyed Catalysts," 2014 Annual Merit Review, [http://www.hydrogen.energy.gov/pdfs/review14/fc087\\_kongkanand\\_2014\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review14/fc087_kongkanand_2014_o.pdf)
- g. Measured using protocol in Table 3.4.18.
- h. B. Popov et al., "Development of Ultra-low Doped-Pt Cathode Catalysts for PEM Fuel Cells," 2015 Annual Merit Review, [http://www.hydrogen.energy.gov/pdfs/review15/fc088\\_popov\\_2015\\_o.pdf](http://www.hydrogen.energy.gov/pdfs/review15/fc088_popov_2015_o.pdf).
- i. D.J. Liu (ANL), "Novel Non-PGM Catalysts from Rationally Designed 3-D Precursors," 2015 Annual Merit Review, [http://www.hydrogen.energy.gov/pdfs/review15/fc118\\_liu\\_2015\\_p.pdf](http://www.hydrogen.energy.gov/pdfs/review15/fc118_liu_2015_p.pdf), slide 9.
- j. Target is equivalent to PGM catalyst mass activity target of 0.44 A/mg<sub>PGM</sub> at 0.1 mg<sub>PGM</sub>/cm<sup>2</sup>.

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Table 3.4.8 Technical Targets: Bipolar Plates			
Characteristic	Units	2015 Status	2020 Targets
Cost <sup>a</sup>	\$ / kW <sub>net</sub>	7 <sup>b</sup>	3
Plate weight	kg / kW <sub>net</sub>	<0.4 <sup>c</sup>	0.4
Plate H <sub>2</sub> permeation coefficient <sup>d</sup>	Std cm <sup>3</sup> /(sec cm <sup>2</sup> Pa) @ 80°C, 3 atm 100% RH	0 <sup>e</sup>	<1.3 x 10 <sup>-14,f</sup>
Corrosion, anode <sup>g</sup>	μA / cm <sup>2</sup>	No active peak <sup>h</sup>	<1 and no active peak
Corrosion, cathode <sup>i</sup>	μA / cm <sup>2</sup>	<0.1 <sup>b</sup>	<1
Electrical conductivity	S / cm	>100 <sup>j</sup>	>100
Areal specific resistance <sup>k</sup>	Ohm-cm <sup>2</sup>	0.006 <sup>h</sup>	0.01
Flexural strength <sup>l</sup>	MPa	>34 (carbon plate) <sup>m</sup>	>25
Forming elongation <sup>n</sup>	%	20–40 <sup>o</sup>	40

- a. Costs projected to high volume production (500,000 80 kW systems per year), assuming MEA meets performance target of 1000 mW/cm<sup>2</sup>.
- b. Cost when producing sufficient plates for 500,000 systems per year. DOE Hydrogen and Fuel Cells Program Record 15015, "Fuel Cell System Cost – 2015." [http://www.hydrogen.energy.gov/program\\_records.html](http://www.hydrogen.energy.gov/program_records.html)
- c. C.H. Wang (Treadstone), "Low-cost PEM Fuel Cell Metal Bipolar Plates," 2012 Annual Progress Report, [http://www.hydrogen.energy.gov/pdfs/progress12/v\\_h\\_1\\_wang\\_2012.pdf](http://www.hydrogen.energy.gov/pdfs/progress12/v_h_1_wang_2012.pdf).
- d. Per the standard gas transport test (ASTM D1434).
- e. C.H. Wang (Treadstone), private communication, October 2014.
- f. Blunk, *et al*, J. Power Sources 159 (2006) 533-542.
- g. pH 3 0.1ppm HF, 80°C, peak active current <1x10<sup>-6</sup> A/cm<sup>2</sup> (potentiodynamic test at 0.1 mV/s, -0.4V to +0.6V (Ag/AgCl)), de-aerated with Ar purge.
- h. A. Kumar, M. Ricketts, and S. Hirano, "Ex-situ evaluation of nanometer range gold coating on stainless steel substrate for automotive polymer electrolyte membrane fuel cell bipolar plate," Journal of Power Sources 195 (2010): 1401-1407, September 2009.
- i. pH 3 0.1ppm HF, 80°C, passive current <5x10<sup>-8</sup> A/cm<sup>2</sup> (potentiostatic test at +0.6V (Ag/AgCl) for >24h, aerated solution.
- j. O. Adrianowycz (GrafTech), "Next Generation Bipolar Plates for Automotive PEM Fuel Cells," 2009 Annual Progress Report, [http://www.hydrogen.energy.gov/pdfs/progress09/v\\_g\\_2\\_adrianowycz.pdf](http://www.hydrogen.energy.gov/pdfs/progress09/v_g_2_adrianowycz.pdf)
- k. Includes interfacial contact resistance (on as received and after potentiostatic test) measured both sides per Wang, *et al*. J. Power Sources 115 (2003) 243-251 at 200 psi (138 N/cm<sup>2</sup>).
- l. ASTM-D 790-10 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- m. D. Haack *et al*. (Porvair), "Carbon-Carbon Bipolar Plates," 2007 Annual Progress Report, [http://www.hydrogen.energy.gov/pdfs/progress07/v\\_b\\_3\\_haack.pdf](http://www.hydrogen.energy.gov/pdfs/progress07/v_b_3_haack.pdf)
- n. Per ASTM E8M-01 Standard Test Methods for Tension Testing of Metallic Materials, or demonstrate ability to stamp generic channel design with width, depth, and radius.
- o. M. Brady *et al*. (Oak Ridge National Laboratory), "Nitrided Metallic Bipolar Plates," 2010 Annual Progress Report, [http://www.hydrogen.energy.gov/pdfs/progress10/v\\_l\\_1\\_brady.pdf](http://www.hydrogen.energy.gov/pdfs/progress10/v_l_1_brady.pdf).

