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

Hydrogen and Fuel Cells R&D 2021 FOA

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002446
FOA Type: Mod 0001
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FOA Issue Date:	12/10/2020
Submission Deadline for Concept Papers:	01/15/2021 5:00pm ET
Submission Deadline for Full Applications:	03/08/2021 5:00pm ET
Expected Submission Deadline for Replies to Reviewer Comments:	04/09/2021 5:00pm ET
Expected Date for EERE Selection Notifications:	May 2021
Expected Timeframe for Award Negotiations:	May 2021 - August 2021

- 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 Excahnge 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.

Modifications

Modifications to the FOA are [HIGHLIGHTED] in the body of the FOA.

Mod. No.	Date	Description of Modification
0001	01/22/2021	Changed all EPIC links and references to EERE Exchange
0001	01/22/2021	Changed FOA Question submission from EPIC url to HFTOFOA@ee.doe.gov
0001	01/22/2021	Updated Table 2 footnote (f) to indicate cost target is relative to net fuel cell system power
0001	01/22/2021	Removed Executive Order 13950

I. Funding Opportunity Description

A. Background and Context

The Office of Energy Efficiency and Renewable Energy (EERE) is issuing, on behalf of the Hydrogen and Fuel Cell Technologies Office (HFTO), Funding Opportunity Announcement (FOA) DE-FOA-0002446. The activities supported by this FOA are authorized under the Energy Policy Act of 2005 (EPACT 2005) Public Law 109-58 (Aug. 5, 2005), Title VIII - HYDROGEN, Sections 801 to 816. These provisions are found in the United States Code at 42 U.S.C. §§ 16151 to 16165. Title VIII authorizes the Secretary of Energy to conduct a program of research, development and demonstration on technologies relating to the production, purification, distribution, storage, and use of hydrogen energy, fuel cells, and related infrastructure.

i. Background and Purpose

Hydrogen and fuel cells represent a growing industry with potential to enable energy resiliency, energy security, emission reductions and economic growth. In recent years, the industry has delivered thousands of fuel cells across the U.S. for use in limited stationary and transportation applications; today, an expansion to heavy-duty applications is taking shape, with potential new hydrogen-use markets including trucks, marine vessels, rail, data centers, and the expanded industrial use of hydrogen in chemicals synthesis, metals refining, energy storage and grid integration.

This FOA supports research and development (R&D) to enable "H2@Scale" – a DOE initiative to achieve large scale production, storage, transport, and utilization of hydrogen across multiple sectors.[1] Supporting EERE's core priorities of energy affordability, integration and storage, H2@Scale research, development and demonstration (RD&D) aims to advance the adoption of hydrogen and fuel cell technologies in integrated energy systems across key applications that provide a value proposition as well as reduce emissions. However, a number of challenges remain including cost, performance, durability, manufacturing and scale-up issues, and developing integrated systems that demonstrate the unique technical, economic and environmental benefits of hydrogen and fuel cells.

To address these challenges, HFTO supports a comprehensive RD&D portfolio addressing materials-, component- and systems-level R&D on hydrogen and fuel cell technologies (e.g., MW-scale electrolyzers, fuel cells for heavy-duty transportation applications, hydrogen delivery and fueling infrastructure, among others); and technology acceleration efforts addressing first-of-a-kind

[1] https://www.energy.gov/eere/fuelcells/h2scale

demonstrations of integrated energy systems, as well as manufacturing innovations and safety codes and standards. HFTO RD&D relies heavily on collaborations among various industry and university stakeholders and the national laboratories, including through HFTO-managed consortia.

This year, HFTO launched two major collaborative research initiatives leveraging world-class expertise and state-of-the-art equipment at the national laboratories: the Million Mile Fuel Cell Truck (M2FCT) consortium and the H2NEW consortium.[2] Under each consortium, DOE national laboratories are working together in cutting-edge R&D and collaborating with the hydrogen and fuel cell communities to identify innovative ways to make hydrogen and fuel cell technologies more affordable and competitive in today's market. Each consortium is planned at $50 million over five years, along with a similar level for industry and university FOAs, to advance progress in specific hydrogen production and fuel cell RD&D areas:

- **M2FCT** includes Los Alamos and Lawrence Berkeley National Laboratories as co-leads, and focuses on fuel cell durability, performance, and cost to better position fuel cell trucks as a viable option in the long-haul trucking market.

- **H2NEW** includes National Renewable Energy Laboratory and Idaho National Laboratory as co-leads, and focuses on R&D to enable affordable, durable and efficient large-scale electrolyzers, which produce hydrogen from electricity and water (at both high and low temperatures).

This HFTO FY21 RD&D FOA will provide more than $33,500,000 in Federal funding for topics designed to supplement the current HFTO RD&D portfolio in the advancement of hydrogen and fuel cell technologies, with an emphasis on incentivizing collaborative progress among industry, university and national laboratory stakeholders, including coordination with the M2FCT and H2NEW Consortia. This FOA includes the following four areas of R&D:

1) Fuel Cell R&D for Heavy-Duty Applications

This topic includes two focus areas to reduce the cost and enhance the durability and performance of Polymer Electrolyte Membrane (PEM) fuel cell stacks for heavy-duty applications. Efforts in both areas are to be coordinated with the Million Mile Fuel Cell Truck consortium. The first research area supports development of bipolar plates with a focus on innovative, low-cost materials with high corrosion resistance and minimal degradation. The second research area is focused on the development of air management components and subsystems for improved reliability and lower overall heavy duty fuel cell system costs.

[2] https://www.energy.gov/articles/doe-announces-new-lab-consortia-advance-hydrogen-and-fuel-cell-rd

2) Efficient and Innovative Hydrogen Production
This topic includes two focus areas aimed at developing sustainable generation technologies to enable low-cost production of clean hydrogen at large scale. The first area, carried out in collaboration with DOE's Advanced Manufacturing Office (AMO), focuses on increasing the production volume of advanced components, stacks, sub-systems, and systems for multi-MW-scale high-temperature electrolyzers to lower hydrogen production costs. This would be coordinated with the H2NEW consortium. The second focus area supports technology development which enables low cost hydrogen production via waste and biomass conversion. Research approaches in this area include microbial conversion technologies viable at large or distributed/community scales, with development of novel systems to bring down cost, improve yield, and enable scale-up.

3) High-flow Fueling Applications
This topic includes two focus areas for development of novel hydrogen fueling technologies and processes that can increase hydrogen dispensing rates to facilitate rapid fueling of heavy-duty vehicles. The first focus area supports low-cost, reliable, domestically supplied hydrogen fueling station components to enable high-flow hydrogen fueling of heavy-duty trucks. The second focus area supports R&D necessary to develop a high-flow gaseous fueling model and ultimately a standard protocol which can achieve targeted fill rates.

4) Cost Analysis for Fuel Cells, Hydrogen Production, and Hydrogen Storage
This topic includes three focus areas for the development of a comprehensive set of cost analyses involving all aspects of hydrogen and fuel cell technologies. Projects would define the current state-of-the-art in key areas, develop and refine system configurations and designs, provide guidance on R&D gaps, and help to direct future R&D priorities in fuel cell, hydrogen production, and hydrogen storage technologies.

EERE will have substantial involvement in work performed under the awards made as a result of this FOA. EERE does not limit its involvement to the administrative requirements of the awards. Instead, EERE will maintain involvement in the direction and redirection of the technical aspects of the projects. EERE anticipates hands-on participation and involvement in the projects, including those expected to collaborate with lab-based consortia. See Section VI.B.ix, Statement of Substantial Involvement, for more details.

Topic Area 1: Fuel Cell R&D for Heavy-Duty Applications

Hydrogen-fueled polymer electrolyte membrane fuel cells (PEMFCs) are an attractive technology to power multiple applications, particularly zero-emission heavy-duty vehicles for on road (trucks and buses), as well as marine, rail, and off-road (e.g., mining and construction) applications. They offer several advantages over incumbent technologies such as diesel engines, including higher efficiency, reduced emissions, higher torque, and no noise pollution. Additionally, they offer fast fueling and adequate fuel storage for applications demanding longer range.

Regardless of application, it is critical to provide a competitive total cost of ownership considering capital, fuel costs, and lifetime. High fuel cell system durability, while ensuring cost-competitiveness with incumbent and advanced alternative powertrains, is essential to amortize capital costs over a longer lifetime. For example, long haul trucks require a lifetime of over 1 million miles and 25,000 operation hours. Significantly longer vehicle lifetimes and range requirements also mean that hydrogen fuel costs comprise a greater proportion of vehicle lifecycle cost. As such, increased fuel cell efficiency is a key parameter for economic viability. At the same time, fuel cell components and systems need to be cost-competitive with incumbent and advanced alternative powertrains.

The DOE has set targets for long-haul class 8 fuel cell trucks at 25,000 hour lifetime, 68% peak efficiency, and \$80/kW_{net} fuel cell system cost by 2030.[3] To meet these targets, advances are required for fuel cell stack and balance-of-plant components and their associated manufacturing technologies and processes.

To expedite fuel cell competitiveness, the DOE launched the Million Mile Fuel Cell Truck consortium (M^2FCT), which includes a number of national laboratories with demonstrated leadership in the topic area in partnership with universities and industry to accelerate research and development (R&D) that would enable meeting a fuel cell durability of a million miles and other relevant targets.[4] The M^2FCT cross-disciplinary national lab core team serves as a resource for industry and the research community. Applications selected in this Topic are expected to partner with M^2FCT.

This Topic Area includes two subtopics to advance fuel cells for heavy-duty applications. Subtopic 1A (Low-Cost, Durable Bipolar Plates) focuses on the development of low-cost, reliable and durable bipolar plates; Subtopic 1B (Innovative, Low-Cost Air Management Components) focuses on the development of air management components and subsystems for lower cost

[3] U.S. Department of Energy "Hydrogen Class 8 Long Haul Truck Targets" Program Record, December 12, 2019: https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf

[4] Million Mile Fuel Cell Truck (M^2FCT) consortium announcement, October 8, 2020: https://www.energy.gov/eere/articles/doe-launches-two-consortia-advance-fuel-cell-truck-and-electrolyzer-rd

balance of plant (BOP). DOE's anticipated funding levels, including the range of federal funding per award are given below.

Anticipated Funding and Award Details

Topic Area	Total Funding Level	Anticipated Number of Awards	Federal Funding per Award	Max. Project Duration (years)	Min Required Non-Federal Cost Share %
Subtopic 1A: Fuel Cell R&D for Heavy-Duty Applications – Low-Cost, Durable Bipolar Plates	**$4M**	**2 to 4**	**$1-2M**	**3**	**20%**
Subtopic 1B: Fuel Cell R&D for Heavy-Duty Applications – Innovative, Low-Cost Air Management Components	**$4M**	**2 to 4**	**$1-2M**	**3**	**20%**
Total:	**Up to $8M**	**4 to 8**			

* The funding requested should be commensurate with the level of work proposed. While the maximum per award is $2M for Topics 1A and 1B, smaller more focused projects (~$1M/project) that advance existing/most promising concepts are also encouraged.

Subtopic 1A: Fuel Cell R&D for Heavy-Duty Applications – Low-Cost, Durable Bipolar Plates

Subtopic 1A Introduction/Background:

Bipolar plates play an important role in fuel cell performance through reactant distribution, water management, and the collection of the electric current produced. Bipolar plates are projected to be the second most expensive PEMFC stack component in scaled-up systems using state-of-the-art technology.[5] Metallic and carbon-based (carbon composites and flexible graphite) bipolar plates are both potential options for transportation fuel cells. Metallic plates enable high power densities, but are susceptible to corrosion, which can be mitigated either through expensive base metals (e.g., titanium) or through a corrosion-resistant coating applied to a less expensive base metal (e.g., gold-coated stainless steel). Carbon-based plates offer low materials cost, negligible corrosion, and advantages in formability, but currently have lower strength and must be thicker than metal plates, resulting in lower stack power density. In

[5] Brian D. James, Jennie M. Huya-Kouadio, Cassidy Houchins, Daniel A. DeSantis, "Mass Production Cost Estimation of Direct H_2 PEM Fuel Cell Systems for Transportation Applications: 2018 Update", Strategic Analysis Inc. December 2018: https://www.energy.gov/sites/prod/files/2020/02/f71/fcto-sa-2018-transportation-fuel-cell-cost-analysis-2.pdf

addition, manufacturing processes for both metal and carbon-based plates, including forming and joining half-plates, are also costly and time consuming.

Subtopic 1A Description/Objective:

This subtopic solicits applications that, in coordination with the M²FCT consortium, will develop innovative bipolar plates to reduce the cost and enhance the durability and performance of PEM fuel cell stacks for heavy-duty applications. The Subtopic targets critical advances in bipolar plates to enable substantial progress towards meeting 2030 system level heavy-duty truck targets of 25,000 hour durability and $80/kW system cost. Both metallic and carbon-based materials are of interest. R&D needs for both approaches have been identified with industry, university, and national laboratory expert stakeholder input.[6]

Metallic bipolar plate materials priorities include improving the forming limit of the substrate materials and developing robust coating materials to mitigate base metal leaching and enable a pre-forming deposition process, as well as improving material forming limits to enable flow field fabrication for enhanced performance. Of interest are coating deposition processes that improve durability by improving chemical stability, provide self-protection from corrosion/degradation at coating defect areas, and mitigate the introduction of defects (such as cracks or delamination) during the stamping process. Processes that reduce cost by minimizing or eliminating the use of precious metals and allowing for the use of low-cost base metals, or improving amenability to high-throughput manufacturing process are also of interest.

For carbon composite plates, R&D priorities include the development of high throughput production processes (forming, sealing, curing, gluing and cutting operations) and materials. Higher strength materials and materials that improve thermal conductivity would be beneficial and are also of interest.

Applications should focus on innovative, low-cost materials with high corrosion resistance and minimal degradation to achieve lifetimes of 25,000 hours. More specifically:

- Development of low-cost, defect-free coatings for metal bipolar plates to enable use of low-cost base metals, such as low-grade stainless steel and aluminum, while improving durability through decreased base metal leaching
- Improved manufacturability of carbon-based and metal bipolar plates to enable high production rates and decrease costs
- Improved mechanical properties of plates to allow thinner plates and better flow field formability to improve stack power density

Applicants should seek to significantly surpass the durability of existing state-of-the-art bipolar plates by meeting 25,000 hours of durability suitable for heavy-duty applications while

[6] https://publications.anl.gov/anlpubs/2017/11/137641.pdf

addressing bipolar plate targets listed in Table 1. The applicant should discuss: the status of their proposed technology in relation to the targets and the application's potential to meet the targets; the potential for their proposed approaches to meet a bipolar plate cost of ≤$5/kW projected at a manufacturing level suitable for 100,000 fuel cell stacks per year; how they will assess bipolar plates for the durability requirements of heavy-duty applications, including the 25,000 hour lifetime target.[7]

Table 1: Bipolar Plate Targets

Characteristic	Units	2030 Targets
Cost [a]	$/kW$_{net}$	5
Durability	hrs	25,000
Plate weight	kg/kW$_{net}$	<0.18
Plate H_2 permeation coefficient[b]	std cm^3/(sec cm^2 Pa) @80°C, 3 atm, 10%RH	<2x10^{-6}
Corrosion anode [c]	µA/cm^2	<1 and no active peak
Corrosion, cathode [d]	µA/cm^2	<1
Electrical conductivity	S/cm	>100
Area specific resistance [e]	ohm cm^2	<0.01
Flexural strength [f]	Mpa	>40
Forming elongation [g]	%	40

a. Costs projected to high volume production (100,000 systems per year).
b. Per the standard gas transport test (ASTM D1434).
c. At pH 3 0.1ppm HF, 80°C, peak active current <1x10^{-6} A/cm^2 (potentiodynamic test at 0.1 mV/s, -0.4V to +0.6V (Ag/AgCl)), de-aerated with Ar purge.
d. At pH 3 0.1ppm HF, 80°C, passive current <5x10^{-8} A/cm^2 (potentiostatic test at +0.6V (Ag/AgCl) for >24h, aerated solution.
e. Includes interfacial contact resistance (on as received and after potentiostatic test) measured both sides per Wang, et al. J. Power Sources 115 (2003) 243–251 at 200 psi (138 N/cm^2).
f. Per ASTM-D 790-10 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
g. Per ASTM E8M-01 Standard Test Methods for Tension Testing of Metallic Materials, or demonstrate ability to stamp generic channel design with width, depth, and radius.

