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

Fiscal Year 2019 Commercial Trucks and Off-road Applications FOA: Natural Gas, Hydrogen, Biopower, and Electrification Technologies

Funding Opportunity Announcement (FOA) Number: DE-FOA-0002044
FOA Type: Amendment 000002
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FOA Issue Date:	3/1/2019
Amendment 000001	3/20/2019
Amendment 000002	6/6/2019
Submission Deadline for Concept Papers:	3/29/2019 5:00 pm ET
Anticipated Date of Concept Paper Notifications:	4/16/2019
Submission Deadline for Full Applications:	5/15/2019 5:00 pm ET
Anticipated Date of Reviewer Comments Availability (AOIs 1a, 1b, 3 and 4 only)	6/6/2019 5:00 pm ET
Anticipated due Date for Replies to Reviewer Comments (AOIs 1a, 1b, 3 and 4 only)	6/11/2019 5:00 pm ET
Anticipated Date for EERE Selection Notifications:	August 2019
Anticipated Timeframe for Award Negotiations	August-September 2019

- Applicants must submit a Concept Paper by 5:00pm ET on the due date listed above to be eligible to submit a Full Application.

- To apply to this FOA, applicants must register with and submit application materials through EERE Exchange at https://eere-Exchange.energy.gov, EERE's online application portal.

  Applicants must designate primary and backup points-of-contact in EERE Exchange with whom EERE will communicate to conduct award negotiations. If an application is selected for award negotiations, it is not a commitment to issue an award. It is imperative that the applicant/selectee be responsive during award negotiations and meet negotiation deadlines. Failure to do so may result in cancelation of further award negotiations and rescission of the selection.

Amendments

All changes to the Funding Opportunity Announcement as a result of this amendment are highlighted as shown below.

Amendment No.	Date	Description of Amendment
000001	3/20/2019	Changed the due date for full applications from May 14, 2019 to May 15, 2019
000002	6/6/2019	For AOIs 1a, 1b, 3 and 4 only. • Changed the dates for reviewer comment availability from 6/7/2019 to 6/6/2019. • Changed the deadline for reply to reviewer comments submission from 6/12/2019 to 6/11/2019 • Incorporated in Section V.A.iv. evaluation criteria for the reply to reviewer comments.

NOTE: REGISTRATION/SUBMISSION REQUIREMENTS

Registration Requirements

There are several one-time actions you must complete in order to submit an application in response to this Announcement (e.g., obtain a Dun and Bradstreet Data Universal Numbering System (DUNS) number, register with the System for Award Management (SAM), and register with EERE Exchange (https://eere-exchange.energy.gov/). Applicants who are not registered with SAM and Grants.gov, should allow at least 44 days to complete these requirements (start this process as soon as possible).

Applicants must register through the EERE eXCHANGE.
EERE eXCHANGE website: https://eere-exchange.energy.gov/
Applicants must obtain a DUNS number.
DUNS website: http://fedgov.dnb.com/webform

Applicants must register with the SAM.
SAM website: https://www.sam.gov/ If you had an active registration in CCR, you should have an active registration in SAM. More information about SAM registration for applicants is found at: **https://www.sam.gov/sam/transcript/Quick_Guide_for_Grants_Registrations_v1.7.pdf.**

Applicants must register with Grants.gov.
Grants.gov website: http://grants.gov/
Applicants must register with Grants.gov in order to receive automatic updates, in the event that Amendments to this FOA are posted. However, please note that applications will not be accepted through Grants.gov.

Applicants must register with FedConnect.
FedConnect website: www.fedconnect.net.
In the event that an application is selected for negotiation of award, applicants must be registered with FedConnect to receive the award. For more information regarding registration with FedConnect review the FedConnect Ready, Set, Go! Guide at **https://www.fedconnect.net/FedConnect/Marketing/Documents/FedConnect_Ready_Set_Go.pdf.**

Submission Requirements

All application submissions are to be made via the EERE Exchange **at https://eere-exchange.energy.gov/**. To gain access to the EERE Exchange system, the applicant must first register and create an account on the main EERE Exchange site. This account will then allow the user to submit an application for open EERE Funding Opportunity Announcements (FOAs) that are currently in EERE Exchange. EERE recommends that each organization or business unit, whether acting as a team or a single entity, use one account as the appropriate contact information for each submission.

Applicants will receive an automated response when the Application is received; this will serve as a confirmation of EERE receipt. Please do not reply to the automated response. A "User Guide" for the EERE Exchange can be found on the EERE website at https://eere-exchange.energy.gov/Manuals.aspx after logging in to the system.

To receive notices via email regarding a FOA in EERE Exchange, such as amendments to the announcement or the posting of new questions and answers from Exchange you must initiate an application submission to the FOA of interest. Please note that you must finalize and submit your application before the specified due date and time to be considered for award.

Questions

Questions related to the use of the EERE Exchange website or technical issues concerning the application submittal should be submitted to: EERE-ExchangeSupport@hq.doe.gov.

Questions related to the content of this FOA must be submitted to DE-FOA-0002044@netl.doe.gov not later than three business days before the Full Applications are due. Questions submitted after that date may not allow the Government sufficient time to respond.

All questions and answers related to the content of this FOA will be posted at https://eere-exchange.energy.gov/FAQ.aspx. DOE will try to respond to questions within 5 business days, unless a similar question and answer have already been posted on the website. Applicants are encouraged to review the posted questions and answers daily. **Please note that you must first select this FOA Number in order to view the questions and answers specific to this FOA**.

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I. Funding Opportunity Description

A. Background and Context

The Office of Energy Efficiency and Renewable Energy (EERE) is issuing a Funding Opportunity Announcement (FOA) entitled, "Fiscal Year 2019 Commercial Trucks and Off-road Applications FOA: Natural Gas, Hydrogen, Biopower, and Electrification Technologies, DE-FOA-0002044 (FY19 Truck FOA)."

Economic growth, commercial trucks, and transportation energy are closely intertwined. Economic growth requires the movement of goods. Trucks carry more than 70% of the nation's freight on both a tonnage and value basis[1] – at some point on their way from manufacturer to consumer, virtually all goods travel by truck. The movement of goods requires energy, and medium- and heavy-duty trucks (Class 3-8) consume 25% of annual vehicle fuel use,[2] despite comprising only 4% of the total number of U.S. on-road vehicles. Off-road vehicles account for 8% of the total energy consumed in the U.S. transportation sector and are used in key domestic industries, including construction, agriculture, and mining.[3] Energy use by trucks is also growing. U.S. Energy Information Administration (EIA) projections indicate that the freight truck sector's annual vehicle miles traveled (VMT) will increase by 54% by 2050.[4] As the fastest growing fuel users in the United States (and the world), trucks are a dominant factor in American energy independence and energy security.

EERE has a strong track record of successful investment in the research and development of a broad portfolio of technologies, including electrification, advanced combustion engines, and fuels such as natural gas, hydrogen, and biofuels, that can significantly improve the efficiency and reduce the cost of transportation energy. Historically, EERE transportation programs and projects have focused on light-duty vehicles (passenger cars and light trucks), as this sector comprises a large portion of the on-road vehicle market. EERE's earlier-stage research has been (and continues to be) applicable to a variety of vehicle platforms, however. This work has enabled new technologies across multiple fuel-vehicle pathways potential to improve the efficiency, and ultimately the affordability, of commercial truck transportation as well. In addition to efficiency opportunities for advanced diesel engines, with a broad domestic supply and potentially favorable business case driven by relatively low and stable fuel prices, natural gas provides an opportunity to reduce both operating cost and emissions. Natural gas is not

[1] U.S. Department of Transportation, Bureau of Transportation Statistics and Federal Highway Administration, Freight Analysis Framework, version 4.4.1, 2018, https://www.bts.gov/topics/freight-transportation/freight-shipments-mode.
[2] Oak Ridge National Laboratory, 2017. *Transportation Energy Data Book 36*, tables 4.1, 4.2, 5.1, and 5.2.
[3] Oak Ridge National Laboratory, 2017. *Transportation Energy Data Book 36*, table 2.8.
[4] U.S. Energy Information Administration, 2018. *Annual Energy Outlook 2018, Transportation Sector Key Indicators and Delivered Energy Consumption Table (Reference Case),* accessed May 10, 2018.

only lower in cost, it is also abundant. EIA estimates that the United States has about 90 years of natural gas reserves at current usage rates. Also, renewable natural gas (RNG) derived from landfills or agricultural digesters provides a path to improve the carbon profile of natural gas trucks in select applications. Though the resource base for RNG is abundant, expensive clean-up of raw waste gas is required to make it suitable for vehicle use, which limits its adoption.

Electrification is also becoming a viable solution for moving freight, especially as more freight moves to a "hub and spoke" distribution system. Research has lowered battery costs by 75% since 2008, and manufacturers report increasing market success for electrified freight trucks is on the horizon. Fuel cell electric vehicles have made significant progress as well; fuel cell system cost has dropped 60% in the last decade, increasing interest in the potential of these systems for medium-duty and heavy-duty vehicles. Despite this progress, however, barriers remain. Medium- and heavy-duty vehicles use different drive cycles and have different durability requirements than those for passenger cars, and cost continues to be a challenge, particularly for the trucking industry, which operates on a thin profit margin.

Recognizing the advantages of collaboration across the transportation sector, this FOA brings together related activities in EERE's Transportation Offices – Vehicle Technologies, Fuel Cell Technologies, and Bioenergy Technologies – for an integrated approach to affordable, energy efficient technology development for medium- and heavy-duty vehicle, including off-road, applications. It supports a broad and multi-fuel pathway strategy that builds on successful previous research in gaseous fuels storage, biopower production, advanced batteries and electric drive systems, and fuel cell technologies.

This FOA also addresses Congressional direction for support of the Energy Independence and Security Act of 2007/Transportation Electrification; natural gas; fuel cells, hydrogen generation, delivery, and storage systems; biopower; technology integration, including Clean Cities; and off-road vehicles. Detailed technical descriptions of the specific areas of interest are provided in the sections that follow.

B. Areas of Interest

AOI Number	Area of Interest (AOI)
1	Gaseous Fuels Research and Technology Integration for Medium- and Heavy-duty Vehicles
1a	Research: Advanced Storage for Gaseous Fuels
1b	Research: Waste-to-Energy

1c	Technology Integration: Natural Gas Vehicle Maintenance Cost Study
1d	Technology Integration: Compressed Natural Gas (CNG) Fuel Tank Affordability
1e	Technology Integration: Smart Compressed Natural Gas (CNG) Refueling
1f	Technology Integration: Next-Generation Compressed Natural Gas (CNG) Driver Information Systems
2	Battery Electric Heavy-duty Freight Vehicles
3	High Throughput Hydrogen Fueling Technologies for Medium- and Heavy-duty Transportation
4	High-durability, Low Platinum Group Metal (PGM) Membrane Electrode Assemblies (MEAs) for Medium- and Heavy-duty Truck Applications
5	Energy Efficient Commercial Off-road Vehicles

AOI 1: Gaseous Fuels Research and Technology Integration for Medium- and Heavy-duty Vehicles

Natural Gas (NG) is an abundant resource across the United States, and new discoveries and extraction methods have led to a dramatic rise in shale gas development, making the United States the world's leading natural gas producer while changing the dynamics of the global energy mix. Advances in the ability to capture methane for production of renewable natural gas (RNG) adds a robust renewable alternative to conventional fuels. RNG is biogas derived from waste streams such as landfills, wastewater treatment plants, municipal solid waste, and dairies that has been upgraded to a quality suitable for use, including use in natural gas vehicles (NGVs). Due to low carbon fuel and renewable fuel initiatives, RNG is well positioned to further increase the interest in and motivation for expanding the use of natural gas in the transportation sector.