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**Table 3.4.17 Testing Protocol: Electrocatalyst Cycle and Metrics**

<b>Cycle</b>	Triangle sweep cycle: 50 mV/s between 0.6 V and 1.0 V; run polarization curve and ECSA at specified intervals. Single cell 25-50 cm <sup>2</sup>	
<b>Number</b>	30,000 cycles	
<b>Cycle time</b>	16 s	
<b>Temperature</b>	80°C	
<b>Relative Humidity</b>	Anode/Cathode 100/100%	
<b>Fuel/Oxidant</b>	Hydrogen/N <sub>2</sub> (H <sub>2</sub> at 200 sccm and N <sub>2</sub> at 75 sccm for a 50 cm <sup>2</sup> cell)	
<b>Pressure</b>	Atmospheric pressure	
<b>Metric</b>	<b>Frequency</b>	<b>Target</b>
<b>Catalytic Mass Activity<sup>a</sup></b>	At Beginning and End of Test minimum	≤40% loss of initial catalytic activity
<b>Polarization curve from 0 to ≥1.5 A/cm<sup>2</sup><sup>b</sup></b>	After 0, 1k, 5k, 10k, and 30k cycles	≤30 mV loss at 0.8 A/cm <sup>2</sup>
<b>ECSA/Cyclic Voltammetry<sup>c</sup></b>	After 10, 100, 1k, 3k, 10k, 20k and 30k cycles	≤40% loss of initial area

- a. Mass activity in A/mg @ 150 kPa abs backpressure at 900 mV iR-corrected on H<sub>2</sub>/O<sub>2</sub>, 100% RH, 80°C, anode stoichiometry 2; cathode stoichiometry 9.5. A minimum hold time of 15 min at 0.9 V is recommended, with the mass activity calculated based on the average current during the last 5 min. Measured ORR current may be corrected for H<sub>2</sub> crossover. Based on the protocol published by Gasteiger et al., Applied Catalysis B: Environmental, 56 (2005) 9-35.
- b. Polarization curve per protocol in Table 3.4.21.
- c. Sweep from 0.05 to 0.6 V at 20 mV/s, 80°C, 100% RH.

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**Table 3.4.18 Testing Protocol: Catalyst Support Cycle and Metrics**

