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Buildings Energy Efficiency Frontiers & Innovation Technologies (BENEFIT) – 2018

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Expected Date for EERE Selection Notifications:	Autumn 2018
Expected Timeframe for Award Negotiations	Winter 2018

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

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

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

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I. Funding Opportunity Description

A. Description/Background

Residential and commercial buildings account for approximately 40% of the nation's total energy demand – greater than that attributable to either industry (32%) or transportation (29%) – and about 75% of all electricity use, resulting in an annual national energy bill totaling more than $425 billion. The U.S. Department of Energy's Building Technologies Office (BTO) Emerging Technologies (ET) Program is working in partnership with industry, national laboratories, and academia to develop innovative energy saving technologies, systems, tools, and models that could lead to a significant reduction in building energy consumption.

The ET Program has identified the program-specific goal of supporting the development of cost-effective technologies capable of reducing the energy use of typical buildings by 45% by 2030, relative to high-efficiency technologies available in 2010.[1] The rapid development of next-generation building technologies are vital to advance building materials, components, tools and systems that are critical to meeting BTO's building energy use reduction goals. Moreover, by cutting the energy use of U.S. buildings by 20%, the American people could save approximately $80 billion annually on energy bills.[2] And, money saved on energy costs flows to other sectors of the economy, leading to the creation of new jobs.

The ET Program continues to work toward its program-specific goal by enabling the development of cost-effective, energy-efficient technologies. A portion of the ET budget provides support for research and development (R&D) at the Department of Energy (DOE) national laboratories. The remaining budget is distributed competitively through solicitations, including Funding Opportunity Announcements (FOAs) like this one, to allow all interested parties (corporations, universities, non-profits, as well as the national labs) to innovate advanced technologies, leading to reduced primary energy consumption in buildings.

Government investment through mechanisms such as the Building Energy Efficiency Frontiers and Innovation Technologies (BENEFIT) FOA in early-stage R&D

[1] https://www.energy.gov/sites/prod/files/2016/02/f29/BTO_MYPP_2016.pdf
[2] DOE, "Quadrennial Technology Review 2015", "Chapter 5: Increasing Efficiency of Building Systems and Technologies", https://energy.gov/ under-secretary-science-and-energy/quadrennial-technology-review-2015

to enable industry to develop novel technologies that can improve the efficiency and reduce the energy costs of the nation's buildings is essential. This FOA will accelerate energy performance R&D, providing the early-stage research results that support industry innovation. The BENEFIT FOA has been issued annually since 2014.[3,4,5,6] This year's BENEFIT FOA builds off of the successful "Early Stage Innovations" topics that were primarily developed to engage university, industry and national lab researchers in early-stage research relevant to the buildings sector. The "Innovations" topics target proof-of-concept stage hardware and software technology solutions to building energy efficiency. Innovative energy-efficiency technologies that have significant technical potential for annual primary energy savings (minimum 0.25 Quads) in the following six (6) topic areas are eligible. Applicants are required to report two performance metrics: primary energy savings and cost effectiveness, as measured by the simple payback, with supporting analysis as described in Appendix F.

Below is a summary of the six (6) topic areas:

Topic 1 – Advanced Separation Technologies for Building Energy Efficiency.
Development of Innovative separation technologies, such as membranes and ad/ab-sorption technologies, capable of significantly improving building energy efficiency in HVAC, water heating and appliances, and building envelope applications.

Topic 2 – Advanced Building Materials.
Development of smart, tunable, and highly insulating building envelope materials to enable significant reductions in cooling and heating loads.

Topic 3 – High-Performance Windows.
Development of highly insulating R7 to R10 window technologies, as well as advanced coatings for dynamic glazing.

[3] DE-FOA-0001632. Buildings Energy Efficiency Frontiers and Innovation Technologies (**BENEFIT**) – 2017, https://eere-exchange.energy.gov
[4] DE-FOA-0001383: Buildings Energy Efficiency Frontiers and Innovation Technologies (**BENEFIT**) – 2016, https://eere-exchange.energy.gov
[5] DE-FOA-0001166: Buildings Energy Efficiency Frontiers and Innovation Technologies (**BENEFIT**) – 2015, https://eere-exchange.energy.gov
[6] DE-FOA-0001027: Buildings Energy Efficiency Frontiers and Incubator Technologies (**BENEFIT**) – 2014, https://eere-exchange.energy.gov

Topic 4 – Novel Approaches for Cyber-physical Systems in Buildings.
New and enhanced synergies at the nexus of building energy modeling (BEM) and Sensors and Controls (S&C) that together cover portions of the building cyber-physical space.

Topic 5 – Integration Research of Advanced Commercial Energy Efficiency Packages.
Testing of next-generation building systems and equipment that improve efficiency across two or more building end uses in real-world operating conditions.

Topic 6 – Advancements in Natural Gas and Other Fuel-driven Equipment.
Innovative solutions that significantly improve the energy efficiency of natural gas and other fuel-driven equipment and achieve a coefficient of performance (COP) of greater than 1.0.

B. Topic Areas/Technical Areas of Interest

i. Topic 1: Advanced Separation Technologies for Building Energy Efficiency.