The relatively low and stable price of natural gas provides heavy-duty vehicle fleets with an option for consistently lower transportation costs. The transportation sector can benefit economically from using low-cost natural gas as an alternative to other energy sources for transporting goods. The shift to natural gas, in particular with regard to medium- and heavy-duty vehicle fleets, could result in increased profitability, improved supply chain performance, and reduced consumer costs for goods.

AOI 1a (Research): Advanced Storage for Gaseous Fuels

Storage tanks are one of the largest costs in both natural gas (NG) and hydrogen fuel cell vehicles. Gaseous fuels such as NG and hydrogen (H_2) have very high energy densities per unit mass, but low energy densities per unit volume. Gaseous storage of significant

amounts of these fuels therefore requires either very high pressures or low temperatures. Current storage systems for H_2 and NG use composite overwrapped pressure vessels (COPVs) typically designed to contain 700 bar (H_2) or 250 bar/3600 psi (NG). The high cost of these tanks restricts the widespread use of these fuels for a variety of transportation and stationary applications.

Alternatively, H_2 or NG may be stored densely at relatively low pressure within materials. The two types of materials-based storage are (1) through binding to other elements to form compounds or solid solutions (e.g., hydrogen in metal hydrides), or (2) through the adsorption of gas molecules onto the surface of porous materials. Both methods provide the potential for higher energy densities at significantly lower pressures within a given volume when compared to current COPV technology.

Reduced pressure storage (less than 100 bar) in materials-based systems has the potential to lower system cost in multiple ways. Most significantly, the pressure decrease would allow for a large reduction in the most expensive component of COPVs, the carbon fiber, which typically accounts for 55-75% of the overall COPV system cost.[5] Certain materials-based systems may even allow for the use of all-metal Type 1 tanks, which would completely eliminate the need for carbon fiber. Lower storage pressure can also yield fueling infrastructure cost savings due to reduced compression requirements at a station.

The objective of this AOI is to research, develop, and demonstrate novel materials concepts that enable lower pressure gas storage systems with the potential to outperform current compressed 700 bar H_2 or 250 bar NG systems on a cost and energy density basis.

AOI 1a General Requirements

Applications must describe novel, high-risk, high-reward research on the preparation and characterization of innovative materials to address the needs for onboard rechargeable gas storage. Applications should describe in detail the underlying material concepts and/or mechanisms and include targeted performance metrics focusing on system-level concerns. Applicants are encouraged to consider use of high-throughput and combinatorial methodologies for materials development and characterizations. Storage material cost must be addressed, and EERE encourages applications that encompass novel concepts focusing on cost improvements of the synthesis processes or production of storage materials. Areas of particular interest are described below.

[5] B. James, Strategic Analysis Inc., presented to IACMI on 12/17/2015.

Applications for the development of gas adsorbents, including but not limited to, metal-organic frameworks (MOFs), covalent organic frameworks (COFs), porous organic polymers (POPs), and functionalized porous carbons, are of interest for both H_2 and NG storage applications. A key focus is adsorbents with particularly strong binding sites (e.g., in the 15-25 kJ/mol range theorized to enable ambient temperature H_2 storage in a MOF).[6,7] Additionally, further development of materials that can adsorb more than a single gas molecule at one site are desired.

Other adsorbent material concepts of interest could benefit both H_2 and NG storage systems. For example, materials that undergo a phase change or pore-opening mechanism upon exposure to moderate gas pressures have been demonstrated.[8] This can enable a much higher usable capacity relative to the total adsorbed capacity because the materials can desorb nearly the entire amount of adsorbed gas at or above the required minimum discharge pressure (e.g., 5 bar). Additionally, such flexible structures could provide further thermal management benefits, as an endothermic step can offset heat generated upon adsorption.

Another recent advancement involves the ability to minimize, or in some cases completely avoid, the capacity penalty due to inefficient material packing within a storage system. Traditional powder pressing or pelletization strategies can cause degradation of the adsorbent structure, reducing the surface area and capacity. Recent work has demonstrated that alternative synthetic methods can yield densified samples of MOFs with very high volumetric capacities.[9] EERE seeks strategies that address packing inefficiencies to enhance the volumetric capacity at a system-level and are not specific to a single material.

Continued rapid advancement of theoretical techniques applied to gas storage materials has resulted in the ability to predict adsorption behavior with high accuracy. Projects that either focus on novel theoretical capability development or include theory-driven synthetic exploration are also of interest. However, such applications must include an experimental component designed to validate the advanced theoretical concepts proposed.

Metal hydrides as gaseous storage materials are also of interest, given their potential for very high capacities on both a gravimetric and volumetric basis. The main barriers to the practical use of metal hydrides are the prohibitively high temperatures and pressures

[6] S. K. Bhatia et al, Langmuir 2006 https://pubs.acs.org/doi/10.1021/la0523816
[7] Y.-S. Bae et al, Micropor. Mesopor. Mater. 2010 https://www.sciencedirect.com/science/article/abs/pii/S1387181110000673
[8] J. A. Mason et al, Nature 2015 https://www.nature.com/articles/nature15732
[9] T. Tian et al, Nature Materials 2018 https://www.nature.com/articles/nmat5050

necessary for reversible operation. A major success of EERE's HyMARC effort (http://hymarc.org) is coordinated research to improve the (de)hydrogenation conditions for $Mg(BH_4)_2$, one of the most promising complex metal hydride compounds (given its very high, potentially reversible hydrogen content (14.8 wt.%)).[10]

Applications that can build on these advancements and focus on the improvement of, or increased control over, the thermodynamics and kinetics of (de)hydrogenation reactions in metal hydride materials are of interest. Proposed research must focus on reversible, high-capacity metal hydride materials that have the potential to outperform 700 bar compressed H_2 on a system-level basis. Proposed research should not duplicate research already investigated through the DOE Hydrogen Storage Program. The Annual Merit Review and Peer Evaluation Proceedings[11] can be used to identify research already investigated through the program.

EERE welcomes applications for novel gas storage materials development efforts that fall outside of the categories above, provided they demonstrate a pathway to materials with the potential to outperform current compressed H_2 or NG systems.

AOI 1a Specific Requirements

Projects must be multi-phase efforts with a Go/No-Go decision point at the end of Phase 1, when teams demonstrate technical feasibility. The Go/No-Go milestone must provide confidence that the proposed materials concept has potential to result in a gas storage material capable of outperforming incumbent technologies. This milestone should include multiple quantitative material property metrics. Although the maximum EERE share for the multi-phase effort is $1,000,000, the maximum EERE share for Phase 1 activities is $300,000. Projects will receive initial funding only for Phase 1, with funding for additional phases allocated only after meeting the Phase 1 Go/No-Go criteria.

AOI 1a Teaming Arrangements

Projects selected under this sub-topic will be integrated into HyMARC as individual "seedling" projects. Each project selected for award must execute the HyMARC standard non-disclosure agreement, found at https://www.energy.gov/eere/fuelcells/hymarc-hydrogen-materials-advanced-research-consortium. Applications should identify areas of interaction and collaboration with the HyMARC core national laboratory team. Applicants do not need to contact the HyMARC core national laboratory team prior to selection or include letters of commitment from HyMARC in the application. Potential capabilities within the HyMARC core national laboratory team include synthetic, characterization, or computational capabilities. Applicants must leverage and not

[10] G. Severa, 2018 Annual Merit Review presentation https://www.hydrogen.energy.gov/pdfs/review18/st138_severa_2018_o.pdf

[11] https://www.hydrogen.energy.gov/annual_review.html

duplicate HyMARC capabilities. Information about HyMARC can be found at http://HyMARC.org.

AOI 1a Special Deliverables

- A Phase 1 Go/No-Go report is required to demonstrate the technical feasibility of the approach and must include the following:
  - Discussion of the material concept and its potential to result in a gas storage material capable of outperforming incumbent, high-pressure compressed gas systems.
  - Discussion of material performance metrics, including, but not limited to, reversible volumetric and gravimetric capacities, (de)sorption kinetics within reasonable pressure and temperature ranges, thermodynamics, and/or any other relevant material property metrics appropriate for the specific type of material being developed.
- EERE may require applicants to send samples of materials developed to a third-party laboratory, specified by EERE, for independent material evaluation and testing.

AOI 1b (Research): Waste-to-Energy

EERE seeks to encourage the development of solutions that make full and innovative use of biomass, municipally-derived biosolids, and sorted-municipal solid waste (MSW) feedstocks to advance the state-of-the-art in waste-to-energy, such as renewable natural gas. In addition, the energy produced from these materials can be employed as fuel for medium-/heavy-duty vehicles in the form of liquid fuels, or electricity. These feedstocks often present a clear disposal problem for municipalities and similar responsible parties, and they are generally already being collected through existing waste management practices. These materials include, but are not limited to, forest residues (notably, trees that have succumbed to environmental stresses); municipal sludges and biosolids; industrial, commercial, and residential organic wastes; fats, oils, and greases; yard trimmings; construction and demolition wastes; non-recyclable paper; and other non-recyclable organic components of MSW.

Given their distributed nature, these feedstocks are not produced in the quantities and concentrations required for traditional power plants. Further, given their generally high moisture content, long-distance transportation is rarely economically viable. Thus, there is a need for conversion strategies that are techno-economically feasible at scales that match available feedstock volumes and comply with relevant emissions standards.

This area of interest seeks proposals to convert these valuable resources into biopower and/or intermediates that are potentially useful as medium-/heavy-duty vehicle fuels, such as renewable natural gas, or in the production of biopower at appropriate scales

(e.g., less than or equal to five dry tons of feedstock/day). Applicants must develop technologies that reduce the levelized cost of energy (LCOE) by at least 25% and provide a justified benchmark for the state-of-the-art as part of their application.

Helpful Equations:
LCOE:

$$LCOE = \frac{Total\ Life\ Cycle\ Costs}{\sum_{t=1}^{N} \frac{System\ Energy\ Output}{(1+i)^t}} = \frac{\sum_{t=1}^{N} \frac{After\ Tax\ Cash\ Flow}{(1+i)^t}}{\sum_{t=1}^{N} \frac{System\ Energy\ Output}{(1+i)^t}} = \frac{\$}{kWh\ \ or\ MMBtu}$$

In addition, by the end of the project, technologies must be capable of exceeding an Energy Return on Investment (EROI) of 5.

