Department of Energy (DOE)
Office of Energy Efficiency and Renewable Energy (EERE)

Fuel Cell Technologies Office Annual FOA

Funding Opportunity Announcement (FOA) Number: DE-FOA-0001647
FOA Type: Initial
CFDA Number: 81.087

FOA Issue Date:	11/18/16
Submission Deadline for Concept Papers:	12/20/16; 5:00pm ET
Submission Deadline for Full Applications:	2/21/17; 5:00pm ET
Expected Submission Deadline for Replies to Reviewer Comments:	3/28/17; 5:00pm ET
Expected Date for EERE Selection Notifications:	Summer 2017
Expected Timeframe for Award Negotiations:	Aug./Sept. 2017

- Applicants must submit a Concept Paper by 5:00pm ET on 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 cancelation of further award negotiations and rescission of the Selection.

Table of Contents

I. Funding Opportunity Description

A. Description/Background

The Fuel Cell Technologies Office (FCTO)[1] is a key component of the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) portfolio. FCTO aims to provide safe, secure, affordable, and reliable clean energy from diverse domestic resources, providing the benefits of increased energy security and reduced pollution by adopting a technology-neutral approach toward research, development, and demonstration (RD&D). FCTO addresses key technical challenges for both fuel cells and hydrogen fuels (i.e., hydrogen production, delivery and storage) and institutional barriers such as hydrogen codes and standards. The global fuel cell market has steadily been growing at about 30% per year since 2010[2], with revenues of over $2 billion in 2014[3] and over 11,000 fuel cell units for material handling equipment purchased in the U.S. alone since 2009.[4] Light duty vehicles are an emerging application for fuel cells that has earned substantial commercial and government interest worldwide due to the superior efficiencies, reductions in petroleum consumption, and reductions in criteria pollutants possible with fuel cells. Fuel cell electric vehicles (FCEVs) reduce petroleum consumption by about 95% in comparison to conventional light duty vehicles when the hydrogen is produced from natural gas.[5] The research areas identified in this Funding Opportunity Announcement (FOA) will enable progress toward DOE cost targets for light duty FCEVs. Recent analyses project that, if DOE cost targets for FCEVs are met, U.S. petroleum consumption can be reduced by over a 1 million barrels per day.[6]

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

- Energy Policy Act of 2005 (EPAct 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 EPAct 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 EPAct states:

[1] FCTO website: http://energy.gov/eere/fuelcells/fuel-cell-technologies-office
[2] https://www.hydrogen.energy.gov/pdfs/review16/02_satyapal_plenary_2016_amr.pdf
[3] http://energy.gov/sites/prod/files/2016/10/f33/fcto_myrdd_fuel_cells.pdf
[4] https://www.hydrogen.energy.gov/pdfs/16012_industry_deployed_fc_powered_lift_trucks.pdf
[5] https://www.hydrogen.energy.gov/pdfs/16004_life-cycle_ghg_oil_use_cars.pdf
[6] https://www.hydrogen.energy.gov/pdfs/16003_ghg_emissions_oil_use_reduction_from_fc.pdf

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

This FOA will provide approximately $30M in funding to meet FCTO's goals for sustainable hydrogen production, and low cost hydrogen storage and hydrogen fuel cells for vehicles.

B. Topic Areas/Technical Areas of Interest

Topics 1-3: Energy Materials Network- Advanced Materials Research and Development

Accelerating the discovery and deployment of novel materials is essential for the U.S. to compete globally in manufacturing in the 21st century. In support of the DOE's materials innovation and advanced manufacturing priorities, EERE launched the Energy Materials Network (EMN) in 2016.[7] The EMN is a network of national lab-led consortia that aim to accelerate the development and commercial deployment of novel materials by enhancing the accessibility of unique material research resources at the national laboratories to external stakeholders, such as academia and industry. The EMN is currently composed of 7 consortia, with each consortium focused on a specific material class. Three of these consortia were launched by EERE's Fuel Cell Technologies Office (FCTO)[8], and are being leveraged in this FOA:

1. ElectroCat[9]: Focused on catalysts for fuel cells that are free of platinum group metals (PGMs)
2. HydroGEN[10]: Focused on advanced water splitting materials for hydrogen production
3. HyMARC[11]: Focused on materials for hydrogen storage

[7] EMN is a DOE initiative that aims to dramatically decrease the time-to-market for advanced materials innovations: http://energy.gov/eere/energy-materials-network/energy-materials-network
[8] FCTO website: http://energy.gov/eere/fuelcells/fuel-cell-technologies-office
[9] ElectroCat website: http://www.electrocat.org/
[10] HydroGEN website: https://www.h2awsm.org/
[11] HyMARC website: https://hymarc.org/

Each EMN consortium abides by four defining principles:

1) Assembling and publicizing world class capabilities at the national laboratories that are available for external use,
2) Establishing a single point-of-contact (i.e., "steering committee") that assists interested users in identifying capabilites within the consortium that are relevant to their research,
3) Expediting access to the national laboratories through the establishment of short-form contractual agreements, and
4) Launching online portals of materials data.

For Topics 1-3 detailed below, applicants are encouraged to identify ways to collaborate with the EMN consortia in their applications. Applicants should specify "nodes" (i.e., capabilities) within the respective EMN consortia that they will utilize in their proposed research, and describe how these nodes will be incorporated (within both the Concept Paper and Full Applications). Please note that the funding necessary for use of the nodes within each FCTO EMN consortium (ElectroCat, HydroGEN, and HyMARC) will be provided by DOE directly to the consortium independent of the funding awarded through this FOA. Thus, applicants to Topics 1-3 should not account for any funding necessary to use or work with an FCTO consortium within their applications. Additonally, at a minimum, awardees selected under Topics 1-3 will be required to sign standard, non-negotiable non-disclosure agreements (NDAs) and may also be required to sign cooperative research and development agreements (CRADAs) and materials transfer agreements (MTAs) with their respective consortia.

Topic 1: ElectroCat (Electrocatalysis Consortium) – PGM-free Catalyst and Electrode R&D

Program Background:

The Fuel Cells program supports research, development, and demonstration of fuel cell technologies for transportation, stationary, and early market applications, with a primary focus on reducing cost and improving durability. The program's R&D portfolio is primarily focused on polymer electrolyte membrane fuel cells (PEMFCs), which are expected to be the dominant technology for vehicles in the near term. While PEMFCs are expected to use platinum metal group (PGM)-based catalysts in the near-term, reaching cost competitiveness with conventional automobiles in the long-term will require a transition from PGM-based catalysts to PGM-free catalysts. Recent projections show that PEMFCs, using next-generation technologies demonstrated in the lab to date, could be expected to cost about $53/kW if manufactured at high volume today.[12] Over 40% of the fuel cell stack cost is dominated by the cost of the catalyst, owing largely to the use of PGMs. In order to achieve the DOE Fuel Cells Program's[13] ultimate cost targets for fuel cells of $30/kW, transformative materials and materials

[12] https://www.hydrogen.energy.gov/pdfs/15015_fuel_cell_system_cost_2015.pdf
[13] DOE Fuel Cell Program's website: http://energy.gov/eere/fuelcells/fuel-cells

integration R&D is essential. Accordingly, the focus of this topic is on the development of high-performing PGM-free electrocatalysts and electrodes for PEMFCs to be used in automobiles.

Consortium Background:

Reduction in the costs of catalysts in both automotive and stationary PEMFCs requires an integrated, collaborative approach to research. ElectroCat[9], a consortium formed by DOE as part of the EMN[7], aims to expedite the development of next-generation catalysts and electrodes for fuel cells that are free of the precious PGMs currently required for good fuel cell performance. Addressing this barrier is key to meeting DOE's ultimate fuel cell cost target of $30/kW. It is also a critical step in increasing U.S. competitiveness in manufacturing FCEVs and other fuel cell energy conversion devices. ElectroCat helps universities and companies to accelerate their PGM-free[14] catalyst research by providing access to high-throughput combinatorial methods, multi-scale modeling techniques, and PGM-free catalyst expertise at the national labs and by providing a public-facing data repository to document the findings of the consortium. The ElectroCat Consortium is led by Argonne (ANL) and Los Alamos National Laboratories (LANL), and comprises tools and expertise housed at these labs as well as at Oak Ridge National Laboratory (ORNL) and the National Renewable Energy Laboratory (NREL).

Topic Description:

Applications are invited for novel and innovative concepts that advance the development of PGM-free oxygen reduction electrocatalysts and electrodes for use in PEMFCs, with a primary focus on automotive applications. Applicants should propose 2-3 year projects for a maximum total DOE funding of $2,000,000. Applications should be at Technology Readiness Levels of 2-3, and the funding request should be commensurate with the level of work proposed. Proposed cathode catalyst concepts should demonstrate the potential to meet or exceed DOE's 2020 activity target of 0.044 A/cm^2 at 0.9 $V_{IR\text{-}free}$ in a PEMFC membrane electrode assembly (MEA)[15], which is equivalent to the PGM catalyst activity target of 0.44 A/mg$_{PGM}$ at 0.1 mg$_{PGM}$/cm^2 (this PGM loading describes the cathode catalyst content only), as well as the potential to meet DOE's 2020 MEA activity and durability targets.[16] The proposed work should include electrode development pathways addressing mass transport limitations potentially imposed by high catalyst loadings and thicknesses, and performance degradation issues at high current densities.