Membrane and other separation technologies is an emerging field in building energy efficiency that has significant room for growth. BTO has previously funded membrane technologies but sees further opportunity to connect separation researchers with the building technologies community to further the applications for separation and membrane-based technologies in building systems.

Membrane and separation technologies could be a critical component of BTO's plan to achieve a reduction of the national building energy use intensity (EUI), measured as primary energy per square foot, by 2030. Many of the technologies are cross-cutting across multiple functions, thereby offering potential savings for numerous building end-use applications. This report identified several research and development (R&D) initiatives across several building applications where further investigations could result in impactful savings.

The goal of this topic is to unlock the potential that membrane and separation technologies have for the building space. All solutions that utilize membrane and separation technologies that will increase the efficiency of buildings in general are encouraged. The applicant will have to clearly document the state of the art (SOA) for that end use, and how membrane

and separation technologies will result in energy saving and that it is a better solution economically than the baseline (existing) solution.
Previous BTO reports are available for reference (See Appendix G.i.) and will serve to gauge the state of the art (SOA) for a specific technology in the HVAC, Water heating and appliances area.

BTO is seeking innovative separation technologies, such as membranes and ad/ab-sorption technologies, capable of significantly improving building energy efficiency, for these two subtopic areas:

- Applications for HVAC, Water Heating, and Appliances
- Applications for the Building Envelope

Applications for HVAC, Water Heating, and Appliances

BTO seeks to accelerate the development of next generation heating, ventilation, air-conditioning, and refrigeration (HVAC&R and appliance technologies). This represents approximately half of the total energy used in U.S. residential and commercial buildings.[6] HVAC is the largest energy end-use for U.S. buildings, consuming approximately 40% of total energy in 2016. Residential appliances also consume large amounts of energy. Daily use of refrigerator/freezers, dishwashers, laundry equipment, and cooking equipment accounts for more than 10% of residential building primary energy consumption. Appliances used for cooking and refrigeration are a potential source of energy savings for commercial buildings such as grocery stores and hotels.

Membrane and separation technologies is a low-TRL technology for the HVAC and appliances area with very few if any technologies in the marketplace today. A recent low TRL multifunction project centered on a design that combined water heating and dehumidification functions into a single design, in which a novel absorber pulled water vapor directly from the air through a membrane into a liquid solution and as the vapor was absorbed; this heat was transferred for domestic hot water. Equipment that merges several end uses are encouraged.

BTO has recently covered Membranes and Separation Technologies in a recently published report that can aid as background material, https://energy.gov/sites/prod/files/2017/11/f46/DOE-BTO%20Membranes%20Separations%20Report%20Nov%202017.pdf . This report focused on determining where the greatest opportunities for

advancement in membrane and separation technologies exist, and to characterize those initiatives that are well suited for BTO. Membrane and separation technologies span a wide range of HVAC and Appliance end uses[7].

Category	End Use	Use-Case Example
Appliances	Refrigeration – Non-Condensable Gas Removal	Removal of non-condensable gasses in compressors can boost compressor performance
Appliances	Clothes Dryer	Removal of moisture from clothes-dryer exhaust, enabled by a water-vapor-permeable membrane, can reduce the energy consumption of a clothes dryer by enabling heat-recovery
Appliances	Flue-gas condensing heat recovery	A membrane to replace the condensing heat exchanger of condensing natural gas equipment to eliminate the need for high-cost, acid-resistant, stainless components.
HVAC	Space Cooling	Separate sensible and latent heat controls can enable increased efficiency and occupant comfort in buildings
HVAC	Electrochemical compressors	Leveraging hydrogen flow through a proton exchange membrane to achieve compression
HVAC	Energy Recovery Ventilation	Vapor selective membrane for improved energy recovery relative to an enthalpy wheel
HVAC	Heat Pumps	Membrane-enabled heat pump for combined sensible and latent cooling
HVAC	Humidity Control	Moisture control can provide increased occupant comfort in space heating applications
HVAC	Indoor Air Quality	Gas-separations for the improved removal of VOCs and other harmful gasses; membrane-enabled sensors to detect high levels of harmful gasses

Those membrane and separation technologies that intersect Natural gas (or fuel driven equipment) should be submitted to Topic 5 of this FOA.

Applications for the Building Envelope

BTO seeks to accelerate the development of next-generation building envelope mass transport materials that can be tuned to allow for selective flow of air and moisture, including, but not limited to:

- Vapor diode that can be tuned to only allow moisture transfer in preferred directions, such as a controllable water vapor membrane that has low permeability when outdoor humidity is high and high permeability when the relative humidity within the envelope cavity is high. This controllable water vapor membrane technology in combination with hygroscopic materials could also be used to reduce latent loads during peak energy demands or leverage outdoor conditions to provide dynamic climate control, resulting in a decreased energy demand required to manage indoor humidity.

- Self-healing membranes that improve the effectiveness of air barriers, water barriers, roofing membranes, etc., by self-sealing micro-punctures created by fasteners or installation defects.

REFERENCES can be found in Appendix G.i

ii. Topic 2: Advanced Building Materials.