[7] Plans for accelerated stress testing protocols for the appropriate duty cycles should be provided to demonstrate 25,000 hour life.

Selected applications will collaborate with M^{2}FCT where possible, including testing and utilizing appropriate accelerated stress tests, as well as system-modeling efforts to assess the proposed technology's impact on heavy-duty fuel cell cost and performance.

The final deliverable for all applicants in this subtopic is a set of 6 or more plates (active area ≥ 25 cm^2) for independent testing and evaluation by the M^{2}FCT. A detailed assessment of the cost and manufacturability of the bipolar plates, in coordination with M^{2}FCT, should be provided to DOE at the end of the project. Applicants that apply at the upper end of the DOE funding range should also perform testing of their bipolar plates as part of a fuel cell stack under heavy-duty operating conditions specified by M^{2}FCT.

Subtopic 1A Project Structure:

The maximum DOE funding for this subtopic is $4,000,000. Applicants should propose projects up to 3 years in length for a total DOE funding of $1,000,000 to $2,000,000 for each project, and the funding requested should be commensurate with the level of work proposed. EERE intends to select 2 to 4 projects based on available funds and proposed scope. Applications should include the Technology Readiness Level (TRL). Smaller projects at a lower TRL should propose at the lower range of DOE funding ($1M/project) while higher TRL projects can apply up to the maximum for this Subtopic ($2M/project). Projects should be planned as two or three multi-phase efforts with a quantitative Go/No-Go decision point with specific criteria and metrics separating each phase (each budget period should be approximately 12 to 18 months long). Projects must include at least 20% cost share, consistent with R&D activities.

Subtopic 1A Teaming Arrangements:

A domestic bipolar plate manufacturer as part of the team is encouraged. Upon selection, applicants are expected to partner with M^{2}FCT; coordination will include testing and utilizing appropriate accelerated stress tests, as well as system-modeling efforts to assess the proposed technology's impact on heavy-duty fuel cell cost and performance.

Teaming arrangements that include multiple stakeholders across academia, industry, national laboratories as appropriate, and across technical disciplines are strongly encouraged. For example, teams that include multiple partners are preferred over applications that only include a single organization. Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and

Universities (HBCUs)/Other Minority Institutions (OMIs),[8] or through linkages with Opportunity Zones[9] are encouraged.

EERE is compiling a Teaming Partner List to facilitate the widest possible national participation in the formation of applicant teams for this topic. The list allows organizations who may wish to participate in an application, but do not wish to apply as the Prime applicant, to express their interest to potential applicants and to explore potential partners.

The Teaming Partner List will be available on the HFTO website at https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office-funding-opportunities under FOA DE-FOA-0002446 during the time of its release through its closing. The Teaming Partner List will be updated at least weekly until the close of the Full Application period, to reflect new Teaming Partners who have provided their information. Any organization that would like to be included on this list should submit the following information to HFTOFOA@ee.doe.gov, with the subject line "Teaming Partner Information FOA-0002446":

Topic Area(s) of Interest, Organization Name, Contact Name, Contact Address, Contact Email, Contact Phone, Organization Type, Area of Technical Expertise, and Brief Description of Capabilities.

By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of the above-referenced information. By facilitating this Teaming Partner List, EERE does not endorse or otherwise evaluate the qualifications of the entities that self-identify themselves for placement on the Teaming Partner List. EERE will not pay for the provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

Subtopic 1B: Fuel Cell R&D for Heavy-Duty Applications – Innovative, Low-Cost Air Management Components

Subtopic 1B Introduction/Background:

Successful development of fuel cell system balance of plant (BOP) components specifically designed for heavy-duty vehicle drive cycles is critical if overall fuel cell system cost, durability,

[8] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[9] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

and performance goals are to be achieved. Improvements to BOP component durability will increase the system reliability and decrease maintenance cost. Improvements to BOP component efficiency will decrease parasitic power required, thereby decreasing fuel use and reducing stack oversizing.

Air management components (e.g., compressors/expanders) are the major cost contributor to the fuel cell system, and the largest contributor to system BOP cost. Compressors specifically designed for heavy-duty fuel cell applications are needed to minimize parasitic power consumption while meeting packaging and cost requirements. For example, because recent advances in fuel cell power density have relied on higher pressure operation for the cathode, this has resulted in cost and reliability issues due to the air handling system. Therefore, innovative concepts are needed to enable such systems to achieve optimal performance and to better understand the integration of components into subsystems and full systems.

Over the last decade, automotive fuel cell systems have been developed with air management systems to meet the light duty vehicle specifications, including input power, compressor/expander efficiency, motor controller efficiency, volume, weight, cost, turndown ratio, and noise.[10] Heavy-duty fuel cell applications have not been subject to this level of analysis, and possess a different set of requirements for their air management systems, requiring greater uptime (reliability), improved efficiency (reduced input power), and extended durability (25,000 hour lifetime). Air management systems present the primary parasitic load and require a concerted research and development effort to meet the 68% efficiency target for heavy-duty truck applications.

A study of fuel cell buses, an application with similar durability requirements to heavy-duty trucks, found that availability ranged from a low of 55% to a high of 88% with an overall average of 72%. Fuel cell system issues made up 25% of the unavailable time, and were largely attributed to balance of plant components and not issues with the fuel cell stack. Air blowers, compressors, and sometimes plumbing leaks were responsible for downtime for the buses. Reliability of the air management system must improve for heavy-duty truck applications. Reliability is even more important for long-haul trucking than for municipal buses that operate on a fixed route near their maintenance facilities.[11]

Subtopic 1B Description/Objective:

This subtopic solicits applications that will develop air management components capable of:

- Greater uptime (reliability), improved efficiency (reduced input power), extended durability (lifetime), and higher turndown ratio relative to light-duty applications

[10] Light-Duty Vehicle Air Compression System Targets from 2016 MYRD&D Plan: https://www.energy.gov/sites/prod/files/2017/05/f34/fcto_myrdd_fuel_cells.pdf

[11] Fuel Cell Buses in U.S. Transit Fleets: Current Status 2018: https://www.nrel.gov/docs/fy19osti/72208.pdf

- Providing a lower cost, easy-to-manufacture solution for air compression for heavy-duty fuel cell systems
- Flexibility in being used across multiple heavy-duty fuel cell applications, increasing manufacturing volumes and offering potential economies of scale benefits

The final project deliverable will be a sub-scale prototype heavy-duty vehicle air management system with the target specifications, as shown in Table 2.

Table 2: Heavy-Duty Vehicle Air Compression System Targets [12]

Characteristic	Units	2030 Targets
Motor + Motor Controller Efficiency		
At 100% flow [a]	%	92
At 50% flow [b]	%	92
At Idle [c]	%	80
Compressor/Expander Efficiency		
At 100% flow [a]	%	75/70
At 50% flow [b]	%	80/80
At Idle [c]	%	62/60
Transient time for 10-90% of maximum flow	seconds	2
Durability [d]	hours	25,000
Reliability [e]	Miles Between Road Calls (MBRC)	50,000
Number of start-up and shut-down cycles	-	50,000
Noise at Idle	dBa @ 1m	65
System Cost [f]	$/kW	12
System Volume [g]	L/kW	0.25
System Weight [g]	kg/kW	0.50
Turndown Ratio (max/min flow)	-	20

a. Compressor: 285 g/s flow rate, 2.55 bar (absolute) discharge pressure; 40°C, 25% RH inlet conditions. Expander: 270 g/s flow rate, 2.2 bar (absolute) inlet pressure, 90°C, 85% RH inlet conditions. Compressor flow rates include 8% allowance for motor cooling and need to be adjusted if the actual motor cooling requirement is different.

b. Compressor: 143 g/s flow rate, 2.5 bar (absolute) discharge pressure; 40°C, 25% RH inlet conditions. Expander: 135 g/s flow rate, 2.4 bar (absolute) inlet pressure, 90°C, 85% RH inlet conditions. Compressor flow rates include 8% allowance for motor cooling and need to be adjusted if the actual motor cooling requirement is different.

c. Compressor: 14 g/s flow rate at idle, minimum 1.1 bar (absolute) discharge pressure; 40°C, 25% RH inlet conditions. Expander: 12 g/s flow rate, 1.05 bar (absolute) inlet pressure, 60°C, 100% RH inlet conditions. Compressor flow rates include 8% allowance for motor cooling and need to be adjusted if the actual motor cooling requirement is different.

[12] Air compression system for 250 to 300-kWe (beginning of life maximum net electrical power available) heavy duty fuel cell systems operating on direct hydrogen.

d. Durability testing should be done according to protocols to be developed by M²FCT. Protocols are expected to be similar to that in Table P.10 (https://www.energy.gov/sites/prod/files/2017/05/f34/fcto_myrdd_fuel_cells.pdf), with relative numbers of start/stops and power ramps adjusted to match HD truck duty cycles rather than LDV duty cycles
e. A MBRC of 50,000 miles corresponds to one service call/year related to the air management system. Current diesel truck reliability varies with truck type and for the same truck type varies substantially between operators (https://www.freightwaves.com/news/tmc20-unscheduled-truck-maintenance-costs-rising). Higher reliability may be required in the future to match current diesel truck reliability.
f. Air compression system cost target relative to fuel cell system net power (based on a manufacturing volume of 100,000 units per year).
g. Weight and volume include the motor, motor controller (dry weight). kW is based on 250 to 300-kWe (beginning of life maximum net electrical power available) heavy duty fuel cell systems operating on direct hydrogen.

The applicant should discuss: the status of their proposed technology in relation to the targets and the potential of the proposed system to meet the targets; and how they will assess air management system performance and durability under heavy duty fuel cell operating conditions. A detailed assessment of the cost and manufacturability of the hardware should be provided to DOE at the end of the project. Applicants are required to carry out their cost, performance, and durability assessments and testing in coordination with M²FCT.

Subtopic 1B Project Structure:

Applicants should propose projects up to 3 years in length for a total DOE funding of $1,000,000 to $2,000,000 for each project. The maximum DOE funding of $4,000,000 for this subtopic enables selection of 2 to 4 projects. The funding requested should be commensurate with the level of work proposed. Projects should be planned as two or three multi-phase efforts with a quantitative Go/No-Go decision point with specific criteria and metrics separating each phase (each phase should be approximately 12 to 18 months long). Projects must include at least 20% cost share consistent with R&D activities.

Subtopic 1B Teaming Arrangements:

A domestic air management component/system manufacturer and a fuel cell system developer (OEM or OEM supplier) knowledgeable in the requirements for polymer electrolyte membrane fuel cell systems for heavy-duty transportation applications as part of the team is encouraged. Upon selection, applicants are expected to partner with the M²FCT national lab consortium; coordination will include system-modeling efforts to assess the proposed technology's impact on heavy-duty fuel cell cost and performance, as well as performance and durability testing.

Teaming arrangements that include multiple stakeholders across academia, industry, national laboratories as appropriate, and across technical disciplines are strongly encouraged. For example, teams that include multiple partners are preferred over applications that only include a single organization. Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and

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Topic Area 2: Efficient and Innovative Hydrogen Production

Hydrogen demand is increasing globally across sectors with the United States producing and consuming almost 10 MMT annually.[15] Today, the vast majority of hydrogen is produced from

[13] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[14] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

[15] U.S. Department of Energy. October 2019. Hydrogen and Fuel Cells Program Record 19002. "Current Hydrogen Market Size: Domestic and Global." https://www.hydrogen.energy.gov/pdfs/19002-hydrogen-market-domestic-global.pdf

natural gas, but to meet the growing demand, a broad portfolio of hydrogen production pathway technologies utilizing a variety of the U.S.'s abundant and domestic resources are being considered and developed. Feedstock diversity is one of the major benefits of hydrogen as it provides opportunities to increase energy security, resiliency, and economic opportunities while also offering environmental benefits. The three broad resource classes that can be used as the feedstock for hydrogen production are fossil fuel, biomass/waste, and water, and each of these three has multiple pathways/technologies to generate hydrogen. HFTO is focused on developing sustainable, clean non-fossil generation technologies to enable low-cost hydrogen production at scale. In particular, HFTO's Hydrogen Production sub-program supports R&D to address the critical challenges and barriers associated with hydrogen production te chnologies via water splitting technologies such as electrolysis and waste and biomass conversion technologies such as fermentation. This FOA Topic Area covers (A) High Temperature Electrolyzer Manufacturing R&D and (B) Innovative Hydrogen Production from Biomass Waste Streams.

Anticipated Funding and Award Details

Topic Area	Total Funding Level	Anticipated Number of Awards	Federal Funding per Award	Max. Project Duration (years)	Min Required Non-Federal Cost Share %
Subtopic 2A: High Temperature Electrolyzer Manufacturing R&D	**$10M**	**2 to 3**	**$3-5M***	**3**	**20%**
Subtopic 2B: Innovative Hydrogen Production from Biomass Waste Streams	**$2M**	**1 to 2**	**$1M**	**3**	**20%**
Total:	**Up to $12M**	**3 to 5**			

* The funding requested should be commensurate with the level of work proposed. While the maximum per award is $5M for Topic 2A, smaller more focused projects (~$3M/project) that advance existing/most promising concepts are also encouraged.

Subtopic 2A: High Temperature Electrolyzer Manufacturing R&D

Subtopic 2A Introduction/Background:

Electrolyzers split water into hydrogen and oxygen electrochemically using electricity that can be produced from diverse domestic resources. The large-scale production of hydrogen from water by electrolysis is a key enabler of EERE's H2@Scale vision of affordable hydrogen production, distribution, storage, and use across multiple applications, such as chemical synthesis, steel and cement manufacturing, and other end uses. Power-to-gas methods that use electricity to generate hydrogen for energy storage and other end use applications are

emerging as pathways to mitigate curtailed renewable resources and provide flexible operation for baseload nuclear plants, contributing to improved grid stability and resilience. Large, multi-MW scale electrolyzers are needed for these applications, but the high cost of these systems and general lack of domestic manufacturing facilities remain critical challenges impeding widespread adoption. Part of this high cost comes from the low production volume of manufacturing electrolyzer components and systems, leading to high processing expenses.

HFTO has previously supported and will continue to support both low- and high-temperature electrolyzer technology development as each will have important, and potentially distinct, roles in enabling the efficient and affordable production of hydrogen in a future clean energy economy. While HFTO's FY20 FOA had a topic on low temperature electrolyzer (LTE) manufacturing, this FY21 FOA topic is focused on advancing and enabling domestic manufacturing of high temperature electrolyzers (HTE), also commonly referred to as solid oxide electrolysis cells (SOEC), based on oxide-ion conducting materials (e.g., zirconia-based electrolyte systems). EERE's Advanced Manufacturing Office (AMO) is an important funding partner on this topic as it sees a critical need for domestically competitive manufacturing of technologies such as high temperature electrolyzers. SOEC technology is less developed than low temperature PEM and conventional alkaline electrolyzer technologies. It is not yet widely commercialized; however, an increasing number of organizations are looking to bring this technology to market. The high operating temperature offers significant benefits including low electricity requirements (i.e., high electrical efficiency) and opportunity to couple the electrolyzer with heat from nuclear, solar, or other sources. While HTE performance and durability have improved significantly in recent years, due in part to component-level advancements enabled by ongoing HFTO-supported R&D,[16] achieving necessary cost reductions will require significant manufacturing economies-of-scale to be reached. Cost-effective scale-up and high-throughput manufacturing processes are among the necessary innovations. For electrolyzers to produce affordable hydrogen at the DOE cost target of <$2/kg, such innovations will be critical.