Applicants must clearly identify the status of the proposed technology as it relates to the state-of-the-art in PGM-free catalysts and provide sufficient justification that the approach has the potential to meet the aforementioned activity and durability targets. The use of PGM-free precious metals (e.g., gold or rhenium) is not of interest for this topic. The development of

[14] The platinum group metals are: indium, osmium, rhodium, platinum, palladium, and ruthenium. "PGM-free" fuel cell catalysts do not contain any of these elements.

[15] Testing at 80°C H_2/O_2 in an MEA; fully humidified with total outlet pressure of 150 kPa (abs); anode stoichiometry of 2; and cathode stoichiometry of 9.5, See reference in footnote *b* on page 3.4 – 46 of the Fuel Cells MYRDD: http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

[16] 2020 technical performance and durability targets listed in Table 3.4.5 of the Fuel Cells MYRDD: http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

anode hydrogen oxidation reaction catalysts and catalysts for non-PEM fuel cells (i.e., alkaline membrane fuel cells) are also not solicited in this topic.

The Application must encompass work up to and including single cell MEA testing at a size of ≥50 cm^2. The work plan should include strong annual Go/No-Go decision point metrics, including meeting the PGM-free catalyst interim activity target of 0.044 A/cm^2 at 0.88 $V_{IR\text{-}free}$ in a PEMFC MEA. The Applicant should discuss H_2/air MEA performance and propose appropriate end of project metrics demonstrating potential to be competitive with low-PGM MEAs. The work plan should also include a discussion of a durability testing procedure of sufficient length to demonstrate longevity. At a minimum, durability testing should include Accelerated Stress Tests (ASTs) performed according to protocols in the DOE's Fuel Cells Multi-Year Research Development and Demonstration Plan (MYRDD).[16] Specific PGM-free catalyst and MEA performance and durability test protocols are under development and will be posted on the ElectroCat website[9] when available.

Developing durable, high-mass activity PGM-free catalysts at an accelerated pace requires a systematic approach in which potential catalysts are synthesized and analyzed rapidly and comprehensively. In ElectroCat, this is accomplished using high throughput, combinatorial methods that are guided both by computational studies and a foundational knowledge of electrocatalysis and materials science – capabilities that are provided by consortium laboratory members. Each consortium member lab possesses a unique set of expertise and tools for use by applicants. In drafting their proposals, applicants are encouraged to review the ElectroCat[9] website for more details and a complete list of capabilities.

Upon award, recipients are requested to access ElectroCat capabilities in carrying out the project. While the specific ElectroCat capabilities planned for use under the project should be clearly identified in the application, applicants are not expected to include the cost of using ElectroCat in their proposed budget or to explain the ElectroCat scope of work in the same level of detail as the applicant's scope of work. Access to tools in ElectroCat will be provided by DOE at no cost to the project. Applicants are encouraged to list by priority the full extent of ElectroCat tools with which they would like to engage with the understanding that the majority of the research effort is to be performed by the applicant. Depending on DOE resources and the level of availability of each consortium node, this list may be de-scoped or negotiated during award negotiations.

The deliverable in this topic is a set of MEAs (6 or more, each with active area ≥50 cm^2) that are made available for independent testing and evaluation to ElectroCat. Also, recipients will provide all public data (such as technical data used to support published journal articles) to ElectroCat for curation and hosting.

Topic 2: HydroGEN – Advanced Water Splitting Materials

Program Background:
The DOE Hydrogen Production & Delivery Program supports research, development and demonstration (RD&D) efforts to address critical challenges and barriers for sustainable, large-scale hydrogen production technologies. The long-term goal of hydrogen production and delivery RD&D is a high-volume cost of <$4/kg-$H_2$ (delivered and dispensed, but untaxed). The amount of the cost goal apportioned to hydrogen production is <$2/kg-$H_2$.[17] Relevant to this topic, innovative materials, processes, and systems are needed to establish the technical and cost feasibility for sustainable, low-carbon hydrogen production. While the Program is involved in many hydrogen production pathways, this topic focuses on advanced water splitting pathways using sustainable, domestic resources. The primary emphasis is on materials RD&D needed to enhance the performance and durability of water splitting systems that demonstrate potential for meeting the hydrogen production cost goal.

Consortium Background:
The HydroGEN Consortium[10], established under the U.S. DOE's Energy Materials Network[7], aims to accelerate the RD&D of advanced water splitting technologies for clean, sustainable hydrogen production. This consortium, announced in October 2016, currently comprises six core national laboratories: the National Renewable Energy Laboratory (NREL) - lead, Sandia National Laboratory (SNL), Lawrence Berkeley National Laboratory (LBNL), Idaho National Laboratory (INL), Lawrence Livermore National Laboratory (LLNL), and Savanah River National Laboratory (SRNL). The HydroGEN Consortium offers an extensive collection of materials research capabilities for addressing RD&D challenges in efficiency, durability and cost relevant to the four promising water splitting technologies listed below:

1. *Advanced low temperature electrolysis*
2. *High-temperature electrolysis*
3. *Photoelectrochemical (PEC) water splitting*
4. *Solar thermochemical hydrogen (STCH) production*

Each of these pathways has its own unique materials and integration challenges, but they share common underlying physics and operational principles associated with the water splitting process. Leveraging the HydroGEN Consortium's staff of leading technical experts and broad collection of resource capabilities is expected to advance the maturity and technology readiness levels in all the advanced water splitting technologies. The consortium's unique and world-class capabilities comprise a portfolio of computational material design tools (including combinatorial computation capabilities), synthesis and fabrication tools (including combinatorial synthesis), characterization methodologies (including rapid throughput screening), and benchmarking facilities. Further information on the national laboratory core team's work plans and capabilities can be found on the HydroGEN website.[10]

[17] Program Record 12001, December 142012, http://www.hydrogen.energy.gov/pdfs/12001_h2_pd_cost_apportionment.pdf

Under this FOA topic, FCTO is soliciting applications for two subtopics that leverage and support the HydroGEN's mission in accelerated RD&D of advanced water splitting materials. Applicants are encouraged to visit the HydroGEN website to identify consortium nodes they could leverage in their proposed research. Effective utilization of the HydroGEN capabilities to facilitate RD&D is strongly encouraged. The first subtopic, 2A, will fund innovative materials RD&D to accelerate the development of promising water splitting technologies. Successful applicants to subtopic 2A will work closely with the HydroGEN Consortium to leverage the unique capabilities identified in their applications to facilitate the development of their water splitting materials and systems. While the specific HydroGEN capabilities planned for use under the project should be clearly identified in the application, applicants are not expected to include the cost of using HydroGEN in their proposed budget or to explain the HydroGEN scope of work in the same level of detail as the applicant's scope of work. Access to nodes in HydroGEN will be provided by DOE at no cost to the project. Applicants are encouraged to list by priority the full extent of HydroGEN nodes with which they would like to engage with the understanding that the majority of the research effort is to be performed by the applicant. Depending on DOE resources and the level of availability of each consortium node, this list may be de-scoped or negotiated during award negotiation.

The second subtopic, 2B, will fund the development of standardized Best Practices for characterizing and benchmarking advanced water splitting materials, creating a foundation in accelerated materials RD&D for the broader research community. For subtopic 2B, the successful applicants will also work closely with all labs within the HydroGEN consortium as well as other stakeholders to develop, vet and publish Best Practices for materials screening, benchmarking and characterization.

Topic 2A: Durable, High-Performance Materials and Interfaces for Advanced Water Splitting

FCTO solicits applications for the discovery and development of novel, advanced water splitting materials systems which will enable meeting the DOE ultimate hydrogen production goal of \$2/kg H_2. This subtopic will focus on advancing the state of the art in durable materials and interfaces for efficient water splitting under real-world operating conditions. Applications are encouraged which integrate theoretical modeling, synthesis, and experimental characterization of the material systems under investigation to advance the scientific understanding of these systems while providing experimental validation of their viability in practical large-scale water splitting. As previously stated, project teams will be expected to collaborate with the HydroGEN Consortium to leverage available national laboratory resource nodes in theory, computation, synthesis, characterization and benchmarking. It is expected that non-proprietary results on performance and durability, including thermodynamic as well as kinetic data, from the selected projects will be added to the HydroGEN data portal for the purpose of advancing a broader understanding of material systems for sustained high performance water splitting. It is anticipated that these projects would run 2 to 3 years in length for a maximum total DOE funding of \$1,000,000, with a quantitative Go/No-Go decision point between each phase.

Funding for the use of HydroGEN's national laboratory nodes will be provided by DOE directly to the national labs. The applicant's proposed budget should not include funds associated with the use of HydroGEN. 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-reward concepts for advanced water splitting materials in each of the four HydroGEN technology pathways listed above. Innovations with potential impact on multiple pathways are encouraged. It is expected that not all of the selected projects will achieve their phase 1 Go/No-Go criteria, and that a No-Go decision will result in a discontinuation of support beyond phase 1.