EROI:

$$EROI = \frac{Energy\ Output}{Energy\ Input} = \frac{Q}{S_1 + S_2}$$

Where:
Q = rate of energy output (kWh/analysis period) for the entire energy production system
S_1 = the conversion energy input into the process (kWh/analysis period)
S_2 = is the embodied energy in the various items the energy production system uses (kWh/analysis period)
i = the discount rate
t = the year
N = the system lifetime in years

Anticipated technical approaches include, but are not limited to the following:

- Processes to produce pipeline-quality renewable natural gas or compressed natural gas for vehicle use through lower-cost biogas cleanup approaches (relative to incumbent technologies, such as pressure swing adsorption.
- Novel anaerobic digestion processes or alternatives that offer substantial reductions in capital and/or operating costs, including both pre-treatments that substantially

enhance the performance of anaerobic digestion and post-treatments that further reduce solids volume and/or recover additional energy and other valuable resources, as well as processes that operate independently of anaerobic digestion.
- Innovations in gasification of eligible feedstocks, including more cost-effective syngas cleanup.
- Strategies to materially improve the LCOE of electricity produced from MSW incineration. Possibilities include, but are not limited to, more cost-effective emissions controls to meet EPA standards, more efficient recovery of valuable metals and trace elements from waste streams, significantly improved high-temperature corrosion resistance at competitive costs and streamlined sorting methods for mixed MSW streams.

AOI 1b General Requirements

Applications must do the following:
- Identify a baseline technology or baseline approach;
- Provide detailed calculations of LCOE and EROI; and
- Identify specific feedstock, intermediate (if applicable), and end-product.

AOI 1b Specific Requirements

Applications must employ an organic waste feedstock, with particular emphasis on the following:
- Municipal sludges, biosolids, and wastewaters;
- Industrial, commercial, and residential food wastes and wastewaters;
- Yard waste, construction and demolition wastes, and forest products residuals;
- Non-recyclable organic components of municipal solid wastes, including plastics;
- Animal manure or slurries; and
- Biogas produced from any of the above.

The following four areas of interest, funded through the Vehicle Technologies Office Technology Integration Program, seek to complement the early-stage research in AOIs subtopics 1a – 1c by providing nearer-term cost reduction opportunities and greater understanding of barriers to further natural gas vehicle deployment in medium- and heavy-duty vehicle freight and delivery trucks.

AOI 1c (Technology Integration): Natural Gas Vehicle Maintenance Cost Study

In evaluating natural gas vehicle (NGV) total cost of ownership (TCO), maintenance cost is often cited as a potential advantage that reduces NGV TCO relative to comparable diesel-powered vehicles. However, there is no recent data that clearly compares the relative maintenance costs of NGVs and diesel trucks. This lack of data has led to maintenance cost uncertainty, which has been cited as a barrier to NGV adoption by fleets at both industry meetings and DOE stakeholder feedback sessions. In addition,

available maintenance data does not reflect NGV technology advancements that may have reduced maintenance costs, and these data do not include the maintenance costs associated with new diesel exhaust after-treatment systems.

The objective of this area of interest is to complete a comprehensive study that documents maintenance costs, technology solutions, or best practices capable of reducing maintenance or other related ongoing costs for medium- and heavy-duty NGVs used in freight and goods movement, relative to equivalent base diesel models, including emissions after-treatment systems.

Studies that identify specific end-use applications or duty-cycle variables that affect maintenance costs significantly and disproportionately when comparing natural gas and diesel engine systems are also of interest.

AOI 1c General Requirements

Applications must do the following:

- Include freight and goods movement for medium- or heavy-duty truck applications;
- Identify the type of fleet, vehicle, end-use application, and drive/duty cycles;
- Include maintenance cost records for comparable diesel vehicles, including exhaust after-treatment systems;
- Present analysis justifying cost reduction estimates for the proposed activity; and
- Include a data gathering/sharing plan to document maintenance costs and impact of critical variables.

AOI 1c Teaming Arrangements

Project teams that include the following partners are highly encouraged:

- Clean Cities coalitions (https://cleancities.energy.gov/coalitions/locations/);
- Fleets with medium- and/or heavy-duty diesel and natural gas work trucks and vehicles used for goods and freight movement;
- Fleet management organizations; and
- Relevant trade associations.

The following are highly discouraged:

- Applications that promote a specific brand;
- Projects that include the purchase of vehicles and/or fueling or charging infrastructure as a project cost;
- Applications that include converting or re-powering vehicles to operate on compressed natural gas as a project cost; and

- Applications that include novelty vehicles and other off-road recreational or sport vehicles.

AOI 1d (Technology Integration): Compressed Natural Gas (CNG) Fuel Tank Affordability

Natural Gas Vehicles (NGVs) can have a significantly higher initial cost than similar vehicles powered by conventional fuels, and CNG fuel tanks are recognized as the most expensive component contributing to that higher cost. A typical long-haul truck may require as many as 5-7 CNG tanks, each storing fuel at 248 bar, or 3600 psi. In addition, CNG fuel tanks require periodic inspections and possible replacement over time, which increases the total cost of ownership (especially for long-life NGV applications). Area of interest 1b (above) focuses on early-stage research of new, materials-based technologies, which, if ultimately successful, could replace current natural gas storage tanks.

This area of interest (AOI) seeks projects to reduce the initial cost of CNG fuel tank systems for the nearer-term, resulting in lower total cost of ownership and improved affordability for NGVs. Specifically, the objective of this AOI is to research, develop, and demonstrate technologies and approaches that reduce both the initial cost of Type 3, Type 4, and Type 5 CNG fuel tank systems and the maintenance/replacement cost of those tanks, in order to reduce the total cost of ownership and improve NGV affordability.

Project activities of interest, include, but are not limited to, the following:

- Directly address CNG tank design and manufacture;
- Reduce the cost of fabricating and installing complex tank mounting systems and packages to include improved tank designs;
- Enable automated CNG fuel tank diagnostic systems for service technicians that result in reduced inspection/maintenance costs; and
- Develop reduced-cost CNG fuel tank designs for unique vehicles with shorter/limited useful life spans or reduced service duty needs, for which current CNG tanks may be over-designed.

AOI 1d General Requirements

Applications must do the following:

- Identify the baseline technology and cost assumptions;
- Identify technologies, designs, or approaches that will result in cost savings and/or improved affordability;
- Include cost reduction estimates and the methodology/basis used to justify estimates;
- Include technology field-test and/or demonstration in a practical application;

- Include design considerations to meet CNG tank safety compliance requirements;
- Include plans for collaboration relevant agencies/organizations involved in CNG tank safety compliance (see Alternative Fuels Data Center summary of important CNG fuel tank safety matters, at https://afdc.energy.gov/vehicles/natural_gas_cylinder.html); and
- Identify a commercialization pathway for any new designs or equipment developed under the project.

AOI 1d Teaming Arrangements

Project teams that include the following partners are highly encouraged:

- Clean Cities coalition (https://cleancities.energy.gov/coalitions/locations/);
- CNG fuel tank manufacturers;
- Academic institutions and research/technology partners with relevant gaseous fuel experience;
- Vehicle and sub-assembly manufacturers;
- Fleets and end-user groups with related field experience; and
- Relevant industry trade associations.

The following are highly discouraged:

- Applications that include novelty vehicles, restricted use low-speed vehicles, and recreational or sport vehicles;
- Projects with a primary purpose of subsidizing the cost of vehicles, infrastructure, construction, hardware, and equipment; and
- Applications that include converting or re-powering vehicles to operate on CNG as a project cost.

AOI 1e (Technology Integration): Smart Compressed Natural Gas (CNG) Refueling

Maximizing fuel use from onboard storage is among the challenges to widespread CNG vehicle use. Current CNG fueling stations use only basic temperature compensation controls and do not communicate with a vehicle's onboard fuel tanks. This can result in less-than-full refueling sessions and affect cost by requiring more vehicle fuel tanks than necessary, more frequent and unnecessary fueling stops, reduced driver productivity, and disrupted workflow for the fleet operator. New CNG fueling technology that optimizes the fill process could increase the amount of CNG that a tank can hold, improving vehicle range and/or allowing for fewer or smaller tanks, which would lower cost. Most large trucks have 5-7 natural gas tanks, which comprise the largest incremental cost for a natural gas vehicle. Technology that allows for even one less tank could reduce storage cost by 15% - 20%.

The objective of this area of interest is to develop and demonstrate "smart" CNG fuel tank and fueling system technologies that can increase the useable capacity of on-board CNG storage by 10% - 20%.

Examples include, but are not limited to, the following:

- Automated CNG fueling station controls that can continuously monitor and communicate system temperatures, pressures, fuel transfer, fuel tank age, and other critical operating conditions;
- Use of real-time vehicle/station data exchange to optimize CNG tank full-fills and perform automated system diagnostics for use by maintenance technicians; and
- New refueling technology at either the station or vehicle that achieves goal of increased useable capacity.

AOI 1e General Requirements

Applications must do the following:

- Identify a baseline technology;
- Identify smart CNG fuel tank/fueling station technologies, designs, or approaches capable of improved CNG refueling and/or improved affordability;
- Justify the estimated quantity of additional fuel a vehicle could accept through the use of the proposed technology;
- Include a technology field-test and/or demonstration in a realistic application;
- Include a data gathering/sharing plan to document performance improvements;
- Identify any increased fueling time or cost (vs the baseline technology); and
- Include a pathway to commercialization for any new designs or equipment developed under the project.

AOI 1e Teaming Arrangements

Project teams **must** include CNG fueling station manufacturing and packaging partners with a path to commercialization.

EERE also highly encourages project teams that include the following partners:

- Clean Cities coalitions (https://cleancities.energy.gov/coalitions/locations/);
- CNG fuel tank manufacturers/suppliers;
- Partners with relevant gaseous fuel research/technology experience;
- CNG refueling station design/engineering organizations;
- Fleets and end-user groups with related field experience; and
- Relevant industry trade associations.

EERE highly discourages applications that include the following:

- Projects with the primary purpose of subsidizing the cost of vehicles, infrastructure, construction, hardware, and equipment; and
- Projects that include converting or re-powering vehicles to operate on CNG as a project cost.

AOI 1f (Technology Integration): Next Generation Compressed Natural Gas (CNG) Driver Information Systems

Maximizing fuel use from onboard storage is among the challenges to widespread CNG vehicle use. Current CNG fueling stations use only basic temperature compensation controls and do not communicate with a vehicle's onboard fuel tanks. This can result in less-than-full refueling sessions and affect cost by requiring more vehicle fuel tanks than necessary, more frequent and unnecessary fueling stops, reduced driver productivity, and disrupted workflow for the fleet operator. New CNG fueling technology that optimizes the fill process could increase the amount of CNG that a tank can hold, improving vehicle range and/or allowing for fewer or smaller tanks, which would lower cost. Most large trucks have 5-7 natural gas tanks, which comprise the largest incremental cost for a natural gas vehicle. Technology that allows for even one less tank could reduce storage cost by 15% - 20%.

The objective of this AOI is to develop and demonstrate advanced CNG fuel gauges or other driver feedback systems that provide accurate "miles-to-empty" driver information in order to optimize and extend driving range and/or reduce the number or size of CNG fuel tanks needed onboard a vehicle. Projects must include on-road baseline testing in conjunction with on-road demonstrations to validate technology accuracy and vehicle performance impacts.

AOI 1f General Requirements

Applications must include the following:

- Type of fleet, vehicle descriptions, and drive/duty cycle information;
- Data gathering/sharing plan to document performance improvements and impact of critical variables; and
- Before and after on-road demonstration.

AOI 1f Teaming Arrangements

Project teams must include industry partners with a path to commercialization, as well as a fleet partner for on-road demonstration testing. Additionally, EERE highly encourages project teams that include partners such as the following:

- Clean Cities coalitions (https://cleancities.energy.gov/coalitions/locations/);

- Fleets with medium-/heavy-duty diesel and natural gas vehicles;
- Research/technology partners with relevant gaseous fuel experience; and
- Fleet management organizations, trade associations, and national laboratories.