HFTO recently launched the H2NEW (Hydrogen from the Next-generation of Electrolyzers of Water) Consortium. This national lab-led consortium is focused on making large-scale electrolyzers more durable, efficient, and affordable. H2NEW will focus on integrating existing materials and manufacturing R&D to meet specified cost, durability and performance targets in LTE and HTE with an end goal of enabling the production of hydrogen at a cost of <$2/kg H_2. As shown in Figure 1., manufacturing and scale-up efforts have a key role in H2NEW. Projects selected through this FOA topic will be associated and coordinated with the overall H2NEW effort. It is anticipated the projects will engage and collaborate with the H2NEW HTE labs, led by Idaho National Laboratory (INL) and Pacific Northwest National Laboratory (PNNL), with

[16] https://www.hydrogen.energy.gov/pdfs/review19/plenary_hydrogen_fuel_stetson_2019.pdf

these manufacturing R&D efforts expected to be complementary to the national lab H2NEW R&D efforts, which initially are focused on addressing degradation-related issues.

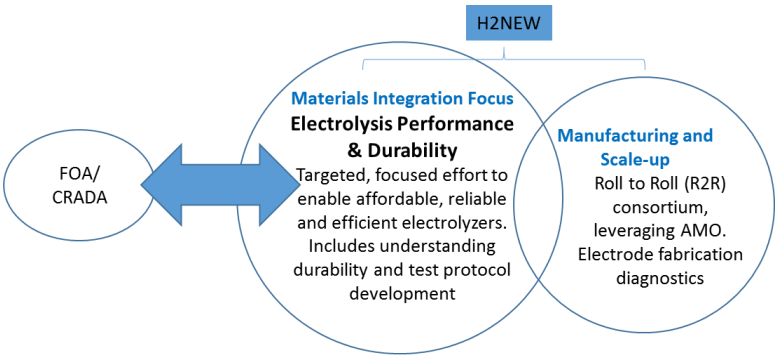

Figure 2. H2NEW Structure

A recent analysis using DOE's H2A model[17] shows that H_2 production costs of ~$2/kg can potentially be achieved at electricity prices of 3¢/kWh (which is becoming increasingly common with wind and solar installations), when the electrolyzer system capital cost is on the order of $350/kW.[18] This analysis assumes high-volume manufacturing production capacity (700 MW/yr) has been reached. Based on these results as well as feedback from technical experts, HFTO has set a target of $300/kW by 2030 for electrolyzer system capital cost. Other draft HTE stack targets include electrical efficiency of 98% at 1.5 A/cm^2 and durability of 60,000 hours.

Achieving needed scales of manufacturing will require leveraging lessons learned to date from the hydrogen and fuel cell R&D communities along with the implementation of state-of-the-art manufacturing innovations. Manufacturers of HTEs have historically leveraged work carried out by solid oxide fuel cell (SOFC) developers. There may therefore be opportunities to adapt state-of-the-art methods used for the manufacture of SOFCs to the specific needs of SOECs, capitalizing on some common requirements. The basic cell compositions and cell/stack designs are similar for the two technologies. Conventional ceramic processing techniques used for SOFCs can be applied in the manufacture of HTEs.

In addition to leveraging SOFC manufacturing techniques, electrolyzer manufacturing cost could also be lowered by reducing the number of parts in a cell unit and reducing the total number of processing steps (e.g., multiple high temperature sintering processes). Other innovative manufacturing approaches such as additive manufacturing, process automation, and advanced real-time metrology techniques for QC/QA also have potential to enable overall system cost reductions. Standardization in electrolyzer manufacturing processes and in the design/optimization of components, stacks and systems offers another important pathway for

[17] H2A is a discounted cash-flow model providing transparent reporting of process design assumptions and a consistent cost analysis methodology for H_2 production at central and distributed facilities: http://www.hydrogen.energy.gov/h2a_production.html

[18] DOE Hydrogen and Fuel Cells Program Record, Hydrogen Production Cost From High Temperature Electrolysis – 2020, https://www.hydrogen.energy.gov/pdfs/20006-production-cost-high-temperature-electrolysis.pdf

the promotion of a more effective and robust domestic supply chain, with significant cost saving potential. A combination of manufacturing and related supply chain innovations may be needed to enable commercialization of large-scale HTEs that can produce affordable hydrogen at the target of <$2/kg.

Subtopic 2A Description/Objective:

EERE seeks applications in R&D of manufacturing techniques to produce advanced components, stacks, sub-systems, and systems for multi-MW-scale HTEs at high production volumes, leveraging one or more of the innovations/approaches such as those described above and listed below. For the SOEC components targeted in the application, the applicant should provide their current status against relevant metrics. An example of state-of-the-art metrics that could be considered is electrolyzer stack performance of 1 A/cm^2 at ≤1.4 V with a degradation rate of <10 mV/khr for electrode supported cells. In all proposals, applicants will be expected to address the impact of their manufacturing innovations on projected cost reductions for large-scale electrolyzers. Some potential areas of interest for this topic include but are not limited to:

- Approaches to decrease the stack part count, including integrating multiple components into one and decreasing the number of assembly steps required for stack fabrication
- Developing best practices for material/component handling, automated component and stack assembly as appropriate, quality control, repeatability, in situ diagnostics/inspection (at required production rates, in-line), reducing reject rates, reducing material waste, addressing non-uniformities, conditioning, and other required steps in the manufacturing process, including approaches that minimize service requirements and enable ease of servicing
- Innovations in interconnect manufacturing for high temperature electrolyzers (including improved processes for depositing stable, conductive coatings at high production volumes)
- Advanced high-volume fabrication methods including thin film deposition techniques to improve rate and yield
- Minimize number of high temperature sintering/firing steps
- Decrease required firing/sintering temperature (e.g., add sintering aids while confirming no negative impacts) and other approaches to densify the electrolyte (needs to be demonstrated on commercially relevant sized cells)
- Application of known industrial techniques to electrolyzers (e.g., robotics for glass seals, brazes, laser cutting, automation, or other processes)

Applications should be more focused on taking proven or commercially viable materials and scaling to high-volume manufacturing processes rather than developing new, higher risk materials or manufacturing methods that end with only a small-scale demonstration. In alignment with the focus of the H2NEW HTE national lab effort and due to its more advanced

level of development, cells/stacks should be based on oxide-ion conducting materials (e.g., zirconia-based electrolyte systems). Deliverables could include, but are not limited to: new, high-speed, high-volume manufacturing processes that generate cell components, cells, stacks, balance-of-plant, or systems sized for multi-MW electrolyzers that would enable meeting targets ($300/kW, 60,000 hours, etc.)

Applicants must clearly identify the status of their proposed high temperature electrolyzer technology as it relates to the state-of-the-art. They should provide sufficient justification in the application, supported by a cost analysis, that the approach proposed has the potential to lead to a competitive modular, scalable manufacturing solution suitable for low cost, efficient, durable, and reliable multi-MW scale electrolyzer deployments. The project must include production of electrolyzers or electrolyzer components/subsystems using the manufacturing technology on a scale relevant to high-volume manufacturing. High-throughput manufacturing approaches with appropriate quality inspection (including uniformity and tolerances) are encouraged. While the focus is on MW-scale cell and stack technology, applicants may propose limited critical BOP activities as long as they are not "one-off" and emphasize/enable manufacturability and scale-up. If components and subsystems can benefit from standardization to help develop a supply chain with higher economies-of-scale, particularly among electrolyzer manufacturers, such standardization approaches may be proposed.

Subtopic 2A Project Structure:

Applicants should propose 2-3 year projects for total DOE funding amounts between $3,000,000 and $5,000,000. The funding request should be commensurate with the level of work proposed. Projects should be planned as 2-3 multi-phase efforts (depending on the duration of the project) with a Go/No-Go decision point separating each phase (budget period). Each phase (budget period) should be 12-18 months in duration. Applicants should provide project work plans with strong quantitative Go/No-Go decision points including clear metrics that demonstrate lower cost manufacturability while maintaining the state-of-the-art in performance and durability, targeting the metrics given in the previous section, as applicable. Projects must include at least 20% cost share consistent with R&D activities.

Subtopic 2A Teaming Arrangements:

Collaborative projects comprising appropriate industrial and manufacturing expertise are strongly encouraged. Applicants should describe succinctly the qualifications, experience, and capabilities of the proposed project team to execute the project plan successfully. If the project lead does not have the facilities/capabilities to carry out the electrolyzer/electrolyzer component production on a high-volume relevant manufacturing scale, it will be necessary to include a project partner or partners who can perform that role. Applicants are highly encouraged to develop teaming arrangements between stack/system integrator and stack and component suppliers. For example, rather than only including suppliers as vendors, domestic component suppliers (e.g., both stack and BOP components) are encouraged as

partners/subrecipients, where appropriate. Applicants are encouraged to coordinate and leverage activities funded by the Advanced Manufacturing Office and other relevant DOE Offices, and avoid duplicative efforts. Applicants are encouraged to engage, team and/or collaborate where appropriate with one or more of the H2NEW HTE labs with the expectation that the manufacturing R&D projects resulting from this FOA topic will support H2NEW and be complementary to the national lab H2NEW R&D efforts. Strong preference is given to applicants with domestic manufacturing capabilities and intent to manufacture in the United States.

Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs),[19] or through linkages with Opportunity Zones[20] are encouraged.

EERE is compiling a Teaming Partner List to facilitate the widest possible national participation in the formation of applicant teams for this topic. The list allows organizations who may wish to participate in an application, but do not wish to apply as the Prime applicant, to express their interest to potential applicants and to explore potential partners.

The Teaming Partner List will be available on the HFTO website at https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office-funding-opportunities under FOA DE-FOA-0002446 during the time of its release through its closing. The Teaming Partner List will be updated at least weekly until the close of the Full Application period, to reflect new Teaming Partners who have provided their information. Any organization that would like to be included on this list should submit the following information to HFTOFOA@ee.doe.gov, with the subject line "Teaming Partner Information FOA-0002446":

Topic Area(s) of Interest, Organization Name, Contact Name, Contact Address, Contact Email, Contact Phone, Organization Type, Area of Technical Expertise, and Brief Description of Capabilities.

[19] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[20] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

Subtopic 2B: Innovative Hydrogen Production from Biomass Waste Streams

Subtopic 2B Introduction/Background:

With the potential for over a billion dry tons of feedstock annually,[21] domestic biomass and waste-stream resources can be leveraged for sustainable biofuel and/or hydrogen production. Primary biomass energy sources such as poplar, willow, and switchgrass, as well as biogas produced from anaerobic digestion of organic residues from sources such as landfill, agricultural waste, and municipal solid waste are all potential feedstocks.[22] While EERE's Bioenergy Technologies Office (BETO) develops technologies that utilize these feedstocks to produce cost-competitive advanced biofuels, biopower and bioproducts, HFTO invests in R&D to enable low cost H_2 via waste and biomass conversion technologies. In an effort to enhance and accelerate R&D, HFTO and BETO look for opportunities to collaborate and leverage efforts and investments in these areas.

Key to the DOE's H2@Scale initiative is affordable hydrogen production utilizing diverse feedstocks at a variety of scales ranging from large central production to small local production. Enabling affordable hydrogen production via microbial biomass conversion technologies directly supports H2@Scale. Waste streams in particular offer unique opportunities for low cost hydrogen via microbial conversion. Industrial and municipal waste stream clean-up is costly and energy intensive. In fact, it is estimated that waste water treatment alone consumes 2 to 4% of globally produced electricity.[23] At the same time, the energy content of these waste streams is high and could instead be used to generate renewable energy. A recent report published by BETO found the United States has the potential to generate about 1.079 quadrillion British thermal units (Btu) of energy from 77 million dry tons of wet waste per year.[24] Many states and municipalities are seeking new solutions for managing these organic waste streams as opposed to incumbent practices (e.g. landfilling) which can avoid the high costs associated with treatment, transportation, and disposal. Thus, they represent a considerable economic opportunity compared to microbial hydrogen production from lignocellulosic feedstocks.

[21] U.S. Department of Energy. 2016. "2016 Billion-Ton Report: Advancing Domestic Resources for a Thriving Bioeconomy, Volume 1: Economic Availability of Feedstocks." M.H. Langholtz, B.J. Stokes, and L.M. Eaton (Leads). ORNL/TM-2016/160. Oak Ridge National Laboratory, Oak Ridge, TN. 448p. doi: 10.2172/1271651. https://www.energy.gov/sites/prod/files/2016/12/f34/2016_billion_ton_report_12.2.16_0.pdf

[22] National Research Council and National Academy of Engineering. 2004. "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs." (Washington, DC: National Academies Press), http://www.nap.edu/openbook.php?isbn=0309091632.

[23] ACS Central Science 2019 5 (2), 203-205. Lim, XiaoZhi "Turning Organic Waste into Hydrogen" DOI: 10.1021/acscentsci.9b00132

[24] U.S. Department of Energy. 2017. "Biofuels and Bioproducts from Wet and Gaseous Waste Streams: Challenges and Opportunities." https://www.energy.gov/sites/prod/files/2017/09/f36/biofuels_and_bioproducts_from_wet_and_gaseous_waste_streams_full_report.pdf

Microbial biomass conversion processes and systems such as dark fermentation and microbial electrolysis cells (MECs) take advantage of microorganisms' abilities to consume and digest organic matter and release hydrogen. In dark fermentation, microbes break down complex molecules through multiple metabolic pathways where the byproducts of some of the pathways can then be combined by enzymes to produce hydrogen. MECs, on the other hand, harness energy and protons produced by microbes from organic matter that when combined with an additional small electric current, produce hydrogen. Fermentation is already a proven and industrial technology used to generate biofuels and other products; however there are challenges unique to hydrogen production that need to be addressed for this pathway to be feasible for production of low-cost hydrogen at relevant scales. MEC-based systems have the potential to produce hydrogen from resources that otherwise can't be used for fuel production, and could reduce high energy requirements and costs associated with waste stream clean-up while producing a valuable fuel in the form of hydrogen. Yet, scale-up, performance and durability issues remain.

Compared to conventional biomass feedstocks that can be cost prohibitive, waste streams have a greater potential to enable low-cost hydrogen from microbial processes by eliminating the cost of the feedstock and avoiding costs otherwise required for disposal and/or clean-up. Recent analysis shows that the projected cost to produce hydrogen from dark fermentation of biomass (corn stover) using techniques and strains currently in development at the laboratory scale is greater than $50/gge (untaxed, high volume production rates). There is the potential to dramatically reduce the cost to less than $6/gge by 2025 if improvements in the technology and high volumes are realized. This will require improvements in the molar yield of the conversion of biomass to hydrogen, along with a substantially higher operating fermentation broth concentration while maintaining reasonable rates, among other advancements, such as integration with microbial-aided electrolysis systems. When waste streams are considered, costs are expected to drop even more. However, there are additional challenges associated with waste stream feedstocks that will also need to be addressed, such as the fluctuation in quality (temperature, pH, organic and inorganic contents, etc.).