In addition to the proposal requirements defined in section IV.D.ii, submissions to this subtopic must include:

- *Innovation Statement:*
    - Provide a clear description of the proposed materials innovation and how it addresses technical barriers to durable and efficient water splitting by one or more of the four HydroGEN technology pathways.
    - Summarize the current state-of-the-art related to the proposed innovation in the context of the impacted water splitting pathway(s) should be provided, including fundamental barriers and promising solutions currently under investigation.
    - Describe the projected impact of the innovation on projected hydrogen production costs and harmful emissions based on available techno-economic and lifecycle assessments and studies.
- *Workplan:* The detailed materials R&D plan should be founded on a scientific basis that incorporates theoretical modeling as well as synthesis and experimental characterization to validate the proposed innovation. The plan should explicitly include the HydroGEN resource nodes to be leveraged by the project team in their research as well as how the nodes will be utilized. Required elements in the research plan include:
    - *Theoretical Foundation:* A sound scientific basis supporting the proposed materials innovation should be provided, including relevant theory and calculations, with a summary of any available supporting experimental validation. This should also include a description of how theoretical considerations will guide the design of experiments, and how experimental results will be used to advance state-of-the-art theory.
    - *Synthesis Approach*: The project team's proposed synthesis route(s) for experimental demonstration and validation of their materials innovation should be provided, including a discussion of advantages, limitations and future scalability of the synthesis techniques employed. This discussion should also include possible alternative routes (e.g., different synthesis capabilities available through the HydroGEN Consortium) that could address limitations and scalability.
    - *Validation Strategy*: The project team will be required to provide compelling, quantitative metrics and targets necessary for the demonstration and validation

of their proposed materials innovation. A validation strategy should be provided that includes the quantitative metrics and targets along with the relevant screening, characterization, and/or benchmarking capabilities in the HydroGEN Consortium that will be used to verify and validate performance of synthesized test samples against targeted levels. The validation strategy should clearly articulate how achieving targets would positively impact technology-specific efficiency and durability, and how in turn this would impact projected hydrogen cost and/or harmful emissions.

- *Deliverables and Milestones:* Consistent with the general FOA requirements, the proposal should provide a complete table of deliverables and milestones. The deliverables should include computational models and fundamental knowledge developed through the research as well as synthesized materials with comprehensive characterization/benchmarking data. As the basis for a Go/No-Go decision at the end of budget period 1, a strong SMART milestone must be provided that includes screening/characterization/benchmarking of the proposed materials innovation performed by relevant HydroGEN resource nodes. DOE will assess the Go/No-Go decision based on whether the materials innovation has shown significant enough advancement to justify further investigation.

Consistent with EMN guiding principles, non-proprietary results and data resulting from awards under this subtopic will be included in a publicly available HydroGEN data portal for the purpose of advancing a broader understanding of material systems for sustained high performance water splitting. Applicants that are selected for awards under this solicitation will be required to submit data management plans that detail the specific computational and/or experimental data and information expected to result from the proposed research (e.g., performance and durability information, including thermodynamic as well as kinetic data).

All applications must describe novel research on innovative materials systems relevant to one or more of the four HydroGEN advanced water splitting pathways. Through the required elements described above, the application must also clearly identify the expected impact of its materials innovation in terms of well-articulated and quantitative technology-specific metrics. Outlined below are descriptions of major materials needs and challenges for each of the water splitting pathways which are specifically of interest to this subtopic, along with some example metrics and targets:

1. **Low Temperature Electrolysis:** In the context of this subtopic, low temperature electrolysis is restricted to polymer based technologies including, for example, alkaline exchange membrane (AEM) and proton exchange membrane (PEM) systems for direct water splitting, or for half reactions in multi-step water splitting approaches such as hybrid STCH cycles which include an electrolysis step.[18] Areas of interest include materials stability/durability of membranes, ionomers, catalysts (including low PGM and non-PGM), gas diffusion layers, bipolar plates, and their interfaces when operating

[18] Examples include the hybrid sulfur STCH cycle and the hybrid copper-chloride STCH cycle.

under electrochemical half reactions for water splitting. Advancing the understanding of and developing mitigation strategies for degradation mechanisms associated with the effects of temperature, pressure, current density, cell potential, and water purity is encouraged. Effective integration of theory, synthesis and characterization to validate proposed materials innovation benchmarked under hydrogen generation conditions should be demonstrated to assist in acceleration of future materials discovery. Materials selected should have the potential of meeting FCTO's Multi-year Research, Development, and Demonstration (MYRD&D) plan 2020 stack energy efficiency target of 43 kWh/kg H_2, and degradation rate of less than 4 mV/1000h.[19] Applications must include quantifiable materials metrics goals (e.g., membrane conductivity, catalyst activity, etc.) and identify how they will contribute to meeting the broader performance metrics and DOE production cost goals of $2 / kg H_2.

2. **High Temperature Electrolysis:** Applications to this subtopic area should be focused on improving the durability of high temperature electrolysis materials, such as those based on solid oxide fuel cells. It is well documented that significant hydrogen production rates can be obtained at stack electrical efficiencies in the range of 100% with high temperature electrolysis technologies; however, the degradation rate is too high, commonly in the range of 1-4%/1000 hrs. Development of both a better fundamental understanding of the causes of degradation for cell and stack materials and interfaces as well as a materials-based solution for overcoming the identified degradation mechanisms is of interest. An approach which integrates theory, synthesis, and characterization leading to the improved understanding of degradation is desired. There is some indication that degradation rate increases as the current density increases. The degradation studies must be relevant to operation at current densities of at least 1 A/cm^2 with higher current densities preferred. Development of accelerated stress tests that have a validated basis for the acceleration factor and the mechanism that it is accelerating is of interest. The material set to be investigated must be relevant to and capable of high performance (1 A/cm^2 at 1.4 V) with a goal of achieving lifetimes of at least 40,000 hours (e.g., degradation rates on the order of 4 mV/1000 hrs.). Applications must include quantifiable materials metrics goals (e.g., area specific resistance) and identify how they will contribute to meeting the broader performance metrics and DOE production cost goals of $2/kg H_2.

3. **Photoelectrochemical (PEC) Hydrogen Production[20]:** Efficient PEC solar water-splitting approaches to date suffer from corrosion and photo-corrosion which severely limits lifetime and long term commercial viability. Specific areas of interest for this subtopic include materials or material systems with bandgap and band alignment compatible with efficient PEC conversion, which include innovations for increased durability of functional interfaces, and stable surface catalysis. Applications advancing the

[19] http://energy.gov/sites/prod/files/2015/06/f23/fcto_myrdd_production.pdf

[20] The Office of Science's Joint Center for Artificial Photosynthesis has led substantial research in PEC hydrogen production since its inception. Many of their accomplishments are now being leveraged by the HydroGEN consortium.

understanding of and developing mitigation strategies for degradation mechanisms, both thermodynamic and kinetic, are specifically sought. The proposal should include materials discovery, synthesis and characterization of novel materials that demonstrate significant progress toward MYRD&D 2020 target of a 20% solar-to-hydrogen conversion efficiency (% STH).[19] Only materials or material systems with a demonstrable pathway to achieving greater than 10% STH efficiency will be considered. Further, applications must include quantifiable materials metrics goals (e.g., corrosion resistance and durability, absorber quantum efficiency, catalyst activity, etc.) and identify how they will contribute to meeting the broader MYRD&D performance metrics and DOE production cost goals of $2 / kg H_2.[19]

4. **Solar Thermochemical (STCH) Hydrogen Production[21]:** Materials development for STCH technologies focused on two-step metal oxide cycles is of specific interest to this subtopic. The hybrid cycles are covered under the low temperature electrolysis thrust where R&D efforts in collaboration with the HydroGEN Consortium will be focused on the development of the electrolysis step. For materials development focused on two-step metal oxide water splitting cycles for STCH hydrogen production, applications should include materials discovery, synthesis and characterization of novel materials that when incorporated with a feasible reactor design demonstrate significant progress towards relevant 2020 targets in the MYRDD for solar-to-hydrogen conversion efficiency (20% STH) and the potential for meeting the ultimate production cost goal of < $2/kg H_2. Of particular interest are materials that have the potential to reduce sufficiently at temperatures < 1400°C and also oxidize under reasonable conditions necessary for real world implementation (i.e., less than 10 mol H_2O required/ mol H_2 produced). Further, applications must include quantifiable metrics for materials durability such as number of cycles to be demonstrated and maximum acceptable reactivity losses, as material stability over thousands of cycles will be necessary to achieve performance and cost goals. Development of an enhanced fundamental understanding of material requirements in terms of thermodynamics and kinetics is also of particular interest and will be key to the acceleration of materials discovery, development, and engineering of high performing water splitting materials.