<b>Cycle</b>	Triangle sweep cycle: 500 mV/s between 1.0 V and 1.5 V; run polarization curve and ECSA at specified intervals. Single cell 25–50 cm <sup>2</sup>	
<b>Number</b>	5000 cycles	
<b>Cycle time</b>	2 seconds	
<b>Temperature</b>	80°C	
<b>Relative humidity</b>	Anode/cathode 100/100%	
<b>Fuel/oxidant</b>	Hydrogen/nitrogen	
<b>Pressure</b>	Atmospheric	
	<b>Metric</b>	<b>Frequency</b>
		<b>Target</b>
<b>Catalytic activity<sup>a</sup></b>	At beginning and end of test, minimum	≤40% loss of initial catalytic activity
<b>Polarization curve from 0 to ≥1.5 A/cm<sup>2</sup><sup>b</sup></b>	After 0, 10, 100, 200, 500, 1k, 2k, and 5k cycles	≤30 mV loss at 1.5 A/cm <sup>2</sup> or rated power
<b>ECSA/cyclic voltammetry<sup>c</sup></b>	After 0, 10, 100, 200, 500, 1k, 2k, and 5k cycles	≤40% loss of initial area

- a. Mass activity in A/mg @ 150 kPa abs backpressure at 900 mV iR-corrected on H<sub>2</sub>/O<sub>2</sub>, 100% RH, 80°C, anode stoichiometry 2; cathode stoichiometry 9.5, normalized to initial mass of catalyst and measured before and after test (as per Gasteiger et al. Applied Catalysis B: Environmental, 56 (2005) 9-35). Measured ORR current may be corrected for H<sub>2</sub> crossover.
- b. Polarization curve per protocol in Table 3.4.21.
- c. Sweep from 0.05 to 0.6 V at 20 mV/s, 80°C, and 100% RH.

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**Table 3.4.19 Testing Protocol: MEA Chemical Stability and Metrics (Test Using a MEA)**

<b>Test Condition</b>	Steady state OCV, single cell 25-50 cm <sup>2</sup>	
<b>Total time</b>	500 h	
<b>Temperature</b>	90°C	
<b>Relative Humidity</b>	Anode/Cathode 30/30%	
<b>Fuel/Oxidant</b>	Hydrogen/Air at stoics of 10/10 at 0.2 A/cm <sup>2</sup> equivalent flow	
<b>Pressure, outlet kPa abs</b>	Anode/Cathode 150/150	
<b>Metric</b>	<b>Frequency</b>	<b>Target</b>
<b>F<sup>-</sup> release or equivalent for non-fluorine membranes</b>	At least every 24 h	No target – for monitoring
<b>Hydrogen Crossover (mA/cm<sup>2</sup>)<sup>a</sup></b>	Every 24 h	≤15 mA/cm <sup>2</sup>
<b>OCV</b>	Continuous	Initial OCV ≥ 0.95 V, <20% OCV decrease during test
<b>High-frequency resistance</b>	Every 24 h at 0.2 A/cm <sup>2</sup>	No target – for monitoring
<b>Shorting resistance<sup>b</sup></b>	Every 24 h	>1,000 ohm cm <sup>2</sup>

- a. Measured at 0.5 V applied potential, 80°C, 100% RH H<sub>2</sub>/N<sub>2</sub>.
- b. Measured at 0.5 V applied potential, 80°C, 100% RH N<sub>2</sub>/N<sub>2</sub>. Compression to 20% strain on the GDL.

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**Table 3.4.20 Testing Protocol: Membrane Mechanical Cycle and Metrics (Test Using a MEA)**

<b>Cycle</b>	<b>Cycle 0% RH (2 min) to 90°C dewpoint (2 min), single cell 25-50 cm<sup>2</sup></b>	
<b>Total time</b>	Until crossover >15 mA/cm <sup>2</sup> or 20,000 cycles	
<b>Temperature</b>	80°C	
<b>Relative Humidity</b>	Cycle from 0% RH (2 min) to 90°C dewpoint (2 min)	
<b>Fuel/Oxidant</b>	Air/Air at 2 SLPM on both sides	
<b>Pressure</b>	Ambient or no back-pressure	
<b>Metric</b>	<b>Frequency</b>	<b>Target</b>
<b>Crossover<sup>a</sup></b>	Every 24 h	≤15 mA/cm <sup>2</sup> <sup>b</sup>
<b>Shorting resistance<sup>c</sup></b>	Every 24 h	>1,000 ohm cm <sup>2</sup>

- a. Measured at 0.5 V applied potential, 80°C, 100% RH H<sub>2</sub>/N<sub>2</sub>.
- b. For air or N<sub>2</sub> testing, an equivalent crossover metric of 0.1 sccm/cm<sup>2</sup> at a 20 kPa pressure differential, 80°C, and 100%RH may be used as an alternative.
- c. Measured at 0.5 V applied potential, 80°C and 100% RH N<sub>2</sub>/N<sub>2</sub>. Compression to 20% strain on the GDL.