Subtopic 2B Description/Objective:

Conversion of waste feedstocks (including industrial waste water, food waste, municipal solid waste, and other non-fossil waste streams) to hydrogen via microbial conversion technologies at large or distributed/community scales are of interest. Waste feedstock applications offer a unique opportunity to meet long-term goals of $2/kg-$H_2$ in support of the H2@Scale initiative while simultaneously addressing waste disposal issues faced by a variety of industry stakeholders. Early stage R&D is needed to optimize and/or integrate microbial electrolysis cells (MEC), fermentation and/or other novel systems to bring down cost, improve yield, and enable scale-up. University and industry proposals are being solicited for R&D to:

- Design novel MECs and/or reactors that improve H_2 yield and/or reduce costs at relevant scale including costs of separation and purification requirements and enabling modular designs for on-site installation/use by end-user;

- Improve MEC lifetime and robustness to enable system resilience with real waste streams;
- Optimize hybrid systems to maximize the H_2 produced per unit of feedstock, addressing any potential integration issues (such as mass flow or thermal management); and
- Develop other innovative biological approaches to waste stream conversion.

In addition to the requirements defined in Section IV., applicants must indicate how the work proposed complements on-going research in this area and advances the state-of-the-art towards meeting the hydrogen production cost goal while also meeting the hydrogen purity standards specified in the DOE MYRD&D Plan.[25] Applicants should consider the projected impact of the proposed innovation on hydrogen cost based on available techno-economic and lifecycle assessments and studies. Applicants should base early stage R&D on a sound scientific basis and concentrate on scientific advances that will enable microbial biomass conversion for hydrogen production at relevant scales. While a better understanding of microbial communities' activities and interactions for improved control and optimization is needed and could be a small part of the scope of potential proposals, it should not be the focus.

Deliverables of the proposed work must include demonstration of hydrogen production utilizing real organic waste streams as opposed to surrogate or mock compounds with significant improvement over the state-of the–art (SOA). For example, current work has demonstrated an integrated fermentation-MEC system operating on a waste stream with a hydrogen production rate of 20 $L_{H2}/L_{reactor}$/day for more than 30 hours.[26] Applications must thoroughly define the SOA baseline their innovation will improve upon if different than this. Proposed projects should include a pathway (systems analysis deliverable) to a large-scale system, of at least 1,000 kg H_2/day production, along with projected capital and operating expenses including separation and purification (if necessary). The final deliverable of the proposed project should clearly define incremental advancements needed to achieve the $2/kg H_2 target.

Subtopic 2B Project Structure:

Applicants should propose projects up to 3 years in length for a maximum total DOE funding of $1,000,000 per project. The funding request should be commensurate with the level of work proposed. Applicants should plan projects as two or three multi-phase efforts with a quantitative Go/No-Go decision point separating each phase (budget period). Each budget period should be approximately 12 to 18 months long. Projects must include at least 20% cost share, consistent with R&D activities.

[25] https://www.energy.gov/sites/prod/files/2014/03/f12/appendix_c.pdf

[26] Hong Liu, Yuyan Shao, and Vilayanur Viswanathan, "Novel Hybrid Microbial Electrochemical System for Efficient Hydrogen Generation from Biomass," presented at the DOE AMR meeting, Washington, D.C., April 2019. https://www.hydrogen.energy.gov/pdfs/review19/p129_liu_2019_p.pdf

Subtopic 2B Teaming Arrangements:

Applicants are highly encouraged to team with waste producers/managers that are interested in adopting the technology and can provide the waste feedstock for the project.

Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs),[27] or through linkages with Opportunity Zones[28] are encouraged.

EERE is compiling a Teaming Partner List to facilitate the widest possible national participation in the formation of applicant teams for this topic. The list allows organizations who may wish to participate in an application, but do not wish to apply as the Prime applicant, to express their interest to potential applicants and to explore potential partners.

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Topic Area 3: High-flow Fueling Applications

DOE's H2@Scale initiative (https://www.energy.gov/eere/fuelcells/h2-scale) is focused on enabling large scale hydrogen production, delivery, storage, and use across applications and

[27] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[28] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

sectors, including heavy-duty transportation. A key activity to achieve the H2@Scale vision is to enable hydrogen use in heavy-duty (HD) vehicles, including truck, marine, and rail applications.

Interest in HD fuel cell vehicles operating on hydrogen is growing rapidly, due to the benefits of zero tailpipe emissions (i.e., carbon, NOx, SOx, etc.) as well as low life-cycle greenhouse gas emissions, along with long driving range, fast fueling times, high fuel efficiency, and high power operation. Deployment of HD fuel cell vehicles will require the design and development of novel hydrogen fueling technologies and processes that can enable fueling times comparable to incumbent technologies (i.e., diesel trucks). This will require hydrogen flow rates approximately five times greater[29] than those in current light-duty hydrogen fueling stations.[30]

This Topic Area includes two subtopics to advance high-flow fueling technologies and processes. Subtopic 3A (Domestic Supply Chain for High-flow Hydrogen Fueling Stations) focuses on the development of low-cost, reliable, high-flow hydrogen fueling station components for HD trucks. Subtopic 3B (Validation of High-Flow Refueling Models) focuses on experimental evaluation and validation of a fueling model suitable for high-flow gaseous fueling processes (i.e., for heavy-duty trucks, marine, rail, etc.). This area of R&D is also applicable to medium duty (MD) fuel cell vehicles which can offer opportunities in specific applications, for low life-cycle emissions (zero tailpipe emissions), along with fast fueling and long driving ranges.

Anticipated Funding and Award Details

Topic Area	Total Funding Level	Anticipated Number of Awards	Federal Funding per Award	Max. Project Duration (years)	Min Required Non-Federal Cost Share %
Subtopic 3A: Domestic Supply Chain for High-flow Hydrogen Fueling Stations	**$8M**	**4 to 6**	**$1-3M***	**3**	**20%**
Subtopic 3B: Validation of High-flow Refueling Models	**$2M**	**1 to 2**	**$1-2M**	**3**	**20%**
Total:	**Up to $10M**	**5 to 8**			

* The funding requested should be commensurate with the level of work proposed. While the maximum per award is $3M for Topic 3A, smaller more focused projects (~$1M/project) that advance existing/most promising concepts for high-flow components are also encouraged.

[29] https://www.hydrogen.energy.gov/pdfs/19006_hydrogen_class8_long_haul_truck_targets.pdf

[30] https://www.sae.org/standards/content/j2601_202005/https://www.sae.org/standards/content/j2601_202005/

Subtopic 3A: Domestic Supply Chain for High-flow Hydrogen Fueling Stations

Subtopic 3A Introduction/Background:

Deployment of MD/HD fuel cell vehicles is currently limited by the availability of hydrogen fueling technologies that can affordably and reliably dispense hydrogen approximately five times faster than equipment used in light-duty fueling. Aggressive fill rates will be necessary because HD trucks are expected to store an order of magnitude more hydrogen onboard than light-duty vehicles to meet their power and range requirements.

While the fill rate required will vary depending upon a truck's class and vocation, DOE's fueling rate target for Class 8 long-haul trucks is 10 kg H_2/min[29] (averaged over the duration of the fill), to enable full fills within timeframes comparable to those for today's diesel trucks (e.g. approximately 5-6 minutes). This target is based on a desire for hydrogen fuel cell trucks to achieve a 750-mile driving range between refueling, which will require onboard storage of approximately 60 kg of H_2 (assuming a fuel economy of 12.4 mpkg for Class 8 tractor-trailer trucks).

Back-to-back fueling of fuel cell trucks at rates close to 10 kg/min is also essential for a commercial market, and will necessitate the development of hydrogen fueling technologies that have up to ten times greater capacity than those currently commercially available. R&D is needed to develop novel approaches to scale current components and to expand the domestic supply chain for heavy-duty hydrogen fueling technology.

While 10 kg/min is the ultimate target, DOE also set an interim (2030) target of 8 kg/min to provide a fill sufficient for a 750-mile range in under 10 minutes, assuming a lower fuel economy. Components that can enable meeting or approaching this interim target are also desired and applicants should state the average flow rate they propose to achieve.

Subtopic 3A Description/Objective:

EERE seeks the development of low-cost, reliable, domestically supplied hydrogen fueling station components to enable high-flow hydrogen fueling of heavy-duty trucks. Potential heavy-duty hydrogen fueling station technologies of interest include, but are not limited to, the following:

- Dispensing hoses, breakaway couplings, and nozzles;
- Chillers;
- High-precision flow meters;
- Flow control and shut-off valves; and
- Compressors and cryo-compressors / cryopumps.

Key performance metrics include:

1) Components must be designed to enable 700-bar fueling at -40°C and an average fill rate of approximately 10 kg H_2/min[29]. While 10 kg/min is the ultimate target, concepts that can meet or at least approach this target are desired and applicants should state the average rate they propose to achieve. Components for fueling at alternative pressures and temperatures will also be considered with with letter(s) of support from at least one end user; and
2) Peak operating pressure of at least 875 bar for all components, and an operating temperature of -40°C for components downstream of the chiller (e.g., hose, valves, dispenser, etc.).

Applications should include the following:

- Describe the current status of the technology, including any limitations of commercially available components;
- Compare the proposed concept's cost and performance capabilities (e.g., pressure, flow rate, temperature) with current state-of-the-art;
- Describe how the proposed concept would enable 10 kg/min (average) fills at fueling stations;
- Detail the design and development effort;
- Specify the materials of construction;
- Include a detailed estimate of the cost of the proposed technology;
- Describe how the prototype equipment will be tested, including a description of data that will be collected during prototype testing;
- As applicable, address cybersecurity challenges and vulnerabilities; and
- To ensure market relevance, EERE encourages applicants to include letters of support from industry stakeholders (e.g., station developers/operators, MD/HD vehicle manufactures or operators).

Below is more information regarding the individual heavy-duty hydrogen fueling station technologies of interest.

Dispensing Components

This subtopic seeks high-flow dispensing concepts able to achieve average flow rates of 10 kg/min, designed to accommodate operating pressures of at least 875 bar. Concepts sought include nozzles, hoses, and associated breakaway couplings. Applications may focus on novel designs for these components or novel manufacturing processes.

Components should be capable of sustaining a 10 kg/min average flow rate for 10-minute intervals and sustaining a peak flow rate of up to 14 kg/min. Nozzles should also be resistant to freeze-lock. Nozzles and hoses must both be lightweight and flexible enough for regular use by truck drivers and fueling station attendants. Hoses should target a fatigue life of at least 50,000

cycles. Concepts should also be capable of incorporating communications technologies. Applications should include detailed cost estimates of the proposed technology (not including the cost of communications).

Chillers:

Hydrogen chillers that can achieve -40 °C fills are commercially available, but do not meet the flow rate and cooling power requirements of MD/HD vehicles. Cooling capacities of over 100 kW will be necessary to facilitate 10 kg/min refueling at -40°C.[31]

Applications are sought for R&D of novel concepts that will allow for rapid hydrogen refueling of HD vehicles. Concepts proposed should adhere to the flow rate and temperature standards of 10 kg/min (average) and -33 °C at the point of dispensing within 30 seconds; however, viable alternatives to temperature standards will be considered. Proposed concepts can range in scope from component to system level. Examples include, but are not limited to, chillers that enable on-demand supply of cold hydrogen, short-term intermediate cold storage, and systems that circumvent hydrogen precooling.

Chiller concepts must describe the scalability of the design, maintenance requirements, ambient operating temperature range, and expected cost. Concepts must target a cooling power of at least 100 kW, with a stretch goal of 300 kW.

Meters:

In order to accurately measure the mass of hydrogen dispensed at HD retail stations, new higher-capacity meters will be needed. This subtopic seeks the development of hydrogen gas flowmeters with an accuracy of at least 5%, with a stretch goal of 2%, with repeatable results over the entire flow range (up to 14 kg/min peak flow). The meters must be capable of retaining a 5% accuracy during pressure and temperature fluctuations expected during a fill (up to at least 950 bar and down to -40 °C).

Flow control and shut-off valves:

A supply chain for high-flow, high-pressure components, such as flow control and shut-off valves, will be necessary for station development. This subtopic seeks the development of these flow control and shut-off valves designed for compatibility with MD/HD fueling station designs. The necessary dimensions of these components will vary depending on the fuel flow rate and pressure rating of the fuel dispensing system itself. To ensure the development of commercially relevant concepts, applicants must partner with an industry stakeholder involved in the development of MD/HD fueling stations or vehicles. The pressure rating, temperature rating,

[31] Based on simulations of 7 kg/min fills with a 50-truck fleet comprising 60 kg storage onboard within the Heavy Duty Refueling Station Analysis Model (HDRSAM). In this scenario, the cooling power required is approximately 80 kW. While 10 kg/min is the ultimate target, concepts that can meet or at least approach this target are desired and applicants should state the maximum rate they propose to achieve.

dimensions, and uses of the components being developed must be described, rationale for these specifications must be provided, and the current state-of-the-art must also be described.

Compressors/Cryopumps:

Compressor and cryopump concepts should target output pressures of at least 875 bar, and a flow rate of 500 kg/hour, with a stretch goal of 1,000 kg/hour. EERE may consider applications that target intermediate output pressures if a strong market viability justification is provided. Applications should include detailed cost estimates of the proposed technology.

Proposed high-flow compressor/cryopump concepts should target > 90% reliability and should be designed to mitigate contamination of hydrogen fuel. To verify reliability, applications should include prototype testing, including long-duration performance testing that measures energy consumption and assesses reliability.

Compressor and cryopump components (e.g., valves, diaphragms, pistons, and seals) must be designed for aggressive mechanical loading in high-pressure hydrogen. In addition to an overall focus on cost, flow rate, and reliability, proposed R&D may include the following:

- Design of novel components (e.g., diaphragms, valves, pistons, and driving components) to facilitate high-flow operation;
- Novel management of boil-off to reduce the cryopump operating cost; and
- Processes and technologies for manufacturing of large-scale components.

Compressor concepts must include a description of key compressor metrics necessary to meet the targeted flow rates (e.g., piston speed, displacement, etc.) and projected energy consumption.

Subtopic 3A Project Structure:

Applicants should propose projects up to 3 years in length for a total DOE funding of $1,000,000 to $3,000,000 for each project. EERE intends to select 4 to 6 projects based on available funds and proposed scope, with a preference for smaller more focused projects (~$1M/project) that advance existing/most promising concepts of high-flow components. The funding requested should be commensurate with the level of work proposed. Projects should be planned as two or three multi-phase efforts with a quantitative Go/No-Go decision point with specific criteria and metrics separating each phase (each budget period should be approximately 12 to 18 months long). Projects must include at least 20% cost share consistent with R&D activities.

Subtopic 3A Teaming Arrangements:

Teams that include fueling component developers are strongly encouraged. For example, teams that include industry partners that have previous experience in hydrogen and/or other (e.g., natural gas) fueling applications are preferred over applications that do not. Partnerships with domestic entities are strongly preferred, and a foreign work waiver will be required for any work performed outside the United States (see Section IV.J.iii Performance of Work in the United States for more information). Strong preference is given to applicants with domestic manufacturing capabilities and intent to manufacture in the United States.

Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs),[32] or through linkages with Opportunity Zones[33] are encouraged.

EERE is compiling a Teaming Partner List to facilitate the widest possible national participation in the formation of applicant teams for this topic. The list allows organizations who may wish to participate in an application, but do not wish to apply as the Prime applicant, to express their interest to potential applicants and to explore potential partners.

The Teaming Partner List will be available on the HFTO website at https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office-funding-opportunities under FOA DE-FOA-0002446 during the time of its release through its closing. The Teaming Partner List will be updated at least weekly until the close of the Full Application period, to reflect new Teaming Partners who have provided their information. Any organization that would like to be included on this list should submit the following information to HFTOFOA@ee.doe.gov, with the subject line "Teaming Partner Information FOA-0002446":

Topic Area(s) of Interest, Organization Name, Contact Name, Contact Address, Contact Email, Contact Phone, Organization Type, Area of Technical Expertise, and Brief Description of Capabilities.

