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

FY18 Hydrogen and Fuel Cell R&D FOA

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Submission Deadline for Concept Papers:	May 7, 2018 5:00pm ET
Expected Date for Concept Paper Encourage/Discourage Notification:	May 11, 2018
Submission Deadline for Full Applications:	June 12, 2018 5:00pm ET
Expected Submission Deadline for Replies to Reviewer Comments:	July 13, 2018 5:00pm ET
Expected Date for EERE Selection Notifications:	September 2018
Expected Timeframe for Award Negotiations	Fall 2018

- 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.

- Before Concept Papers for this FOA are due, FCTO may hold an informational webinar for Topic 1 (ElectroCat) wherein interested applicants can ask questions about the FOA. This will be open to the public, and the recording will be posted on FCTO's website at https://www.energy.gov/eere/fuelcells/webinars to ensure everyone has the same access.

MODIFICATIONS

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

Mod. No.	Date	Description of Modifications
000001	05/22/2018	**Section I.B.ii – Topic 2A - Integrated Energy Production and Hydrogen Fueling R&D:** *Edited*: Applicants should clearly describe plans for early-stage and applied R&D and for system performance verification testing, explaining the innovation, and must include a **20% ~~industry~~ cost share**. **Section IV.D.ii – Technical Volume:** *Edited*: **Workplan ~~and Market Transformation Plan~~** (This section should constitute approximately 40% of the Technical Volume) **Section V.A.ii – Full Applications:** *Edited*: **Criterion 2: Project Research ~~and Market Transformation Plan~~ (30%)**

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I. Funding Opportunity Description

A. Description/Background

Hydrogen and fuel cells are key components of the Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) portfolio. The Fuel Cell Technologies Office (FCTO) plays an integral role in expanding the frontiers of energy research. Aligned with EERE's mission, FCTO focuses on research, development, and innovation to advance hydrogen and fuel cells for transportation and diverse applications, including cross-sector applications such as energy storage to enable energy security, resiliency, and a strong domestic economy.[1] Fuel cells powered by hydrogen from either renewable or other resources like natural gas, nuclear power, or coal (with sequestration) can lead to substantial energy savings and to reductions in imported petroleum and their associated emissions. The FCTO's research activities aim to provide affordable, clean, safe, and reliable energy from multiple domestic resources; provide the benefits of increased energy security; and reduce emissions through early-stage research and development (R&D). This work addresses key early-stage technical challenges for fuel cells and for hydrogen fuel production, delivery, and storage, and leverages the private sector to address institutional barriers that impact progress in the field, such as hydrogen safety, codes and standards. The global fuel cell market surpassed 500 MW and 62,000 systems shipped worldwide in 2016, with an annual revenue of over $1.6 billion.[2] Early market applications such as fuel cell forklifts and backup power units are demonstrating commercial viability with over 20,000 systems in the U.S. alone since 2009.[3] Other examples, to name a few, include fuel cells for portable or easily dispatchable power, auxiliary power units (APUs) for applications such as aircraft and ships, unmanned aerial vehicles (UAVs), unmanned underwater vehicles (UUVs), marine, and rail applications.

Most of these fuel cell deployments rely on hydrogen as fuel. Hydrogen can be produced using a diverse range of domestic resources—including fossil fuels like natural gas, nuclear energy, and renewable energy sources, such as biomass, wind, solar, geothermal, and hydro-electric power—and uses a variety of processes to harness and convert each type of resource into hydrogen. However, the costs of hydrogen production, delivery, and storage are challenges that require R&D to

[1] https://energy.gov/eere/fuelcells/about-fuel-cell-technologies-office
[2] https://www.energy.gov/sites/prod/files/2017/06/f34/01_satyapal_plenary_2017_amr.pdf
[3] *Ibid.*

enable widespread commercial viability.

The use of fuel cells to power light duty vehicles is an emerging application that has earned substantial commercial and government interest worldwide due to the superior efficiencies and reductions in petroleum consumption and criteria pollutants that fuel cell technology makes possible. 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.[4] Recent analyses project that, if DOE cost targets for FCEVs are met, U.S. petroleum consumption can be reduced by over one million barrels per day.[5] Hydrogen and fuel cell technologies also find use in stationary applications, improving the reliability and energy security of the electrical grid and fuel distribution systems by providing responsive back-up power and energy storage, in addition to other services.

Increasingly, in a broader sense, many stakeholders are recognizing the unique potential of hydrogen as an energy carrier. The DOE's H2@Scale Initiative presents an innovative approach to energy infrastructure, storage, and resiliency that takes advantage of hydrogen's flexibility in production, storage, and utilization across sectors. The H2@Scale Initiative aims to support R&D innovations to economically generate hydrogen as an energy carrier; couple its generation to nuclear, fossil fuels, and renewable power to enhance the economics of both baseload plants and intermittent renewable energy on the grid; and to enable resiliency and avoid curtailment. Hydrogen production can additionally be used as a form of "responsive load" on the grid, enhancing stability while creating a revenue stream for generators. R&D efforts related to H2@Scale are broad and include scalable concepts for dispatchable hydrogen production, delivery and storage. Some specific research strategies include developing chemical carriers, liquefaction, materials development, and integration of hydrogen with diverse generation sources. For the reasons described above, fuel cell and hydrogen technologies are an energy option that can enable American energy dominance by safely and efficiently harnessing domestic resources.

This Funding Opportunity Announcement (FOA) will provide up to $39,000,000 in Federal funding to meet FCTO's goals of enabling cost-competitiveness and adoption of fuel cells, renewable hydrogen production, and low cost hydrogen storage for both transportation and stationary applications.

[4] https://www.hydrogen.energy.gov/pdfs/16004_life-cycle_ghg_oil_use_cars.pdf
[5] https://www.hydrogen.energy.gov/pdfs/16003_ghg_emissions_oil_use_reduction_from_fc.pdf

This FOA targets three topic areas:

- Topic 1: Fuel cell R&D concepts that aid in the mission of the ElectroCat Energy Materials Network (EMN) consortium to accelerate the development of platinum group metal-free (PGM-free) catalysts and electrodes.
- Topic 2: H2@Scale concepts focusing on technology acceleration activities that support hydrogen fueling and energy storage applications. Topic 2 specifically calls for concepts that advance the development of a hydrogen-focused integrated renewable energy production, storage, and transportation fuel distribution system, focusing on early-stage R&D that promotes the integration of sequential processes comprising the hydrogen transportation fuel pathway (2A); additional points of focus include R&D concepts in advanced manufacturing technologies that will enable high-volume electrolyzer production (2B), and innovative early-stage component design that can improve the functionality and footprint of stations (2C).
- Topic 3: Early stage, innovative fuel cell membrane R&D that enables use of PGM-free catalysts or the use of higher operating temperatures, towards the goal of meeting performance, durability, and cost targets (3A), as well as fuel cell component R&D to enable resilient stationary power and energy storage applications, including unitized reversible fuel cells and direct liquid fuel cells (3B).

B. Topic Areas/Technical Areas of Interest

i. Topic 1 – Energy Materials Network (EMN) - ElectroCat

The EMN aims to organize DOE national laboratory capabilities into consortia that are easily accessible to industry and academia, with the goal of accelerating the discovery, development, manufacturing, and deployment of advanced materials at a rate substantially faster than what is possible today. In line with this goal, the Electrocatalysis (ElectroCat) Consortium is aimed at increasing U.S. competitiveness in manufacturing FCEVs and other fuel cell energy conversion devices by accelerating the development of PGM-free catalysts for fuel cells used in FCEVs and for other applications.

Background:

FCTO's Fuel Cells program supports applied early stage R&D 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 used within vehicles in the near term. While the first FCEV PEMFCs are expected to use platinum group metal (PGM)-based catalysts, 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 that have been demonstrated in the lab, could be expected to cost about $45/kW if manufactured at high volume (500,000 units/year) or $50/kW at 100,000 units/year.[6] 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 FCTO's[7] ultimate cost targets for fuel cells of $30/kW, transformative materials and materials integration R&D are 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.