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**Table 3.4.21 Testing Protocol: Polarization Protocol**

Test Point #	Current Density [A/cm <sup>2</sup> ]	Anode H <sub>2</sub> Stoich	Cathode Inlet O <sub>2</sub> % (dry basis)	Cathode Inlet N <sub>2</sub> % (dry basis)	Cathode O <sub>2</sub> Stoich	Test Point Run Time [min]
Break-in						
B1	0.6	1.5	21%	79%	1.8	20
Reduction						
R1	0	1.5	21%	79%	1.8	1
R2	0	1.5	0%	100%	1.8	Until V<0.1V
Polarization curve						
P1	0.2	1.5	21%	79%	1.8	3
P2	0.4	1.5	21%	79%	1.8	3
P3	0.6	1.5	21%	79%	1.8	3
P4	0.8	1.5	21%	79%	1.8	3
P5	1	1.5	21%	79%	1.8	3
P6	1.2	1.5	21%	79%	1.8	3
P7	1.4	1.5	21%	79%	1.8	3
P7	1.6	1.5	21%	79%	1.8	3
P8	1.8	1.5	21%	79%	1.8	3
P9	2	1.5	21%	79%	1.8	3
P10	1.8	1.5	21%	79%	1.8	3
P11	1.6	1.5	21%	79%	1.8	3
P12	1.4	1.5	21%	79%	1.8	3
P13	1.2	1.5	21%	79%	1.8	3
P14	1	1.5	21%	79%	1.8	3
P15	0.8	1.5	21%	79%	1.8	3
P16	0.6	1.5	21%	79%	1.8	3
P17	0.4	1.5	21%	79%	1.8	3
P18	0.2	1.5	21%	79%	1.8	3
P19	0.1	1.5	21%	79%	1.8	3
P20	0.05	1.5	21%	79%	1.8	3
P21	0.02	1.5	21%	79%	1.8	3
P22	0.05	1.5	21%	79%	1.8	3
P23	0.1	1.5	21%	79%	1.8	3
P24	0.2	1.5	21%	79%	1.8	3

a. The following parameters are constant throughout the test: anode inlet composition of 100% H<sub>2</sub> (excluding water vapor) at 80°C, humidified to 59°C dew point, 150 kPa<sub>abs</sub> outlet pressure; cathode feed at 80°C, humidified to 59°C dew point, 150 kPa<sub>abs</sub> outlet pressure; cell/stack control temperature of 80°C; set point transit time of 0 s. The anode and cathode flowrate stoichiometric ratios are 1.5 and 1.8, respectively, for currents of 0.2 A/cm<sup>2</sup> or greater, with 0.2 A/cm<sup>2</sup> equivalent flows used at lower currents (affected points highlighted in green).

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**Table 3.4.22 Drive Cycle Durability Protocol<sup>a,b</sup>**

Test Point #	Current Density [A/cm <sup>2</sup> ]	Anode H <sub>2</sub> Stoich	Anode Dew point Temp [°C]	Anode Inlet Temp [°C]	Cathode O <sub>2</sub> Stoich	Cathode Dew point Temp [°C]	Cathode Inlet Temp [°C]	Test pt. Run Time [min]	Worst-Case Response Transition Time [s]
<b>Wet w/load cycling</b>									
RH1	0.02	96	83°	85°	108	83°	85°	0.5	2
RH2	1.2	1.6	83°	85°	1.8	83°	85°	0.5	2
RH3	0.02	96	83°	85°	108	83°	85°	0.5	2
RH4	1.2	1.6	83°	85°	1.8	83°	85°	0.5	2
RH5	0.02	96	83°	85°	108	83°	85°	0.5	2
RH6	1.2	1.6	83°	85°	1.8	83°	85°	0.5	2
RH7	0.02	96	83°	85°	108	83°	85°	0.5	2
RH8	1.2	1.6	83°	85°	1.8	83°	85°	0.5	2
RH9	0.02	96	83°	85°	108	83°	85°	0.5	2
RH10	1.2	1.6	83°	85°	1.8	83°	85°	0.5	2
Trans1	0.6	2	70°	80°	2	70°	80°	2	30 (dew point)
<b>Dry w/load cycling</b>									
RH11	0.1	5	53°	80°	5	53°	80°	0.5	30 (dew point)
RH12	0.02	25	53°	80°	25	53°	80°	0.5	2
RH13	0.1	5	53°	80°	5	53°	80°	0.5	2
RH14	0.02	25	53°	80°	25	53°	80°	0.5	2
RH15	0.1	5	53°	80°	5	53°	80°	0.5	2
RH16	0.02	25	53°	80°	25	53°	80°	0.5	2
RH17	0.1	5	53°	80°	5	53°	80°	0.5	2
RH18	0.02	25	53°	80°	25	53°	80°	0.5	2
RH19	0.1	5	53°	80°	5	53°	80°	0.5	2
RH20	0.02	25	53°	80°	25	53°	80°	5	2