By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of the above-referenced information. By facilitating this Teaming Partner List, EERE does not endorse or otherwise evaluate the qualifications of the entities that self-identify themselves for placement on the Teaming Partner List. EERE will not pay for the

[32] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[33] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

Subtopic 3B: Validation of High-flow Refueling Models

Subtopic 3B Introduction/Background:

A critical barrier to the deployment of heavy-duty applications (trucks, rail, marine, etc.) is the lack of protocols for high-flow fueling. The accepted industry-standard protocol for light duty vehicles is SAE J2601, which establishes guidance for factors such as maximum flow rate, rate of pressure increase, and temperature. With this protocol, fueling heavy-duty applications (such as Class 8 trucks) would be too slow to meet industry and end-user needs.[29] R&D is necessary to support the development of a high-flow fueling protocol which can achieve the targeted average fill rate of 10 kg/minute.

Such high-flow fueling protocols are currently in the early stages of development in the international regulations, codes and standards (RCS) community. A number of high-flow fueling models have been developed or are currently being developed, and R&D input to validate the theoretical models (preferably reduced-order models) is a critical component to the development of a scientifically defensible fueling protocol.

Subtopic 3B Description/Objective:

This subtopic seeks applications for experimental evaluation and validation of a fueling model suitable for high-flow gaseous fueling processes. EERE seeks applications focused on fueling for 350 bar and 700 bar applications, in alignment with RCS development efforts. This topic is aimed at identifying fueling process characteristics to support the development of international codes and standards for high-flow gaseous fueling process control.

Applicants should describe plans to demonstrate validation of fueling models capable of accurately simulating the relevant technical targets for 700 bar fueling (as outlined in the DOE Technical Targets for Class 8 Trucks[29]) and 350 bar fueling. If other pressures (e.g. 500 bar) are proposed, the applicants should provide strong justification.

Given the limited availability of facilities capable of performing full-scale experimental validation, EERE is interested in sub-scale validation efforts for this subtopic. Sub-scale validation also allows for flexibility to adapt to varied vehicle and station configurations, as components for high-flow fueling are still in development as well. Applicants should demonstrate that the sub-scale results can be brought to full scale and should address the range of conditions they intend to examine, such as those conditions beyond the capabilities of currently available hardware. Applicants should also address the extensibility of the validation to applications beyond that examined in the scope of work.

Applicants should consider existing fueling models as well as those currently in development for validation. Collaboration with international partners is encouraged. Model development should only be proposed where necessary to fill critical gaps in model scope or capability, and applicants should provide justification for including model development.

Applicants should describe planned efforts to engage with the RCS community to support the development of international codes and standards for high-flow gaseous fueling process control. Applications should also clearly describe reporting plans to make validation methodologies and resulting data publicly available. This reporting should include:

- Boundary conditions;
- Results of model validation;
- Scaling assumptions and calculations (if validation is performed at sub-scale);
- Operational space constraints (e.g., limitations for flows, temperatures, pressures, vehicle or station storage capacities, etc.) in validated model(s); and
- Model revisions and/or model(s) developed during the course of the work.

Subtopic 3B Project Structure:

Applicants should propose projects up to 3 years in length for a total DOE funding of $1,000,000 to $2,000,000 for each project. EERE intends to select 1 to 2 projects based on available funds and proposed scope. The funding requested should be commensurate with the level of work proposed. Projects should be planned as two or three multi-phase efforts with a quantitative Go/No-Go decision point with specific criteria and metrics separating each phase (each budget period should be approximately 12 to 18 months long). Projects must include at least 20% cost share consistent with R&D activities.

Subtopic 3B Teaming Arrangements:

Industry led efforts are highly encouraged. Applicants should consider leveraging the world-class capabilities of the DOE's national laboratories[34] and should engage relevant stakeholders. Applications should detail: 1) the manner in which national laboratory capabilities will be effectively leveraged (if used), and 2) proposed engagement of stakeholders (e.g., hydrogen providers, OEMs or other end users of hydrogen, state organizations, etc.) for work.

[34] https://www.energy.gov/national-laboratories

Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs)[35], or through linkages with Opportunity Zones[36] are encouraged.

EERE is compiling a Teaming Partner List to facilitate the widest possible national participation in the formation of applicant teams for this topic. The list allows organizations who may wish to participate in an application, but do not wish to apply as the Prime applicant, to express their interest to potential applicants and to explore potential partners.

The Teaming Partner List will be available on the HFTO website at https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office-funding-opportunities under FOA DE-FOA-0002446 during the time of its release through its closing. The Teaming Partner List will be updated at least weekly until the close of the Full Application period, to reflect new Teaming Partners who have provided their information. Any organization that would like to be included on this list should submit the following information to HFTOFOA@ee.doe.gov, with the subject line "Teaming Partner Information FOA-0002446":

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Topic Area 4: Cost and Performance Analysis for Fuel Cells, Hydrogen Production, and Hydrogen Storage

A key component of the HFTO portfolio is a comprehensive set of analysis projects involving all aspects of hydrogen and fuel cell technologies; including hydrogen production, delivery, dispensing, and storage, as well as fuel cells and end use applications. HFTO's analytical efforts

[35] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[36] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

include a bottom up approach for projecting the costs of components and systems based on performance characteristics. Through analysis work, HFTO seeks to define the current state-of-the-art in all areas, develop and refine system configurations and designs, provide guidance on R&D gaps, and help to direct future R&D priorities. As H2@Scale enables a broadening of hydrogen's application space to include emerging uses in medium- and heavy-duty transportation, energy storage (e.g., data centers) and industrial applications (e.g., steelmaking), a concurrently broader scope is needed in the office's analysis portfolio to appropriately match hydrogen technologies to various use cases and needs. In this topic, HFTO seeks cost and performance analysis projects under three subtopics, specifically aimed at fuel cells, hydrogen production, and hydrogen storage.

For all subtopics, it is expected that cost analyses will include, but not be limited to: literature and patent reviews; component design evaluation with relevant third-parties to ensure sufficient detail to allow accurate definition of bill of materials and the associated costing; and detailed Design-for-Manufacturing-and-Assembly (DFMA) cost analysis. The recipient will be expected to work with HFTO to obtain relevant technical information from third-party technology developers. The recipient is also expected to work with equipment vendors to obtain relevant equipment manufacturing cost and production volume data to be used in the overall system cost analyses.

The analyses will include activities such as review of the status of selected technologies and constituent components. Efforts may also include analysis of materials properties and characterization, system level designs, safety procedures and testing, and subsystem and BOP components as directed by HFTO. Cost model validation will include defining baseline costs incorporating data from current industry-accepted technologies, with HFTO guidance and approval. Relative to the baselines, analysis will be performed to determine sensitivities to major cost drivers, such as capital expenses, feedstock costs, installation costs, and operations and maintenance. At the conclusion, a report must be generated documenting the results of the analyses, including sensitivity analyses along with standard tornado charts to demonstrate critical correlation among the cost drivers.

All projects will be subject to evaluation by system developers, independent peer review, and the HFTO Annual Merit Review evaluation process. Results of the merit review will factor into project continuation decisions through following years. The recipient will also be required to present results as needed to relevant DOE and U.S. DRIVE[37] Technology Teams. Project deliverables will include manufacturing cost estimates and analysis for complete systems of the applicable technology; fuel cells, production, or storage. The applicant will provide HFTO with comprehensive reports which will be made available to the public for each of the systems analyzed, and at a minimum will include the following:

[37] Information on USDRIVE can be found at http://www.uscar.org/guest/partnership/1/us-drivehttp://www.uscar.org/guest/partnership/1/us-drive

1. Detailed system definition (including bill of materials) for the technology being analyzed in the chosen subtopic (e.g., fuel cells for heavy-duty applications, hydrogen production technologies, and hydrogen storage technologies, as described in subtopic descriptions below).
2. Baseline technology assessments of current components and/or systems, with validation of cost models based on data from current industry-accepted representative system designs.
3. Cost estimates, assumptions, key input parameters and associated data used in the analyses; the sensitivity/uncertainty analyses and the associated range of uncertainties used as well as rationale for the selected ranges; and out year cost projections for varying manufacturing volumes as directed by HFTO (with presentations and written reports when requested).
4. Mathematical functions for scaling component cost as a function of component design specifications (e.g., stack cost as a function of voltage and current density at rated power, or air blower cost as a function of pressure and flow rate). The functions will be developed in consultation with the system performance modelers specified by HFTO as a means to optimize system designs for lowest lifecycle cost.
5. Assistance in drafting of cost records on request by HFTO and as appropriate.[38]
6. Final report documenting the results, assumptions, and key input parameters and associated data of the analyses including sensitivity analyses along with standard tornado charts to demonstrate critical correlation among cost drivers.

Anticipated Funding and Award Details

Topic Area	Total Funding Level	Anticipated Number of Awards	Federal Funding per Award	Max. Project Duration (years)	Min Required Non-Federal Cost Share %
Subtopic 4A: Fuel Cells	$1.5M	1	$1.5	4	N/A
Subtopic 4B: Hydrogen Production	$1M	1	$1M	3	N/A
Subtopic 4C: Hydrogen Storage	$1M	1	$1M	3	N/A
Total:	Up to $3.5M	3			

[38] https://www.hydrogen.energy.gov/program_records.html
https://www.hydrogen.energy.gov/program_records.html

Subtopic 4A: Fuel Cells

Subtopic 4A Introduction/Background:

Applications are sought for fuel cell system techno-economic analyses for heavy-duty and medium-duty applications. The analyses will envision, define, and determine the cost of current and future advanced fuel cell systems for various sizes, applications, and manufacturing volumes. The analyses should include a ground-up cost projection based on conceptual designs and related costs of fuel cell system and component manufacturing equipment and processes.

There is a rapidly growing interest in the use of hydrogen fuel cells for transportation applications, including heavy-duty and medium-duty trucks, marine, and rail applications. Fuel cells offer several advantages over incumbent technologies such as diesel engines, including higher efficiency, reduced emissions with no tailpipe emissions, higher torque, and no noise pollution. Additionally, they offer fast fueling and adequate fuel storage for applications demanding longer range. In order to accelerate commercialization for heavy-duty applications, a credible and referenceable manufacturing cost estimate is required to accurately gauge the status and the potential of the technology.

Subtopic 4A Description/Objective:

The applicant will be expected to conduct a bottom-up assessment of the projected current and future costs (2025 and 2030) that are based on scenarios with the potential to meet HFTO goals. Generating a rigorous cost estimate requires a thorough understanding of current polymer electrolyte membrane fuel cell (PEMFC) technology, as well as a rigorous design and evaluation methodology, that when applied to the technology will yield optimized (on a lifecycle cost basis) components and manufacturing processes. The assessment should include reasonable assumptions of the durability that can be obtained by the fuel cell system, including the costs associated with oversizing the initial fuel cell stack and any necessary system mitigation strategies that would allow meeting durability targets.

The applicant's work scope should include a detailed annual reference report on the cost of heavy duty fuel cell systems for the following applications: class 8 heavy-duty trucks, class 4 medium-duty trucks, trains, and ferries. Ideally, the applicant will develop a flexible model that will easily allow for additional heavy-duty applications, with the understanding that detailed analysis of one system could be leveraged to do analyses of other applications (e.g., analyzing class 5, 6, and 7 based on classes 4 and 8). The heavy-duty analysis should also be leveraged to provide biannual updates to light-duty vehicle cost estimates. The report must document the cost of transportation technologies, reflecting technological advances made to date, and provide a calculated cost per kilowatt of the baseline fuel cell system that could be built with present technology at several application-relevant production rates, with the volume to be analyzed varying depending on particular applications (e.g., 200, 500, 1,000, 10,000, 50,000, and 100,000 systems per year). The analysis will also include an examination of the capital equipment specified in the annual system cost analysis, clarifying which equipment uses

existing manufacturing technologies and which equipment costs are higher-risk, conceptually-designed manufacturing methods. The risk of each proposed manufacturing process should be assessed to identify processes that may benefit from further R&D as a method of risk reduction. Manufacturing quality control measures necessary to ensure the high yields and low cost at high annual production rates assumed in the cost analysis should be thoroughly examined and included in the report. As a reference, prior cost analyses may be found under transportation at: http://energy.gov/eere/fuelcells/fuel-cell-technical-publications.

In addition to the standard bottom-up approach, the applicant will be expected to assist in top-down techno-economic analyses, led by national laboratory analyses projects funded by HFTO. In particular, the applicant will work with the Million Mile Fuel Cell Truck (M^2FCT) consortium to assess the cost of advanced materials and components; optimize modeled system designs projected to meet durability and performance requirements; and optimize the total cost of ownership, based on system models that investigate unique system architectures and hybridization schemes that include tradeoffs between durability, efficiency, and capital cost. The result of the top-down approach should be a streamlined, publically accessible model on a website that allows users to evaluate the total cost of ownership for various applications based on their own assumptions. M^2FCT will lead this effort, and the applicant should support this work wherever possible.

Subtopic 4B: Hydrogen Production

Subtopic 4B Introduction/Background:

At the center of the H2@Scale initiative is the production of hydrogen from diverse domestic resources across a variety of technology pathways. Understanding the potential of these pathways to meet HFTO cost targets for diverse end uses (including high-quality hydrogen used as transportation fuel as well as different industrial applications) is critical. System and component-level analyses of hydrogen production technologies are needed to define the current state-of-the-art; direct system configuration and design; identify R&D gaps; and help direct future priorities.

Subtopic 4B Description/Objective:

Applications are sought for comprehensive techno-economic analyses of distributed- and/or centralized-hydrogen production pathways[39] that include, but are not limited to: waste and/or biomass conversion technologies; high and low temperature electrolysis; solar thermochemical and photoelectrochemical water splitting; and other innovative concepts as requested by HFTO. Production pathways that enable emerging hydrogen end uses, such as heavy-duty transportation, grid resiliency, data centers, and steelmaking, are of particular interest.

[39] Distributed assumes 1,500 kg-H_2/day and Central assumes 50,000 kg-H_2/day.

The applicant will be expected to perform a thorough cost analysis for the chosen hydrogen production pathway, including component- and system-level assessments of the hydrogen generation equipment with associated balance-of-plant (BOP). This will include assessing the current state of the hydrogen production technology, incorporating current manufacturing costs and volumes of both systems and components, and identifying key barriers limiting production scale up. Working with original equipment manufacturers, researchers, and other analysis teams, applicants will be expected to assess the potential of and associated costs for current status as well as increased production volumes in the 2025 timeframe and beyond. Applicants also will be required to incorporate assessments of any feedstock procurement and pre-treatment costs (including the additional BOP needed for pre-treatment). Considerations should include costs associated with feedstocks at the national, regional, and local levels.

Applicants for this subtopic are also expected to identify specific requirements and parameters for different end uses (e.g., fuel cells for transportation and power generation compared with industrial/chemical processes, which can require hydrogen of different purity levels, pressure, etc.). Specific end-use considerations may include but are not limited to footprint; duty cycles; hydrogen storage needs; dryer and purification requirements; compressor needs; and dispenser requirements. The analysis is expected to focus on evaluating a hydrogen production technology's potential for meeting HFTO targets, and determining the crossover point where the hydrogen produced becomes a viable and cost-competitive option for the identified application, including cost issues related to component/system manufacturing, operational maintenance and replacement requirements.

Analysis efforts related to hydrogen production pathways are expected to leverage the most recent version of Hydrogen Analysis (H2A v3.2018)[40] to evaluate technology-specific hydrogen production cost status as a function of production volume; and to identify potential cost reductions based on sensitivity analyses, specifically to quantify the improvements possible through technology advancements. Updates to previously-published technology-specific H2A case studies, which are publicly available,[41] may also be needed, as per HFTO directive.