Successfully reducing the costs of catalysts in both automotive and stationary PEMFCs requires an integrated, collaborative approach to research. The ElectroCat consortium[8], formed by DOE as part of the EMN,[9] 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. ElectroCat helps universities and companies to accelerate their PGM-free[10] 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. ElectroCat is co-led by Argonne National Laboratory (ANL) and Los Alamos National Laboratory (LANL), and comprises tools and expertise housed at these labs as well as tools at Oak Ridge National Laboratory (ORNL) and the National Renewable Energy Laboratory (NREL).

Topic Description:

FCTO seeks applications 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, but with cross-

[6] https://www.hydrogen.energy.gov/pdfs/review17/fc163_james_2017_o.pdf
[7] DOE Fuel Cell Program's website: http://energy.gov/eere/fuelcells/fuel-cells
[8] ElectroCat website: http://www.electrocat.org/
[9] 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
[10] The platinum group metals are: indium, osmium, rhodium, platinum, palladium, and ruthenium. "PGM-free" fuel cell catalysts do not contain any of these elements.

cutting impact for stationary power. Successful applicants under this topic will be considered to be part of the DOE EMN ElectroCat consortium. Applicants should propose 2 year projects for a maximum total DOE funding of $1,000,000. Applications should be at Technology Readiness Levels (TRL) of 2-3, and the funding request should be commensurate with the level of work proposed. Proposed cathode catalyst concepts should demonstrate the potential to meet or exceed activity of 0.044 A/cm^2 at 0.9 V when tested under H_2/O_2 and achieve a durability of 5,000 hours under cycling conditions in a PEMFC membrane electrode assembly (MEA) by 2025;[11] this is equivalent to a PGM catalyst activity target of 0.44 A/mg$_{PGM}$ at 0.1 mg$_{PGM}$/cm^2 cathode catalyst loading. 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, as well as demonstrate the potential to meet DOE's 2025 MEA activity and durability targets.[12]

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 precious metals (e.g., gold or rhenium) is not of interest for this topic. The development of 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 a strong Go/No-Go decision point at the end of the first year, including meeting or exceeding the PGM-free catalyst interim activity target in a H_2/O_2 fuel cell of 0.025 A/cm^2 at 0.90 V (iR-corrected) at 1.0 bar partial pressure of O_2 and cell temperature 80 °C in a PEMFC MEA. Applicants 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 that is 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 (MYRD&D).[13] Specific PGM-free catalyst and MEA

[11] 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

[12] 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

[13] *Ibid.*

performance and durability test protocols are under development and will be posted on the ElectroCat website[14] 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 rapidly and comprehensively analyzed. 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 applications, applicants are strongly encouraged to review the ElectroCat website[15] for more details.

Upon award, FCTO requires recipients to utilize national laboratory-based 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 utilizing these in their proposed budget, nor need they 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 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 to ElectroCat for independent testing and evaluation. Also, recipients will provide all public data (such as technical data used to support published journal articles) to ElectroCat for curation and hosting. To be consistent with current operation of the ElectroCat EMN, all partners comprising the selected awardee teams will be required to agree to and sign a standardized non-disclosure agreement (NDA) as part of the award negotiation process; the standard template NDAs used for the ElectroCat consortium is available on request.

[14] http://www.electrocat.org/
[15] *Ibid.*

ii. Topic 2 – H2@Scale

The H2@Scale Initiative developed by FCTO outlines a potential framework for wide-scale hydrogen production and utilization in the United States. H2@Scale recognizes and applies hydrogen's multifaceted utility as a connectivity tool to improve the efficiency and resiliency of the electrical grid and of the transportation sector, and to realize gains in the various industries using or producing hydrogen that can enable cross-sector benefits.[16] FCTO has conducted several workshops on the H2@Scale concept to determine priorities for the H2@Scale Initiative and to identify opportunities to align R&D efforts with industry and national priorities.[17] The following topics address some of the key research areas appropriate for government funding as highlighted in the outcomes of this work, including materials compatibility, electrolyzer integration R&D, and analysis. These topics will, along with others, form the pillars of FCTO's H2@Scale Consortium.

Topic 2A - Integrated Energy Production and Hydrogen Fueling R&D

Background

FCTO seeks applications on concepts for industry-led efforts on hydrogen-focused integrated renewable energy production, storage, and transportation fuel distribution R&D. Specifically of interest are projects which include R&D of first of a kind technology. To address the aspect of an integrated renewable system, applications should include concepts that integrate across two or more of the steps in the hydrogen fuel pathway, as outlined in Figure 1 below, and perform system verification testing to help guide future early-stage R&D needs. The figure shows examples of renewable technologies and production pathways, but other innovative concepts that meet the intent of an integrated approach will be considered.

[16] https://energy.gov/eere/fuelcells/h2-scale
[17] https://energy.gov/sites/prod/files/2017/11/f46/fcto_2017_may_h2_at_scale_wkshp_report_0.pdf

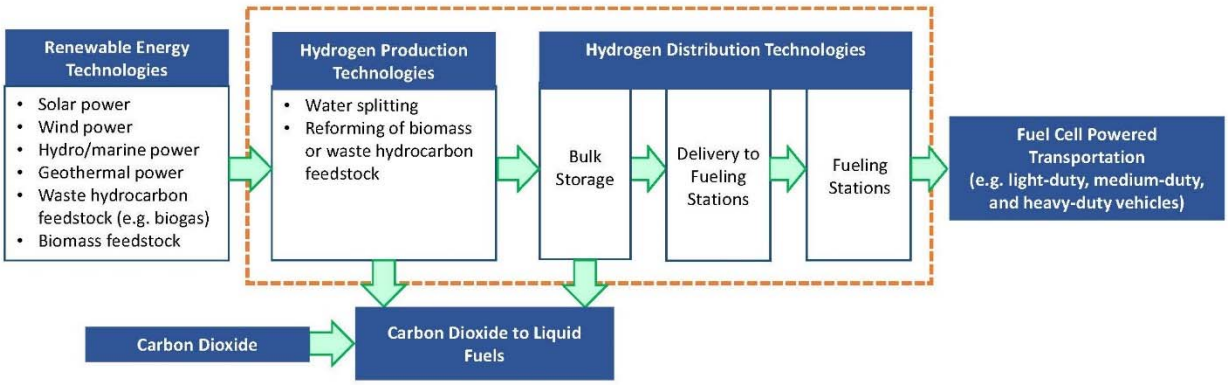

Figure 1: Renewable hydrogen transportation fuel pathway of interest

The pathway in Figure 1 is currently challenged by capital costs, reliability, energy consumption, and footprint of current technologies. Most retail stations for hydrogen in use today are located in California, where 33% of the hydrogen sold from stations deployed with government funding must be sourced from renewable sources[18]; hydrogen produced through steam methane reforming (SMR) of natural gas still comprises the majority of hydrogen sold. Hydrogen is delivered to stations primarily through gaseous tube trailers and liquid tankers, but can also be produced at the stations via electrolysis or delivered via pipeline. The cost of producing, delivering, and dispensing hydrogen in early markets for light duty vehicles during recent commercial station deployments was estimated to be $13-$16/gallon gasoline equivalent (gge).[19,20] At most of today's commercial retail stations, the price of hydrogen charged to the consumer is roughly $16/gge and most of this cost is due to delivery, bulk storage, compression, and dispensing. The average footprint of today's liquid fuel stations is estimated at 18,000 square feet, and energy consumption is, on average, 7 kWh/kg for a representative station dispensing about 500 kg/month.[21]

The current status of examples of hydrogen systems of interest and key associated research challenges are described below. Any research conducted on individual components must be as part of a project that addresses integration of systems (see Figure 1), as described above. Concepts proposed should focus on technologies currently at TRLs of 2 through 5.