Approximately 39% of total primary building energy consumption can be attributed to losses through the building envelope, via heat transfer and air infiltration. Approximately 24% of that energy, or 9% of total energy use in buildings, is lost due to air infiltration alone. The building envelope (e.g., walls, roof, foundation, and windows) being the thermal and mass barrier between the interior and outdoor environment, is thus one of the primary determinants of energy use to maintain comfort and safety. As a result, developing innovative building envelope solutions that efficiently reduce and manage energy is paramount for achieving BTO's building energy use reduction goals. To this end, BTO seeks to develop and accelerate next-generation building envelope technologies that reduce the amount of energy lost through the building envelope, contribute to improved occupant comfort, and have low product and installation costs.

BTO is seeking proposals for breakthrough building envelope technology innovations with the potential to enable significant reductions in cooling and heating loads in the following areas of interest.

High-Performance Thermal Insulation Technologies for Retrofitting Existing Buildings

In 2010, the primary energy consumption attributed to building envelope (roofs and walls) was 5.8 quadrillion BTUs (*almost 6% of entire US energy consumption*).[9] In new construction, highly insulated building envelopes can

partially address this opportunity; however, in existing buildings, adding the appropriate amount of insulation material is often impractical due to high cost and/or space limitations. Commercially available building insulation materials are typically high cost and high R-value (low thermal conductivity) or low cost and low R-value (see Figure 2.1). The development of a lower cost, low thermal conductivity material (the green shaded area in the plot in Figure 2.1) could have a significant impact on the building insulation market.

BTO is seeking the development of ultra-low thermal conductivity insulation technologies that are applicable for wall insulation for existing buildings, are robust, and have the long-term potential to meet the targets specified in Table 2.1. The proposed insulation material can also be applicable for other portions of the envelope in either existing buildings or new construction.

The development of a viable retrofit insulation that provides high R/inch thermal insulation cost-effectively necessitates:

- **Low-cost and scalable synthesis methods:** The methods used to synthesize the insulation material must be amenable to high-throughput production (high-yield and continuous processes) at near standard temperature and pressure conditions and avoid exotic or toxic chemistries.
- **Low-cost and robust installation:** The insulation material must be amenable to fast and easy installation, minimize occupant disturbance during the retrofit effort, and be able to withstand common handling and installation practices.

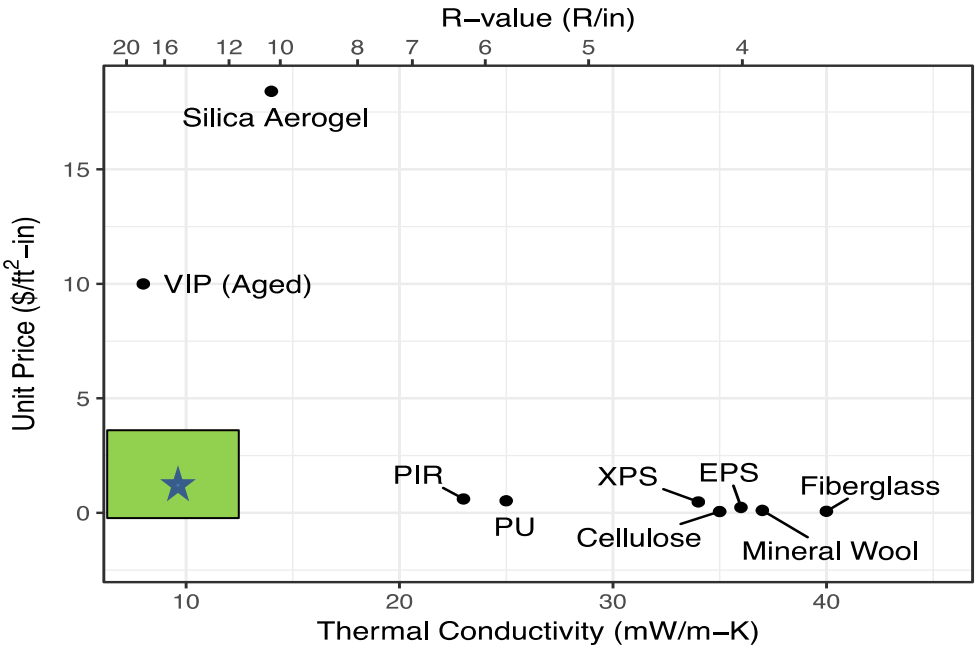

Figure 2.1: R-value per Inch and Cost per Unit Area and Thickness of Commercially Available Insulation Materials

Table 2.1. Targets for High-Performance Thermal Insulation Technologies

Market	Performance	Installed Price Premium[10]
Residential and Commercial Sectors	≥ R15/inch	≤ 0.85 $/ft2 wall area

The proposed insulation material should also be able to meet existing durability (fire, structure, moisture, acoustic code) requirements.

Smart Building Envelope Technologies

BTO is seeking proposals for R&D focusing on multi-function materials (both static and dynamic), and single function dynamic materials.

The building envelope is a complex and multifunctional system. Overall building envelope functionality is typically achieved through the integration of multiple components and systems with distinct and typically static functionalities. For example, windows, thermal insulation, and air barriers are used to control light, heat and air exchange, respectively. This complicated array of components and systems with complex interfaces results in limited opportunities to achieve optimal integrated performance at a minimal price.