Applications that do the following are highly discouraged:

- Promote a specific brand;
- Include the purchase of vehicles and/or fueling or charging infrastructure as a project cost;
- Include converting or re-powering vehicles to operate on CNG as a project cost; and
- Include novelty vehicles and other off-road recreational or sport vehicles.

Area of Interest 2: Battery Electric Heavy-duty Freight Vehicles

EERE-funded research projects to improve the energy efficiency of medium- and heavy-duty vehicles have successfully demonstrated hybrid and plug-in hybrid truck electrification. However, these applications have focused mostly on lower-mileage work/vocation trucks or limited-range trucks for drayage operation in and around ports. Recent improvements in the cost and power density of batteries, as well as the associated power electronics and electric systems, have raised the prospect that battery electric heavy-duty freight movement may also be a viable and competitive alternative to conventional systems. The lower cost per mile compared to existing approaches, combined with high vehicle usage rates, hold the promise to make electric operation more cost-effective than other options for heavy-duty freight applications.

Significant technical barriers still exist, however, inhibiting adoption. Research to remove technology barriers can play an important role in accelerating adoption and demonstrating benefits across multiple heavy-duty freight applications. Also, additional data could help in evaluating battery electric vehicle performance in heavy-duty freight truck duty cycles (most data to date focuses on light-duty vehicle operation). This data could help set future research targets for batteries and electric drive systems specific to heavy-duty vehicles.

The objective of this area of interest is to research, develop, and demonstrate heavy-duty (classes 7-8) battery electric vehicle technologies capable of increasing efficiency and productivity over baseline vehicle performance for freight movement with a daily travel profile ≥250 miles. Data from the U.S. Department of Transportation Bureau of Transportation Statistics and Federal Highway Administration shows that 50% of all freight in the United States moves less than 100 miles and nearly 70% moves less than 250 miles.[12] In addition, the trend toward “hub-and-spoke” freight movement, with shorter runs between hubs and trucks

[12] U.S. Department of Transportation, “Freight Facts and Figures 2017,” https://www.bts.gov/sites/bts.dot.gov/files/docs/FFF_2017.pdf.

operating much of the day, may enable battery recharging between multiple deliveries in a single day.

AOI 2 General Requirements

Applications must include the following:

- A description of the baseline system and the associated vehicle performance;
- Research and development for heavy-duty (classes 7-8) battery electric vehicles, vehicle systems, or vehicle off-board charging infrastructure in budget periods 1 and 2;
- Demonstration of heavy-duty (classes 7-8) battery electric vehicles designed for freight movement in budget period 3, capable of traveling at least 250 total miles in a single day;
- Analysis demonstrating that the proposed technology is a life-cycle (i.e., up-front cost and operating cost) cost-effective solution;
- A description of heavy-duty battery electric vehicle or system requirements, and how R&D in areas such as electric drive systems, charging systems, and vehicle chargers will target and develop new technical solutions to overcome specific technology and performance barriers;
- A description of the demonstration vehicles to be used, the proposed vehicle duty cycle including charging, and the proposed demonstration period;
- A list of data to be collected and analyzed to evaluate vehicle performance, cost, and usage characteristics; and
- Estimates of efficiency and productivity increases based on proposed technology implementation.

AOI 2 Teaming Arrangements

EERE highly encourages project teams that include the following:

- A heavy-duty freight fleet operator;
- A heavy-duty vehicle manufacturer or Tier 1 supplier of the powertrain systems for heavy-duty vehicles; and
- Partnerships likely to advance the production of vehicles, batteries, and/or electric drive system components in the United States.

Consistent with requirements specified in the Energy Independence and Security Act of 2007, Section 131 (b)(1), proposed project teams **must** include at least one of the following as a project partner during the demonstration period: state governments, local governments, metropolitan transportation authorities, air pollution control districts, and private or nonprofit entities.

Area of Interest 3: High Throughput Hydrogen Fueling Technologies for Medium- and Heavy-duty Transportation

Medium- and heavy duty transportation is a key to DOE's H2@Scale initiative, focused on enabling widescale hydrogen production, delivery, storage, and use across applications and sectors (https://www.energy.gov/eere/fuelcells/h2-scale). For hydrogen and fuel cells to enter the medium- and heavy-duty transportation sector, technologies that enable affordable, high-throughput hydrogen fueling are needed. Current state-of-the-art stations for light-duty vehicles typically dispense up to 5 kg of hydrogen in 3 minutes (1.67 kg/min), and today's commercial fuel cell cars can achieve a driving range of over 300 miles between fueling. In comparison, to compete with incumbent technologies, fuel cell-powered long-haul trucks may ultimately require more than 50 kg of dispensed hydrogen in 6 minutes to achieve the targeted 750-mile range. (For reference, a typical truck refueling operation can fill 300 gallons of diesel in just 5 minutes; 300 gallons diesel can power a long-haul truck well over 1500 miles.)

Although fueling time is critical for long-haul trucks, fueling rate also affects a fueling station's overall throughput, real estate, and capital cost. Station reliability and the ability to provide high throughput – both in terms of volumes per fill and back-to-back fills for multiple trucks, with minimal waiting times – is a priority for commercial viability.

This AOI seeks compressor, cryopump, nozzle, and related technology R&D to enable high-throughput hydrogen fueling capable of fueling fleets of medium- and heavy-duty fuel cell electric vehicles. Specifically, projects should target hydrogen fueling rates of at least 6 kg/min, and an ultimate goal of 8 kg/min.

Compressors / Cryopumps:

Compressor and cryopump concepts should target output pressures of either 530 bar or 950 bar (necessary to fill 350 and 700 bar onboard storage vessels), and a flow rate of 200 kg/hr, with a stretch goal of 400 kg/hr.[13] EERE may consider applications that target intermediate output pressures (i.e., between 530 and 950 bar) if a strong market viability justification is provided. Applications should include detailed cost estimates that show that proposed concepts have uninstalled capital equipment costs below the following amounts (based on a throughput of 200 kg H_2/hr):

- 950-bar compressors: $2,000,000
- 530-bar compressors: $500,000
- 950-bar cryopumps: $450,000

[13] Hydrogen fueling stations for light duty vehicles currently typically have 1 compressor onsite, with a maximum flow rates of ~40 kg/hr. Compressors with flow rates of 400 kg/hr are ultimately targeted to enable stations that can complete 10 back-to-back fills for at least 5 hours a day at ~8 kg/min., with no more than 2 compressors onsite. Targets in this solicitation were informed by modeling completed using the Heavy-Duty Refueling Station Analysis Model, available here: https://hdsam.es.anl.gov/index.php?content=hdrsam

- 530-bar cryopumps: $275,000

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

Compressor and cryopump components (e.g., valves, diaphragms, pistons, and seals) must be designed for aggressive mechanical loading, and they must be constructed using hydrogen-compatible materials to ensure reliability. In addition to an overall focus on cost, throughput, and reliability, proposed R&D may include the following:

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

Nozzles:

This AOI also seeks high-throughput nozzle concepts able to achieve average flow rates of 6 kg/min, with a stretch goal of 8 kg/min, designed to accommodate operating pressures of 530 bar or 950 bar (necessary to fill 350 and 700 bar onboard storage vessels). Nozzles should be capable of sustaining average flow rates for 10-minute intervals. Existing nozzles for light-duty filling are currently designed for average fill rates of 1.67 kg/min and a peak fill rate of 60 g/s to enable compliance with the Society of Automotive Engineers (SAE) J2601 fueling protocol.

An increase in flow rate will require innovations in nozzle design, as well as development of manufacturing processes for high-throughput nozzles. Development of nozzle concepts may require research to inform materials selection and ensure nozzles are both lightweight for users (i.e., truck drivers) and compatible with required operating conditions (i.e., pressure, temperature, humidity, hydrogen environment, etc.). Nozzle concepts should be capable of incorporating communications technologies and target a capital cost of $7,000 (not including the cost of communications). Applicants are encouraged to base nozzle design around hose configurations that may be feasible in the future for heavy-duty filling, and collaboration with hose suppliers during the proposal phase is encouraged.

Other Innovative Concepts Enabling High-Throughput Hydrogen Fueling:

EERE also seeks R&D of other innovative concepts that would enable high-throughput hydrogen fueling. Other proposed concepts (i.e., those concepts not included within compressors, cryopumps, or nozzles as detailed above) must provide a detailed analysis illustrating how the proposed concept would enable 200-400 kg/hr throughput at fueling stations. Analysis should compare the proposed concept's cost and performance capabilities (e.g., pressure, flow rate, temperature) to current state-of-the-art to highlight specific benefits in detail. Examples of

other potential technologies of interest include, but are not limited to, the following: chillers, valves, meters, and bulk storage. To ensure market relevance, EERE encourages applicants to include letters of support from industry.

AOI 3 General Requirements

Applications must include the following:

- Compressor concepts must include a description of key compressor metrics necessary to meet the targeted throughput (e.g., piston speed, displacement, etc.) and projected energy consumption;
- Nozzle concepts must include a comprehensive discussion of key engineering requirements;
- Nozzle concepts must include a description of design features that should be coordinated with other stakeholders so that the design could be standardized; and
- Description of data that will be collected during compressor, cryopump, or nozzle prototype testing.
- In line with H2@Scale objectives, and as applicable, address cybersecurity challenges and vulnerabilities.

Area of Interest 4: High-durability, Low Platinum Group Metal (PGM) Membrane Electrode Assemblies (MEAs) for Medium- and Heavy-duty Truck Applications

Medium- and heavy-duty fuel cell electric vehicles operating on hydrogen offer several advantages over incumbent technologies, 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. Medium- and heavy-duty truck applications require a lifetime of up to one million miles, and therefore require fuel cells with innovative membrane, catalyst, and electrode structures with enhanced durability. Significantly longer vehicle lifetimes and range requirements also mean that hydrogen fuel costs comprise a greater proportion of vehicle lifecycle cost. As such, increased MEA efficiency is a key parameter for economic viability.

For state-of-the-art MEAs, durability decreases with decreasing PGM loading, making it difficult to meet the DOE target of 25,000 hours (h) for medium- and heavy-duty transportation applications while also meeting cost and platinum group metal (PGM) loading targets[14]. In the most demanding applications, these conditions include operation in the presence of fuel and air

[14] 2025 technical performance and durability targets listed in Table 3.4.5 of the Fuel Cells MYRDD: http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

[15] Durability testing protocols target <10% voltage degradation for automotive and <20% for transit bus applications: http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

impurities, starting and stopping, freezing and thawing, and humidity and load cycling that result in mechanical and chemical stresses on fuel cell materials, components, and interfaces.

EERE seeks applications for novel and innovative concepts that advance the development and integration of low-PGM electrocatalysts and electrodes for use in direct hydrogen PEMFCs, with a focus on high durability and high fuel efficiency. Fuel cell MEAs should demonstrate significant progress toward ultimate targets for efficiency (>65%) and durability (25,000 h), while limiting platinum group metal (PGM) loading to <0.2 mg/cm^2. Fuel cells meeting these criteria can be applied to a range of trucks from medium-duty parcel delivery vehicles to heavy-duty long-haul tractor trailers, encompassing a substantial fraction of vehicles on the road. Moreover, highly-durable, low-PGM MEAs are applicable to transportation technologies beyond trucks, including rail, maritime, and others.