Renewable Hydrogen Production

[18] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200520060SB1505
[19] https://www.hydrogen.energy.gov/pdfs/15011_low_volume_production_delivery_cost.pdf
[20] https://www.energy.gov/sites/prod/files/2018/02/f49/fcto_webinarslides_tea_models_hdsam_hdrsam_022718.pdf
[21] https://www.nrel.gov/hydrogen/assets/images/cdp-retail-infr-78.jpg

Given the growth of renewable generation in regions of the U.S., the potential of renewable hydrogen production technologies to enhance grid stability (e.g., ancillary services) and diversify the revenue streams available to utilities and generators is of interest. Renewable hydrogen production is also of interest to transportation markets, due to customer preferences, regulatory requirements, and, specifically for California, the Low Carbon Fuel Standard, which allows generators to further monetize renewable production.[22] One promising approach is based on water electrolysis powered by renewable electricity generation, such as wind, solar, geothermal, etc. Technoeconomic analysis indicates that electrolyzers have a value proposition in grid services, particularly when the hydrogen can be sold as fuel (e.g., for fuel cell vehicles)[23] and in areas where pumped hydro or compressed air energy storage are not feasible.[24] Furthermore, power hardware in the loop testing of electrolyzers has established that polymer electrolyte membrane (PEM) electrolyzers are able to follow simulated grid signals within sub-seconds; these response times meet the performance requirements of typical grid services. Ongoing research is evaluating the impact of such dynamic operation on electrolyzer durability. Examples of remaining research and development needs include[25,26] but are not limited to:

- Development of an external machine interface between a regional transmission organization (RTO)/independent system operator (ISO) and an electrolysis plant. Please see the following references for common interface requirements: PJM[27,28], CAISO[29,30], and ERCOT[31].
- Development of low-cost balance-of-plant components to integrate electrolyzers with intermittent electricity, such as power electronics.
- Evaluation of the impacts of specific utility load profiles on electrolyzer performance and durability.

Alternative approaches to renewable hydrogen not dependent on water electrolysis are available, but come with their own set of research challenges. For example, the reforming of biogas produced through anaerobic digestion of bio waste streams is an option that faces technoeconomic challenges related to

[22] https://www.arb.ca.gov/fuels/lcfs/electricity/electricityh2.htm
[23] https://www.nrel.gov/docs/fy16osti/65856.pdf
[24] https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_E-storage_2016.pdf
[25] https://energy.gov/sites/prod/files/2017/11/f46/fcto_2017_may_h2_at_scale_wkshp_report_0.pdf
[26] https://www.nrel.gov/docs/fy17osti/68244.pdf
[27] http://www.pjm.com/-/media/markets-ops/ancillary/regulation-uplift-and-lost-opportunity-cost.ashx?la=en
[28] http://www.pjm.com/-/media/etools/emkt/sandbox-external-interface-specification-guide-revision.ashx?la=en
[29] https://www.caiso.com/Documents/SettlementsInterfaceSpecificationforSchedulingCoordinators.doc
[30] http://www.caiso.com/Documents/OASIS-InterfaceSpecification_v4_2_6Clean_Independent2015Release.pdf
[31] http://www.ercot.com/content/wcm/lists/89535/eip_external_interfaces_specification_v1_20I.zip

feedstock availability, biogas cleanup and hydrogen purification issues, as well as heat management and process intensification issues related to scale-down of reformer processes for distributed applications.

Interstate Hydrogen Distribution and Bulk Storage

Large-scale hydrogen distribution technologies currently include over 1,600 miles of hydrogen pipeline[32] and three geologic caverns[33,34] that primarily serve the petrochemical industry, along with nine liquefaction plants. Innovations from the national laboratories in this area in recent years have included: 1) characterization of the performance of fiber reinforced polymers (FRP) in high-pressure (> 100 bar) hydrogen service, which led to the acceptance of FRP into the ASME B31.12 Hydrogen Piping and Pipelines Code[35] and provided an alternative to conventional steel pipeline; 2) evaluation of the costs and regional viability of geologic caverns for hydrogen storage[36]; 3) initiation of the development of an approach to liquefy hydrogen from room temperature using magnetocaloric materials, to improve efficiency, scalability, and the potential for variable (e.g., load-following) operation[37]; 4) thermodynamic analysis of liquid hydrogen handling and transfer processes to identify strategies to mitigate boil-off[38]; and 5) technoeconomic evaluation of chemical carriers for large-scale hydrogen storage and distribution. Examples of remaining research needs in these areas include, but are not limited to:

- Research and evaluation of potential off-gassing impacts for FRP materials in hydrogen service, through in-field evaluation, and ensuring a viable, self-sustaining business case, including mitigation strategies as required.
- R&D of geographically agnostic, high-volume hydrogen storage technologies (e.g., boreholes[39]). This research needs to enable concepts based on including an in-depth techno-economic analysis that determines the parameters that must be optimized to achieve the lowest possible hydrogen storage cost. Parameters of interest include capacity, depth, diameter, liner

[32] https://www.phmsa.dot.gov/data-and-statistics/pipeline/distribution-transmission-gathering-lng-and-liquid-annual-data

[33] https://www.airliquide.com/media/usa-air-liquide-operates-world-largest-hydrogen-storage-facility

[34] http://www.fch.europa.eu/sites/default/files/project_results_and_deliverables/D3.1_Overview%20of%20all%20known%20underground%20storage%20technologies%20%28ID%202849643%29.pdf

[35] https://www.hydrogen.energy.gov/pdfs/review15/pd022_rawls_2015_o.pdf

[36] https://www.sciencedirect.com/science/article/pii/S0360319914021223

[37] https://www.hydrogen.energy.gov/pdfs/review17/pd131_holladay_2017_o.pdf

[38] https://www.hydrogen.energy.gov/pdfs/review17/pd135_petitpas_2017_o.pdf

[39] See, e.g., U.S. Patent No. 5,207,530 (filed Jul. 29, 1992, expired) https://patents.google.com/patent/US5207530A

material and thickness, number of wells, underlying geology, geographic potential relative to hydrogen sources and markets, and storage pressure.
- R&D and experimental evaluation of strategies to mitigate boil-off during the liquid transfer process to liquid fueling stations.
- R&D for cost-competitive, efficient, and reliable chemical carrier systems for transporting or storing hydrogen that can complement or replace pure hydrogen transport or storage without introducing any contaminants that can impact fuel cell performance.

Hydrogen Fueling

Hydrogen fuel is currently available for retail sale to light duty vehicles at over 30 fueling stations in the U.S., primarily in California. While current stations are often 180 kg/day or 350 kg/day in capacity, capacities of up to 1,000 kg/day will be necessary in the near future to meet demands of light-duty vehicle market penetration. Additionally, interest in fleet applications (e.g., medium- and heavy-duty vehicles) is growing, and will require the design and development of larger-scale fueling stations that are optimized for each application.

Recent FCTO research activities in these areas include the following examples: 1) development of the Heavy Duty Refueling Station Analysis Model (HDRSAM), which characterizes the levelized cost of hydrogen in user-defined fueling stations[40]; 2) development of the Hydrogen Risk Analysis Model (HyRAM)[41] to enable the use of quantitative risk analysis in design of fueling stations; 3) validation of gaseous and liquid hydrogen behavior models; 4) evaluation of the business case for cryo-compressed hydrogen storage in fleet applications; 5) experimental evaluation of the performance of various fueling technologies (e.g., valves, nozzles, hoses) under different fueling protocols[42]; 6) design of steel concrete composite vessels with potential to provide cost-effective underground storage of hydrogen[43]; and 7) evaluation of the performance of fueling station components, such as hoses and seals, in representative environments. Examples of additional research needs for large-scale stations include, but are not limited to:

- Research and implementation of quantitative risk analysis (QRA) and safety R&D in the development of code-compliant fueling station designs with a footprint and cost optimized for the equipment onsite.

[40] https://www.hydrogen.energy.gov/pdfs/review17/pd014_elgowainy_2017_o.pdf
[41] http://energy.sandia.gov/transportation-energy/hydrogen/quantitative-risk-assessment/hydrogen-risk-assessment-model-hyram/
[42] https://www.hydrogen.energy.gov/pdfs/review17/pd140_ainscough_2017_o.pdf
[43] https://www.osti.gov/biblio/1072154

- R&D for fueling methods enabling efficient and cost-effective fleet and medium and heavy duty vehicle fueling.
- R&D on technologies aligned with enabling autonomous vehicles in the long term, such as systems for autonomous fueling.