Topic 2B: Development of Best Practices in Materials Characterization and Benchmarking for Advanced Water Splitting Technologies

Under this subtopic, FCTO solicits applications to develop comprehensive, documented Best Practices for public dissemination, covering procedures and protocols for screening, characterizing, and benchmarking of materials systems in each of the four HydroGEN Consortium's advanced water splitting technologies listed above. Standardized methodologies and reporting procedures are critical for facilitating materials RD&D in each production pathway; and comprehensive, uniformly-established Best Practices can promote important

[21] Over 300 STCH cycles have been investigated in the literature to date. In 2011, DOE down-selected 8 cycles to study in detail, and documented their evaluation here: http://energy.gov/sites/prod/files/2014/03/f9/solar_thermo_h2.pdf

cross-cutting RD&D relevant to all the technologies. Developing and documenting the Best Practice procedures and protocols will be integrally tied to the ongoing and independently-funded work to build up the capabilities portfolio at the consortium's core laboratories. Extensive collaborative efforts and stakeholder engagement with HydroGEN and other research experts will be necessary. The Best Practices developed through this subtopic are expected to serve as the gold-standard for screening, characterization and benchmarking within the HydroGEN Consortium, and provide significant benefit in the accelerated RD&D of advanced water splitting materials. As an example of successful prior related work, FCTO's Hydrogen Storage Program has developed comprehensive Best Practices documents for the characterization of hydrogen storage materials.[22] Projects in this subtopic should be planned as multi-phase efforts, with $2,000,000 maximum total DOE funding over a four year total duration, and with a quantitative Go/No-Go decision point between each phase. Applicants to this subtopic are not required to provide any cost share.

A primary objective of projects awarded in this subtopic is to establish and maintain a balanced portfolio of documented Best Practices covering all four of the HydroGEN Consortium's advanced water splitting technologies. Platforms for materials screening, characterization and benchmarking in the consortium are focused on two general operational scales: (1) Bench-scale platforms, equipped for materials and components qualification under water-splitting operating conditions with H_2 production rates up to ~ 0.1 kg/day; and (2) Sub-scale qualification platforms operating with H_2 production rate of up to ~2 kg/day. The *Bench-scale* platforms used for screening, characterizing and qualifying new materials and components can offer quick turnaround testing as well as longer-term durability testing up to 100 hours. The *Sub-scale* platforms are intended for testing integrated water splitting units at the prototype scale under real-world operating conditions relevant to a specific pathway (e.g., current densities and thermal management in the electrolytic pathways, outdoor sunlight and duty cycles in the solar pathways, etc.), capable of durability testing up to approximately 5000 hours.

Applicants in this subtopic are expected to propose a detailed plan to establish and maintain a balanced portfolio of Best Practices in materials screening, characterization, and benchmarking covering all four of the HydroGEN advanced water splitting technologies under both bench- and sub-scale operations. The workplan for this subtopic should include the following required tasks:

1. PRIOR WORK**:** Compile a library of prior published literature related to standard practices in materials screening, characterization, and benchmarking relevant to advanced water splitting technologies. An example of previously published work documenting experimental standards and protocols within the PEC community can be found in the *Springer Briefs in Energy*.[23] The library of prior work compiled through this task will be publicly disseminated through the HydroGEN Consortium's web-based data portal. This reference library will be

[22] 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

[23] http://link.springer.com/book/10.1007/978-1-4614-8298-7

an important resource for the advanced water splitting materials RD&D community. It will also serve to avoid duplication in project's Best Practices development work.

2. STATUS ASSESSMENT**:** Perform ongoing analytical assessments of the current operational status of the HydroGEN Consortium's resource capabilities dedicated to materials screening, characterization and benchmarking, including the status of all associated documentation and published Best Practices. This task will require extensive collaboration with the HydroGEN Consortium steering committee and core laboratory experts to ensure consistency in assessments across all four water splitting pathways.

3. GAP ASSESSMENT**:** Perform and document ongoing assessments of significant gaps relevant to materials screening, characterization, and benchmarking. This task will require extensive stakeholder engagement with the HydroGEN Consortium Steering Committee and laboratory experts; as well as industry, academia and national laboratory researchers and experts committed to the consortium's continued growth and improvement. Providing up-to-date information on critical gaps and needs to FCTO will be an essential outcome of this task. This information is expected to guide DOE in identifying near-term priorities and longer-term opportunities for the enhancement of HydroGEN Consortium.

4. BEST PRACTICES DOCUMENTATION**:** Develop clear and comprehensive documentation of Best Practices in materials screening, characterization, and benchmarking for the HydroGEN Consortium's advanced water splitting technologies. Rigorous vetting of these Best Practices will require close collaboration with HydroGEN experts in all the pathways, and entail extensive engagement with stakeholders from the broader RD&D community. FCTO, guided by stakeholder feedback from other project tasks, will prioritize the work needed to establish a balanced portfolio of Best Practices documentation; and will work closely with project recipients to ensure the highest-priority actions are being addressed. The compiled library of the stakeholder-vetted Best Practices documentation developed in this project will be publicly disseminated through the HydroGEN Consortium's web-based data portal. This documentation should be clear, concise and comprehensive, and should be *user friendly* with extensive indexing and search features. It should be structured to provide the broadest impact for the benefit of the HydroGEN Consortium, as well as the entire advanced water splitting RD&D community.

To be considered responsive to this subtopic, applications must include the following required elements:

- Workplan:
    - Include a detailed plan for establishing and maintaining a balanced portfolio of documented Best Practices in materials screening, characterization and benchmarking covering all four of the HydroGEN advanced water splitting technologies under both bench- and sub-scale operations. The plan should include strategies and approaches for addressing requirements in the four major tasks outlined above.
    - Strategies and plans for critical stakeholder engagements with the HydroGEN Consortium, the broader advanced water splitting RD&D communities, and FCTO should be highlighted.

- Consistent with general FOA requirements, the proposal should provide a complete table of deliverables and milestones. The deliverables should include products from the *Prior Works, Status Assessment, Gap Assessment* and *Best Practices Documentation* tasks outlined above. Examples of milestones could include the number of expected stakeholder engagements, the number of expected capabilities assessments/documentation, etc.
- Consistent with EMN guiding principles, applicants selected under this solicitation will be asked to detail a strategic plan for developing user-friendly and searchable data and documents on prior works and Best Practices for public dissemination on the HydroGEN Consortium's upcoming data portal.

- Technical Qualifications and Resources: Applicants must indicate their prior work and experiences working with research/research experts in hydrogen, fuel cell and/or related technologies. Previous experience in developing Best Practices, protocols and documentation should be described. Previous scientific and/or engineering work in the advanced water splitting technologies for renewable hydrogen production and/or materials RD&D is preferred.

Topic 3: HyMARC - Hydrogen Storage Materials Discovery

Program Background:

The goal of the DOE Hydrogen Storage Program[24] 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 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

[24] DOE Hydrogen Storage Program website: http://www.energy.gov/eere/fuelcells/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.[25] Interim 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 on the DOE Hydrogen Storage website are: gravimetric capacity; volumetric capacity; and system cost. For the interim, the targets are 1.8 kWh/kg (5.5 wt.% H_2), 1.3 kWh/L (40 g H_2/L), and $10/kWh ($333/kg $H_{2\ stored}$). While these targets are periodically revisited and updated based on industry input, they provide general guidance to the R&D community on both system and material requirements. 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 even the interim system level volumetric target when the volume of the tank and rest of the system is included.

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. Those materials that might also ease the burden imposed on and the cost of the emerging high-pressure hydrogen fueling infrastructure are especially of interest. Previous efforts included three material-based "Centers of Excellence," which operated from 2005 through 2010, each focusing on a specific material class.[26,27,28] The program also advanced the state-of-the-art of hydrogen storage systems through the Hydrogen Storage Engineering Center of Excellence (HSECoE)[29], 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

[25] DOE onboard storage targets for light-duty vehicles: http://energy.gov/eere/fuelcells/doe-hydrogen-storage-technical-performance-targets-light-duty-vehicles

[26] Metal Hydride Center of Excellence Final Report: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/metal_hydride_coe_final_report.pdf

[27] Chemical Hydrogen Storage Center of Excellence Final Report: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/chemical_hydrogen_storage_coe_final_report.pdf

[28] Hydrogen Sorption Center of Excellence Final Report: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/hydrogen_sorption_coe_final_report.pdf

[29] Hydrogen Storage Engineering Center of Excellence website: http://hsecoe.srs.gov/

property requirements from full system performance models have been publicly disseminated.[30,31,32,33] 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 applications 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_2 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.[33] 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 Hydrogen Materials – Advanced Research Consortium (HyMARC)[11] national laboratory core team, composed of Sandia (SNL) - lead, Lawrence Livermore (LLNL), and Lawrence Berkeley National Laboratories (LBNL), 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 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 HyMARC website[11] as well as the DOE Hydrogen Storage Program website.[34] 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.[22] 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

[30] R.K. Ahluwalia, et al. IJHE, 2015 http://www.sciencedirect.com/science/article/pii/S0360319915005935
[31] R.K. Ahluwalia, et al. IJHE, 2014 http://www.sciencedirect.com/science/article/pii/S0360319914020114
[32] T.A. Semelsberger, et al. J. Power Sources, 2015 http://www.sciencedirect.com/science/article/pii/S0378775315000415
[33] J.M. Pasini, et. al. IJHE, 2013 http://www.sciencedirect.com/science/article/pii/S0360319912019623
[34] DOE Hydrogen Storage Program website - HyMARC Capabilities: http://energy.gov/eere/fuelcells/hymarc

development activities. The DOE has also established a searchable online hydrogen storage materials database[35] as a repository for the comprehensive collection of hydrogen storage material properties developed through DOE-supported R&D. DOE is also supporting the Hydrogen Storage Characterization Optimization Research Effort (HySCORE), another team of national laboratory research groups that have advanced characterization capabilities that are readily accessible to research teams supported by the DOE Hydrogen Storage Program. The HySCORE team is led by the National Renewable Energy Laboratory (NREL), with partners at Pacific Northwest (PNNL) and Lawrence Berkeley (LBNL) National Laboratories and the National Institute of Standards and Technology (NIST) Center for Neutron Research. HySCORE's characterization capabilities are described on the DOE Hydrogen Storage Program's website.[36] These capabilities can be available for validation measurements, unique measurements that are not readily available outside the national laboratories, and when critical for the supported research effort.