However, recent scientific and engineering advances have made possible the purposeful design of new materials and systems that combine various functionalities and potentially modify properties based on ambient or control driven stimuli, bringing superior flexibility to the performance of the envelope as buildings become active parts of a broader energy system. Multi-functional material design can lead to breakthrough building envelope system solutions. Traditional approaches to system design rely on the intrinsic functionality of constituent materials. However, performance tailoring new materials from the atomic scale to achieve system level multifunctionality can reduce system features such as size, weight, cost, and complexity, while increasing overall system performance.

[10] Installed price premium is additional to the installed price of the wall system with code-minimum insulation and comprises Insulation material and installation labor for 2" of insulation (R-30), and any required insulation protection. The baseline R-30 insulation material price for comparison is $2.15/ft2.

Traditional building materials are designed for static conditions, and therefore disregard the dynamic nature of the ambient environment. Dynamic materials that respond to the changing ambient environment are needed to fully explore the energy efficiency and energy management opportunities in buildings. While dynamic building envelope elements such as automated shading are known, a challenge remains to build dynamic property flexibility into the materials themselves rather than relying on complex sensor and actuator systems.

The ability of the building envelope to predictably respond to dynamic needs of the grid can enhance the flexibility, resiliency, and reliability of the overall energy system. Next generation solutions that can be operated over a range of ambient conditions are needed to optimize grid support by the building. Therefore, in addition to exploring materials that can better respond to ambient conditions, BTO is also seeking dynamic materials that can be predictably and reliably controlled.

It is important to note that multi-functionality and dynamic functionality are not mutually exclusive material properties. Shown in the table below are examples of each scenario.

Table 2.2. Key Material Properties

	Single function	Multi-function
Static performance	Conventional thermal insulation	Structural insulation material
Dynamic performance	Intelligent moisture membrane	Self-healing materials

Potential high-performing and smart materials of interest that enable next-generation building envelopes include, but are not limited to the areas of interest listed below.

- **Self-Healing and Remediation Materials:** *Development of materials that can retain, repair, or restore performance following a failure event, installation error or defect, or facilitate the detection of performance deficiencies.*

  Remediation of defects in existing buildings often requires extensive teardown and reconstruction, which is cost-prohibitive. Technologies that could repair these deficiencies without such extensive teardown or occupant disturbance would thus be of significant value. This would include materials

that could correct air sealing system defects in-situ. Further, existing buildings with underperforming or inadequate air barriers could benefit from materials that can repair or remediate the air barrier system, or perhaps even provide air sealing if there is no existing system. Air barrier system remediation suitable for self-administration or self-assembly at areas of infiltration or exfiltration and for buildings with finished surfaces is of interest.

Autonomic self-healing technologies for vacuum insulation panels (VIPs) that fully remediate cuts and punctures created by fasteners (e.g., nails, screws) during installation, handling, and use in-situ, stopping the loss of vacuum and keeping the R-value per inch intact would greatly improve the in-field performance and acceptance of VIPs. Further, self-healing materials could improve quality through "embedded" control mechanisms and facilitate construction crews or building owners in the tasks of detecting failures or problems.

Membrane-based technologies should be submitted to Topic 1 of this FOA.

- **Directional Heat Transfer Technologies:** *Development of alternate thermal management technologies, beyond static insulation, that can significantly reduce the energy consumption attributed to building envelopes.*

  Advanced thermally anisotropic materials or composites, heat pipe technologies, and other thermal delivery technologies that redirect heat to a sink or thermal reservoir or from a source could significantly reduce heating and cooling energy use, shave peak energy demand, and provide resilience in power outages especially during extreme heat events. Solutions that are applicable for retrofitting existing buildings are encouraged.

  Innovative thermal delivery technologies integrated into the internal envelope surface could direct heat as needed within the building structure. Next generation materials with high thermal properties could enable greater efficiency, comfort, and control through radiant heating and cooling. While hydronic radiant systems are the state of the art in energy distribution within the building envelope, new technologies that provide a thermal equivalent to fiber optics are sought to realize the full potential of these systems. New materials and systems will also enable greater spatial and dynamic control of heat management in the building space that will result in lower energy requirements and greater occupant comfort.

- **Variable Heat Transport Materials:** *Optical and insulation materials that can be tuned to allow for selective flow of heat, as well as dynamically adjusting their properties in anticipation of future environmental variables.*

  In general, current opaque building envelope designs aim to disconnect indoors from outdoors. This "barrier" typically does not vary because envelopes are usually designed as passive systems that do not respond to a stimulus. This permanent disconnect prevents buildings from taking advantage of outdoor conditions that are favorable to decreasing heating and/or cooling loads. Additionally, not being able to control the envelope impedes its ability to self-optimize, interact with active building components (e.g., HVAC system) for whole-building optimization, and contribute to the alignment of building energy use and electric grid system operations.

  Advanced dynamic building envelope technologies that can be controlled so indoor spaces can interact with the outdoor environment on demand to decrease energy consumption and/or support the electric grid are needed, including variable R-value insulating material that are capable of adjusting the interior insulation's effective R-value, thereby allowing heat transfer to be regulated. Such thermal diodes or switches allow the regulation of heat transfer between indoors and outdoors. Under these circumstances, decreasing the thermal resistance of the wall or roof will reduce cooling loads in the summer and potentially lower peak energy demand in the evening hours. Similarly, envelope components will be able to transfer more heat indoors when exposed to high solar irradiance to reduce heating loads in the winter.