- The following parameters are constant throughout the test: anode inlet composition of 80% H<sub>2</sub> / 20% N<sub>2</sub> (excluding water vapor), cathode inlet composition of 21% O<sub>2</sub> / 79% N<sub>2</sub> (excluding water vapor), anode and cathode outlet pressures of 101.3 kPa<sub>abs</sub>, cell/stack control temperature of 80°C, and set point transition time of 0 s.
- Drive cycle testing only reflects degradation losses associated with wet and dry cyclic operation. Other relevant stressors, including startup/shutdown and freeze operation, are not included in this test.

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**Table 3.4.23 Unmitigated Startup/Shutdown Durability Protocol**

Total time		5000 cycles will take ~10 days, with 500 cycles per day (~19.5 hours) and up to 5.5 hours for characterization						
Temperature		35°C						
Pressure		101.3 kPa						
Characterization		Polarization curve, ECSA, and impedance spectra should be measured at 80°C, 100% RH. Characterization should be repeated approximately every 24 hours (~500 cycles).						
Step	Step Name	Duration (s)	Voltage (V)	Current (A/cm <sup>2</sup> )	Load	Anode gas <sup>a</sup>	Anode stoich.	RH
1	FC Operation	60 <sup>b</sup>		0.4	On	H <sub>2</sub>	1.2	100
2	Pre-shutdown	10	1		On	H <sub>2</sub>	0	100
3	Shutdown	5			Off	Air	Varies <sup>c</sup>	0
4	Idle	55			Off	Air	1 (at 0.1 A/cm <sup>2</sup> )	0
5	Startup	10	1		On	H <sub>2</sub>	1.2 (at 1.0 A/cm <sup>2</sup> )	100
Metric			Target			Guideline		
Voltage at 1.2 A/cm <sup>2</sup>			<5% change					
ECSA						<20% change		
HFR at 0.02 and 1.2 A/cm <sup>2</sup>						<5% change		
LFR at 0.02 and 1.2 A/cm <sup>2</sup>						<10% change		

- Anode gas is H<sub>2</sub> or air, depending on step. Cathode gas should be air at a flowrate corresponding to a stoich of 2 at 1.0 A/cm<sup>2</sup> current for all steps.
- Attain steady-state operation before moving to step 2.
- Anode flowrate must be defined by specific cell architecture, and should correspond to an average residence time of 0.3 s. Cell voltage should decrease to < 0.1 V within 1 s (~3 volumetric exchanges).