AOI 4 General Requirements

Applicants should describe how they will engage with EERE's Fuel Cell Performance and Durability (FC-PAD) core lab consortium team, specifically including which national labs and capabilities are necessary for the project. The full list of capabilities can be found on the FC-PAD website (https://www.fcpad.org/).

Applications must include the following:

- Details of novel low-PGM (<0.2 mgPt/cm^2) cathode oxygen reduction catalyst synthesis and electrode layer design;
- Details of how the approach increases understanding of degradation in new and state-of-the-art material sets;
- Details of how the approach improves durability of lower-cost fuel cells under realistic conditions; and
- Proposed accelerated stress testing based on the MEA test protocols in the MYRDD Plan.[15]

AOI 4 Teaming Arrangements

Applicant teams **must** include work with EERE's FC-PAD consortium that leverages national laboratory resources to develop a better mechanistic understanding of fuel cell components enabling improvements (https://www.fcpad.org). As part of the project, each applicant will be required to agree to a non-disclosure agreement with FC-PAD that will govern the treatment of information shared between the applicant and the national laboratory core team (Argonne National Laboratory, Lawrence Berkeley National Laboratory, Los Alamos National Laboratory, National Renewable Energy Laboratory, and Oak Ridge National Laboratory).

AOI 4 Special Deliverables

[15] Durability testing protocols target <10% voltage degradation for automotive and <20% for transit bus applications: http://energy.gov/sites/prod/files/2016/06/f32/fcto_myrdd_fuel_cells_0.pdf

In addition to the deliverables required in the Federal Assistance Reporting Requirements Checklist, awards made under this AOI require as deliverables a set of MEAs (6 or more, each with active area ≥ 50 cm^2) made available for independent testing and evaluation by the FC-PAD core lab consortium.

AOI 5: Energy Efficient Commercial Off-road Vehicles

Off-road vehicles account for 8% of the total energy consumed in the U.S. transportation sector and are a substantial source of harmful emissions, including nitrogen oxides and fine particulate matter. Improving commercial off-road vehicle efficiency can reduce fuel consumption and decrease operating costs for key domestic industries, including construction, agriculture, and mining, which are the primary users of energy in the off-road vehicle sector. This sector faces unique challenges to increasing energy efficiency and achieving emission requirements due to the wide diversity of vehicle type, disparate and vocation-dependent duty cycles, high durability and reliability requirements, and performance needs in harsh environments that can include high levels of vibration, shocks, and dust-/debris-laden air. The challenges and opportunities for increasing off-road vehicle efficiency were the subject of a recent workshop and report.[16]

Off-road vehicles rely heavily on fluid-power (i.e., hydraulics) for their work and drive circuits because it can supply high specific power density and tolerate harsh conditions. Current fluid-power systems have poor efficiency, however. In addition, these fluid powered systems operate as part of the overall power system, in conjunction with the internal combustion engine. Achieving improvements in efficiency requires a system-level approach in many cases.

Improvements in energy efficiency and cost for some off-road vehicle segments, such as agriculture and mining, may also be possible through automated driving and other operation. These sectors have been using increasing levels of automation to enhance productivity, and improvements in automation for other on-road sectors may provide additional opportunity for off-road vehicles.

The objective of this AOI is to research, develop, and demonstrate technologies that can significantly improve (>10%) the work-specific energy-efficiency of commercial off-road vehicles. These technologies must also be cost-effective, meet emissions standards, and maintain the durability required for these vehicles.

Applications that propose system-level approaches combining efficiency improvements in the work-circuit, drive-circuit, and engine to address common sources of fuel consumption inefficiencies across the entire sector are highly encouraged. Technologies could include, but are not limited to, new architectures, energy recovery, electrification and hybridization, and

[16] Elhannouny, Essam M, and Longman, Douglas. "Off-Road Vehicles Research Workshop: Summary Report". United States. https://www.osti.gov/servlets/purl/1493003.

connectivity and automation of vehicles and/or work implements that demonstrate greater energy efficiency.

AOI 5 General Requirements:

Applications must include the following:

- Estimation of technology applicability across the off-road vehicle sector;
- Description of current inefficiencies and how the proposed technology overcomes them;
- Estimation of efficiency improvement when compared to the baseline off-road vehicle;
- Estimation of technology durability impacts, with a comparison to current technologies (if applicable);
- A detailed test plan, including duty cycle, to demonstrate the energy-efficiency benefit of the developed technology, the proposed demonstration period, and a description of the data planned to result from testing;
- A description of the vehicle(s) to be used in the demonstration; and
- A cost analysis of the proposed technologies that demonstrates an operating cost payback of less than two years.

AOI 5 Specific Requirements:

Proposed work should consist of two phases:

- **Phase 1**: **Technology Research and Development.** Not to exceed two budget periods. This phase should culminate in a Go/No-Go milestone to provide proof-of-concept and validation of efficiency improvement in a laboratory or simulated vehicle.
- **Phase 2: Vehicle Integration and Demonstration.** At least one budget period but not to exceed two budget periods. This phase should include technology integration in a commercial off-road vehicle and demonstration in a relevant work environment. Applicants must collect and analyze vehicle data to evaluate performance, cost, and usage characteristics.

AOI 5 Teaming Arrangements

Applicant teams ***must*** include an off-road vehicle original equipment manufacturer (OEM) serving the market with engines sized >150 hp.

C. Applications Specifically Not of Interest

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

- Applications that fall outside the technical parameters specified in Sections 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).

And in addition:

For AOI 1a:

- Hydrolysis of sodium borohydride.[17]
- Pure, undoped single-walled carbon nanotubes.[18]
- Onboard fuel processing (ammonia or hydrocarbon fuels that are reformed onboard to produce hydrogen and nitrogen or carbon dioxide).[19]
- Material development concepts that focus solely on the addition of boron to activated carbons or other porous matrices.[20]
- Concepts relying *solely* on hydrogen storage enhancement via the weak-chemisorption or "spillover" mechanism.[21]
- Systems that were discontinued for investigation by the three DOE Hydrogen Storage Material Centers of Excellence[22,23,24] unless a new approach has been developed that addresses the reasons why DOE discontinued research of the subject material.
- Materials or materials concepts that apply solely to hydrogen carriers for improved hydrogen delivery.

For AOI 1b:

- Applications that propose commercial technologies (for purposes of this AOI, "commercial" technology is defined as more than three installations of the core

[17] Go/No-Go Decision: Sodium Borohydride for Onboard Vehicular Hydrogen Storage: https://www.energy.gov/sites/prod/files/2018/02/f49/fcto_2007_go_nogo_na_borohydride_onboard_h2_storage.pdf

[18] Go/No-Go Decision: Pure, Undoped Single Wall carbon nanotubes for Vehicular Hydrogen Storage: https://www.energy.gov/sites/prod/files/2018/02/f49/fcto_2006_go_nogo_nanotubes_h2_storage.pdf

[19] Go/No-Go Decision: Onboard Fuel Processing: https://www.energy.gov/sites/prod/files/2018/02/f49/fcto_2004_go_nogo_onboard_fuel_processing_fcv.pdf

[20] T. Autrey et al, 2018 Annual Merit Review presentation https://www.hydrogen.energy.gov/pdfs/review18/st132_autrey_2018_o.pdf

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

[22] L. Klebanoff, J. Keller, Final Report of the DOE Metal Hydride Center of Excellence https://www.energy.gov/sites/prod/files/2017/11/f46/fcto_metal_hydride_coe_final_report.pdf

[23] L. Simpson, Hydrogen Sorption Center of Excellence Final Report https://www.energy.gov/sites/prod/files/2014/03/f12/hydrogen_sorption_coe_final_report.pdf

[24] K. Ott, Final Report for the DOE Chemical Hydrogen Storage Center of Excellence https://www.energy.gov/sites/prod/files/2014/03/f11/chemical_hydrogen_storage_coe_final_report.pdf

technology in a comparable or larger scale operation in North America for at least one year). Traditional anaerobic digestion and MSW incineration are considered commercial technologies under this definition. However, alternative reactor designs, such as anaerobic membrane bioreactors or alternative forms of anaerobic digestion that otherwise meet the requirements of this topic area will be considered responsive. Similar logic applies to innovative incineration proposals.

- Applications that propose the following feedstocks:
  - Food or feed carbohydrates, lipids, or proteins (e.g., maize or wheat dextrose, beet sucrose, sugar cane or grain sorghum syrup, starch, soybean oil or meal), and/or derivatives (e.g., amino acids from maize dextrose, glycerol from the transesterification of soybean oil);
  - Plant-based material that is generally intended for use as food, such as sugars derived from sugarcane, sweet sorghum, or beets and oils derived from soy, canola, sunflower, peanut, and other such food sources normally recovered using conventional food processing methods;
  - Fiber from wet and dry-grind corn refineries, distillers dried grains and solubles, or other food-related biomass;
  - Used oils of any kind; neither yellow nor brown grease are allowed;
  - Unsorted MSW;
  - Model compounds (real biomass-derived feedstocks must be used);
  - Aquatic plants, including, but not limited to, water hyacinth, duckweed, and eelgrass;
  - Commonly recycled paper, cardboard, and plastics;
  - Purpose-grown lignocellulosic biomass, including corn stover, and hydrolysates derived therefrom; and
  - Algal biomass, or any intermediate derived from algal biomass, even if nourished by municipal wastewater.
- Applications that propose the following end products:*
  - Hydrogen;
  - Ethanol;
  - Biogas;
  - Dimethyl ether;
  - Methanol; and
  - Biodiesel produced from transesterification or hydrotreating or hydrocracking of natural plant oils (e.g., soybeans, palm, coconut, safflower, and castor) or used oils, such as yellow or brown grease.

*The above products are acceptable as an intermediate, provided that the application is clear how the intermediate will be incorporated into processes to produce biopower or acceptable biopower intermediates by project completion.

For AOI 1d:
Applications that include or rely on adsorbent storage of natural gas.

For AOI 1e:
- Applications that promote a specific brand.
- Applications that include the purchase of vehicles a project cost.
- Applications that include converting or re-powering vehicles to operate on CNG as a project cost.
- Applications that include novelty vehicles and other off-road recreational or sport vehicles.

For AOI 3:
Concepts that cannot achieve 200 kg/hr throughput are not of interest. Additionally, R&D of linear motor reciprocating compression, electrochemical compression, and metal hydride compression is not of interest.

For AOI 4:
Applications that propose development of PGM-free catalysts, anode hydrogen oxidation reaction catalysts, catalysts and MEAs for non-PEMFCs (i.e., alkaline membrane fuel cells, phosphoric-acid-based fuel cells, solid oxide fuel cells), ionomers/membranes, and diffusion media.

For AOI 5:
Applications that include novelty vehicles and other off-road recreational or sport vehicles.

D. Authorizing Statutes

The programmatic authorizing statute is Public Law 102-486, Energy Policy Act (EPAct) of 1992, amended by Public Law 109-58, EPACT 2005, EPAct 2005, Title IX, Subtitle C Section 932. Energy Independence and Security Act of 2007, §201, §207, and EPAct 2005 Title VIII- Hydrogen, Section 801, Section 805

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 $51,500,000 in federal funding for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 22-43 awards under this FOA. EERE may issue one, multiple, or no awards under each area of interest. Individual awards may vary between $300,000 and $5,000,000.