  Variable mass transport materials based on membrane and separation technologies should be submitted to Topic 1 of this FOA.

- **Tunable Thermal Storage in Building Envelopes:**
  Controllable and on demand thermal storage to enable shaving peak energy use, boost resilience in extreme heat events, and increase envelope and building performance

  Tunable thermal storage technologies can improve building efficiency and maintain occupant comfort by capturing, routing, and storing external heat (or cold). Applications include routing and storing solar radiation or other heat or cold sources to reduce heating demand and cooling demand. Technologies with high energy flow rates to transport heat from zones to meet local space conditioning needs are of interest. Solutions viable for both new construction and retrofits are encouraged. Although materials are

available that can store and release sensible and latent loads, solutions are needed that allow for this load exchange to happen on demand. Further, thermal storage with combined water vapor storage for moisture control in buildings would provide increased flexibility and is thus of interest.

REFERENCES can be found in Appendix G.ii

iii. Topic 3: High-Performance Windows.

Energy loss through windows for heating and cooling represents more than 3 quads annually. The typical building stock of windows in America have low thermal performance, represented by low R values (R-1 single clear glass and R-2 double clear glazing). Despite tremendous progress on low-emissivity (low-e) glass development that reduces thermal losses by 50% or greater compared to the old stock, typical new windows continue to be the weakest link in the thermal envelope and have R-values of R-3 to R-3.5 that are far below other parts of the building envelope. BTO's long-term goal is to develop R10 windows, which have comparable energy performance to the vast majority of the walls in the existing building stock.[11]

While low-e glass and spectrally selective glass coatings offer significant thermal improvements, reduced cooling loads, and the greatest overall energy savings within a static glazing environment, passive heating contributions are significantly reduced from older clear glass. Accordingly, BTO's analysis shows that the ultimate performance is one with highly insulating technology along with dynamic solar heat gain. In fact, the combination of the two core technologies could even lead to residential homes in mixed and cold climates to achieve greater energy performance than an otherwise-traditional home that had no windows. In commercial buildings, benefits of natural daylight and reduced cooling loads along with overall thermal management and optimized façade design also result in less energy consumption than a building without any windows. Thus, it is estimated that the entire cooling and heating energy consumption associated with windows can be saved along with over another one-half quad of lighting savings through natural daylight benefits.

BTO is interested in the development of highly insulated windows with R values that range from R-6 to R-10[12] that are marketable based on cost,

[11] The majority of walls have studs with R11 and R13 cavity insulation which results in whole wall performance in the range of roughly R9 to R11.

[12] Corresponds to whole window National Fenestration Rating Council U values of 0.17 to 0.10 [Btu/hr-ft2-F].

visible light transmission (not too dark), and weight (for ease of installation). BTO also has interest in lower cost dynamic glazings that allow for significant modulation of the solar heat gain coefficient (SHGC), from at least 0.10 in the switched or darkened state to 0.50 in the clear state and preferably higher if possible. The ultimate dynamic coating would be one that can modulate near infrared light independently of visible light. Dynamic windows offer significant peak electricity reduction in commercial buildings along with increased natural daylight, comfort and glare control. In residential buildings, they offer greater passive heating contributions along with the potential to provide net zero energy windows when combined with highly insulating properties.

Example topics of interest, listed below, include advanced materials, coatings, overall innovative design strategies as well as fundamentally new approaches to achieving high performance windows. These examples are not comprehensive.

- Vacuum glazing technology that utilizes typical annealed glass or strengthen glass that has a shorter process time and lower cost compared with tempered glass, and have the potential for large scale inline mass production capability with long lasting seals and low thermal conductivity.
- "Hybrid" triple pane products that have an outer lite to buffer the environmental parameters for a vacuum glazing to allow for lower cost approaches.
- Advanced highly insulating materials, coatings, thermal storage, and other approaches that leads to a reduction in heat transfer and significant energy savings while ensuring haze is no more than 1% (ASTM D1003).
- Multi-layer insulated glass units that maintain high visible light, durability (ASTM 2190 at a minimum or industry non-promulgated "P1" test), and are thin such that they can be installed into approximately three quarters of the existing window sashes thus avoiding window redesign. Solutions could include very thin glass or innovative thin window films that have reduced paths for gas leakage and are low cost to produce.
- Coating methods for dynamic glass, particularly focused on modulating near infrared, that have the potential to offer very high durability (e.g. high temperature, high UV, and optical dynamic cycling concurrently in accordance with a variety of test protocols including ASTM 2141) at very low cost.

- Dynamic glazing system designs that through lower cost materials, installation techniques, interface controls and system level improvements can achieve market viability based on energy efficiency.
- Innovative applications that allow for existing windows to be upgraded to high levels of performance that include the retrofit attachment combined with the existing base window, for example a dynamic insulated vacuum exterior storm window that meets key technical characteristics, can be installed without disrupting occupants, and offers wireless installation and controls with minimal maintenance requirements.

REFERENCES can be found in Appendix G.iii

iv. Topic 4: Novel Approaches for Cyber-physical Systems in Buildings.