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## APPENDIX G—ONBOARD STORAGE SYSTEM TARGETS

Table 3.3.3 Technical System Targets: Onboard Hydrogen Storage for Light-Duty Fuel Cell Vehicles <sup>a, i</sup>			
Storage Parameter	Units	2020	Ultimate
<b>System Gravimetric Capacity</b> Usable, specific-energy from H <sub>2</sub> (net useful energy/max system mass) <sup>b</sup>	kWh/kg (kg H <sub>2</sub> /kg system)	1.8 (0.055)	2.5 (0.075)
<b>System Volumetric Capacity</b> Usable energy density from H <sub>2</sub> (net useful energy/max system volume) <sup>b</sup>	kWh/L (kg H <sub>2</sub> /L system)	1.3 (0.040)	2.3 (0.070)
<b>Storage System Cost</b>  • Fuel cost <sup>c</sup>	\$/kWh net (\$/kg H <sub>2</sub> stored) \$/gge at pump	10 333 2-4	8 266 2-4
<b>Durability/Operability</b> • Operating ambient temperature <sup>d</sup> • Min/max delivery temperature • Operational cycle life (1/4 tank to full) • Min delivery pressure from storage system • Max delivery pressure from storage system • Onboard Efficiency <sup>e</sup> • “Well” to Powerplant Efficiency <sup>e</sup>	°C °C Cycles bar (abs) bar (abs) % %	-40/60 (sun) -40/85 1500 5 12 90 60	-40/60 (sun) -40/85 1500 3 12 90 60
<b>Charging / Discharging Rates</b> • System fill time (5 kg)  • Minimum full flow rate • Start time to full flow (20 °C) • Start time to full flow (-20 °C) • Transient response at operating temperature 10%-90% and 90%-0%	min (kg H <sub>2</sub> /min) (g/s)/kW s s s	3.3 (1.5) 0.02 5 15 0.75	2.5 (2.0) 0.02 5 15 0.75
<b>Fuel Quality (H<sub>2</sub> from storage) <sup>f</sup></b>	% H <sub>2</sub>	SAE J2719 and ISO/PDTS 14687-2 (99.97% dry basis)	
<b>Environmental Health &amp; Safety</b> • Permeation & leakage <sup>g</sup> • Toxicity • Safety • Loss of usable H <sub>2</sub> <sup>h</sup>	- - - (g/h)/kg H <sub>2</sub> stored	Meets or exceeds applicable standards, for example SAE J2579  0.05 0.05	

<sup>a</sup> Targets are based on the lower heating value of hydrogen, 33.3 kWh/kg H<sub>2</sub>. Targets are for a complete system, including tank, material, valves, regulators, piping, mounting brackets, insulation, added cooling capacity, and all other balance-of-plant components. All capacities are defined as usable capacities that could be delivered to the fuel cell power plant. All targets must be met at the end of service life (approximately 1500 cycles or 5000 operation hours, equivalent of 150,000 miles).

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- b Capacities are defined as the usable quantity of hydrogen deliverable to the powerplant divided by the total mass/volume of the complete storage system, including all stored hydrogen, media, reactants (e.g., water for hydrolysis-based systems), and system components. Tank designs that are conformable and have the ability to be efficiently package onboard vehicles may be beneficial even if they do not meet the full volumetric capacity targets. Capacities must be met at end of service life.
- c Hydrogen threshold cost is independent of pathway and is defined as the untaxed cost of hydrogen produced, delivered and dispensed to the vehicle. [[http://hydrogen.energy.gov/pdfs/11007\\_h2\\_threshold\\_costs.pdf](http://hydrogen.energy.gov/pdfs/11007_h2_threshold_costs.pdf)] For material-based storage technologies, the impact of the technology on the hydrogen threshold cost, e.g., off-board cooling, off-board regeneration of chemical hydrogen storage materials, etc., must be taken into account.
- d Stated ambient temperature plus full solar load (i.e., full exposure to direct sunlight). No allowable performance degradation from  $-20\text{ }^{\circ}\text{C}$  to  $40\text{ }^{\circ}\text{C}$ . Allowable degradation outside these limits is to be determined.
- e Onboard efficiency is the energy efficiency for delivering hydrogen from the storage system to the fuel cell powerplant, i.e., accounting for any energy required for operating pumps, blowers, compressors, heating, etc. required for hydrogen release. Well-to-powerplant efficiency includes onboard efficiency plus off-board efficiency, i.e., accounting for the energy efficiency of hydrogen production, delivery, liquefaction, compression, dispensing, regeneration of chemical hydrogen storage materials, etc. as appropriate. H2A and HDSAM analyses should be used for projecting off-board efficiencies.
- f Hydrogen storage systems must be able to deliver hydrogen meeting acceptable hydrogen quality standards for fuel cell vehicles (see SAE J2719 and ISO/PDTS 14687-2). Note that some storage technologies may produce contaminants for which effects are unknown and not addressed by the published standards; these will be addressed by system engineering design on a case-by-case basis as more information becomes available.
- g Total hydrogen lost into the environment as  $\text{H}_2$ ; relates to hydrogen accumulation in enclosed spaces. Storage system must comply with applicable standards for vehicular tanks including but not limited to SAE J2579 and the United Nations Global Technical Regulation. This includes any coating or enclosure that incorporates the envelope of the storage system.
- h Total hydrogen lost from the storage system, including leaked or vented hydrogen; relates to loss of range.
- i Details in this table are being revised to match changes in the high level cost target.

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