Synthetic Fuels

Another area of interest to monetize growing sources of carbon dioxide and hydrogen is in the production of synthetic fuels. Synthetic fuels can be produced from high purity streams of carbon and hydrogen feedstock, from waste hydrocarbon feedstock (e.g., landfill gas), or from syngas streams produced from existing industrial processes (e.g., refineries). Synthetic fuels have potential to diversify the feedstock available to transportation, while leveraging the existing infrastructure of the oil and gas industry (e.g., pipelines). Their use is particularly attractive in applications where high power density requirements restrict electrification, such as aviation, shipping, etc. Synthetic fuels of interest include, but are not limited to, methanol and its derivatives, like dimethyl ether or olefins.

Of interest to FCTO are innovative concepts that utilize hydrogen, carbon dioxide, and/or syngas generated from industrial processes or waste feedstock (e.g. biogas or landfill gas). Examples of research needs that the proposed research should address include (but are not limited to):

- Discovery and development of catalysts that can improve the efficiency, cost and durability (e.g. resistance to poisoning) of methods used in liquid fuels synthesis.
- Innovations that improve the scalability of, and/or lower the pressure and temperature of reactors used for fuel synthesis.
- Development of technologies that can be used to recover hydrogen from process streams, to then be used in liquid fuels synthesis.

Applicants should clearly articulate how their proposed early-stage R&D and innovations are different from work already done in this field of research. R&D on separation of carbon dioxide is not of interest in this topic. Applicants are encouraged to coordinate and leverage activities funded by the Bioenergy Technologies Office.

<u>Topic Description</u>

Since a key objective of Topic 2A is enabling benefits through systems/components *integration*, applicants should propose R&D of innovative systems that integrate two or more pieces of the renewable hydrogen production, storage and

distribution, and dispensing pathway, as described in Figure 1. Duplication or deployment of existing commercial integrated systems must be avoided as EERE's intent is to push the frontiers of technology and leverage the private sector for late-stage deployments. Projects may include research to advance pre-commercial technologies and facilitate their integration with the fuel pathway. Projects may include the use of diverse relevant technologies (e.g., low-temperature electrolyzers, geological storage such as salt caverns, gaseous tube trailers, reforming of anaerobic digestion gas, etc.) while focusing on innovative integration R&D of these technologies with other steps in the hydrogen fuel pathway as described in Figure 1. Examples of possible innovative integrations of technologies include, but are not limited to: 1) integration of electrolyzers and advanced components with renewable power sources or the electricity grid to support grid stability and/or leverage intermittent low-cost electricity, demonstrating R&D advances that can help guide future early-stage R&D; 2) innovative strategies and components to improve efficiency of liquid hydrogen transfer from tankers to bulk storage at fueling stations; and 3) dynamic integration of fueling station technologies or components with the grid to leverage intermittently available low-cost electricity and surpass existing technology in driving both affordability and performance. Other innovative concepts aligned with the topic that enable clear advantages (e.g., lower cost, improved performance, reliability, efficiency, etc.) through component/systems integration may also be proposed. While the focus of this Topic is early-stage R&D, later phases of the project can include activities to help validate the R&D performed and to provide feedback to guide future early-stage R&D needs. Concepts should be aligned with the H2@Scale vision where hydrogen is an enabler that can contribute to overall goals for energy security, resilience, and economic growth. Applicants should clearly describe plans for early-stage and applied R&D and for system performance verification testing, explaining the innovation, and must include a **20% cost share**.

Applicants should quantify how proposed projects will advance hydrogen systems over the current baseline, toward the program's target for the delivered cost of hydrogen generated from renewable feedstocks of $7/gge by 2025 and a 40% reduction in station footprint from the current baseline by 2022.[44] For concepts involving the utilization of CO_2 and hydrogen to make higher molecular weight fuels, applicants should clearly state the feedstock gases that the proposed innovations are most compatible with, and the technoeconomic improvements being targeted relative to current state-of-the-art. Concepts that rely on biomass

[44] For more information on current station designs and layouts, please see: https://www.h2tools.org/sites/default/files/fcto_h2first_reference_station_design_report_april2015_0.pdf

feedstock, or that can only generate incremental improvements in existing commercial processes (e.g., Haber Bosch or Fischer-Tropsch) are not of interest. Applicants are also encouraged to explore research already being pursued at other DOE offices (e.g., on solar fuels), to preclude the proposal of duplicative efforts. Showing how the proposed work complements activities through other DOE offices (e.g., Fossil Energy for carbon dioxide capture, or Bioenergy Technologies Office for use of biological feedstock) but avoids overlap is of value.

Applicants are encouraged to leverage the world-class capabilities of the DOE's national laboratories and align research to support the H2@Scale concept. Successful applicant teams would ideally include stakeholders from diverse industries, and leverage national laboratory research capabilities where they add value in developing and implementing the proposed technologies. Applications should detail: 1) proposed research advancements to cost-competitively enhance the performance and capabilities of integrated hydrogen systems/components, as defined in Figure 1; 2) the manner in which national laboratory capabilities will be effectively leveraged; and 3) proposed engagement of external stakeholders (e.g., utilities, hydrogen providers, OEMs or other end users of hydrogen, state organizations, etc.) for work (for example, in regional analysis of resource availability for hydrogen production and hydrogen demand to ensure a value proposition). Coordination and leveraging of activities that can enable synergies with nuclear power (e.g., enabling operation of baseload nuclear plants to generate hydrogen or hydrogen related systems integration R&D) is encouraged.

Applicants should propose 3 year projects for a maximum total DOE funding of $2,000,000. Applications should be at a TRL of 2-5, and the funding request should be commensurate with the level of work proposed. The work plan should include strong annual Go/No-Go decision points. Projects should advance concepts that are currently at research stage in these areas through research, optimization, and verification testing to guide future R&D and inform codes and standards development. Teams are encouraged to leverage national laboratory resources (equipment and expertise) as described above, accomplishments from other ongoing projects, and funding from external stakeholders. National laboratory facilities may not be utilized for retail operations. At a minimum, all team partners for the selected awardees may be required to agree to and sign a non-disclosure agreement (NDA) as part of the award negotiation process; the standard template NDAs used for the Energy Materials Network consortia are available on request. Team partners may also be required to sign cooperative research and development agreements (CRADAs) and materials transfer agreements (MTAs) with the national laboratory partners.

Topic 2B - Electrolyzer Manufacturing R&D

Background

Critical challenges in the manufacture of cell and stack components for electrolyzers include the low maturity level of manufacturing and the associated low volume production rates of these components. These challenges lead to high-cost processing steps, because economies of scale are not reached. Reducing the cost of manufacturing components and systems can lead to increased market pull for hydrogen and fuel cell technologies. Analysis efforts undertaken as part of the H2@Scale Initiative have shown that decreasing the capital cost of electrolyzers is critical to meeting the DOE hydrogen production cost target of < $2/kg, under the conditions of inexpensive electricity and intermittent operation that are core aspects of the H2@Scale concept.[45] Electrolyzer stack production volumes will need to increase dramatically from the multi-megawatt (MW) scale seen today to gigawatt (GW) production levels in order to fully implement the H2@Scale vision. Currently, low demand and the underdeveloped supply chain for electrolyzers result in high manufacturing costs. Additionally, R&D advances in electrolyzer stack components (e.g., low-loading PGM catalysts in electrodes) have not been fully realized in commercial products.

Topic Description

FCTO seeks applications on R&D of manufacturing techniques to produce advanced components for multi-MW scale electrolyzers at high production volume. One of the critical challenges facing the widespread deployment of electrolyzers is their cost; the manufacture of the components needed for these systems occurs at low production volumes, which leads to a high cost of the constituent processing steps. Developers of PEM and solid oxide electrolyzers (both of interest for this topic) have historically leveraged work carried out by their fuel cell counterparts and there may be opportunities to adapt state-of-the-art fuel cell manufacturing methods for the specific needs of electrolyzers. One example of a manufacturing advancement that was developed specifically for fuel cells and that could potentially be applied in the manufacture of electrolyzers is roll-to-roll processing, a platform technology process approach which enables 2D processing of materials in a continuous manner at high process rates and which can be integrated with a range of 3D additive printing manufacturing technologies within the continuous process flow. The impact of this technology approach

[45] H2@Scale Concept Overview and Preliminary Analysis: https://energy.gov/sites/prod/files/2017/06/f34/fcto_may_2017_h2_scale_wkshp_ruth.pdf

enables integration of both membrane and electrode deposition processes when combined with real-time metrology technologies to lower the overall cost of MEA manufacturing. FCTO also seeks manufacturing innovations to enable the scale up of lower catalyst loading technologies and other advances that can reduce cost while meeting performance and durability goals[46], including increasing the rate of catalyst layer deposition during high volume manufacturing. Additionally, additive manufacturing techniques that lower the cost and improve the durability of porous transport layers within the electrolyzer, especially on the anode side, are of interest if they can help meet overall goals. Other needs include, but are not limited to, innovations in bipolar plate manufacturing and balance of system component development in parallel with other manufacturing innovations.