Both the HyMARC Consortium and the HySCORE team are funded independent of this FOA and their capabilities are available to all supported research projects selected under this topic. Applicants do not need to contact the consortia when writing their proposals, or request letters of commitment for inclusion in their proposals.

Topic Description:
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 targets.[25] Project teams will be integrated into HyMARC as individual projects collaborating with the national laboratory core team. As part of the project, each applicant will be required to agree to an NDA with HyMARC[37] 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, $1,000,000 maximum total DOE funding over 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.

Applications must describe novel research on the preparation and characterization of innovative materials to address the needs for onboard rechargeable hydrogen storage. The applications should also describe in detail the underlying material concepts and include targeted performance metrics for the materials that address the critical properties identified

[35] Hydrogen Storage Materials Database: http://www.hydrogenmaterialssearch.govtools.us/
[36] DOE Hydrogen Storage Program Website – HySCORE Capabilities: http://energy.gov/eere/fuelcells/downloads/hydrogen-storage-rd-core-characterization-capabilities
[37] HyMARC Standard NDA: http://energy.gov/eere/fuelcells/downloads/hymarc-non-disclosure-agreement

through "reverse engineering" from the system level performance.[32,33] The work plan should be multi-phase, with phase 1 planned for 12-18 months to focus on synthetic efforts and subsequent materials characterization to demonstrate the feasibility of the materials concept. It is expected that since these projects will be integrated into the overall HyMARC Consortium structure described above, the application (both concept papers and full applications) and proposed work plan will include intended activities that take advantage of the capabilities of the HyMARC national laboratory core team and/or HySCORE. These may include synthetic, characterization, or computational activities.

A Go/No-Go milestone must be proposed that includes quantitative, measurable metrics at the end of phase 1. The Go/No-Go milestone must also provide confidence that the proposed materials concept has reasonable potential to result in a hydrogen storage material capable of meeting automotive performance requirements. In addition, ideally, the Go/No-Go would include several material performance metrics; these may include reversible volumetric and gravimetric capacities, (de)sorption kinetics within reasonable pressure and temperature ranges, thermodynamics, and/or any other relevant material property metrics appropriate for the specific type of material being developed. 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. DOE is looking for novel, high-risk, high-payoff proposals that will result in materials which can 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 validation.

The following technologies will not be accepted under this topic: hydrolysis of sodium borohydride[38]; pure, undoped single-walled carbon nanotubes[39]; and onboard fuel processing (ammonia or hydrocarbon fuels that are reformed onboard to produce hydrogen and nitrogen or carbon dioxide).[40] In addition, DOE is not interested in concepts relying *solely* on hydrogen storage enhancement via the weak-chemisorption or "spillover" mechanism.[41] 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)[26,27,28] are also not solicited unless a new approach has been developed that addresses the reasons why the subject material was discontinued for R&D.

[38] Go/No-Go Decision: Sodium Borohydride for Onboard Vehicular Hydrogen Storage: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/42220.pdf

[39] 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

[40] Go/No-Go Decision: Onboard Fuel Processing: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/committee_report.pdf

[41] H. Oh, et. al., Micorpor. Mesopor. Mater., 2013 http://www.sciencedirect.com/science/article/pii/S1387181113002229

Topic 4: Precursor development for low-cost, high-strength carbon fiber for use in composite overwrapped pressure vessel applications

Background:

Light-duty FCEVs are being commercially released with 700 bar compressed hydrogen stored onboard the vehicle in composite overwrapped pressure vessels (COPVs). The COPVs have a liner (Type III – metallic; Type IV - polymer) to primarily reduce hydrogen permeation, wrapped with a carbon fiber (CF) reinforced polymer matrix composite to provide strength. Extensive techno-economic analyses have been performed to understand the costs associated with compressed hydrogen onboard storage systems. In 2013, a baseline 700 bar Type IV system with 5.6 kg of usable hydrogen was analyzed and projected to have a cost of $17/kWh of stored hydrogen when manufactured at a rate of 500,000 systems per year.[42] This equates to a system cost of approximately $3,200 per vehicle. In 2015 this analysis was updated to account for technology improvements developed with DOE Hydrogen Storage Program's[24] support and identified design modifications. The updated analysis resulted in a reduced projected cost to $15/kWh of stored hydrogen, equating to about $2,800 per vehicle system cost.[43] These projected costs are significantly higher than the DOE interim cost target of $10/kWh (~$1,900/system)[25], for 5.6 kg of usable stored hydrogen. For successful commercialization of fuel cell electric vehicles, the cost of onboard hydrogen storage must be significantly reduced.

COPVs are typically manufactured by a wet filament winding process. In this process, continuous fiber tows are pulled through a resin bath to impregnate the fibers with resin and then wound under tension around the cylinder liner. The COPVs are then heat treated at various temperatures and durations to cure the resin. A standard CF used to produce COPVs for 700 bar service is Toray T700S. This fiber is available in tow sizes of 6k, 12k and 24k filaments. The CF properties are specified as 711 ksi tensile strength, 33.4 Msi tensile modulus; strain 2.1%, density of 1.80 g/cm^3 and filament diameter of 7 µm.[44] The polymer matrix is typically an epoxy thermoset resin. The 2013 baseline system analysis indicated that 67% ($11.33/kWh) of the 700 bar, Type IV system costs were due to the composite materials and winding processes.

The 2015 cost analysis indicated that 62% of the system cost, when manufactured at 500,000 systems per year, would come from the cost of CF alone.[43] The CF cost used in the 2015 analysis was based on projections for a CF developed with Hydrogen Storage Program support at Oak Ridge National Laboratory. The CF was converted from a precursor fiber of polyacrylonitrile (PAN) co-monomered with methyl acrylate (MA) and spun on a high-volume, large-tow textile manufacturing line. While the projected cost for this CF was about 18% lower than for Toray

[42] McWhorter, S. and G. Ordaz. 2013. "Onboard Type IV Compressed Hydrogen Storage System – Current Performance and Cost," DOE Hydrogen and Fuel Cells Program Record, https://www.hydrogen.energy.gov/pdfs/13010_onboard_storage_performance_cost.pdf.

[43] Ordaz, G., C. Houchins, and T. Hua. 2015. "Onboard Type IV Compressed Hydrogen Storage System - Cost and Performance Status 2015," *DOE Hydrogen and Fuel Cells Program Record*, https://www.hydrogen.energy.gov/pdfs/15013_onboard_storage_performance_cost.pdf.

[44] Toray T700S data sheet: http://www.toraycfa.com/pdfs/T700SDataSheet.pdf

T700S ($23.43/kg versus $28.67/kg)[43] the CF still had demonstrated properties similar to Toray T700S.[45]

The cost of CF is approximately evenly split between the cost of the precursor material and the cost of converting the material to CF. High-strength CF is almost exclusively produced from PAN precursor fibers with PAN contents typically 92% or greater.[46] PAN fiber precursors are typically produced by a solution spinning process that requires extensive capital investment for the coagulation, stretching, washing, drying and solvent recovery processes. The conversion of PAN precursor fiber to CF includes several moderate to high temperature processing steps to stabilize and partially oxidize the material and then high-temperature, inert atmosphere carbonization steps to drive off most non-carbon elements and leave essentially pure carbon. These steps are carried out with the fiber under tension to reduce the fiber diameter and obtain a high degree of molecular alignment within the fiber to obtain the high-strength. For more information on the processing steps, see the presentation of C. David Warren.[46] For high PAN content precursor materials, the mass yield of the CF is approximately half the starting PAN fiber mass (i.e., approximately 2 kg of PAN fiber needed to make 1 kg of CF).

To significantly reduce the cost of high-strength CF, so that 700 bar compressed hydrogen storage systems can meet the DOE cost targets[25], the cost of the precursor fiber and its conversion to CF need to be further reduced. At 62% of the current projected cost of $15/kWh, the CF represents $9.3/kWh. If the CF cost is reduced to $5/kWh ($12.60/kg CF), it would represent 50% of the interim DOE target of $10/kWh.