Cyber-physical systems integrate sensing and actuation with computing and communications to monitor and control the physical world. BTO has two R&D sub-programs, Building Energy Modeling (BEM) and Sensors and Controls (S&C) that together cover portions of the building cyber-physical space. Early-stage R&D by these sub-programs complements BTO R&D efforts in solid-state lighting, HVAC, refrigeration, water heating, windows, and opaque building envelope technologies. BEM informs envelope design and material selection, as well as selection and sizing of HVAC components. Analysis of American Institute of Architects (AIA) 2030 Commitment data shows that commercial buildings designed using BEM consume 15% less energy than those designed using rules of thumb or prescriptive checklists[13]. Sensors and controls ensure energy savings from efficient equipment are achieved by monitoring and correcting for faulty operation, as well as provide opportunities for additional savings by tuning operations to match environmental conditions and occupancy patterns. An aggregated annual energy savings of 29% of commercial building energy consumption can be achieved through the implementation of efficiency measures using current state-of-the-art sensors and controls to optimize programmable settings and to detect and diagnose operational problems.[14] Additional savings of 10-15% is estimated to be possible via implementation of more sophisticated control sequences. The Sensors & Controls and BEM sub-programs also complement one another. The aforementioned national technical potential analysis uses

large scale BEM analysis on prototype building models. Sensors and sub-meters provide detailed time-series data that support model input calibration for existing-building applications.[15,16,17] Simulation, in turn, is used to design and evaluate control algorithms[18] and demand response (DR) strategies,[19,20] as well as to commission HVAC and control systems post construction.[21] During building operation, BEM is used in model predictive control,[22,23,24] real-time performance assessment and fault detection,[25,26] system identification,[27] and continuous commissioning.[28,29]

BTO is interested in new and enhanced synergies between these related areas, leveraging either BTO-supported or other tools. Applications can target static/offline/design applications or dynamic/online/operational applications. Other creative ideas at this nexus with significant energy saving potential are also encouraged. Examples of new focus areas for BTO include demand flexibility, grid response, and resiliency .[30,31,32] BTO will also consider synergistic applications that promote these attributes and capabilities to provide their owners, occupants, and the grid with greater value.

A description of the relevant sub-programs, current synergistic efforts, and examples of potential future synergies follows.

Building Controls

Traditional building HVAC control is rule-based, reactive, and designed to meet short-term thermal and ventilation loads. It is also typically separated from control of other building subsystems such as lighting. To both meet energy-efficiency targets and co-exist with and leverage a more dynamic electricity grid, next-generation control systems will co-emphasize energy efficiency in addition to meeting loads. To achieve this, emerging controls advancements are focused on managing multiple building systems (e.g., HVAC, refrigeration, and lighting), executing more complex strategies over longer time periods (e.g., hours and days rather than minutes) and at multiple spatial scales (e.g., occupant, zone, whole-building, campus), incorporating predictions (e.g., occupancy patterns, weather forecasts) in addition to current state information, and employing optimization techniques rather than rules. To meaningfully participate in grid transactions, control systems also need to quantify potential energy savings, demand flexibility, and impact on occupants and energy-related building services.

BTO's controls R&D sub-program aims to accelerate these transitions through a portfolio approach focused on the development of hierarchical, predictive and adaptive controls approaches. Current examples include occupancy-driven techniques,[33,34] as well as automated fault detection and diagnostic (AFDD) applications to enable continuous or monitoring-based commissioning, and controls optimization.[35, 36, 37]

Whole-building Energy Modeling

Whole-building energy modeling (BEM)—physics based simulation of building energy use—is used to inform design for new construction and retrofits and to document building performance. Design applications also extend to control strategies.[38] These static or offline use-cases focus on annual energy use in a typical year. In recent years, dynamic, online or real-time applications of BEM in building controls and operations have emerged. These include model predictive control (MPC) as well as continuous commissioning (CCx) to detect and diagnose system faults.[39] Some commercial products are available,[40,41,42] but upfront costs generally limit these to very large buildings

To support both static and dynamic BEM applications in building control and to align its sub-program portfolios, BTO's BEM and Sensors & Controls sub-programs are co-sponsoring two foundational projects: Spawn-of-EnergyPlus[43] and Open Building Control.[44] Spawn is a next-generation BEM engine that accepts control specifications in Modelica,[45] a standard language that can be compiled and executed on existing control platforms. The use of Modelica allows Spawn to model real-world, as opposed to idealized, control and bridges workflows for energy simulation on one side and control design, testing, and implementation on the other. The Open Building Control project complements Spawn with reference implementations of ASHRAE Guideline 36 control sequences as well as tools for control sequences testing and diagnostics. These projects enable further development, as well as correct implementation of the more sophisticated control sequences and strategies targeted by the Sensors & Controls sub-program.