Applicants should propose 2 year projects for a maximum total DOE funding of $2,000,000 at a TRL of 2-4. The funding request should be commensurate with the level of work proposed. Applicants must clearly identify the status of the proposed technology as it relates to the state-of-the-art and provide sufficient justification that the approach has the potential to lead to a high volume manufacturing process relevant to at least one advanced electrolyzer cell, stack, or system component. Successful applicants are expected to provide a cost analysis of their proposed high volume electrolyzer manufacturing innovations as part of the project. The work plan should include strong annual Go/No-Go decision points and metrics that demonstrate lower cost manufacturability while maintaining the state of the art in performance and durability. Applicants are encouraged to coordinate and leverage activities funded by the Advanced Manufacturing Office and other relevant Offices, but to avoid duplicative efforts.

Topic 2C – Breakthrough Infrastructure R&D

Background

Hydrogen fueling infrastructure for light duty vehicles is still in the early stages of growth, with fewer than 35 retail FCEV fueling stations currently open in California, and plans for expansion of development into the Northeast. Most stations currently receive hydrogen from centralized production facilities via gaseous tube trailers or liquid tankers. Ultimately, regardless of fueling pathway, a range of station capacities will be required to accommodate the hydrogen fueling demands of individual locations and regions throughout the country.[47] In order to achieve

[46] https://www.hydrogen.energy.gov/pdfs/h2a_pem_electrolysis_case_study_documentation.pdf
[47] https://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_final_june2014.pdf

widespread growth, a reduction in the footprint of hydrogen fueling components will be necessary for hydrogen stations to be viable, as current station footprints restrict potential siting locations, particularly in urban areas.[48] Furthermore, hydrogen costs at retail fueling stations today are $13-$16/gge, nearly double FCTO's target for the cost of hydrogen (produced, delivered, and dispensed) at $7/gge.[49] Simultaneous reductions in station footprint and cost will require material and component innovations, as well as innovative integration of station functions (e.g., dispensing, compression, buffer storage, and pre-cooling). Additionally, achieving financial viability of liquid stations will require approaches that substantially reduce hydrogen boil-off. Reductions in fuel costs will also require the development of novel, low-cost concepts for hydrogen liquefaction.

Topic Description

FCTO seeks applications for breakthrough innovations in hydrogen fueling materials and components that can reduce cost and footprint, and improve durability while ensuring the safety of hydrogen fueling infrastructure. Examples of applications being solicited include (but are not limited to) concepts that: 1) reduce station footprint, 2) mitigate hydrogen boil-off at fueling stations, and 3) enables scalable, low-cost hydrogen liquefaction capable of dynamic, dispatchable operation.

Many fueling station components currently in service have been developed through modifications to equipment originally designed for other industries and applications. Some station functions, such as compression and pre-cooling, rely on relatively mature technologies and will require breakthrough concepts to achieve the needed dramatic improvements in cost and footprint without compromising reliability.[50] FCTO encourages new concepts that combine station functions (e.g., pumping, compression, bulk storage, dispensing and pre-cooling) to reduce the station footprint while at the same time reducing cost. Examples of concepts that could combine multiple station functions to reduce footprint include, but are not limited to: development of small-scale cryo-coolers that can be integrated with dispensers for pre-cooling, development of innovative materials that can enable thermal compression concepts, and the design of novel high-pressure cryo-pumps integrated with vaporization.

[48] https://www.arb.ca.gov/msprog/zevprog/ab8/ab8_report_2017.pdf
[49] https://www.hydrogen.energy.gov/pdfs/15012_hydrogen_early_market_cost_target_2015_update.pdf
[50] https://www.nrel.gov/docs/fy14osti/58564.pdf

Additionally, concepts that can enable step-change improvements in the reliability and cost of conventional station components like nozzles, hoses, and chillers are of interest. Nozzles currently cost approximately $7,000 each, hoses cost approximately $2,000 each, and chillers cost approximately $140,000 each.[51,52] Part failures are one of the most common causes for nozzle maintenance[53], and dispensing hoses are commonly reported to fail in less than one year of operation; moreover, while nozzles are often able to be refurbished, hoses must typically be replaced.[52] Examples of concepts of interest include, but are not limited to: 1) development of novel materials (e.g., self-healing) for dispensing hoses, 2) light-weighting of nozzles to reduce cost and improve durability, and 3) direct mixing chillers that can achieve J2601 temperature requirements without vapor-compression refrigeration.

Concepts that mitigate liquid hydrogen boil-off are also of interest to FCTO under this Topic. Liquid hydrogen boil-off throughout the delivery pathway (including liquefaction, trucking, offloading to the station, and station operation) can amount to over 15% of a station's capacity in early markets,[54] representing a significant inefficiency. Strategies to eliminate the boil-off of fuels in general have been explored in many other industries to date, including the aerospace and liquefied natural gas (LNG) sectors. Approaches that have been studied include innovative methods of insulation, mixing of layers within liquid dewars to prevent stratification, use of cryo-coolers, recovery of boil-off to power ancillary equipment, and sophisticated cryo-pump designs. Many of these approaches are capital-intensive, which prohibits their widespread use and would hinder any ability to achieve FCTO's hydrogen cost target. Concepts of interest are those that substantially mitigate, recapture, or beneficially use boil-off (< 1%)[55] at hydrogen fueling stations for light duty vehicles in the emerging market while still enabling a hydrogen cost of $7/gge by 2025. Examples include but are not limited to development of novel materials and components that manage heat transfer from liquid equipment, and innovative integrations of station components (e.g., cryo-pumps and liquid dewars).

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[51] https://www.energy.gov/sites/prod/files/2015/08/f25/fcto_myrdd_delivery.pdf

[52] Harrison, K. "700 bar Hydrogen Dispenser Hose Reliability and Improvement Annual Progress Report". National Renewable Energy Laboratory. 2017. *In press.*

[53] https://www.nrel.gov/hydrogen/assets/images/cdp-infr-69.jpg

[54] https://www.hydrogen.energy.gov/pdfs/progress16/iii_15_simon_2016.pdf

[55] FCTO's Hydrogen Delivery cost analyses are based on the Hydrogen Delivery Scenario Analysis Model, which currently assumes low levels of boil-off (0.3% from liquid dewars, and 4 kg/day from cryo-pumps) due to the use of state-of-the-art technologies at well-utilized fueling stations. Innovation is needed to enable such levels of boil-off mitigation in the emerging market, at capital costs that allow for an overall hydrogen cost of $7.00/gge.

Applications should characterize concepts for fueling station components on the basis of: 1) reduction of capital and operating costs, 2) reduction of land area requirements and improvement in station energy density (e.g., MWh/acre), and 3) improvement in performance and reliability under the expected operating conditions as compared to the state-of-the-art. Successful applicants must demonstrate a pathway for concepts to enable the near-term hydrogen cost goal of $7/gge by 2025 (including production, delivery, and dispensing). Technologies proposed should be intended for use in fueling light duty vehicles per standardized fueling methods, such as the SAE J2601 protocol and the MC method.[56] If national laboratories are part of the team, they should use existing core capabilities for the R&D and should clearly show how they avoid duplication of capabilities among labs.