Subtopic 4C: Hydrogen Storage

Subtopic 4C Introduction/Background:

For widespread adoption, any hydrogen storage system must be competitive with alternative technology options in terms of performance and cost. As new applications for hydrogen emerge, such as for medium and heavy-duty transportation (e.g., trucks, rail, marine), stationary energy storage (e.g, data centers), industrial (e.g., steel manufacturing), alternative types of hydrogen storage to the traditional 700 bar technology first utilized on light-duty vehicles are gaining attention. These other storage options include bulk compressed, liquid,

[40] H2A is a discounted cash-flow model providing transparent reporting of process design assumptions and a consistent cost analysis methodology for hydrogen production at central and distributed facilities.

[41] The H2A Production Case Studies can be found at: https://www.hydrogen.energy.gov/h2a_production.html

materials-based, and hydrogen carriers. Analysis is needed to identify the cost benefits or drawbacks of various storage options for each new application solutions.

Subtopic 4C Description/Objective:

Applications are sought for techno-economic and life-cycle assessment analyses of advanced hydrogen storage technologies. The techno-economic analyses should include a bottom-up assessment of the projected future costs (2025 and beyond), at low through high-volume manufacturing of hydrogen storage systems with comparisons to HFTO cost targets and identification of primary contributors in need of further development for cost reduction. Hydrogen storage systems to be considered span a large range of sizes and technologies—from smaller compressed systems for onboard use to large liquid systems for bulk stationary storage (e.g. for data centers, industrial end uses, etc.). The analyses will need to include developing manufacturing costs for innovative system components, such as alternative fibers, advanced fiber composites, novel hydrogen storage materials and systems, or equipment to carry out hydrogenation/dehydrogenation of hydrogen carriers. The hydrogen storage systems will be based primarily on system process designs and specifications from a third-party. The system specifications and designs will be based on referenceable system models. The cost analysis will also consider and include material disposal requirements, as well as validation of spent fuel regeneration and first fill fuel costs.

Generating a rigorous cost estimate requires a thorough understanding of currently used hydrogen storage systems and proposed technologies for a range of applications at all scales (e.g., 350 bar, 700 bar, liquid hydrogen, cryo-compressed storage, adsorbent material, low-temperature metal hydride, complex metal hydride, and hydrogen carriers); specific requirements of current and early market end use applications; balance-of-plant (BOP) component requirements; and all associated manufacturing processes. These system cost analyses should be based on hydrogen storage system measurements that have been previously verified or on well-vetted projections of performance for proposed and developing technologies. The impact of the variation of hydrogen storage performance on cost should be analyzed, quantified, and documented.

Topic 4 Project Structure:

Applicants should propose 4-year projects for total DOE funding of up to $1,500,000 for topic 4a, and 3-year projects for total DOE funding up to $1,000,000 for topics 4b and 4c. The funding request should be commensurate with the level of work proposed. Projects should be planned as 3-4 multi-phase efforts (depending on the duration of the project) with a Go/No-Go decision point separating each phase (budget period). Each phase (budget period) should be planned for approximately 12 to 18 months. Applicants should provide project work plans with strong quantitative Go/No-Go decision points including clear metrics that demonstrate progress in developing assessment of the hydrogen industry, targeting the metrics given in the previous section, as applicable. Projects are not required to provide cost share.

Topic 4 Teaming Arrangements:

Teams that include representation from diverse entities such as, but not limited to: Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities (HBCUs)/Other Minority Institutions (OMIs),[42] or through linkages with Opportunity Zones[43] are encouraged.

EERE is compiling a Teaming Partner List to facilitate the widest possible national participation in the formation of applicant teams for this topic. The list allows organizations who may wish to participate in an application, but do not wish to apply as the Prime applicant, to express their interest to potential applicants and to explore potential partners.

The Teaming Partner List will be available on the HFTO website at https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office-funding-opportunities under FOA DE-FOA-0002446 during the time of its release through its closing. The Teaming Partner List will be updated at least weekly until the close of the Full Application period, to reflect new Teaming Partners who have provided their information. Any organization that would like to be included on this list should submit the following information to HFTOFOA@ee.doe.gov, with the subject line "Teaming Partner Information FOA-0002446":

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By submitting a request to be included on the Teaming Partner List, the requesting organization consents to the publication of the above-referenced information. By facilitating this Teaming Partner List, EERE does not endorse or otherwise evaluate the qualifications of the entities that self-identify themselves for placement on the Teaming Partner List. EERE will not pay for the provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

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

[42] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[43] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

B. Applications Specifically Not of Interest

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

- Applications that fall outside the technical parameters specified in Section I.A. and I.B. of the FOA.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- **Subtopic 1A:** Proposals for solid oxide fuel cells, molten carbonate fuel cells, phosphoric acid, polybenzimidazole-type phosphoric-acid fuel cells, and alkaline anion exchange fuel cells, will not be considered. Also, proposals that rely on the extensive use of precious metals and system mitigation approaches to enhance durability will not be considered.
- **Subtopic 1B:** Proposals for blowers more suitable to supply air to stationary fuel cell systems and air management components designed for high temperature fuel cells, including solid oxide fuel cells and molten carbonate fuel cells, will not be considered.
- **Subtopic 2A:** EERE is not interested in projects specifically addressing low temperature electrolyzers (e.g., PEM and alkaline (including both conventional KOH and alkaline exchange membrane)). Projects focused on new materials development are also not of interest. In addition, EERE is not interested in BOP components other than power electronics for this topic.
- **Subtopic 2B:** Pathways specifically not considered in this topic include biological processes that utilize sunlight energy such as photolytic or photofermentative systems; these applications will be considered nonresponsive. Applications specifically designed for and demonstrated exclusively on fossil-based waste streams are not of interest.
- **Subtopic 3A:** Components that are not currently viable at high flow rates (such as metal hydride and electrochemical compressors) are not of interest.
- **Subtopic 3B:** EERE is not interested in applications proposing modeling efforts, except where justified to fill critical gaps as described above. Additionally, EERE does not seek applications proposing to build commercial fueling infrastructure.

C. Authorizing Statute

The activities supported by this FOA are authorized under the Energy Policy Act of 2005 (EPACT 2005) Public Law 109-58 (Aug. 5, 2005), Title VIII - HYDROGEN, Sections 801 to 816. These provisions are found in the United States Code at 42 U.S.C. §§ 16151 to 16165. Title VIII authorizes the Secretary of Energy to conduct a program of research, development and demonstration on technologies relating to the

production, purification, distribution, storage, and use of hydrogen energy, fuel cells, and related infrastructure.

Awards made under this announcement will fall under the purview of 2 Code of Federal Regulation (CFR) Part 200 as amended by 2 CFR Part 910.

II. Award Information

A. Award Overview

i. Estimated Funding

EERE expects to make a total of approximately $33,500,000 of federal funding available for new awards under this FOA; $28,500,000 from HFTO, $5,000,000 from AMO, all subject to the availability of appropriated funds. EERE anticipates making approximately 16 to 24 awards under this FOA. EERE may issue one, multiple, or no awards. Individual awards may vary between $1,000,000 and $5,000,000.

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

Topic Area Number	Topic Area Title	Anticipated Number of Awards	Anticipated Minimum Award Size for Any One Individual Award (Fed Share)	Anticipated Maximum Award Size for Any One Individual Award (Fed Share)	Approximate Total Federal Funding Available for All Awards	Anticipated Period of Performance (months)
1A	Fuel Cell R&D for Heavy-Duty Applications – Low-Cost, Durable Bipolar Plates	2-4	$1,000,000	$2,000,000	$4,000,000	36
1B	Fuel Cell R&D for Heavy-Duty Applications – Innovative, Low-Cost Air Management Components	2-4	$1,000,000	$2,000,000	$4,000,000	36
2A	Efficient and Innovative Hydrogen Production – H2NEW - High Temperature Electrolysis	2-3	$3,000,000	$5,000,000	$10,000,000	36
2B	Efficient and Innovative Hydrogen	2	$1,000,000	$1,000,000	$2,000,000	36

	Production – Innovative Biological/Waste to Hydrogen					
3A	High-flow Fueling Applications – Domestic Supply Chain for High-flow Hydrogen Fueling Stations	4-6	$1,000,000	$3,000,000	$8,000,000	36
3B	High-flow Fueling Applications – Validation of High-flow Refueling Models	1-2	$1,000,000	$2,000,000	$2,000,000	36
4A	Heavy Duty Fuel Cell Cost Analysis	1	$1,500,000	$1,500,000	$1,500,000	48
4B	Hydrogen Production Cost Analysis	1	$1,000,000	$1,000,000	$1,000,000	36
4C	Hydrogen Storage Cost Analysis	1	$1,000,000	$1,000,000	$1,000,000	36

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. Before the expiration of the initial budget period(s), EERE may perform a down-select among different recipients and provide additional funding only to a subset of recipients.

ii. Period of Performance

EERE anticipates making awards that will run from 24 months up to 48 months in length, comprised of one or more budget periods. Project continuation will be contingent upon several elements, including satisfactory performance and Go/No-Go decision review. For a complete list, see Section VI.B.xiv. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule adherence, the extent milestone objectives are met, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, EERE 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.

Topic Area Number	Topic Area Title	Estimated Duration of Award (months)
1A	Fuel Cell R&D for Heavy-Duty Applications – Low-Cost, Durable Bipolar Plates	36
1B	Fuel Cell R&D for Heavy-Duty Applications – Innovative, Low-Cost Air Management Components	36
2A	Hydrogen Production - H2NEW - High Temperature Electrolysis	36
2B	Hydrogen Production - Innovative Biological/Waste to Hydrogen	36
3A	Hydrogen Infrastructure: Domestic Supply Chain for High-flow Hydrogen Fueling Stations	36
3B	Hydrogen Infrastructure: Validation of High-flow Refueling Models	36
4A	Heavy Duty Fuel Cell Cost Analysis	48
4B	Hydrogen Production Cost Analysis	36
4C	Hydrogen Storage Cost Analysis	36

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 Federally Funded Research and Development Center (FFRDCs)

In most cases, FFRDCs 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 eligibility requirements, it will be considered ineligible and removed from further evaluation.

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 and have a physical location for business operations in 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 FFRDCs are eligible to apply for funding as a subrecipient, but are not eligible to apply as a prime recipient.

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 and have a physical location for business operations in the United States. If a foreign entity applies for funding as a prime recipient, it must designate in the Full Application a subsidiary or affiliate incorporated (or otherwise formed) under the laws of a state or territory of the United States to be the prime recipient. The Full Application must state the nature of the corporate relationship between the foreign entity and domestic subsidiary or affiliate.

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

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

A foreign entity may receive funding as a subrecipient.

iv. Incorporated Consortia

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

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

v. Unincorporated Consortia

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

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

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

B. Cost Sharing

Topic Areas 1A, 1B, 2A, 2B, 3A, and 3B: 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.)

Topic Areas 4A, 4B, and 4C: Cost sharing is not required under this FOA for analysis activities.

Topic Area Number	Topic Area Title	Cost Share Requirement
1A	Fuel Cell R&D for Heavy-Duty Applications – Low-Cost, Durable Bipolar Plates	20%
1B	Fuel Cell R&D for Heavy-Duty Applications – Innovative, Low-Cost Air Management Components	20%

2A	Hydrogen Production - H2NEW - High Temperature Electrolysis	20%
2B	Hydrogen Production - Innovative Biological/Waste to Hydrogen	20%
3A	Hydrogen Infrastructure: Domestic Supply Chain for High-flow Hydrogen Fueling Stations	20%
3B	Hydrogen Infrastructure: Validation of High-flow Refueling Models	20%
4A	Heavy Duty Fuel Cell Cost Analysis	Cost Sharing Not Required
4B	Hydrogen Production Cost Analysis	Cost Sharing Not Required
4C	Hydrogen Storage Cost Analysis	Cost Sharing Not Required

To assist applicants in calculating proper cost share amounts, EERE has included a cost share information sheet and sample cost share calculation as Appendices A and B 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. 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 for additional cost sharing requirements.

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.

C. Compliance Criteria

Concept Papers, Full Applications, and Replies to Reviewer Comments 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 by the applicable deadline 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.

D. Responsiveness Criteria

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

E. Other Eligibility Requirements

i. 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 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 (WP) 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, the subrecipient'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 FFRDC effort, in aggregate, shall not exceed 50% of the total estimated cost of the project, including the applicant's and the FFRDC's portions of the effort.

F. Limitation on Number of Concept Papers and Full Applications Eligible for Review

An entity may submit more than one Concept Paper and Full Application to this FOA, provided that each application describes a unique, scientifically distinct project and provided that an eligible Concept Paper was submitted for each Full Application.

G. Questions Regarding Eligibility

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

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 Excahnge, submissions submitted after the applicable deadline, or 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 EERE Excange 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 Calibri 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; and
- 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, Full Applications, and Replies to Reviewer Comments 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 Excange, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made to any of these documents, 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, Full Applications, and Replies to Reviewer Comments 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 EERE 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 applicant should contact the EERE Exchange helpdesk for assistance (EERE-ExchangeSupport@hq.doe.gov). The EERE Exchange helpdesk and/or the EERE Exchange system administrators will assist applicants in resolving issues. .

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:

TechnicalVolume_Part_1
TechnicalVolume_Part_2

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 Section	1 page maximum	The cover page should include the project title, the specific announcement 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 page 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 posted on EERE Excange 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 Excange website at http://eere-Excahnge.energy.gov in accordance with the instructions.

Applicants will have approximately 30 days from receipt of the Concept Paper Encourage/Discourage notification on EERE Excange 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 clicking the "Create Concept Paper" button in EERE Excange, 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:

Topic Areas 1A, 1B, 2A, 2B, 3A, and 3B:

Component	File Format	Page Limit
Technical Volume	PDF	15
Resumes	PDF	1
Letters of Commitment	PDF	1
Statement of Project Objectives	MS Word	10
SF-424		
Budget Justification Workbook		
Summary/Abstract for Public Release	PDF	1

Summary Slide	MS PowerPoint	1
Subrecipient Budget Justification		
DOE Work Proposal for FFRDC, if applicable (see DOE O 412.1A, Attachment 3)	PDF	
Authorization from cognizant Contracting Officer for FFRDC	PDF	
SF-LLL Disclosure of Lobbying Activities	PDF	
Foreign Entities and Foreign Work	PDF	
U.S. Manufacturing Plan	PDF	
Data Management Plan	MS Word	

Topic Area 4A, 4B, and 4C:

Component	File Format	Page Limit
Technical Volume	PDF	15
Resumes	PDF	1
Letters of Commitment	PDF	1
Statement of Project Objectives	MS Word	10
SF-424	PDF	
Budget Justification Workbook		
Summary/Abstract for Public Release	PDF	1
Summary Slide	MS PowerPoint	1
Subrecipient Budget Justification		
DOE Work Proposal for FFRDC, if applicable (see DOE O 412.1A, Attachment 3)	PDF	
Authorization from cognizant Contracting Officer for FFRDC	PDF	
SF-LLL Disclosure of Lobbying Activities	PDF	
Foreign Entities and Foreign Work	PDF	
Data Management Plan	MS Word	

Note: The maximum file size that can be uploaded to the EERE Excange 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:

TechnicalVolume_Part_1
TechnicalVolume_Part_2

EERE will not accept late submissions that resulted from technical difficulties due to uploading files that exceed 50MB.

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

ii. Technical Volume

The Technical Volume must be submitted in 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.

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.