The anticipated total federal funding and the approximate maximum and minimum federal share for any one individual award made under this FOA is provided in the table below. EERE may issue awards in one, multiple, or none of the areas of interest in the table below.

AOI Number	**Area of Interest**	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
1a	Research: Advanced Storage for Gaseous Fuels*	$300,000	$1,000,000	$6,000,000
1b	Research: Waste to Energy	$1,500,000	$3,000,000	$5,000,000
1c	Technology Integration: Natural Gas Vehicle Maintenance Cost Study	$300,000	$500,000	$500,000
1d	Technology Integration: Compressed Natural Gas (CNG) Fuel Tank Affordability	$1,000,000	$2,000,000	$2,000,000

1e	Technology Integration: Smart Compressed Natural Gas (CNG) Refueling	$1,000,000	$2,000,000	$2,000,000
1f	Technology Integration: Next-Generation Compressed Natural Gas (CNG) Driver Information Systems	$500,000	$1,000,000	$1,000,000
2	Battery Electric Heavy-duty Freight Vehicles	$3,000,000	$5,000,000	$18,000,000
3	High Throughput Hydrogen Fueling Technologies for Medium- and Heavy-duty Transportation	$1,000,000	$3,000,000	$6,000,000
4	High-durability, Low Platinum Group Metal (PGM) Membrane Electrode Assemblies (MEAs) for Medium- and Heavy-duty Truck Applications	$1,000,000	$2,000,000	$6,000,000
5	Energy Efficient Commercial Off-road Vehicles	$2,000,000	$5,000,000	$5,000,000

** For projects awarded through AOI 1a, EERE will provide initial funding for a single 12-18 month budget period at a maximum amount of $300,000. Continuation and additional funding for subsequent phases will be contingent on meeting agreed-upon quantitative Go/No-Go criteria for Budget Period 1.*

ii. Period of Performance

EERE anticipates making awards up to 36 months in length, comprised of one or more 12-month budget periods. Funding for all budget periods, including the initial budget period, is not guaranteed. Project continuation will be contingent upon satisfactory performance and Go/No-Go decision review. At the Go/No-Go decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, EERE will determine whether to continue to fund the

project, recommend re-direction of work under the project, place a hold on federal funding for the project or discontinue funding the project.

AOI Number	**Area of Interest**	Anticipated Number of Awards	Anticipated Period of Performance
1a	Research: Advanced Storage for Gaseous Fuels*	6-12	36 months
1b	Research: Waste to Energy	2-4	36 months
1c	Technology Integration: Natural Gas Vehicle Maintenance Cost Study	1-2	36 months
1d	Technology Integration: Compressed Natural Gas (CNG) Fuel Tank Affordability	1-2	36 months
1e	Technology Integration: Smart Compressed Natural Gas (CNG) Refueling	1-2	36 months
1f	Technology Integration: Next-Generation Compressed Natural Gas (CNG) Driver Information Systems	1-2	36 months
2	Battery Electric Heavy-duty Freight Vehicles	4-6	36 months
3	High Throughput Hydrogen Fueling Technologies for Medium- and Heavy-duty Transportation	2-6	36 months
4	High-durability, Low Platinum Group Metal (PGM) Membrane Electrode Assemblies (MEAs) for Medium- and	3-6	36 months

	Heavy-duty Truck Applications		
5	Energy Efficient Commercial Off-road Vehicles	1-2	36 months

** For projects awarded through AOI 1a, EERE will provide initial funding for a single 12-18 month budget period at a maximum amount of $300,000. Continuation and additional funding for subsequent phases will be contingent on meeting agreed-upon quantitative Go/No-Go criteria for Budget Period 1.*

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. Restricted Eligibility

The National Energy Technology Laboratory is ineligible to participate as a prime applicant or as a team member/sub-recipient on any application because of its role in developing the requirements for this announcement.

Entities applying as the prime applicant under AOI 2, "Battery Electric Heavy-duty Freight Vehicles" are restricted to businesses and entities involved in vehicle production, vehicle component supply, charging equipment manufacturing, and freight movement, logistics, or management. All other entities that submit an application as a prime applicant to this AOI will be considered non-responsive and the application will not be reviewed. The restricted eligibility does not apply to entities applying as a subrecipient.

ii. Individuals

U.S. citizens and lawful permanent residents are eligible to apply for funding as a prime recipient or subrecipient.

iii. 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 as follows:

AOI Number	Area of Interest	DOE/NNSA FFRDC allowed as Recipient	DOE/NNSA FFRDC allowed as Subrecipient
1a	Research: Advanced Storage for Gaseous Fuels	No	*Yes, except LBNL, LLNL, NREL, PNNL, and SNL
1b	Research: Waste-to-Energy	No	Yes
1c	Technology Integration: Natural Gas Vehicle Maintenance Cost Study	No	Yes
1d	Technology Integration: Compressed Natural Gas (CNG) Fuel Tank Affordability	No	No
1e	Technology Integration: Smart Compressed Natural Gas (CNG) Refueling	No	Yes
1f	Technology Integration: Next-Generation Compressed Natural Gas (CNG) Driver Information Systems	No	Yes
2	Battery Electric Heavy-duty Freight Vehicles	No	Yes
3	High Throughput Hydrogen Fueling Technologies for Medium- and Heavy-duty Transportation	No	Yes
4	High-durability, Low Platinum Group Metal (PGM) Membrane Electrode Assemblies (MEAs) for Medium- and Heavy-duty Truck Applications	No	*Yes, except ANL, LANL, LBNL, NREL and ORNL.
5	Energy Efficient Commercial Off-road Vehicles	No	Yes

* These FFRDCs are not eligible to participate as a subrecipient due to their participation in a consortium that is already funded to perform similar work.

For all AOIs where an FFRDC is eligible to apply as a subrecipient, the FFRDC's scope of work may not exceed that of the prime recipient as measured by total project cost.

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.

iv. Foreign Entities

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.

A foreign entity may receive funding as a subrecipient.

v. 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.

vi. 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

The cost share must be at the required percentages identified in the table below and is calculated based on the total allowable costs (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.)

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

PLEASE NOTE: Section 108, "Short-Term Cost-Share Pilot Program" of the Department of Energy Research and Innovation Act (RIA), Pub. L. 115-246, amended EPACT 2005 section 988 to include a 2-year pilot program exempting Institutions of Higher Education and Non-Profit Organizations from the minimum 20 percent cost share requirement for research and development activities. Nevertheless, RIA did not change the cost share requirements set forth in 2 CFR 910.130 of DOE's financial assistance regulation and the requirements of that regulation remain in effect. Until the regulation is amended to align with RIA or a cost share reduction or elimination is issued, DOE programs and Contracting Officers must adhere to the cost share requirements as set forth in 2 CFR 910.130. Independent of the EPACT 2005 section 988 and 2 CFR 910.130 requirements and the Pilot Program notwithstanding, DOE may require cost share of any activity as a matter of programmatic discretion.

AOI Number	Area of Interest		Cost Share for Universities, Institutions of Higher Learning, and Non-Profits	Cost Share for all Other Applicants
1a	Research: Advanced Storage for Gaseous Fuels		20%	≥20%
1b	Research: Waste-to-Energy		20%	≥20%
1c	Technology Integration: Natural Gas Vehicle Maintenance Cost Study		≥50%	≥50%
1d	Technology Integration: Natural Gas Vehicle Tank Affordability		≥50%	≥50%
1e	Technology Integration: Smart Compressed Natural Gas (CNG) Infrastructure Projects		≥50%	≥50%
1f	Technology Integration: Next Generation Compressed Natural Gas (CNG) Driver Information Systems		≥50%	≥50%
2	Electrification of Heavy-duty Freight Vehicles	Phase 1: Technology Research and Development:	20%	≥20%
		Phase 2: Vehicle Integration and Demonstration:	50%	50%
3	High Throughput Hydrogen Fueling Technologies for Medium- and Heavy-duty Transportation		20%	≥20%
4	High-durability, Low Platinum Group Metal Membrane Electrode Assemblies (MEAs) for Medium- and Heavy-duty Truck Applications		20%	≥20%
5	Energy Efficient Commercial Off-road Vehicles	Phase 1: Technology Research and Development:	20%	20%

		Phase 2: Vehicle Integration and Demonstration:	50%	50%

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.I.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 guidance on cost sharing.

iv. Cost Share Contributions by FFRDCs

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

v. Cost Share Verification

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

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

vi. Cost Share Payment

EERE requires prime recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the prime recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a minimum, the cost sharing percentage negotiated). As DOE will provide FFRDC funding directly to the FFRDC(s), prime recipients must 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. Prime recipients must send such requests 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 and Full Applications must meet all compliance criteria listed below, or they will be considered noncompliant. EERE will not review or consider noncompliant submissions, including Concept Papers and Full Applications that were: submitted through means other than EERE Exchange; submitted after the applicable deadline; and/or submitted incomplete. EERE will not extend the submission deadline for applicants that fail to submit required information due to server/connection congestion.

i. Compliance Criteria

1. **Concept Papers**
   Concept Papers are deemed compliant if:
   - The Concept Paper complies with the content and form requirements in Section IV.C of the FOA; and
   - The applicant successfully uploaded all required documents and clicked the "Submit" button in EERE Exchange by the deadline stated in this FOA.

2. **Full Applications**
   Full Applications are deemed compliant if:
   - The applicant submitted a compliant Concept Paper;
   - The applicant complied with the required teaming arrangements (if applicable);
   - 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 (AOIs 1a, 1b, 3 and 4 only)**
   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.

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

An entity may submit more than one Concept Paper and one Full Application to this FOA, provided that each concept paper/application describes a unique, scientifically distinct project, and provided that an eligible Concept Paper was submitted for each Full Application. All concept papers and applications must be for a stand-alone project that is not dependent or contingent upon another application submitted to this or any other FOA.

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 Exchange, 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 Exchange application process. This control number must be included with all application documents, as described below.

The Concept Paper and Full Application must conform to the following requirements:

- Each must be submitted in Adobe PDF format unless stated otherwise.
- Each must be written in English;
- All pages must be formatted to fit on 8.5 x 11 inch paper with margins not less than one inch on every side. Use Times New Roman typeface, a black font color, and a font size of 12 point or larger (except in figures or tables, which may be 10 point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirement still applies. References must be included as footnotes or endnotes in a font size of 10 or larger. Footnotes and endnotes are counted toward the maximum page requirement.
- 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 and Full Applications at least 48 hours in advance of the submission deadline**. Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), applicants should allow at least 1 hour to submit a Concept Paper and Full Application. Once the Concept Paper and Full Application is submitted in EERE Exchange, 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 and Full Application before the applicable deadline.

EERE urges applicants to carefully review their Concept Papers and Full Applications and to allow sufficient time for the submission of required information and

documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V.A.ii.-iii. 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.