Finally, novel concepts to cost-competitively liquefy hydrogen are also solicited. Liquefaction plants in the U.S. are currently designed to operate at constant throughput, have capacities of 10-30 tonnes/day, and typically consume roughly 15 kWh/kg of electricity. As the FCEV industry continues to expand geographically, new liquefaction capacity will become necessary to meet the growing demands of high-volume fueling stations. Concepts that are scalable will have a strong value proposition in enabling hydrogen delivery from regions with small-scale volumes of low-cost feedstock for hydrogen production, such as low-cost electricity or stranded hydrocarbon feedstock (e.g., landfill gas, biogas). Concepts that can cycle their output as a function of fluctuations in electricity input also have value in regions with intermittent low-cost electricity. Accordingly, concepts for scalable, dispatchable hydrogen liquefaction are requested. Concepts should have potential to meet at least one of the following performance goals[57]:

- Energy consumption of 6 kWh/kg
- Capital cost of $50 million for a 30 tonnes/day plant
- Ability to function as responsive load, following an independent system operator (ISO)'s dynamic regulation signal[58]

Examples of concepts of interest include but are not limited to: novel designs of regenerators for magnetocaloric liquefaction, discovery and development of

[56] https://saemobilus.sae.org/content/j2601_201407

[57] The energy consumption goals is from the Hydrogen Delivery Multi-year Research Development and Demonstration Plan (MYRD&D). The capital cost goal reflects a 50% decrease in capital costs for hydrogen liquefaction; this goal represents progress toward the ultimate target in the MYRD&D, a 75% decline in capital costs of higher capacity units (300 tones/day).

[58] For example, the dynamic regulation (RegD) signal of the PJM interconnect, or similar. http://www.pjm.com/-/media/markets-ops/ancillary/reg-d.ashx?la=en

caloric materials (e.g., elastocaloric, electrocaloric, and magnetocaloric) and regenerators, acoustic liquefaction concepts, and novel mechanical components like vortex tubes.

FCTO anticipates that these projects will comprise 2 budget periods (2 phases), each 12-18 months in length, and with a maximum of $2,500,000 total in DOE funding (Phase 1 and Phase 2 combined). While a maximum of $2,500,000 funding has been established, applications for smaller projects are also encouraged. FCTO requires an ambitious and quantitative Go/No-Go decision point between Phases 1 and 2. If selected for Phase 2, project funding will be used to develop concept prototypes and characterize concept viability. Phase 2 will also be planned to last for 12-18 months. For more information about Go/No-Go decisions, please see Section VI.B.xiii. Projects should be TRL 2-3.

iii. Topic 3 – Innovative Concepts

The Fuel Cells program supports applied early stage research and development of fuel cell technologies for transportation, stationary, and early market applications, with a primary focus on reducing cost and improving durability. PEMFCs are a substantial focus of the program's R&D portfolio; however, the program supports longer-term approaches that offer advantages over PEMFCs.

Topic 3A – Early Stage, Innovative Fuel Cell Membrane R&D

Background:

The fuel cell electrolyte is critical to fuel cell efficiency and performance. The program supports membrane R&D to increase the operating temperature and humidity ranges of fuel cells while improving conductivity, and to increase membrane mechanical, chemical, and thermal stability with diminished fuel crossover. The program's R&D portfolio is primarily focused on PEMFCs, but innovation in other membrane types is crucial to increasing fuel cell commercialization by achieving such goals as facilitating PGM-free catalyst implementation (e.g., with alkaline exchange membranes) and enabling the elimination of certain balance of plant (BOP) components.

Topic Description

Stable, durable electrolytes are critical to the function of high-performance fuel cells. Although PEM membranes are available commercially, the fluorocarbon nature of the polyfluorosulfonic acid (PFSA) polymers used to make these membranes increases cost. In addition, PFSA membranes restrict the fuel cell to low temperature operation, which in turn can drive up system costs by requiring larger cooling systems, humidification, and stricter fuel purity requirements than

higher temperature systems. The acidic environment and low operation temperature also limit the choice of catalyst to those that are stable and active in the fuel cell, resulting in the use of expensive Pt and Pt alloy catalysts.

FCTO seeks applications for innovations in fuel cell membrane technology that address critical barriers to increased performance and durability in one or more types of fuel cells. Development of non-PFSA membrane types is crucial to increasing fuel cell commercialization, in that alternative membranes may facilitate the use of PGM-free catalysts and eliminate the need for some BOP components. Areas of interest in this topic include: 1) innovative alkaline exchange membranes (AEMs); 2) membranes that enable higher operating temperatures (150-400 °C) to allow for the use of lower purity fuel, the simplification or removal of BOP components, and/or potential direct use of biofuels and other liquid fuels; 3) the development of novel low-cost PEM membranes (non-PFSA) that can meet or exceed the technical targets set forth in the MYRD&D Plan[59] while significantly reducing membrane cost; and 4) the development of novel ionomers that significantly improve high-current density fuel cell operation by addressing mass transport limitations while reducing ionomer cost.

PEMFCs are expected to be the dominant technology for vehicles in the near term, but reaching cost competitiveness with conventional automobiles will require a transition from PGM catalysts to PGM-free catalysts. 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 effectively reduce the catalyst cost, promising PGM-free catalysts must be successfully *integrated* into membrane electrode assemblies (MEAs). State-of-the-art PGM-free catalysts, typically iron or cobalt on nitrogen-doped carbon support, have demonstrated high activity, but severely lag behind PGM-based catalysts in stability and durability. These materials demonstrate much higher stability in high pH conditions, but there is a severe lack of readily available alkaline membranes or ionomers for high pH MEAs; therefore, FCTO seeks applications for stable AEMs that can enable the use of PGM-free catalysts in fuel cells. In particular, applications for AEMs should address issues with polymer stability and water management. Proposed materials should demonstrate potential to exceed the interim 2019 FCTO targets of 0.6 V at a current density >

[59] https://www.energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22

600 mA/cm^2 in H_2/O_2 at 1.5 atm and < 10% voltage degradation over 2,000 h hold test at 600 mA/cm^2 and T > 60 °C.[60]

Intermediate temperature fuel cells (ITFCs) have the potential to reap the benefits of favorable kinetics and decreased sensitivity to fuel impurities (e.g., cobalt), both of which enable reduced PGM catalyst usage, and higher efficiency due to the production of useful waste heat and/or the elimination of BOP components. ITFCs would also be more compatible with cycling operation than are high temperature fuel cells. Furthermore, fuel cell catalysts operating this regime offer flexibility in fuel choice, potentially enabling the direct use of biofuels. There is a paucity of demonstrated fuel cell electrolytes that operate in the temperature range of 150-400 °C. FCTO encourages innovative ideas for membranes operating above 150 °C, including, but not limited to phosphoric acid-PEMs, heteropolyacid membranes, and solid acid electrolytes. Thermal stability, phase stability, and mechanical stability are challenges which should be addressed for these membranes. Activity across the entire range of operating temperatures is an ongoing challenge; therefore, proposed technologies for high temperature membranes should also discuss low temperature capability or limitations (e.g., startup performance, humidity sensitivity, etc.).

Proposed novel low-cost PEM membranes (non-PFSA) should have the potential to concurrently meet or exceed all 2020 technical targets set forth by the FCTO MYRD&D Plan, and as such should possess low area specific resistance, low gas permeability, high mechanical strength, and high durability. To date, non-PFSA PEM membranes, including hydrocarbon membranes, have demonstrated relatively low performance and durability. PEM applications could include the R&D of novel ionomers that significantly improve high-current density fuel cell operation by addressing mass transport limitations.

Applicants should propose 2 year projects for a maximum total DOE funding of $1,000,000. Applications should be at a TRL of 2-3, and the funding request should be commensurate with the level of work proposed. Applicants must clearly identify the status of the proposed technology as it relates to the state-of-the-art in the particular membrane application (AEMs, ITFCs, or non-PFSA PEMs) and provide sufficient justification that the approach has the potential to meet the aforementioned activity and durability targets. 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 points and metrics and

[60] MYRDD Plan, p 42: http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

include a discussion of a durability testing procedure of sufficient length to demonstrate longevity. At a minimum, durability testing should include ASTs performed according to protocols in the DOE's Fuel Cells MYRD&D Plan.[61] Successful applicants are expected to provide a cost analysis of proposed membrane innovations. Areas specifically not of interest include PFSA membranes (and fluorinated sulfonic acid side chains), sulfonated biphenylene block copolymers, PBI-phosphoric acid polymers, molten carbonate electrolytes, solid oxide fuel cell electrolytes, catalyst development, and MEA integration studies. Collaboration among national laboratories, universities, and industry is encouraged.