Topic Description:

Applications are sought for research and development of lower-cost precursor fibers for conversion into high-strength CF for use in COPVs for onboard hydrogen storage. The resulting CF should have properties similar to Toray T700S with a cost potential of $12.60/kg CF. If the precursor enables production of higher tensile strength CF that can reduce the overall amount of CF required per COPV, higher cost per kg of CF may be acceptable as long as it is offset by the lower amount of CF required. Applications for the following types of precursor fibers are sought:

1. PAN-based fibers formulated with co-monomers and additives that permit lower cost processing to produce the PAN fiber than conventional solution spinning processes, and or that reduce the conversion cost of the PAN-fiber to CF;
2. Polyolefin-based fibers capable of being cost effectively converted into high-strength CF;
3. Novel material precursor fibers that can lead to low-cost, high-strength CF production.

[45] Warren, C.D. and F.L. Paulauskas. 2014. "Development of Low-Cost, High-Strength Commercial Textile Precursor (PAN-MA)," DOE FCTO Annual Progress Report, https://www.hydrogen.energy.gov/pdfs/progress14/iv_f_2_warren_2014.pdf.

[46] Warren, C. D., "Carbon Fiber Precursors and Conversion", *Oak Ridge National Laboratory*, Department of Energy Physical-Based Storage Workshop: Identifying Potential Pathways for Lower Cost 700 Bar Storage Vessels, http://energy.gov/sites/prod/files/2016/09/f33/fcto_h2_storage_700bar_workshop_3_warren.pdf, August 24, 2016.

Note, proposals for lignin, pitch, and cellulosic material fiber precursors are not being sought through this topic.

PAN fibers are typically produced through solution spinning due to the melt temperature of PAN being higher than the crosslinking and decomposition temperature of PAN. Other spinning processes, such as melt spinning, can lead to significant cost reductions. PAN-formulations that reduce the melting temperature could allow for use of lower-cost alternative spinning processes for the PAN precursor fibers. The produced PAN-fibers would need to have properties, such as molecular orientation, that lead to production of high-strength CF on conversion. Co-monomers and additives can also affect the conditions for conversion to CF, and the resulting fiber structure, and therefore PAN-fibers formulated to reduce the severity of the conversion conditions and increase the throughput of conversion into the high-strength CF are also sought.

Polyolefin fibers have the potential to be lower cost than PAN fibers. Also, the mass yield on conversion of polyolefin fibers can be significantly higher than for PAN fibers, and thus lead to lower cost CF. To convert polyolefin fibers to CF, the fibers are typically chemically stabilized (sulfonation) versus thermally stabilized as with PAN fibers prior to carbonization. The sulfonation process leads to crosslinking and cyclization of the fiber molecules. The sulfonation and subsequent sulfur removal processes are costly, and the use of polyolefin precursor fibers for the production of low-cost, high-strength CF has not yet been demonstrated.

Applications are sought for alternative precursor fibers as described above. The applications should describe the type of material proposed and provide justification for the selection including how it will lead to lower-cost CF that meets the cost and property targets provided above. To demonstrate merit of the proposal, sufficient detail should be provided on the proposed material formulation, fiber processing methods and conditions, expected precursor fiber properties and projected conversion processes and conditions.

A Go/No-Go milestone must be proposed that includes quantitative, measurable metrics at the end of phase 1. The Go/No-Go milestone must also provide confidence that the proposed precursor has reasonable potential to meet the metrics provided above. As final project deliverables, the application will need to provide tensile strength and tensile modulus measurements on CF converted from the developed precursor fiber. Preliminary cost analysis projecting the cost of both the precursor fiber and produced CF is also required. Sufficient details of the formulation and processing will need to be made available to DOE before the end of the project to allow for detailed independent cost analysis to be performed. DOE may also request sufficient quantities of the developed precursor fiber for conversion to CF for property validation by an independent third party (COPV fabrication / demonstration are not being requested in this FOA). Applicants are also **highly encouraged** to leverage carbon fiber characterization and scale up resources within the DOE National Laboratory system (e.g., The Institute for Advanced Composites Manufacturing Innovation - IACMI[47]). In addition, a host of

[47] IACMI website: http://iacmi.org/

carbon fiber capabilities are now available through the Lightweight Materials Consortium (LightMAT).[48] Collaboration through the LightMAT Consortium, which is another key DOE EMN, is strongly encouraged and the value and impact of the tools and resources (both experimental and computational) leveraged through any potential collaboration should be documented in the applications. It is anticipated that these projects would run for up to 3 years in length for a maximum total DOE funding of $1,000,000.

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 the FOA, including but not limited to:
  - Topic 1: PGM-free precious metals (e.g., gold or rhenium), anode hydrogen oxidation reaction catalysts, catalysts for non-PEM fuel cells (i.e., alkaline membrane fuel cells).
  - Topic 3: hydrolysis of sodium borohydride[38]; pure, undoped single-walled carbon nanotubes[39]; and onboard fuel processing (ammonia or hydrocarbon fuels that are reformed onboard to produce hydrogen and nitrogen or carbon dioxide).[40] In addition, DOE is not interested in concepts relying *solely* on hydrogen storage enhancement via the weak-chemisorption or "spillover" mechanism.[41] 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)[26,27,28] are also not solicited unless a new approach has been developed that addresses the reasons why the subject material was discontinued for R&D.
  - Topic 4: lignin, pitch, and cellulosic material fiber precursors.

- 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.

[48] LightMAT Consortium website: http://LightMat.org

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make approximately $30 million of Federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 20-30 awards under this FOA. EERE may issue one, multiple, or no awards.

Individual awards may vary between $1 million ($250,000 maximum for Phase 1 for Topic 2A and Topic 3 awards) and $2 million – see Table 1 below.

EERE may issue awards in one, multiple, or none of the topic areas addressed in Table 1 below:

Table 1: Anticipated Funding and Award Details

Topic Area	Anticipated Number of Awards	Max. Federal Funding per Award	Max. Project Duration (years)	Min. Required Non-Federal Cost Share %
Topic 1: ElectroCat – PGM-free Catalyst and Electrode R&D	4-5	$2,000,000	3	20%*
Topic 2A: HydroGEN - Durable, High-Performance Materials and Interfaces for Advanced Water Splitting	6-8	$1,000,000**	3	20%*
Topic 2B: HydroGEN - Development of Best Practices in Materials Characterization and Benchmarking for Advanced Water Splitting Technologies	1-2	$2,000,000	4	0%
Topic 3: HyMARC- Hydrogen Storage Materials Discovery	5-10	$1,000,000**	3	20%*
Topic 4: Precursor development for low-cost, high-strength carbon fiber for use in composite overwrapped pressure vessel applications	3-4	$1,000,000	3	20%*

*A reduced cost share requirement of 10% is available for domestic institutions of higher education, domestic nonprofit entities, FFRDCs, and U.S. State, local, and tribal government entities
**Initially, only $250,000 per award will be provided for Budget Period 1

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

Specifically, projects awarded through Topics 2A and 3 will only be initially funded for a single 12-18 month budget period at a maximum amount of $250,000. The continuation for additional phases and funding will be contingent on meeting agreed upon quantitative Go/No-Go criteria for Budget Period 1.

ii. Period of Performance

EERE anticipates making awards that will run up to 36 months in length for all topics except for Topic 2B which will run up to 48 months in length. 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 funding the project.

iii. 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.

i. 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.ix of the FOA for more information on what substantial involvement may involve.

ii. 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.

iii. 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.

iv. 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.

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

i. Individuals

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

ii. 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, with the exception of the FFRDC eligibility restrictions set forth in Section III.B.i below.

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.

iii. 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.

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.

iv. 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.

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

B. Ineligible Applicants

i. Core EMN FFRDC Members

For Topics 1, 2, and 3, core FFRDC members of the ElectroCat, HydroGEN, and HyMARC EMN consortia are ineligible to apply to their associated FOA topic(s) as prime or subrecipients. However, core FFRDCs that are core members of a consortium can apply to other consortium topics for which they are not core members (e.g., Argonne National Laboratory is ineligible to apply to Topic 1 since they are a core member of ElectroCat, but is eligible to apply to Topics 2 and 3). The table below lists the core members of each consortium.

Topic	Core FFRDCs that are Ineligible
1. ElectroCat	Los Alamos National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, National Renewable Energy Laboratory
2. HydroGEN	National Renewable Energy Laboratory, Sandia National Laboratory, Lawrence Berkeley National Laboratory, Idaho National Laboratory, Savannah River National Laboratory, Lawrence Livermore National Laboratory
3. HyMARC	Sandia National Laboratory, Lawrence Livermore National Laboratory, Lawrence Berkeley National Laboratory

C. Cost Sharing

Topics 1, 2A, 3, and 4: Cost Share 20%, Blanket Cost Share Waiver Utilized

- *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.)

- *Blanket 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 this FOA. 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.

Topic 2B: Cost Sharing Not Required for Analysis Activities

i. 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 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 obligations assumed by Project Team members in subawards or related agreements.

ii. 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.

iii. Cost Share Types and Allowability

Every cost share contribution must be allowable under the applicable Federal cost principles, as described in Section IV.K.i 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: rental value of buildings or equipment, the value of a donated service or 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.

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 for additional guidance on cost sharing.

iv. 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.

v. 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.

vi. 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.

D. 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.

i. Compliance Criteria

1. 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.

2. 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.

3. 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.