The Technical Volume should clearly describe and expand upon information provided in the Concept Paper. The Technical Volume must conform to the following content requirements:

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

Project Overview (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 (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 and Market Transformation Plan (Approximately 40% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed 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. • 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 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 Specific, Measurable, Achievable, Relevant, and Timely, 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. At a minimum, 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. See Section VI.B.xiv. The applicant should also provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. 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). At a minimum, 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 • Market Transformation Plan: The applicant should provide a market transformation plan, including the following: o Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan o Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, data dissemination, U.S. Manufacturing Plan, and product distribution.
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. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. • 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. Resumes

Applicants are required to submit 1-page resumes for key participating team members. Multi-page resumes are not allowed. Save the resumes in a single PDF file.

iv. Letters of Commitment

Submit letters of commitment from all subrecipient and third party cost share providers. If applicable, also include any letters of commitment from partners/end users (1-page maximum per letter). Save the letters of commitment in a single PDF file.

v. Statement of Project Objectives (SOPO)

Applicants are required to complete a SOPO. A SOPO template is available on EERE Exchange at https://eere-Exchange.energy.gov/. Applicants can choose to complete the SOPO using the EERE template in the EERE Exchange system, or it can be completed off-line and uploaded to the EERE Exchange system.

The SOPO, including the Milestone Table, must not exceed 10 pages. The SOPO must not exceed the page limit 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 MS Word file.

vi. 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".

vii. Budget Justification Workbook

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. 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".

viii. 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.

ix. Summary Slide

Applicants are required to provide a single MS PowerPoint slide summarizing the proposed project. This slide is used during the evaluation process.

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.

x. Subrecipient Budget Justification (if applicable)

Applicants must provide a separate budget justification for each subrecipient 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.

xi. Budget for DOE/NNSA FFRDC (if applicable)

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE WP in accordance with the requirements in DOE Order 412.1A, Work Authorization System, Attachment 3, available at: https://www.directives.doe.gov/directives-documents/400-series/0412.1-BOrder-a/@@images/file. Save the WP in a single PDF file.

xii. 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.

xiii. SF-LLL: Disclosure of Lobbying Activities (required)

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 the 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.

xiv. Waiver Requests: Foreign Entities and Foreign Work (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 C lists the necessary information that must be included in a request to waive this requirement.

2. **Performance of Work in the United States (Foreign Work Waiver)**
   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 C lists the necessary information that must be included in a foreign work waiver request.

Save the Waivers in a single PDF file.

xv. U.S. Manufacturing Commitments

Topic Areas 1A, 1B, 2A, 2B, 3A, and 3B:
Pursuant to the DOE Determination of Exceptional Circumstances (DEC) dated September 9, 2013, each applicant is required to submit a U.S. Manufacturing Plan as part of its application. The U.S. Manufacturing Plan represents the applicant's measurable commitment to support U.S. manufacturing as a result of its award.

Each U.S. Manufacturing Plan must include a commitment that any products embodying any subject invention or produced through the use of any subject invention will be manufactured substantially in the United States, unless the applicant can show to the satisfaction of DOE that it is not commercially feasible to do so (referred to hereinafter as "the U.S. Competitiveness Provision"). The applicant further agrees to make the U.S. Competitiveness Provision binding on any subawardee and any assignee or licensee or any entity otherwise acquiring rights to any subject invention, including subsequent assignees or licensees. A subject invention is any invention conceived of or first actually reduced to practice under an award.

Due to the lower technology readiness levels of this FOA, the U.S. Manufacturing Plans may not necessarily be tied to a specific product. However, in lieu of the U.S. Competitiveness Provision, an applicant may propose a U.S. Manufacturing Plan with more specific commitments that would be beneficial to the U.S. economy and competitiveness. For example, an applicant may commit specific products to be manufactured in the U.S., commit to a specific investment in a new or existing U.S. manufacturing facility, keep certain activities based in the U.S. or support a certain number of jobs in the U.S. related to the technology. 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 specific licensing strategy that would likely support U.S. manufacturing.

If DOE determines, at its sole discretion, that the more specific commitments would provide a sufficient benefit to the U.S. economy and industrial competitiveness, the specific commitments will be part of the terms and conditions of the award. For all other awards, the U.S. Competitiveness Provision shall be incorporated as part of the terms and conditions of the award as the U.S. Manufacturing Plan for that award.

The U.S. Competitiveness Provision is also a requirement for the Class Patent Waiver that applies to domestic large business under this FOA (see Section VIII.K. Title to Subject Inventions).

Save the U.S. Manufacturing Plan in a single PDF file.

1. **Domestic Small Businesses, Educational Institutions and Nonprofits**

   Domestic small businesses (including small business concerns), domestic educational institutions, and nonprofits that are recipients or subrecipients

under EERE funding agreements must require their exclusive licensees to substantially manufacture the following products in the United States for any use or sale in the United States: (1) articles embodying subject inventions, and (2) articles produced through the use of subject inventions. This requirement does not apply to articles that are manufactured for use or sale overseas.

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

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

2. **Large Businesses, Foreign Entities, and State and Local Government Entities**

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

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

3. **FFRDCs**

DOE FFRDCs are subject to the U.S. manufacturing requirements set forth in their M&O Contracts. All other FFRDCs are subject to the U.S. manufacturing requirements as set forth above, based on their size and for-profit status.

xvi. Data Management Plan (DMP)

Applicants are required to submit a DMP with their Full Application.

An applicant may select one of the template Data Management Plans (DMP) listed below. Alternatively, instead of selecting one of the template DMPs below, an applicant may submit another DMP provided that the DMP, at a minimum, (1) describes how data sharing and preservation will enable validation of the results from the proposed work, how the results could be validated if data are not shared or preserved and (2) has a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publications. DOE Public Access Plan dated July 24, 2014 provides additional guidance and information on DMPs.

Option 1 (when protected data is allowed): For the deliverables under the award, the recipient does not plan on making the underlying research data supporting the findings in the deliverables publicly-available for up to five (5) years after the data were first produced because such data will be considered protected under the award. The results from the DOE deliverables can be validated by DOE who will have access, upon request, to the research data. Other than providing deliverables as specified in the award, the recipient does not intend to publish the results from the project. However, in an instance where a publication includes results of the project, the underlying research data will be made available according to the policies of the publishing media. Where no such policy exists, the recipient must indicate on the publication a means for requesting and digitally obtaining the underlying research data. This includes the research data necessary to validate any results, conclusions, charts, figures, images in the publications.

Option 2: For any publication that includes results of the project, the underlying research data will be made available according to the policies of the publishing media. Where no such policy exists, the recipient must indicate on the publication a means for requesting and digitally obtaining the underlying research data. This includes the research data necessary to validate any results, conclusions, charts, figures, images in the publications.

Save the DMP in a single Microsoft Word file.

E. Content and Form of Replies to Reviewer Comments

If replies to reviewer comments are applicable, EERE will provide applicants with reviewer comments following the 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 the 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 post the Reviewer Comments in EERE Exchange. The

expected submission deadline is on the cover page of the FOA; however, it is the applicant's responsibility to monitor EERE Exchange 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 EERE Exchange 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 (3) 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 Selection Information Requests

If selected for award, EERE reserves the right to request additional or clarifying information regarding the following (non-exhaustive list):

- 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; and
- Environmental Questionnaire.

G. Dun and Bradstreet Universal Numbering System (DUNS) Number and System for Award Management (SAM)

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 SAM at https://www.sam.gov before submitting its application; (2) provide a valid 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 will 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

All required submissions must be submitted in EERE Exchange no later than 5 p.m. Eastern Time 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:

- Federal Acquisition Regulation (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 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. **National Environmental Policy Act (NEPA) Requirements Related to Pre-Award Costs**
   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 pre-award costs incurred prior to receiving written authorization from the Contracting Officer. If the applicant elects to undertake activities that DOE determines 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 for their project 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. Likewise, if an application 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.

iii. Performance of Work in the United States (Foreign Work Waiver)

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 whether 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 foreign work waiver, the applicant must submit a written waiver request to EERE. Appendix C lists the necessary information that must be included in a request for a foreign work waiver.

   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. 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

Topic Areas 1A, 1B, 2A, 2B, 3A, and 3B: 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.

Topic Areas 4A, 4B, and 4C: Foreign travel costs are not allowable under this FOA.

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. For-profit entity disposition requirements are set forth at 2 CFR 910.360. Property disposition requirements for other non-federal entities are set forth in 2 CFR 200.310 – 200.316.

vii. Domestic Preference – Infrastructure Projects

As appropriate and to the extent consistent with law, Applicants shall ensure that, to the greatest extent practicable, iron and aluminum as well as steel, cement, and other manufactured products (items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber) used in the proposed project shall be produced in the United States. This requirement shall flow down to all sub-awards including all contracts, subcontracts and purchase orders for work performed under the proposed project.

viii. 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 the 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.

ix. 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 Office of Management and Budget (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.

x. 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; and
- Other items as required by DOE.

~~xi. Compliance with Executive Order 13950~~

~~In submitting an application in response to this FOA, the applicant represents that it will not use Federal funds, including funds to meet cost share~~

~~requirements, to promote the concepts that (a) one race or sex is inherently superior to another race or sex; (b) an individual, by virtue of his or her race or sex, is inherently racist, sexist, or oppressive, whether consciously or unconsciously; (c) an individual should be discriminated against or receive adverse treatment solely or partly because of his or her race or sex; (d) members of one race or sex cannot and should not attempt to treat others without respect to race or sex; (e) an individual's moral character is necessarily determined by his or her race or sex; (f) an individual, by virtue of his or her race or sex, bears responsibility for actions committed in the past by other members of the same race or sex; (g) any individual should feel discomfort, guilt, anguish, or any other form of psychological distress on account of his or her race or sex; or (h) meritocracy or traits such as a hard work ethic are racist or sexist, or were created by a particular race to oppress another race.~~

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

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

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

This criterion involves consideration of the following factors:

- 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.

Topic Areas 1A, 1B, 2B, 3A, 3B:

Criterion 1: Technical Merit, Innovation, and Impact (50%)
This criterion involves consideration of the following factors:
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 and Market Transformation Plan (30%)
This criterion involves consideration of the following factors:
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.

Market Transformation Plan

- Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including mitigation plan; and

- Comprehensiveness of market transformation plan including but not limited to product development and/or service plan, commercialization timeline, financing, product marketing, legal/regulatory considerations including intellectual property, infrastructure requirements, Data Management Plan, U.S. manufacturing plan etc., and product distribution.

Criterion 3: Team and Resources (20%)
This criterion involves consideration of the following factors:

- 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.

Topic Area 2A:

Criterion 1: Technical Merit, Innovation, and Impact (40%)
This criterion involves consideration of the following factors:
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 and Market Transformation Plan (30%)

This criterion involves consideration of the following factors:

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.

Market Transformation Plan

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

Criterion 3: Team and Resources (20%)

This criterion involves consideration of the following factors:

- 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.

Criterion 4: Contribution to U.S. Manufacturing (10%)
This criterion involves consideration of the following factors:

- Degree to which the commitments made in the U.S. Manufacturing Plan will strengthen the competitiveness of domestic manufacturing and translate into increased long-term manufacturing and employment in the United States.

Topic Areas 4A, 4B, and 4C:

Criterion 1: Technical Merit, Innovation, and Impact (50%)
This criterion involves consideration of the following factors:
Technical Merit and Innovation

- The relevance of the proposed concept to the technical objectives of the FOA;
- The technical soundness of the proposed analysis plan, including evidence of recent detailed written results and/or experience with performing cost analyses;
- The applicant should show a clear understanding of the principles of the technologies to be analyzed;
- The potential of the proposed cost analyses to provide valuable feedback that guides the R&D efforts of the relevant FCTO Program it will be supporting, as well as a measurement of overall technical progress of the Program; and
- The adequacy of quality control and validation methods to track and ensure that assumptions are well-founded, and to ensure all scenarios are addressed with sufficient effort.

Impact of Technology Advancement

- How the project supports the topic area objectives and target specifications and metrics; and

Criterion 2: Project Research Plan (35%)
This criterion involves consideration of the following factors:
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 (15%)

This criterion involves consideration of the following factors:

- 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 "DOE Merit Review Guide for Financial Assistance," effective 09/2020, 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;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty; and
- The degree to which the proposed project exhibits team member diversity, with participants including but not limited to those from MSIs (e.g. HBCUs/OMIs)[44] or members within Qualified Opportunity Zones.[45]

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

[44] Minority Serving Institutions (MSIs), including HBCUs/OMIs as educational entities recognized by the Office of Civil Rights (OCR), U.S. Department of Education, and identified on the OCR's Department of Education U.S. accredited postsecondary minorities' institution list. See https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html.

[45] Opportunity Zones were added to the Internal Revenue Code by section 13823 of the Tax Cuts and Jobs Act of 2017, codified at 26 U.S.C. 1400Z-1. The list of designated Qualified Opportunity Zones can be found in IRS Notices 2018-48 (PDF) and 2019-42 (PDF). Further, a visual map of the census tracts designated as Qualified Opportunity Zones may also be found at Opportunity Zones Resources. Also see, frequently asked questions about Qualified Opportunity Zones.

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

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

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

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

v. Selection

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

E. Anticipated Notice of Selection and Award Negotiation Dates

EERE anticipates notifying applicants selected for negotiation of award and negotiating awards by the dates provided on the cover page of this FOA.

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 post these notifications to 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 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-eExchange.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 DUNS number (including the plus 4 extension, if applicable) at http://fedgov.dnb.com/webform.

3. **System for Award Management**
   Register with the SAM at https://www.sam.gov. Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called a Marketing Partner ID Number (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 DOE, 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 Under DOE Order 142.3A, "Unclassified Foreign Visits and Assignments Program"

All applicants selected for an award under this FOA may be required to provide information to DOE in order to satisfy requirements for foreign nationals' access to DOE sites, information, technologies, equipment, programs or personnel. A foreign national is defined as any person who is not a U.S. citizen by birth or naturalization. If a selected applicant (including any of its subrecipients, contractors or vendors) anticipates involving foreign nationals in the performance of its award, the selected applicant may be required to provide DOE with specific information about each foreign national to ensure compliance with the requirements for access approval. National laboratory personnel already cleared for site access may be excluded. Access approval for foreign nationals from countries identified on the U.S. Department of State's list of State Sponsors of Terrorism must receive final approval authority from the Secretary of Energy or the Secretary's assignee before they commence any work under the award.

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 NEPA (42 U.S.C. 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 https://www.energy.gov/nepa.

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 recipient may be required to prepare the records and 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 Classified Information Nondisclosure Agreement (https://fas.org/sgp/othergov/sf312.pdf), Form 4414 Sensitive Compartmented Information Disclosure Agreement (https://fas.org/sgp/othergov/intel/sf4414.pdf), 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.

~~**4. Implementation of Executive Order 13950**~~

~~In submitting an application in response to this FOA, the applicant represents that it will not use Federal funds, including funds to meet cost share requirements, to promote the concepts that (a) one race or sex is inherently superior to another race or sex; (b) an individual, by virtue of his or her race or sex, is inherently racist, sexist, or oppressive, whether consciously or unconsciously; (c) an individual should be discriminated against or receive adverse treatment solely or partly because of his or her race or sex; (d) members of one race or sex cannot and should not attempt to treat others without respect to race or sex; (e) an individual's moral character is necessarily determined by his or her race or sex; (f) an individual, by virtue of his or her race or sex, bears responsibility for actions committed in the past by other members of the same race or sex; (g) any individual should feel discomfort, guilt, anguish, or any other form of psychological distress on account of his or her race or sex; or (h) meritocracy or traits such as a hard work ethic are racist or sexist, or were created by a particular race to oppress another race.~~

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 unusual 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 ten (10) years from the date the subject invention was disclosed to EERE on the utilization of the subject invention and efforts made by prime recipient or their licensees or assignees to stimulate such utilization. The reports must include information regarding the status of development, date of first commercial sale or use, gross royalties received by the prime recipient, and such other data and information as EERE may specify.

xi. Intellectual Property Provisions

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

xii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement. This helpful EERE checklist can be accessed at https://www.energy.gov/eere/funding/eere-funding-application-and-management-forms. See Attachment 2 Federal Assistance Reporting Checklist, after clicking on "Model Cooperative Agreement" under the Award Package section.