Topic 3B – Innovative Reversible and Liquid Fuel Cell Component R&D

Background:

Stationary fuel cells can be used in a broad range of commercial, industrial, and residential applications, from multi-megawatt systems for large centralized power generation to smaller units (e.g., 1 kW) appropriate for use as backup power or in micro-combined heat and power (CHP) systems. Even though specific performance requirements differ between the various stationary applications, and are different from those of transportation systems, the main challenges are the same for all: reducing cost and increasing durability. While the acceptable price point for stationary fuel cell systems is considerably higher than that for transportation systems, current costs are still too high to be competitive with the conventional, incumbent technology for most applications. Stationary fuel cell systems have the advantage over incumbent technologies by offering fuel flexibility, including the direct use of liquid fuels, and therefore resiliency. Stationary systems that can perform both fuel cell and electrolyzer functions in a single device (unitized reversible fuel cells, or URFCs) are attractive for increased resilience due to their energy storage capability, but significantly lag behind their non-unitized analogues (i.e., a pair of discrete fuel cell and electrolyzer stacks) in performance, durability, and cost.

Topic Description:

To increase the availability of flexible options for resilient stationary power and fuel cell-based energy storage, FCTO seeks applications for early stage R&D of innovative components for direct liquid fuel cells (DLFCs) and/or URFCs. The use of liquid fuels, including those attained from bio-derived sources (e.g., methanol or dimethyl ether) offers advantages for fuel transport and storage, as well as higher

[61] http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

volumetric energy density compared to hydrogen. Previous efforts to develop such systems, however, have been set back by the need for high PGM metal loadings in the anode, and by fuel crossover, flooding, and catalyst deactivation that arises from unwanted side reactions. With this in mind, FCTO seeks early stage concepts that lower the amount of PGM required and that reduce the impact of phenomena like fuel crossover or mass transport issues on the overall performance of the fuel cell. Examples of such concepts include the development of anode catalysts with improved performance, membranes that selectively limit crossover of liquid fuel, and development of catalyst layer components and electrode composition to improve performance at higher current densities.

The focus for direct liquid fuel cells is early-stage, pre-competitive R&D of components at the cell level (e.g., catalyst and catalyst layers, electrolytes, MEAs etc.) to improve performance with lower PGM requirements and to reduce the impact of phenomena like fuel crossover or mass transport issues on the overall performance of the fuel cell. Innovative components will need to be integrated into MEAs that are able to achieve FCTO's objectives related to stationary system cost, performance, and durability. The topic does not include research into fuel reforming; MEA deliverables should work without any need for up-front reforming. The final deliverable should be able to provide a maximum power of ≥ 300 mW/cm^2 with a total PGM loading of ≤ 3 mg/cm^2, and demonstrate sufficient durability for the application as specified in the Fuel Cell section of the MYRD&D Plan. As an interim goal, projects should include a work plan for the first year to meet the first-year Go/No-Go milestone of ≥ 250 mW/cm^2 at a total loading of 4 mg_{PGM}/cm^2.

URFCs are useful for co-located energy storage and power generation, and they hold promise as an enabler for the implementation of intermittent renewable energy technologies and the widespread utilization of hydrogen. To provide a resolution to intermittency issues inherent in solar and wind power, these systems must be capable of reliably generating hydrogen from water during times of excess power generation (off-peak), and of using hydrogen to generate electricity again during times of peak demand. However, performing both fuel cell and electrolyzer functions in a single device poses significant challenges and can lead to low roundtrip efficiencies. URFCs require early stage R&D to improve materials, structures, and interfaces within URFCs in order to develop cell and stack technology to the point where a unitized system is superior in performance, durability, and cost when it is compared to an analogous pair of discrete fuel cell and electrolyzer stacks that have been optimized separately.

FCTO seeks novel concepts and approaches for substantially improving round trip efficiency. A key challenge is developing low-PGM bifunctional catalyst layers, especially for the oxygen electrode, to include efficient, active bifunctional catalysts in an electrode layer designed for effective dual mode operation. URFCs also must have very high durability when cycling between the two operating modes. Performance, durability, and PGM loading must all be addressed for a potentially commercially relevant URFC system. Several possible technologies are of interest, including reversible PEM, AEM, and solid oxide fuel cells. For low temperature applications, applications should demonstrate the potential of achieving ≥ 50% roundtrip efficiency at 1 A/cm^2 in both operating modes with reasonable PGM loadings (< 2 mg$_{PGM}$/cm^2). High temperature applications should demonstrate the potential to meet or exceed 70% roundtrip efficiency at 1 A/cm^2 in both operating modes. The ability to cycle repeatedly between fuel cell and electrolyzer mode with minimal impact on durability must be demonstrated as well.

Applicants proposing either DLFC or URFC should propose up to 3 year projects for a maximum total DOE funding of $1,000,000. Applications should be at a TRL of 2-3, and the funding request should be commensurate with the level of work proposed. Applicants must clearly identify the status of the proposed technology as it relates to the state-of-the-art in the particular fuel cell application (URFCs or DLFCs) and provide sufficient justification that the approach has the potential to meet the aforementioned performance and durability targets. Additionally, proposed concepts must encompass work up to and including single cell MEA testing at a size of ≥ 50 cm^2. The work plan should also include a discussion of a durability testing procedure of sufficient length to demonstrate longevity. At a minimum, where relevant, durability testing should include ASTs performed according to protocols in the DOE's Fuel Cells MYRD&D Plan.[62]

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

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.E of the FOA):

[62] http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

- Applications that fall outside the technical parameters specified in Section I.B of the FOA, including but not limited to: the development of catalysts that make use of precious metals, like gold or rhenium (Topic 1); the development of anode hydrogen oxidation reaction catalysts and catalysts for non-PEM fuel cells, such as those used in alkaline membrane fuel cells (Topic 1); concepts for synthetic fuel development that rely on biomass feedstock, or that can only generate incremental improvements in existing commercial processes, like the Haber Bosch or Fischer-Tropsch processes (Topic 2A); components or systems for electrolyzer manufacturing that do not result in a significant reduction in the cost of manufacturing (Topic 2B); PFSA membranes (and fluorinated sulfonic acid side chains), sulfonated biphenylene block copolymers, PBI-phosphoric acid polymers, molten carbonate electrolytes, solid oxide fuel cell electrolytes, catalyst development, and MEA integration studies (Topic 3A); and research into fuel reforming or direct liquid solid oxide fuel cells (Topic 3B).
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).

D. Authorizing Statutes

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.

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:

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.

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

II. Award Information

A. Award Overview

iv. Estimated Funding

EERE expects to make approximately $39,000,000 in Federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making up to 31 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $1,000,000 and $2,500,000.

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

i. 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	2 to 5	$1,000,000	2	20%
Topic 2A: Integrated Production and Hydrogen Fueling R&D	Up to 5	$2,000,000	3	20%
Topic 2B: Electrolyzer Manufacturing R&D	2 to 3	$2,000,000	2	20%
Topic 2C: Breakthrough Infrastructure R&D	5 to 7	$2,500,000	3	20%
Topic 3A: Early Stage, Innovative Fuel Cell Membrane R&D	4 to 6	$1,000,000	2	20%
Topic 3B: Innovative Reversible and Liquid Fuel Cell Component R&D	2 to 5	$1,000,000	3	20%

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

ii. Period of Performance

EERE anticipates making awards that will run up to 24 or 36 months in length, comprised of one or more budget periods. 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. 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, except as specified in Section III.B Ineligible Applicants, 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 B 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

Core FFRDC members of the ElectroCat EMN consortium are ineligible to apply to Topic 1 in this FOA as prime or subrecipients. This restriction does not apply to Topics 2 and 3. The table below lists the core members of the ElectroCat EMN consortium.

Topic	Core FFRDCs that are Ineligible
ElectroCat	Los Alamos National Laboratory, Argonne National Laboratory, Oak Ridge National Laboratory, National Renewable Energy Laboratory

ii. Non-Industry Applicants

Only industry applicants are eligible to apply as prime recipients to Topic 2A in this FOA; however, all entities are eligible to apply as subrecipients.

C. Cost Sharing

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.)