E. 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.

F. Other Eligibility Requirements

i. 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 [Enter Laboratory Name] 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.

ii. 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:

1. **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.

2. **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 [Enter Laboratory Name] 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.

3. **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.

4. **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. Please note: in the case of Topics 1-3, cost share will be based on the total cost of the project, excluding the cost of the work to be performed by the consortium.

5. **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.

6. **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.

G. 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.

H. 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.

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 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.ii of the FOA.

i. 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). The Exchange helpdesk and/or the EERE Exchange system administrators will assist Applicants in resolving issues.

Applicants that experience issues 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). 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
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.

i. 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
Cover Page	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.
Technology Description	3 pages maximum	Applicants are required to describe succinctly: • The proposed technology, including its basic operating principles and how it is unique and innovative; • 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);

		• The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; • The potential impact that the proposed project would have on the relevant field and application; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project. • Very brief synopsis of the intended budget and project team.
Addendum	1 pages maximum	Applicants may provide graphs, charts, or other data to supplement their Technology Description.

EERE makes an independent assessment of each Concept Paper based on the criteria in Section V.A.i 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)."

i. Full Application Content Requirements

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

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
Full Application (PDF, unless stated otherwise)	Technical Volume (See Chart in Section IV.D.ii)	ControlNumber_LeadOrganization_TechnicalVolume
	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, if applicable (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange.)	ControlNumber_LeadOrganization_Subawardee_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

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_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.

ii. 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.ii 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.ii of the FOA) when preparing the Technical Volume.

SECTION/PAGE LIMIT	DESCRIPTION
Cover Page (1-page)	The cover page should include the project title, the specific FOA Topic Area being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.

Project Overview (This section should constitute approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: 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. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: 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.
Technical Description, Innovation Statement, and Impact (This section should constitute approximately 40% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: 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. • Feasibility: 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. • Innovation and Impacts: 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.
Workplan (This section should constitute approximately 35% of the Technical Volume)	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: • Project Objectives: 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. • Technical Scope Summary: 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. • Work Breakdown Structure (WBS) and Task Description Summary: 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. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely, and must demonstrate a technical achievement rather than simply completing a task. 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 with at least one SMART technical milestone per year (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. • Go/No-Go Decision Points: The applicant should provide a summary of project-wide Go/No-Go decision criteria at appropriate points in the Workplan. A Go/No-Go decision 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 or phase (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. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone.

	• End of Project Goal: The applicant should provide a summary of the end of project goal(s). Unless otherwise specified in the FOA, the minimum requirement is that each project must have one SMART end of project goal. The summary provided should be consistent with the SOPO.
	• Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points.
	• Project Management: The applicant should discuss the team's proposed management plan, including the following:
	  ○ The overall approach to and organization for managing the work
	  ○ The roles of each Project Team member
	  ○ Any critical handoffs/interdependencies among Project Team members
	  ○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices
	  ○ The approach to project risk management
	  ○ A description of how project changes will be handled
	  ○ How communications will be maintained among Project Team members

Technical Qualifications and Resources (Approximately 15% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • Describe the Project Team's unique qualifications and expertise, including those of key Subrecipients. • 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. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project. • Attach one-page resumes for key participating team members as an appendix to the Technical Volume. Resumes do not count towards the page limit. Multi-page resumes are not allowed. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. • Attach letters of commitment from all Subrecipient/third party cost share providers as an appendix to the Technical Volume. Letters of commitment do not count towards the page limit. • Attach any letters of support from partners/end users as an appendix (1 page maximum per letter) to the Technical Volume. Letters of support do not count towards the page limit. Letters of commitment are not necessary from core consortia members being leveraged in an application.

	• For multi-organizational or multi-investigator projects, describe succinctly:
	  ○ The roles and the work to be performed by each PI and Key Participant;
	  ○ Business agreements between the applicant and each PI and Key Participant;
	  ○ How the various efforts will be integrated and managed;
	  ○ Process for making decisions on scientific/technical direction;
	  ○ Publication arrangements;
	  ○ Intellectual Property issues; and
	  ○ Communication plans

iii. 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 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".

iv. 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".

v. 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 as well as cost necessary to adhere to the required report as specified in section VI.B.xii including a Hydrogen Safety Plan. Applicants

should not include the cost of the work to be performed by the core consortium. 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".

vi. 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".

vii. 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.

viii. Subaward Budget Justification (EERE 335) (if applicable)

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".

ix. 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". A FWP is not required for work that will be performed by EMN consortia in support of a FOA award.

x. 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".

xi. 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/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.

Save the SF-LLL in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_SF-LLL".

xii. Waiver Requests: Foreign Entities and Performance of Work in the United States (if applicable)

1. **Foreign Entity Participation**
   As set forth in Section III.A.iii, 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 B lists the necessary information that must be included in a request to waive this requirement.

2. **Performance of Work in the United States**
   As set forth in Section IV.K.iii, 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 B lists the necessary information that must be included in a request to waive the Performance of Work in the United States requirement.

xiii. U.S. Manufacturing Commitments

EERE requires subject inventions (i.e., inventions conceived or first actually reduced to practice under EERE awards) to be substantially manufactured in the United States by Project Teams and their licensees, as described below. The applicant may request a modification or waiver of the U.S. Manufacturing Requirement.

1. **Domestic Small Businesses, Educational Institutions and Nonprofits**
   Domestic Small businesses (including Small Business concerns), domestic educational institutions, and nonprofits that are Recipients or Subrecipients under EERE funding agreements must require their exclusive licensees to substantially manufacture the following products in the United States for any use or sale in the United States: (1) articles embodying subject inventions, and (2) articles produced

through the use of subject inventions. This requirement does not apply to articles that are manufactured for use or sale overseas.

Domestic small businesses, domestic educational institutions and nonprofits must require their assignees to apply the same U.S. Manufacturing requirements to their exclusive licensees.

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

2. **Large Businesses, Foreign Entities, and State and Local Government Entities**
   Large businesses and foreign entities that are Recipients or Subrecipients under EERE funding agreements that take title to subject inventions through a patent waiver are required to substantially manufacture the following products in the United States: (1) products embodying subject inventions, and (2) products produced through the use of subject invention(s). This requirement applies to products that are manufactured for use or sale in the United States or overseas.

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

3. **FFRDCs**
   DOE FFRDCs are subject to the U.S. Manufacturing requirements set forth in their Management and Operating Contracts. All other FFRDCs are subject to the U.S. Manufacturing requirements as set forth above, based on their size and for-profit status.

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
- Data Management Plan – see Section IV.I
- Non-disclosure agreements (NDAs) and/or cooperative research and development agreements (CRADAs) – see Section IV.K.x

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: (1) Be registered in the System for Award Management (SAM) at https://www.sam.gov before submitting its application; (2) provide a valid Dun and Bradstreet Universal Numbering System (DUNS) number in its application; and (3) 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. Data Management Plan

Applicants whose 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 of the FOA.

J. Intergovernmental Review

Technology Office not subject to Executive Order 12372

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

K. Funding Restrictions

i. 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.

ii. 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.

1. 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.

iii. Performance of Work in the United States

1. 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.

2. 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.

3. 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 B 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.

iv. Construction

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

v. 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 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. Foreign travel costs are allowable only with the written prior approval of the Contracting Officer assigned to the award.

vi. Equipment and Supplies

To the greatest extent practicable, all equipment and products 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.

vii. 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.

viii. 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.

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.

ix. Invoice Review and Approval

DOE employs a risk-based approach to determine the level of supporting documentation required for approving invoice payments. Recipients may be required to provide some or all of the following items with their requests for reimbursement:

- Summary of costs by cost categories
- Timesheets or personnel hours report
- Invoices/receipts for all travel, equipment, supplies, contractual, and other costs
- UCC filing proof for equipment acquired with project funds by for-profit recipients and subrecipients – see Section VI.B.xv
- Explanation of cost share for invoicing period
- Analogous information for some subrecipients
- Other items as required by DOE

x. Additional Requirements

Each of the consortia being leveraged in this FOA have established or are establishing standard non-disclosure agreements (NDAs) and/or cooperative research and development agreements (CRADAs) that applicants will be required to sign prior to receiving an award.

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

Concept Papers for all Topics are evaluated based on consideration of 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.

ii. Full Applications

Applications for Topics 1, 2A, 3, and 4 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;
- 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
- 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

- How 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 Analysis and Work Plan (30%)

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, Go/No-Go criteria, and mid-point deliverables defined in the application, such that meaningful interim progress will be made.

Criterion 3: Team and Resources (20%)

- 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.
- The degree to which the applicant is leveraging capabilities / nodes within the respective consortium to facilitate and expedite the proposed materials discovery/development (only applies to Topics 1, 2A, and 3).