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

- Quarterly Financial and Technical Reports
- Final Technical Report
- Yearly participation at the DOE Hydrogen Program Merit Review and Peer Evaluation (AMR) meeting, typically held in Washington, D.C.
- Yearly participation in one U.S. DRIVE Technical Team Meeting
- DOE may request that material samples, components, and/or prototype systems resulting from the R&D effort be sent for independent, standardized testing at a facility specified by DOE, as appropriate
- Work with independent system and/or cost analysis projects within DOE portfolio for independent performance and model validation as appropriate

- Project Safety Plan: Safe practices in the production, storage, distribution, and use of hydrogen are essential for the widespread acceptance of hydrogen and fuel cell technologies. The recipient must comply with the following requirements:
    1. The recipient is required to coordinate with the Hydrogen Safety Panel (HSP), a resource of the DOE Hydrogen and Fuel Cells Program, throughout the project life cycle. Examples of opportunities for HSP involvement include participation in post-award project kickoff meetings, project design and document reviews, risk assessments, and pre-startup reviews prior to beginning field demonstrations. To minimize project impacts, these engagements should be coordinated with regularly scheduled project activities rather than be unique efforts, and should be based on discussions with HSP.
    2. All projects are required to submit safety plans. Guidance for the creation of the Safety Plan can be found at https://h2tools.org/sites/default/files/Safety_Planning_for_Hydrogen_and_Fuel_Cell_Projects.pdf. The Safety Plan should cover the full scope of the project, including work by the prime as well as any subrecipients, and should be complete before the work is started. The Safety Plan is due to DOE within 90 days after the award is signed unless alternative timing is approved due to project constraints. The HSP will review the Safety Plan and provide feedback to the Recipient (through DOE) within approximately 30 days of receipt. 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. 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 EERE program goals and objectives. Federal funding beyond the Go/No-Go decision point (continuation funding) is contingent upon (1) availability of federal funds appropriated by Congress for the purpose of this program; (2) the availability of future-year budget authority; (3) recipient's technical progress compared to the Milestone Summary Table stated in Attachment 1 of the award; (4) recipient's submittal of required reports; (5) recipient's compliance with the terms and conditions of the award; (6) EERE's Go/No-Go decision; (7) the recipient's submission of a continuation application; and (8) written approval of the continuation application by the Contracting Officer.

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. Uniform Commercial Code (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.

C. Program Down-Select

Program Down Selections are not employed in this FOA.

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: HFTOFOA@ee.doe.gov. Questions must be submitted not later than 3 business days prior to the application due date and time. Please note, feedback on individual concepts will not be provided through Q&A.

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

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

VIII. Other Information

A. FOA Modifications

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

B. Government Right to Reject or Negotiate

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

C. Commitment of Public Funds

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

D. Treatment of Application Information

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. Applicants are advised to not include any critically sensitive proprietary detail.

If an application includes trade secrets or information that is commercial or financial, or information that is confidential or privileged, it is furnished to the Government in confidence with the understanding that the information shall be used or disclosed only for evaluation of the application. Such information will be withheld from public disclosure to the extent permitted by law, including the Freedom of Information Act. Without assuming any liability for inadvertent disclosure, EERE will seek to limit disclosure of such information to its employees and to outside reviewers when necessary for merit review of the application or as otherwise authorized by law. This restriction does not limit the Government's right to use the information if it is obtained from another source.

Concept Papers, Full Applications, Replies to Reviewer Comments, and other submissions containing confidential, proprietary, or privileged information must be marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Government is not liable for

the disclosure or use of unmarked information, and may use or disclose such information for any purpose.

The cover sheet of the Concept Paper, Full Application, Reply to Reviewer Comments, and other submission must be marked as follows and identify the specific pages containing trade secrets, confidential, proprietary, or privileged information:

> **Notice of Restriction on Disclosure and Use of Data:**
> Pages [list applicable pages] of this document may contain trade secrets, confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes or in accordance with a financial assistance or loan agreement between the submitter and the Government. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source. [End of Notice]

The header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Trade Secrets, Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure." In addition, each line or paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

E. Evaluation and Administration by Non-Federal Personnel

In conducting the merit review evaluation, the Go/No-Go Reviews and Peer Reviews, 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, including EERE contractors. The applicant, by submitting its application, consents to the use of non-federal reviewers/administrators. Non-federal reviewers must sign conflict of interest (COI) and non-disclosure acknowledgements (NDA) prior to reviewing an application. Non-federal personnel conducting administrative activities must sign an NDA.

F. Notice Regarding Eligible/Ineligible Activities

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

G. Notice of Right to Conduct a Review of Financial Capability

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

H. 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.

I. Retention of Submissions

EERE expects to retain copies of all Concept Papers, Full Applications, and 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.

J. 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 are sufficient.

- Advance and Identified Waivers: For an applicant not covered by the Class Patent Waiver or the Bayh-Dole Act, the applicant 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; and

- DEC: Each applicant is required to submit a U.S. Manufacturing Plan as part of its application. If selected, the U.S. Manufacturing Plan shall be incorporated into the award terms and conditions for domestic small businesses and nonprofit organizations. DOE has determined that exceptional circumstances exist that warrants the modification of the standard patent rights clause for small businesses and non-profit awardees under Bayh-Dole to the extent necessary to implement and enforce the U.S. Manufacturing Plan. Any Bayh-Dole entity (domestic small business or nonprofit organization) affected by this DEC has the right to appeal it.

K. Government Rights in Subject Inventions

Where prime recipients and subrecipients retain title to subject inventions, the U.S. government retains certain rights.

1. Government Use License

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

2. March-In Rights

The U.S. government retains march-in rights with respect to all subject inventions. Through "march-in rights," the government may require a prime recipient or subrecipient who has elected to retain title to a subject invention (or their assignees or exclusive licensees), to grant a license for use of the invention 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.

L. 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.

M. 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.

N. Export Control

The U.S. government regulates the transfer of information, commodities, technology, and software considered to be strategically important to the U.S. to protect national security, foreign policy, and economic interests without imposing undue regulatory burdens on legitimate international trade. There is a network of federal agencies and regulations that govern exports that are collectively referred to as "Export Controls". To ensure compliance with Export Controls, it is the prime recipient's responsibility to determine when its project activities trigger Export Controls and to ensure compliance.

Export Controls may apply to individual projects, depending on the nature of the tasks. When Export Controls apply, the recipient must take the appropriate steps to obtain any required governmental licenses, monitor and control access to restricted information, and safeguard all controlled materials. Under no circumstances may foreign entities (organizations, companies or persons) receive access to export controlled information unless proper export procedures have been satisfied and such access is authorized pursuant to law or regulation.

Applicants are advised that some of the results of the research conducted under this FOA may be restricted for proprietary reasons and not published or shared broadly within the scientific community.

O. Personally Identifiable Information (PII)

All information provided by the applicant must to the greatest extent possible exclude PII. The term "PII" refers to information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, 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. (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, personal landline/cell phone numbers, and personal emails. **Under no circumstances should Social Security Numbers (SSNs) be included in the application**. Federal agencies are prohibited from the collecting, using, and displaying unnecessary SSNs. (See, the Federal Information

Security Modernization Act of 2014 (Pub. L. No. 113-283, Dec 18, 2014; 44 U.S.C. §3551).

P. 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 subrecipients (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. The 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 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. 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. 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.

3. Funds from other federal sources MAY NOT be counted as cost share. This prohibition includes FFRDC subrecipients. 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 FAR, 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; and

b. Other types of organizations. For all other non-federal entities, allowability of costs is determined in accordance with 2 CFR Part 200 Subpart E.

(5) They are not paid by the federal government under another award unless authorized by federal statute to be used for cost sharing or matching.

(6) They are provided for in the approved budget.

(B) Valuing and documenting contributions

(1) Valuing recipient's property or services of recipient's employees. Values are established in accordance with the applicable cost principles, which mean that amounts chargeable to the project are determined on the basis of costs incurred. For real property or equipment used on the project, the cost principles authorize depreciation or use charges. The full value of the item may be applied when the item will be consumed in the performance of the award or fully depreciated by the end of the award. In cases where the full value of a donated capital asset is to be applied as cost sharing or matching, that full value must be the lesser or the following:

a. The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation; or

b. The current fair market value. If there is sufficient justification, the Contracting Officer may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project. The Contracting Officer may accept the use of any reasonable basis for determining the fair market value of the property.

(2) Valuing services of others' employees. If an employer other than the recipient furnishes the services of an employee, those services are valued at the employee's regular rate of pay, provided these services are for the same skill level for which the employee is normally paid.

(3) Valuing volunteer services. Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services must be consistent with those paid for similar work in the recipient's organization. In those markets in which the required skills are not found in the recipient organization, rates must be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, allowable, and allocable may be included in the valuation.

(4) Valuing property donated by third parties.

a. Donated supplies may include such items as office supplies or laboratory supplies. Value assessed to donated supplies included in the cost sharing or matching share must be reasonable and must not exceed the fair market value of the property at the time of the donation.

b. Normally only depreciation or use charges for equipment and buildings may be applied. However, the fair rental charges for land and the full value of equipment or other capital assets may be allowed, when they will be consumed in the performance of the award or fully depreciated by the end of the award, provided that the Contracting Officer has approved the charges. When use charges are applied, values must be determined in accordance with the usual accounting policies of the recipient, with the following qualifications:

i. The value of donated space must not exceed the fair rental value of comparable space as established by an independent appraisal of comparable space and facilities in a privately-owned building in the same locality.

ii. The value of loaned equipment must not exceed its fair rental value.

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

a. Volunteer services must be documented and, to the extent feasible, supported by the same methods used by the recipient for its own employees.

b. The basis for determining the valuation for personal services and property must be documented.

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

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

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

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

Each task must be calculated individually as follows:

Task 1
$1,000,000 divided by 80% = $1,250,000 (Task 1 Cost)
Task 1 Cost minus federal share = non-federal share
$1,250,000 - $1,000,000 = $250,000 (non-federal share)

Task 2
$500,000 divided 80% = $625,000 (Task 2 Cost)
Task 2 Cost minus federal share = non-federal share
$625,000 - $500,000 = $125,000 (non-federal share)

Task 3
$400,000 / 50% = $800,000 (Task 3 Cost)
Task 3 Cost minus federal share = non-federal share
$800,000 - $400,000 = $400,000 (non-federal share)

Task 4
Federal share = $100,000
Non-federal cost share is not mandated for outreach = $0 (non-federal share)

The calculation may then be completed as follows:

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

Blended Cost Share %
Non-federal share ($775,000) divided by Total Project Cost ($2,775,000) = 27.9% (non-federal)
Federal share ($2,000,000) divided by Total Project Cost ($2,775,000) = 72.1% (federal)

APPENDIX C – WAIVER REQUESTS AND APPROVAL PROCESSES: 1. FOREIGN ENTITY PARTICIPATION AS THE PRIME RECIPIENT; AND 2. PERFORMANCE OF WORK IN THE UNITED STATES (FOREIGN WORK WAIVER)

1. Waiver for Foreign Entity Participation as the Prime Recipient

As set forth in Section III.A.iii., all prime recipients receiving funding under this FOA must be incorporated (or otherwise formed) under the laws of a state or territory of the United States and have a physical location for business operations in 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 and the extent, if any, the entity is state owned or controlled;
- 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; and
- 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 (Foreign Work Waiver)

As set forth in Section IV.J.iii., all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the prime recipient should make every effort to purchase supplies and equipment within the United States. There may be limited circumstances where it is in the interest of the project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit an explicit waiver request in the Full Application. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

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

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

EERE may require additional information before considering the waiver request.

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

Appendix E – Glossary

Applicant – The lead organization submitting an application under the FOA.

Continuation application – A non-competitive application for an additional budget period within a previously approved project period. At least ninety (90) days before the end of each budget period, the Recipient must submit to EERE its continuation application, which includes the following information:

i. A report on the Recipient's progress towards meeting the objectives of the project, including any significant findings, conclusions, or developments, and an estimate of any unobligated balances remaining at the end of the budget period. If the remaining unobligated balance is estimated to exceed 20 percent of the funds available for the budget period, explain why the excess funds have not been obligated and how they will be used in the next budget period.

ii. A detailed budget and supporting justification if there are changes to the negotiated budget, or a budget for the upcoming budget period was not approved at the time of award.

iii. A description of any planned changes from the negotiated Statement of Project Objectives and/or Milestone Summary Table.

Cooperative Research and Development Agreement (CRADA) – a contractual agreement between a national laboratory contractor and a private company or university to work together on research and development. For more information, see https://www.energy.gov/gc/downloads/doe-cooperative-research-and-development-agreements

Federally Funded Research and Development Centers (FFRDC) - FFRDCs are public-private partnerships which conduct research for the United States government. A listing of FFRDCs can be found at http://www.nsf.gov/statistics/ffrdclist/.

Go/No-Go Decision Points: – A decision point at the end of a budget period that defines the overall objectives, milestones and deliverables to be achieved by the recipient in that budget period. As of a result of EERE's review, EERE may take one of the following actions: 1) authorize federal funding for the next budget period; 2) recommend redirection of work; 3) discontinue providing federal funding beyond the current budget period; or 4) place a hold on federal funding pending further supporting data.

Project – The entire scope of the cooperative agreement which is contained in the recipient's Statement of Project Objectives.

Recipient or "Prime Recipient" – A non-federal entity that receives a federal award directly from a federal awarding agency to carry out an activity under a federal program. The term recipient does not include subrecipients.

Subrecipient – A non-federal entity that receives a subaward from a pass-through entity to carry out part of a federal program; but does not include an individual that is a beneficiary of such program. A subrecipient may also be a recipient of other federal awards directly from a federal awarding agency. Also, a DOE/NNSA and non-DOE/NNSA FFRDC may be proposed as a subrecipient on another entity's application. See Section III.E.ii.

APPENDIX D – DEFINITION OF TECHNOLOGY READINESS LEVELS

TRL 1:	Basic principles observed and reported
TRL 2:	Technology concept and/or application formulated
TRL 3:	Analytical and experimental critical function and/or characteristic proof of concept
TRL 4:	Component and/or breadboard validation in a laboratory environment
TRL 5:	Component and/or breadboard validation in a relevant environment
TRL 6:	System/subsystem model or prototype demonstration in a relevant environment
TRL 7:	System prototype demonstration in an operational environment
TRL 8:	Actual system completed and qualified through test and demonstrated
TRL 9:	Actual system proven through successful mission operations

APPENDIX E – LIST OF ACRONYMS

COI	Conflict of Interest
DEC	Determination of Exceptional Circumstances
DMP	Data Management Plan
DOE	Department of Energy
DOI	Digital Object Identifier
EERE	Energy Efficiency and Renewable Energy
FAR	Federal Acquisition Regulation
FFATA	Federal Funding and Transparency Act of 2006
FOA	Funding Opportunity Announcement
FOIA	Freedom of Information Act
FFRDC	Federally Funded Research and Development Center
GAAP	Generally Accepted Accounting Principles
HFTO	Hydrogen and Fuel Cell Technologies Office
IPMP	Intellectual Property Management Plan
M&O	Management and Operating
MPIN	Marketing Partner ID Number
MYPP	Multi-Year Program Plan
NDA	Non-Disclosure Acknowledgement
NEPA	National Environmental Policy Act
NNSA	National Nuclear Security Agency
OMB	Office of Management and Budget
OSTI	Office of Scientific and Technical Information
PII	Personal Identifiable Information
R&D	Research and Development
RFI	Request for Information
RFP	Request for Proposal
SAM	System for Award Management
SOPO	Statement of Project Objectives
SPOC	Single Point of Contact
TRL	Technology Readiness Level
UCC	Uniform Commercial Code
WBS	Work Breakdown Structure
WP	Work Proposal