Applicants that experience issues with submissions that result in late submissions: In the event that an applicant experiences technical difficulties so severe that they are unable to submit their application by the deadline, the applicant should contact the EERE Exchange helpdesk for assistance (EERE-ExchangeSupport@hq.doe.gov). The EERE Exchange helpdesk and/or the EERE Exchange system administrators will assist the applicant in resolving all issues (including finalizing submission on behalf of and with the applicant's concurrence). Please note, network traffic is at its heaviest during the final hours and minutes prior to submittal deadline. Applicants who experience this during the final hours or minutes and are unsuccessful in uploading documents will not be able to use this process.

B. Application Forms

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

Note: The maximum file size that can be uploaded to the EERE Exchange website is 10MB. Files in excess of 10MB cannot be uploaded, and hence cannot be submitted for review. If a file exceeds 10MB but is still within the maximum page limit specified in the FOA, it must be broken into parts and denoted to that effect. For example:
ControlNumber_LeadOrganization_Project_Part_1
ControlNumber_LeadOrganization_Project_Part_2

C. Content and Form of the Concept Paper

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

i. Concept Paper Content Requirements

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

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

The Concept Paper must conform to the following content requirements:

Section	Page Limit	Description
Cover Page	1 page maximum	The cover page should include the project title, the specific FOA Area of Interest being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Technical Description and Impacts	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.

		• 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 adequate access to equipment and facilities necessary to accomplish the effort. 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.

While the content and form of the Concept Paper does not require proposing a cost share amount during this concept paper submission phase, the EERE Exchange system will require entering a proposed cost share as a step in the submission process. Any proposed cost share at the Concept Paper stage of the application process can be updated or amended at the time of full application submission.

D. Content and Form of the Full Application

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

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

All Full Application documents must be marked with the Control Number issued to the applicant. Applicants will receive a control number upon clicking the "Create Concept Paper" button in EERE Exchange. **The applicant is no longer required to follow any specific file naming convention other than to insure the file format and extension of the uploaded file is consistent with the requirements below. The EERE Exchange system will automatically rename the file once it has been successfully uploaded.**

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:

Components	Required/Optional	Required Format	Page Limit	Required Template
Technical Volume (See Chart in Section IV.D.ii.)	Required	Adobe PDF	30	No
Statement of Project Objectives (SOPO)	Required	MS Word	10	https://eere-exchange.energy.gov/FileContent.aspx?FileID=dddd3fd2-0bb7-404a-8df0-d4a7a76668a8
SF-424 Application for Federal Assistance	Required	Adobe PDF	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=b97d3e9c-5bb4-4bac-95c8-13c4a26a20d2
Budget Justification (EERE 335) (See instructions below)	Required	MS Excel	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=083efd3d-abab-451d-8fa6-a03efaa9fefa
Summary/Abstract for Public Release	Required	Adobe PDF	1	No

Summary Slide	Required	MS PowerPoint	1	https://eere-exchange.energy.gov/FileContent.aspx?FileID=7e89dd43-4468-4f15-8d0a-7f9bca35f1f8
Subrecipient Budget Justification, if applicable see instructions below)	Optional	MS Excel	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=083efd3d-abab-451d-8fa6-a03efaa9fefa
DOE WP for FFRDC, if applicable (see DOE O 412.1A, Attachment 3)	Optional	MS Excel	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=fb578469-fea6-45fa-aa4c-6b1fcc946b4b
Authorization from cognizant Contracting Officer for FFRDC, if applicable	Optional	Adobe PDF	N/A	No
SF-LLL Disclosure of Lobbying Activities	Required	Adobe PDF	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=828353f5-1790-41d3-b083-6cc934c8a4f2
Location(s) of Work	Required	MS Excel	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=09c5bc70-450f-437b-a6e1-273207a1f0f2
Performance of Work in the United States waiver requests, if applicable	Optional	Adobe PDF	N/A	No
Cost Share Commitment Letters, if applicable	Optional	Adobe PDF	N/A	No
U.S. Manufacturing Plan	Required	Adobe PDF	N/A	No
Environmental Questionnaire	Required	Adobe PDF	N/A	https://eere-exchange.energy.gov/FileContent.aspx?FileID=2d1d7e10-b9d1-41c3-9af2-3996ccc2690c

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

ControlNumber_LeadOrganization_TechnicalVolume_Part_1
ControlNumber_LeadOrganization_TechnicalVolume_Part_2

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

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

ii. Technical Volume

The Technical Volume must be submitted in Adobe PDF format. The Technical Volume must conform to the following content and form requirements, including maximum page lengths. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages. This volume must address the Merit Review Criteria as discussed in Section V.A.ii-iii. of the FOA.

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 (e.g., Internet websites).

The Technical Volume to the Full Application may not be more than 30 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 page limitation does not include the Statement of Project Objectives, which is a separate document and not included as part of the Technical Volume. The applicant should consider the weighting of each of the evaluation criteria (see Section V.A.ii.-iii. 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	The cover page should include the project title, the specific FOA Area of Interest being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.

Project Overview (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 limited description of the WBS and tasks. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO. • Go/No-Go Decision Points: The applicant should provide a summary of project-wide Go/No-Go decision points at appropriate points in the Workplan. A Go/No-Go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. Unless otherwise specified in the FOA, the minimum requirement is that each project must have

at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of the project. The applicant should also provide the specific technical criteria to be used to make the Go/No-Go decision. The summary provided should be consistent with the SOPO. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone.

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

- Technology Transfer Plan: The applicant should provide a technology transfer plan, including the following:
  - Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including a mitigation plan
  - 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. • Attach one-page resumes for key participating team members as an appendix. Resumes do not count towards the page limit. Multi-page resumes are discouraged. Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. For multi-organizational or multi-investigator projects, describe succinctly: • The roles and the work to be performed by each PI and Key Participant; • Business agreements between the applicant and each PI and Key Participant; • How the various efforts will be integrated and managed; • Process for making decisions on scientific/technical direction; • Publication arrangements; • Intellectual Property issues; and Communication plans

iii. Statement of Project Objectives (SOPO)

Applicants are required to complete a SOPO. A SOPO template is available on EERE Exchange at using the link in the table above. The SOPO, including the Milestone Table, must not exceed 10 pages when printed using standard 8.5 x 11 paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point.

iv. SF-424: Application for Federal Assistance

Complete all required fields in accordance with the instructions on the form. The list of certifications and assurances in Field 21 can be found at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms, under Certifications and Assurances. Note: The dates and dollar amounts on the SF-

424 are for the complete project period and not just the first project year, first phase or other subset of the project period.

v. Budget Justification Workbook

- Applicants are required to complete the Budget Justification Workbook. This form is available on EERE Exchange using the link in the table above.
- 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.

vi. Summary/Abstract for Public Release

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

vii. Summary Slide

Applicants are required to provide a single PowerPoint slide summarizing the proposed project. The slide must be submitted in Microsoft PowerPoint format using the supplied template. This slide is used during the evaluation process

The Summary Slide template requires the following information:

- Proposed objectives;
- A description of the technology's impact and key takeaways;
- Key deliverables and anticipated accomplishments;
- Project title, prime recipient, Principal Investigator, and Key Participant information; and
- Requested EERE funds and proposed applicant cost share(s) for the prime applicant and subrecipients

viii. Subrecipient Budget Justification (if applicable)

Applicants must provide a separate budget 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. The budget template is available using the link in the table above.

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

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE 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-admchg1/@@images/file. Save the WP in a single PDF file.

x. Authorization for non-DOE/NNSA or DOE/NNSA FFRDCs (if applicable)

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

xi. 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" (see EERE Exchange for the document or 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.

xii. Location(s) of Work

The applicant must complete the supplied template by listing the City and State for each location where project work will be performed by the prime recipient and subrecipient(s). The Location of Work Template is available using the link in the table above.

xiii. Waiver Request: Performance of Work in the United States (if applicable)

Performance of Work in the United States

As set forth in Section IV.I.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 request to waive the Performance of Work in the United States requirement.

xiv. Cost Share Commitment Letters

You must have a letter from each third party contributing cost share (i.e., a party other than the organization submitting the application) stating that the third party is committed to providing a specific minimum dollar amount of cost share. Identify the following information for each third party contributing cost share: (1) the name of the organization; (2) the proposed dollar amount to be provided; (3) the amount as a percentage of the total project cost; and (4) the proposed type of cost share – cash, services, or property.

Please combine each individual Cost Share Commitment Letter into a single PDF file.

xv. U.S. Manufacturing Commitments

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, DOE does not expect the U.S. Manufacturing Plans to be tied to a specific product or technology. 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.

xvi. Environmental Questionnaire

You must complete the Environmental Questionnaire. This form is available using the link in the table above.

xvii. Content and Form of Replies to Reviewer Comments (AOIs 1a, 1b, 3 and 4 only)

EERE will provide applicants with reviewer comments following evaluation of all eligible Full Applications. Applicants will have a brief opportunity to review the comments and to prepare a short Reply to Reviewer Comments responding to comments however they desire or supplementing their Full Application. The Reply to Reviewer Comments is an optional submission; applicants are not required to submit a Reply to Reviewer Comments. EERE will 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 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.

E. 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;
- Updated 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
- Foreign National Involvement
- Updated Environmental Questionnaire
- Data Management Plan

Applicants who receive an award will be required to submit a Data Management Plan within ninety (90) days of receiving the award. The Data Management Plan is a document that outlines the proposed plan for data sharing or preservation. Information regarding the content of the Data Management Plan is shown in Appendix D and will also be provided in the Federal Assistance Requirements Reporting Checklist upon receipt of award.

F. 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.

G. Submission Dates and Times

Concept Papers and Full Applications 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.

H. Intergovernmental Review

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

I. 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 costs can only be incurred if such costs would be reimbursable under the agreement if incurred after award.

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

1. Pre-Award Costs Related to National Environmental Policy Act (NEPA) Requirements

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

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

taking any action that may have an adverse effect on the environment or limit the choice of reasonable alternatives.

iii. Performance of Work in the United States

1. **Requirement**
   All work performed under EERE awards must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment; however, the prime recipient should make every effort to purchase supplies and equipment within the United States. The prime recipient must flow down this requirement to its subrecipients.

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

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

   The applicant must demonstrate to the satisfaction of EERE that a waiver would further the purposes of the FOA and is in the economic interests of the United States. EERE may require additional information before considering a waiver request. 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

Foreign travel costs may be necessary to conduct the research and may be allowable (case-by-case basis) only with the written prior approval of the Contracting Officer assigned to the award.

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.

vi. Equipment and Supplies

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

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

vii. Lobbying

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

Recipients and subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-federal funds have not been paid and will not be paid to any person for influencing or attempting to influence any of the following in connection with your application:

- An officer or employee of any federal agency;
- A Member of Congress;
- An officer or employee of Congress; or
- An employee of a Member of Congress.

viii. Risk Assessment

Prior to making a federal award, the DOE is required by 31 U.S.C. 3321 and 41 U.S.C. 2313 to review information available through any 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.

ix. Invoice Review and Approval

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

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

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

Concept Papers will be evaluated against the criteria shown below. All sub-criteria are of equal weight.