Building Monitoring and Sub-Metering

Modeling and control of building operation are both enabled by measurement, and BTO works to advance building sensing and metering technologies. BTO focuses on improved accuracy and reduced total cost

(including installation and maintenance). The R&D focus areas for sensing include new modalities for parameters that are currently limited in their overall performance (e.g., occupancy, building equipment health). Critical information on the state and usage patterns of specific equipment through advanced metering of energy consumption at the equipment-level is useful for monitoring-based commissioning and facilitating AFDD.[44]

An example of sensing in support of BEM includes recent advances in using zone temperature data streams from smart thermostats to perform targeted calibration of infiltration and internal thermal mass, two impactful BEM inputs that are notoriously difficult to measure.[47] This targeted approach—which uses a single simulation with a reformulated heat-balance equation--complements conventional calibration which requires many simulation runs. In another effort of utilizing BEM to support control applications, researchers have developed OpenStudio models of typical HVAC equipment faults for use in the development and evaluation of algorithms for fault detection and diagnostics with minimal sensor installation and customization, making it appealing for small commercial buildings, and even homes.[48]

The examples described above for each of the sub-programs are not comprehensive and merely serve as a representative snapshot of interesting synergies between S&C and BEM. Applicants are encouraged to propose new and enhanced synergies as well.

REFERENCES can be found in Appendix G.iv

v. Topic 5: Integration Research of Advanced Commercial Energy Efficiency Packages.

Building efficiency stakeholders need research, development and validation to inform future R&D and product development, better incorporate end-user requirements and to understand the performance and cost trade-offs of technologies that produce integrated and optimized building systems. Many optimized building systems have the potential to deliver energy savings and grid services, but the savings, cost and performance of systems approaches for building efficiency have not been validated using dynamic building conditions, especially regarding the integration and connectivity benefits and risks such as labor, cost, maintenance, sub-optimal device performance, premature component failures, etc. For example, BTO-supported research found, for the first time, that combining automated shading integrated with

daylight dimming lighting control yielded 9-23% whole building energy savings compared to a utility base case condition (a set of representative existing building configurations developed using building sector data on age and code requirements as obtained from market analysis and available utility data) in lab-simulated building conditions. Original investigation into integrated task/ambient lighting with plug load occupancy-based controls yielded 16-21% whole building savings in lab-simulated experimental building conditions.

BTO seeks proposals for the research, development and field or laboratory testing of highly integrated building systems that respond to dynamic, real world conditions. Proposals under this topic should focus on original investigation and experimentation, fully supporting the development and testing of cost effective, highly integrated systems to understand if and how proposed systems efficiency approaches are able to achieve at least 750 TBtu/yr. in national energy savings potential or 50% whole building savings compared to a code compliant baseline.

Key components of applications should include:

- Next generation technology packages that improve efficiency across **two or more building end uses;**
- Field validation, testing and calculations of technology package to establish energy savings of at least **50% whole building savings compared to a code compliant baseline or 750 TBtu/yr. in national energy savings potential**. Proposals using the code baseline should call out the code used for calculation of whole building savings and display in a pie chart the baseline versus package savings across each system end use. Proposals using the national savings potential should use BTO's Scout tool to calculate national energy savings potential using EnergyPlus simulation results for the proposed package and across applicable reference buildings;
- Strategic public-private industry partnerships that set consistent active channels to access user input and feedback that improves design, application and development decisions. Teams should include representation from each of the following: 1) **technology providers and/or researchers 2) utilities, and 3) building owners and/or operators.** BTO will prefer applications including partners representing large portfolios of buildings to maximize investment impact; and
- Demonstrated capability and commitment to rapidly initiate and complete the project in **three years from September 30, 2018.**

Applicants should include activities targeted at documenting and sharing the definitions, metrics, methodologies and data used to measure and validate performance outcomes (including using M&V 2.0 or auto-M&V methods). Additionally, BTO will prefer applicants that utilize existing data standardization activities and frameworks – including the Building Energy Data Exchange Specification and related applications such as BuildingSync – to collect and share building energy data for more comprehensive and consistent component, building, community and national scale energy evaluations. Data will be standardized, publicly published and distributed in order to support additional research and development. All data and outcomes from these projects are expected to be made public.

REFERENCES can be found in Appendix G.v

vi. Topic 6: Advancements in Natural Gas and Other Fuel-driven Equipment.

BTO is seeking to reduce the energy consumption of natural gas and other fuel-driven (e.g., propane) equipment. Reducing energy consumption from these fuel-driven solutions, however, poses a unique challenge due to the infrastructure in place for the fuel in buildings. The focus of this topic is on the equipment, but BTO is also interested in everything "past the gas meter", all the way to the venting of the combustion byproducts. Conventional fuel-driven technologies using heat derived directly from the combustion of fossil fuels are performance limited, since heat is generated from the fuel directly without taking advantage of existing thermal energy in the environment. While some advanced natural gas systems are currently available, existing systems are too expensive and may not be sufficiently reliable to achieve widespread use. In this context, BTO is interested in new technologies that can radically enable a transformative change to fuel-driven equipment including how we install, operate, maintain and service the next generation of equipment. BTO is particularly interested in types of systems that exhibit a coefficient of performance (COP) greater than 1.0.

In the long term, compared to state-of-the-art systems using the same fuel, these systems must achieve:

- Acceptable reliabilities, maintenance intervals, and life expectancies;
- Similar levels of product safety; and
- Low cost, first and life cycle cost.

Previous BTO reports are available for reference and serve to gauge the state of the art (SOA) for a specific technology (See Appendix G.vi.).