Applications for Topic 2B will be evaluated against the merit review criteria shown below:

Criterion 1: Technical Merit and Impact (35%)

Technical Merit

- The relevance of the proposed concept to the objectives of the FOA;
- The soundness of the proposed assessment and documentation plans;
- The demonstration of a clear understanding of the materials screening, characterization and benchmarking needs in HydroGEN's core advanced water splitting technologies; and
- The likelihood of the proposed plan to produce high-impact Best Practices that will serve to standardize and accelerate RD&D efforts relevant to all four of HydroGEN's core advanced water splitting technologies;

Criterion 2: Project Work Plan (35%)

Approach, Workplan, and SOPO

- Degree to which the approach and proposed engagement with the HydroGEN consortium and other stakeholders have been clearly described and thoughtfully considered in order to develop Best Practices with maximum impact; 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 Risks

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

Criterion 3: Team and Resources (30%)

- 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; including the qualifications, relevant expertise, and time commitment of the individuals on the team;
- Adequacy of demonstrated experience managing a diverse, multi-faceted project with many stakeholders
- The sufficiency of the team's resources to support the work;
- The adequacy of the proposed project organizations to facilitate project success, including the approach for managing the team, engaging the HydroGEN consortium, coordinating all project activities, and ensuring communication among all entities involved in developing Best Practices;

- The adequacy and appropriateness of the roles and responsibilities of the team members; including 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.

iii. 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/management/downloads/merit-review-guide-financial-assistance.

C. Other Selection Factors

i. 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 exhibits technological diversity when compared to the existing DOE project portfolio and other projects selected from the subject FOA;
- 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 accelerate commercialization and overcome key market barriers;
- The degree to which the proposed project is likely to lead to increased employment and manufacturing in the United States
- The degree to which 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 applicant is a Climate Action Champion[49] designated under DOE's Request for Applications DE-FOA-0001189 (RFA)

D. Evaluation and Selection Process

i. 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.

ii. 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.iii 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.

[49] 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.

iii. 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.

iv. Recipient Integrity and Performance Matters

DOE, prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, is required to review and consider any information about the applicant that is in the designated integrity and performance system accessible through SAM (currently FAPIIS) (see 41 U.S.C. 2313).

The applicant, at its option, may review information in the designated integrity and performance systems accessible through SAM and comment on any information about itself that a Federal awarding agency previously

entered and is currently in the designated integrity and performance system accessible through SAM.

DOE will consider any written comments by the applicant, in addition to the other information in the designated integrity and performance system, in making a judgment about the applicant's integrity, business ethics, and record of performance under Federal awards when completing the review of risk posed by applicants as described in 2 C.F.R. § 200.205.

v. 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 2017 and making awards by September 2017.

VI. Award Administration Information

A. Award Notices

i. 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.

ii. 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.ii of the FOA for guidance on pre-award costs.

iii. 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.

iv. 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 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.ii of the FOA for guidance on pre-award costs.

v. 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.

vi. 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

i. 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:

1. **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. 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**.

2. **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.

3. **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.

4. **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

5. **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.

6. **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.

ii. 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.

iii. 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.

iv. 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.

v. 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.

vi. 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.

vii. Applicant Representations and Certifications

1. 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.

2. **Corporate Felony Conviction and Federal Tax Liability Representations**
In submitting an application in response to this FOA, the applicant represents that:
    a. It is **not** a corporation that has been convicted of a felony criminal violation under any Federal law within the preceding 24 months, and
    b. 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.

3. **Nondisclosure and Confidentiality Agreements Representations**
In submitting an application in response to this FOA the applicant represents that:
    a. 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 contactors 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.
    b. 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:
        (1) *''These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing 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.''

(2) 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.

(3) 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.

viii. 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.

ix. 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:

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.

x. 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.

xi. Intellectual Property Provisions

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at http://www1.eere.energy.gov/financing/resources.html.

xii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement. The checklist can be accessed at http://www1.eere.energy.gov/financing/resources.html.

Specific reporting and meeting attendance requirements for projects selected from this FOA will include, but are not limited to:

- Quarterly Financial and Technical Reports
- Final Technical Report
- Yearly participation at the DOE Hydrogen Program Merit Review and Peer Evaluation (AMR) meeting, typically held in Washington, D.C.
- Yearly participation in one U.S. DRIVE Technical Team Meeting
- DOE may request that material samples, components, and/or prototype systems resulting from the R&D effort be sent for

independent, standardized testing at a facility specified by DOE, as appropriate

- Work with independent system and/or cost analysis projects within DOE portfolio for independent performance and model validation as appropriate
- Project Safety Plan: Safe practices in the production, storage, distribution, and use of hydrogen are essential for the widespread acceptance of hydrogen and fuel cell technologies. The recipient must comply with the following requirements:
  1. The recipient is required to coordinate with the Hydrogen Safety Panel (HSP), a resource of the DOE Hydrogen and Fuel Cells Program, throughout the project life cycle. Examples of opportunities for HSP involvement include participation in post-award project kickoff meetings, project design and document reviews, risk assessments, and pre-startup reviews prior to beginning field demonstrations. To minimize project impacts, these engagements should be coordinated with regularly scheduled project activities rather than be unique efforts, and should be based on discussions with HSP.
  2. A Safety Plan for the project is required and will be due to DOE 90 days after the award is signed. Guidance for the creation of the Safety Plan can be found at http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/safety_guidance.pdf. The Safety Plan should cover the scope of the prime as well as any subrecipients. The Hydrogen Safety Panel will review the Safety Plan and provide feedback to the Recipient (through DOE). The Recipient will then have 30 days to respond to the HSP's feedback (e.g., either by incorporating comments into the Plan or by providing rationale for not incorporating comments) and resubmit a revised Safety Plan to DOE.
  3. DOE may request HSP involvement in site visits or via teleconferences. If a safety-focused site visit / teleconference is requested, the HSP will provide a written site visit report to the recipient for review and comment, and may conduct a follow-up interview with the recipient and their project team. All such HSP reports are also provided to DOE.

For all of the items noted above, please ensure that estimated costs associated with the requirements are included within the proposed budget.

xiii. 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 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.

xiv. 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.

xv. UCC Financing Statements

Per 2 CFR 910.360 (Real Property and Equipment) when a piece of equipment is purchased by a for-profit recipient or subrecipient with Federal Funds, and when the Federal share of the financial assistance agreement is more than $1,000,000, the recipient or subrecipient must:

Properly record, and consent to the Department's ability to properly record if the recipient fails to do so, UCC financing statement(s) for all equipment in excess of $5,000 purchased with project funds. These financing statement(s) must be approved in writing by the contracting officer prior to the recording, and they shall provide notice that the Recipient's title to all equipment (not real property) purchased with Federal funds under the financial assistance agreement is conditional pursuant to the terms of this section, and that the Government retains an undivided reversionary interest in the equipment. The UCC financing statement(s) must be filed before the Contracting Officer may reimburse the recipient for the Federal share of the equipment unless otherwise provided for in the relevant financial assistance agreement. The recipient shall further make any amendments to the financing statements or additional recordings, including appropriate continuation statements, as necessary or as the contracting officer may direct.

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: FY17FCTOofficewidefoa@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.

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.

The use of protective markings such as "Do Not Publicly Release – Trade Secret" or "Do Not Publicly Release – Confidential Business Information" is encouraged. However, applicants should be aware that the use of protective markings is not dispositive as to whether information will be publicly released pursuant to the Freedom of Information Act, 5 U.S.C. §552, et. seq., as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175. (See Section I of this document, "Notice of Potential Disclosure Under the Freedom of Information Act (FOIA)" for additional information regarding the public release of information under the Freedom of Information Act.

Applicants are encouraged to employ protective markings in the following manner:

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.

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.

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 (FOIA)

Under the Freedom of Information Act, (FOIA), 5 U.S.C. §552, et. seq., as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175, any information received from the Applicant is considered to be an agency record, and as such, subject to public release under FOIA. The purpose of the FOIA is to afford the public the right to request and receive agency records unless those agency records are protected from disclosure under one or more of the nine FOIA exemptions. Decisions to disclose or withhold information received from the Applicant are based upon the applicability of one or more of the nine FOIA exemptions, not on the existence or nonexistence of protective markings or designations. Only the agency's designated FOIA Officer may determine if information received from the Applicant may be withheld pursuant to one of the nine FOIA exemptions. All FOIA requests received by DOE are processed in accordance with 10 C.F.R. Part 1004.

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.

- 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.
- 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.

L. Government Rights in Subject Inventions

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

i. 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.

ii. 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.

Government rights in Technical Data Produced Under Awards: The U.S. Government retains unlimited rights in technical data produced under Government financial assistance awards, including the right to distribute to the public. One exception to the foregoing is that 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. Personally Identifiable Information (PII)

All information provided by the Applicant must to the greatest extent possible exclude Personally Identifiable Information (PII). The term "personally identifiable information" refers to information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, etc. alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother's maiden name, etc. (See OMB Memorandum M-07-16 dated May 22, 2007, found at: https://www.whitehouse.gov/sites/default/files/omb/memoranda/fy2007/m07-16.pdf

By way of example, Applicants must screen resumes to ensure that they do not contain PII such as personal addresses, phone/cell numbers, personal emails and/or SSNs. In short, if the PII is not essential to the application, it should not be in the application.

P. Annual Compliance Audits

If a for-profit entity is a Prime Recipient 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 be 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.

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 if the FFRDC is a prime or sub recipient. 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:

- 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

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 – 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.iii, 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.iii, 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. 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 C - 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.

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 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.