1. **Concept Paper Criterion: Overall FOA Responsiveness and Viability of the Project (Weight: 100%)**
   This criterion involves consideration of the following factors:

   - Extent to which the concept paper describes the proposed technology, how the technology is unique and innovative, and how the technology will overcome barriers to advance the current state-of-the-art or baseline technology;
   - Extent to which the concept paper identifies risks, technical barriers, challenges, and possible mitigation strategies, and demonstrates the impact that the proposed project would have on the relevant field and application;
   - Extent to which the proposed project team has the qualifications, relevant experience, capabilities, equipment, and facilities to successfully complete the proposed project;
   - Extent to which the proposed project, if successfully accomplished, would meet the objectives as stated in the FOA.

ii. Full Applications (All AOIs except 1b)

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

1. **Criterion 1: Technical Merit, Innovation, and Impact (Weight 45%)**
   This criterion involves consideration of the following factors:

   - Extent to which the applicant demonstrates knowledge of the current state-of-the-art (SOA) or baseline technology and how the proposed project will move the state-of-the-art;
   - Extent to which the proposed project will likely achieve prescribed goals, targets, or requirements as described in the area of interest; and

- Extent to which the proposed project is technically sound, viable, and is supported by relevant data, calculations, technical assumptions, design rationale, alternatives, discussion of prior work, and references to literature.

2. **Criterion 2: Project Plan (Weight 40%)**
   This criterion involves consideration of the following factors:

   - Extent to which the approach comprehensively and logically addresses research, development, validation, technology integration, risks, and risk mitigation strategies as well as provides tasks and detailed task descriptions;
   - Extent to which the project schedule includes all required tasks, reasonable task durations, logical predecessor and successor task ordering, and a defined critical path;
   - Extent to which the baseline performance is defined, performance metrics quantify interim performance progress, appropriately scheduled SMART milestones demonstrate project advancement based upon significant project outcomes, and appropriately scheduled SMART Go/No Go Decision Points represent decisions regarding project continuation; and
   - Extent to which the Technology Transfer Plan/Manufacturing Plan demonstrates knowledge of the target market(s), distribution channels, required licensing, and competitors as well as the risks and risk mitigation strategies associated with each.

3. **Criterion 3: Team and Resources (Weight 15%)**
   This criterion involves consideration of the following factors:

   - Extent to which the qualifications, relevant experience, and time commitment of the individuals on the proposed project team are aligned and integrated for successful completion of the proposed project;
   - Extent to which existing equipment and facilities, along with proposed acquisition of equipment, support successful completion of the proposed project; and
   - Extent and appropriateness of resource commitment to the proposed project by project partners or other key participants validated by letters of commitment.

iii. Full Applications (AOI 1b only)

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

1. **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.

2. **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.

3. **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.

iv. Criteria for Replies to Reviewer Comments (AOIs 1a, 1b, 3 and 4)

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 April 14, 2017, 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 proposed project exhibits technological diversity when compared to the existing DOE project portfolio and other projects selected from the subject FOA;
- 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 proposed project is likely to lead to increased employment and manufacturing in the United States;
- 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 proposed project collectively represents diverse types and sizes of applicant organizations while not being detrimental to the overall objectives of the program;
- The proposed project represents diverse technology concepts and applications, as well as technical approaches, while not being detrimental to the overall objectives of the program;
- The proposed project enables new and expanding market segments; and
- The proposed project, or group of projects, represent a desired geographic distribution (considering past awards and current applications).

D. Evaluation and Selection Process

i. Overview

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

ii. Pre-Selection 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.

iii. 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.

iv. 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 making awards by the dates provided on the FOA cover page.

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

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

v. Alternate Selection Determinations

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

vi. Unsuccessful Applicants

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

B. Administrative and National Policy Requirements

i. Registration Requirements

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

1. EERE Exchange

Register and create an account on EERE Exchange at https://eere-Exchange.energy.gov.

This account will then allow the user to register for any open EERE FOAs that are currently in EERE Exchange. It is recommended that each organization or business unit, whether acting as a team or a single entity, use only one account as the contact point for each submission. Applicants should also designate backup points of contact, so they may be easily contacted if deemed necessary. **This step is required to apply to this FOA.**

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

2. **DUNS Number**
   Obtain a 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 an 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 to DOE Sites

All applicants, except institutions of higher education, selected for an award under this FOA may be required to provide information to the DOE in order to satisfy requirements for foreign nationals' access to DOE sites, information, technologies, equipment, programs, and personnel. A foreign national is any person who was born outside the jurisdiction of the United States, is a citizen of a foreign government, and has not been naturalized under U.S. law. If a selected applicant (including any of its subrecipients or

subcontractors) anticipates involving foreign nationals in the performance of its award, the selected applicant may be required to provide to DOE with specific information about each foreign national to ensure compliance with the requirements for access approval. Access approval for foreign nationals from countries identified on the U.S. Department of State's list of State Sponsors of Terrorism https://www.state.gov/j/ct/list/c14151.htm receive final approval authority from the Secretary of Energy before they can 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 the NEPA (42 USC 4321, *et seq.*). NEPA requires federal agencies to integrate environmental values into their decision-making processes by considering the potential environmental impacts of their proposed actions. For additional background on NEPA, please see DOE's NEPA website, at http://nepa.energy.gov/.

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

Applicants selected for award negotiations will be required to enter their environmental questionnaire electronically at https://www.eere-pmc.energy.gov/

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.

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 that the Go/No Go decision point(s).

4. EERE participates in major project decision-making processes.

x. Subject Invention Utilization Reporting

In order to ensure that prime recipients and subrecipients holding title to subject inventions are taking the appropriate steps to commercialize subject

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

xi. Intellectual Property Provisions

The standard DOE financial assistance intellectual property provisions applicable to the various types of recipients are located at http://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.

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) compliance with the terms and conditions of the award; (6) EERE’s Go/No-Go decision; (7) the 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.

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: DE-FOA-0002044@netl.doe.gov. Questions must be submitted not later than 5 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. All questions submitted must clearly identify the Area of Interest (AOI) to insure a timely and accurate response. Failure to identify the AOI, or not being as specific as possible with a question, may result in additional time to address the question or require further correspondence for further clarification regarding the submitted questions.

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

VIII. Other Information

A. FOA Modifications

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

B. Government Right to Reject or Negotiate

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

C. Commitment of Public Funds

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

D. Treatment of Application Information

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

Applicants should not include trade secrets or commercial or financial information that is privileged or confidential in their application unless such information is necessary to convey an understanding of the proposed project or to comply with a requirement in the FOA.

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

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

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

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

exempt from public disclosure. Such information shall be used or disclosed only for evaluation purposes or in accordance with a financial assistance or loan agreement between the submitter and the Government. The Government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source. [End of Notice]

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

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

E. Evaluation and Administration by Non-Federal Personnel

In conducting the merit review evaluation and Peer Review, the Government may seek the advice of qualified non-federal personnel as reviewers. The Government may also use non-federal personnel to conduct routine, nondiscretionary administrative activities, 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 a 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. Notice of Potential Disclosure Under Freedom of Information Act (FOIA)

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

I. Requirement for Full and Complete Disclosure

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

- The termination of award negotiations;
- The modification, suspension, and/or termination of a funding agreement;
- The initiation of debarment proceedings, debarment, and/or a declaration of ineligibility for receipt of federal contracts, subcontracts, and financial assistance and benefits; and
- Civil and/or criminal penalties.

J. Retention of Submissions

EERE expects to retain copies of all Concept Papers, Full Applications, and other submissions. No submissions will be returned. By applying to EERE for funding, applicants consent to EERE's retention of their submissions.

K. Title to Subject Inventions

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

- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions.

- All other parties: The federal Non-Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (see below);

- Class Patent Waiver: DOE has issued a class waiver that applies to this FOA. Under this class waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class waiver, a domestic large business must agree that any products embodying or produced through the use of a subject invention first created or reduced to practice under this program will be substantially manufactured in the United States, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan are sufficient.

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

L. Government Rights in Subject Inventions

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

i. Government Use License

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

ii. March-In Rights

The U.S. Government retains march-in rights with respect to all subject inventions. Through "march-in rights," the Government may require a prime recipient or subrecipient who has elected to retain title to a subject invention (or their assignees or exclusive licensees), to grant a license for use of the invention to a third party. In addition, the Government may grant licenses for use of the subject invention when a prime recipient, subrecipient, or their assignees and exclusive licensees refuse to do so.

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

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

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

M. Rights in Technical Data

Data rights differ based on whether data is first produced under an award or instead was developed at private expense outside the award.

"Limited Rights Data": The U.S. Government will not normally require delivery of confidential or trade secret-type technical data developed solely at private expense prior to issuance of an award, except as necessary to monitor technical progress and

evaluate the potential of proposed technologies to reach specific technical and cost metrics.

Government rights in Technical Data Produced Under Awards: The U.S. Government 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"). Data protection is available to all AOIs except AOI 1d. For awards permitting Protected Data, the protected data must be marked as set forth in the awards intellectual property terms and conditions and a listing of unlimited rights data (i.e., non-protected data) must be inserted into the data clause in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

N. Copyright

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

O. 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 sub-recipients. Non-federal sources include any source not originally derived from federal funds. Cost sharing commitment letters from subrecipients must be provided with the original application.

4. Fee or profit, including foregone fee or profit, are not allowable as project costs (including cost share) under any resulting award. The project may only incur those costs

that are allowable and allocable to the project (including cost share) as determined in accordance with the applicable cost principles prescribed in FAR Part 31 for For-Profit entities and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

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

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

(A) Acceptable contributions. All contributions, including cash contributions and third party in-kind contributions, must be accepted as part of the prime recipient's cost sharing if such contributions meet all of the following criteria:

(1) They are verifiable from the recipient's records.

(2) They are not included as contributions for any other federally-assisted project or program.

(3) They are necessary and reasonable for the proper and efficient accomplishment of project or program objectives.

(4) They are allowable under the cost principles applicable to the type of entity incurring the cost as follows:

a. For-profit organizations. Allowability of costs incurred by for-profit organizations and those nonprofit organizations listed in Attachment C to OMB Circular A–122 is determined in accordance with the for-profit cost principles in 48 CFR Part 31 in the 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 for Performance of Work in the United States (Foreign Work Waiver)

As set forth in Section IV.I.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 U.S. economy;
    - The associated benefits to be realized and the contribution to the project from the foreign work;
    - How the foreign work will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
    - How the foreign work will promote domestic American manufacturing of products and/or services;
- A description of the likelihood of Intellectual Property (IP) being created from the foreign work and the treatment of any such IP;
- The total estimated cost (DOE and recipient cost share) of the proposed foreign work;
- The countries in which the foreign work is proposed to be performed; and
- The name of the entity that would perform the foreign work.

EERE may require additional information before considering the waiver request.
The applicant does not have the right to appeal EERE's decision concerning a waiver request.

Appendix D - Data Management Plan

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

DMP Requirements

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

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

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

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

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

Data Determination for a DMP

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

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

Suggested Elements for a DMP

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

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

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

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

software, expertise, etc.) requested in the research proposal that are needed to meet the stated goals for sharing and preservation (this could reference the relevant section of the associated research proposal and budget request); and whether/where the data will be preserved after direct project funding ends and any plans for the transfer of responsibilities for sharing and preservation.

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

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

Additional Guidance

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

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

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

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

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

Definitions

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

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

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

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

> (A) Trade secrets, commercial information, materials necessary to be held confidential by a researcher until they are published, or similar information which is protected under law; and
>
> (B) Personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study."

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

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 F – 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 G – 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
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
TIA	Technology Investment Agreement
TRL	Technology Readiness Level
UCC	Uniform Commercial Code
WBS	Work Breakdown Structure
WP	Work Proposal