To assist applicants in calculating proper cost share amounts, EERE has included a cost share information sheet as Appendix A to this FOA.

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 obligation 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.J.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. Cost share may be provided by the Prime Recipient, Subrecipients, or third parties (entities that do not have a role in performing the scope of work). Vendors/Contractors may not provide cost share. Any partial donation of goods or services is considered a discount and is not allowable.

Cash contributions include, but are not limited to: personnel costs, fringe costs, supply and equipment costs, indirect costs and other direct costs.

In-kind contributions are those where a value of the contribution can be readily determined, verified and justified but where no actual cash is transacted in securing the good or service comprising the contribution. Allowable in-kind contributions include, but are not limited to: the donation of volunteer time or the donation of space or use of equipment.

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 & 10 CFR 603.525-555 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). As FFRDC funding will be provided directly to the FFRDC(s) by DOE, Prime Recipients will be required to provide project cost share at a percentage commensurate with the FFRDC costs, on a budget period basis, resulting in a higher interim invoicing cost share ratio than the total award ratio.

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.

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 issue with submissions that result in late submissions: In the event that an applicant experiences technical difficulties so severe that they are unable to submit their application by the deadline, the applicant should contact the Exchange helpdesk for assistance (EERE-ExchangeSupport@hq.doe.gov). 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.
Addendum	1 pages maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: • Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has worked together with its teaming partners on prior projects or programs; and • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities. 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.2)	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
	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
	United States Manufacturing Plan	ControlNumber_LeadOrganization_USMP

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
	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.

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, and Impact (This section should constitute approximately 30% 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 40% 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 points at appropriate points in the Workplan. A go/no-go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to

	actually beginning the execution of future phases. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one project-wide go/no-go decision point for each budget period (12 to 18-month period) of the project. The Applicant should also provide the specific technical criteria to be used to make the go/no-go decision. The summary provided should be consistent with the SOPO. 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: o The overall approach to and organization for managing the work o The roles of each Project Team member o Any critical handoffs/interdependencies among Project Team members o The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices o The approach to project risk management o A description of how project changes will be handled o If applicable, the approach to Quality Assurance/Control o How communications will be maintained among Project Team members
Technical Qualifications and Resources (Approximately 20% 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. 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. Letters of commitment do not count towards the page limit. • Attach any letters of commitment from partners/end users as an appendix (1 page maximum per letter). Letters of commitment do not count towards the page limit. • For multi-organizational or multi-investigator projects, describe succinctly: o The roles and the work to be performed by each PI and Key Participant; o Business agreements between the applicant and each PI and Key Participant; o How the various efforts will be integrated and managed; o Process for making decisions on scientific/technical direction; o Publication arrangements; o Intellectual Property issues; and o 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. 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. 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".

x. 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" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-Federal funds have not been paid and will not 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".

xi. 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.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. Appendix B lists the necessary information that must be included in a request to waive the Performance of Work in the United

States requirement.

xii. U.S. Manufacturing Commitments

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

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

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

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

When an applicant that is a domestic large business is selected for an award, a class patent waiver applies as set forth in Section VIII. L. Under this class

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

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

xiii. 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 C of the FOA.

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	2 pages max	Applicants may respond to one or more reviewer comments or supplement their Full Application.
Optional	1 page max	Applicants may use this page however they wish; text, graphs, charts, or other data to respond to reviewer comments or supplement their Full Application are acceptable.

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.D.xiv
- NDAs and/or 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. Intergovernmental Review

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

J. 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" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-Federal funds have not been paid and will not 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
- Explanation of cost share for invoicing period
- Analogous information for some subrecipients
- Other items as required by DOE

x. Additional Requirements

The ElectroCat consortium has established a standard non-disclosure agreement (NDA) 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 are evaluated based on consideration the following factors. All sub-criteria are of equal weight.

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

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

ii. Full Applications

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

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

Technical Merit and Innovation

- Extent to which the proposed technology or process is innovative;
- 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 Research (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, and a 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.

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: https://energy.gov/management/downloads/merit-review-guide-financial-assistance-and-unsolicited-proposals-current.

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; and
- 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

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.

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

Prior to making a Federal award with a total amount of Federal share greater than the simplified acquisition threshold, DOE 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 fall 2018 and making awards by the end of 2018.

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 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 https://www.energy.gov/eere/funding/eere-funding-application-and-management-forms.

xii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement. The checklist can be accessed at https://www.energy.gov/eere/funding/eere-funding-application-and-management-forms.

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 – The final report will be published in DOE's Office of Scientific and Technical Information (OSTI) DataID Service and will be available to the public.
- Submission of unformatted manuscripts to OSTI
- Yearly participation at the DOE Hydrogen Program Merit Review and Peer Evaluation (AMR) meeting, typically held in Washington, D.C.
- Annual report for the FCTO Annual Progress Report
- Yearly participation in one U.S. DRIVE Technical Team Meeting
- Consortia (EMN) projects (Topic 1) will be required to participate in mandatory meetings of the consortium, agree to standard legal documents (NDAs, etc.), and may be required to submit materials data to consortium data portals
- Projects selected under Topic 2A will be required to submit performance data to the NREL secure data center during the demonstration phase of the projects as appropriate
- 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 (required within 90 days of the start of each project): 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 https://www.energy.gov/eere/fuelcells/downloads/safety-planning-guidance-hydrogen-and-fuel-cell-projects . 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: FCTOFOA@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. Informational Webinar

EERE may conduct at least one informational webinar on the ElectroCat topic (Topic 1) during the FOA process. It will be held after the initial FOA release but before the due date for Concept Papers.

Attendance is not mandatory and will not positively or negatively impact the overall review of any applicant submissions. As the webinar will be open to all applicants who wish to participate, applicants should refrain from asking questions or communicating information that would reveal confidential and/or proprietary information specific to their project. Specific dates for the webinar can be found on the cover page of the FOA.

C. 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. 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).

I. 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.

J. 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.

K. 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.

L. 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, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan, where one has been submitted, are sufficient.
- Advance and Identified Waivers: Applicants may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.

M. 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.

N. 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 normally retains unlimited rights in technical data produced under Government financial assistance awards, including the right to distribute to the public. However, pursuant to special statutory authority, certain categories of

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

O. 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.

P. 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/whitehouse.gov/files/omb/memoranda/2007/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.

Q. Annual Independent Audits

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

If an educational institution, non-profit organization, or state/local government is a Prime Recipient or Subrecipient and has expended $750,000 or more of Federal awards 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. 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.

General Cost Sharing Rules on a DOE award

1. Cash Cost Share - encompasses all contributions to the project made by the recipient or subrecipient(s), for costs incurred and paid for during the project. This includes when an organization pays for personnel, supplies, equipment, etc. for their own company with organizational resources. If the item or service is reimbursed for, it is cash cost share. All cost share items must be necessary to the performance of the project.

2. In Kind Cost Share - encompasses all contributions to the project made by the recipient or subrecipient(s) that do not involve a payment or reimbursement and represent donated items or services. In Kind cost share items include volunteer personnel hours, donated existing equipment, donated existing supplies, etc. The cash value and calculations thereof for all In Kind cost share items must be justified and explained in the Cost Share section of the project Budget Justification (EERE 335). All cost share items must be necessary to the performance of the project. If questions exist, consult your DOE contact before filling out the In Kind cost share section of the Budget Justification (EERE 335).

3. Funds from other Federal sources MAY NOT be counted as cost share. This prohibition includes FFRDC sub-recipients. Non-Federal sources include any source not originally derived from Federal funds. Cost sharing commitment letters from subrecipients must be provided with the original application.

4. Fee or profit, including foregone fee or profit, are not allowable as project costs (including cost share) under any resulting award. The project may only incur those costs that are allowable and allocable to the project (including cost share) as determined in accordance with the applicable cost principles prescribed in FAR Part 31 for For-Profit entities and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

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

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

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

EERE may require additional information before considering the waiver request.

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

2. Waiver for Performance of Work in the United States

As set forth in Section IV.J.3, all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a

waiver is not required for foreign purchases of these items. However, the Prime Recipient 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.

EERE's Digital Data Management principles can be found at: EERE Digital Data Management | Department of Energy

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.