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

C. Applications Specifically Not of Interest

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

- Applications that fall outside the technical parameters specified in Section I.B of the FOA.
- Applications that are focused on deployment.
- Applications for proposed technologies that are not based on sound scientific principles (e.g., violates the laws of thermodynamics).
- Note, since BTO typically releases a separate Solid-State Lighting (SSL) R&D FOA annually, SSL technologies are not included in the BENEFIT FOA.

D. Authorizing Statutes

The programmatic authorizing statute is EPAct 2005 911(a)(2)(B)

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

II. Award Information

A. Award Overview

vii. Estimated Funding

EERE expects to make approximately $19.5 million of Federal funding available for new awards under this FOA, subject to the availability of appropriated funds. EERE anticipates making approximately 14 to 24 awards under this FOA. EERE may issue one, multiple, or no awards.

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

Topic 1: Advanced Separation Technologies for Building Energy Efficiency.
Individual awards may vary between $500,000 to $1 million.

Topic 2: Advanced Building Materials.
Individual awards may vary between $500,000 to $1.5 million.

Topic 3: High-Performance Windows.
Individual awards may vary between $500,000 to $1.5 million.

Topic 4: Novel Approaches for Cyber-physical Systems in Buildings.
Individual awards may vary between $300,000 to $1.5 million.

Topic 5: Integration Research of Advanced Commercial Energy Efficiency Packages.
Individual awards may vary between $300,000 to $1 million.

Topic 6: Advancements in Natural Gas and Other Fuel-driven Equipment.
Individual awards may vary between $750,000 to $1.5 million.

EERE may establish more than one budget period for each award and fund only the initial budget period(s). Funding for all budget periods, including the initial budget period, is not guaranteed. Before the expiration of the initial budget period(s), EERE may perform a down-select among different recipients and provide additional funding only to a subset of recipients.

viii. Period of Performance

EERE anticipates making awards that will run up to 36 months in length, comprised of one or more budget periods. Project continuation will be contingent upon satisfactory performance and go/no-go decision review. At the go/no-go decision points, EERE will evaluate project performance, project schedule adherence, meeting milestone objectives, compliance with reporting requirements, and overall contribution to the program goals and objectives. As a result of this evaluation, EERE will make a determination to continue the project, re-direct the project, or discontinue funding the project.

ix. New Applications Only

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

B. EERE Funding Agreements

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

i. Cooperative Agreements

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

Through Cooperative Agreements, EERE provides financial or other support to accomplish a public purpose of support or stimulation authorized by Federal statute. Under Cooperative Agreements, the Government and Prime Recipients share responsibility for the direction of projects.

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

ii. Funding Agreements with FFRDCs

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

iii. Grants

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

iv. Technology Investment Agreements

In rare cases and if determined appropriate, EERE will consider awarding a Technology Investment Agreement (TIA) to a non-FFRDC applicant. TIAs, governed by 10 CFR Part 603, are assistance instruments used to increase the involvement of commercial entities in the Department's research,

development, and demonstration programs. A TIA may be either a type of cooperative agreement or an assistance transaction other than a cooperative agreement, depending on the intellectual property provisions. In both cases, TIAs are not necessarily subject to all of the requirements of 2 CFR Part 200 as amended by 2 CFR Part 910.

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

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

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

An applicant may request a TIA if it believes that using a TIA could benefit the RD&D objectives of the program (see section 603.225) and can document these benefits. If an applicant is seeking to negotiate a TIA, the applicant must include an explicit request in its Full Application. After an applicant is selected for award negotiation, the Contracting Officer will determine if awarding a TIA would benefit the RD&D objectives of the program in ways

that likely would not happen if another type of assistance agreement (e.g., cooperative agreement subject to the requirements of 2 CFR Part 200 as amended by 2 CFR Part 910). The Contracting Officer will use the criteria in 10 CFR 603, Subpart B, to make this determination.

III. Eligibility Information

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

A. Eligible Applicants

i. Individuals

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

ii. Domestic Entities

For-profit entities, educational institutions, and nonprofits that are incorporated (or otherwise formed) under the laws of a particular State or territory of the United States are eligible to apply for funding as a Prime Recipient or Subrecipient. Nonprofit organizations described in section 501(c)(4) of the Internal Revenue Code of 1986 that engaged in lobbying activities after December 31, 1995, are not eligible to apply for funding.

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

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

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

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

iii. Foreign Entities

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

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

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

A foreign entity may receive funding as a Subrecipient.

iv. Incorporated Consortia

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

v. 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. 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

Cost Share 20%, Cost Share Waiver Not Utilized

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

To assist applicants in calculating proper cost share amounts, EERE has included a cost share information sheet 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. The Prime Recipient's cost share obligation is expressed in the Assistance Agreement as a static amount in U.S. dollars (cost share amount) and as a percentage of the Total Project Cost (cost share percentage). If the funding agreement is terminated prior to the end of the project period, the Prime Recipient is required to contribute at least the cost share percentage of total expenditures incurred through the date of termination.

The Prime Recipient is solely responsible for managing cost share contributions by the Project Team and enforcing cost share obligation assumed by Project Team members in subawards or related agreements.

ii. Cost Share Allocation

Each Project Team is free to determine how best to allocate the cost share requirement among the team members. The amount contributed by individual Project Team members may vary, as long as the cost share requirement for the project as a whole is met.

iii. Cost Share Types and Allowability

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

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

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

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

Project teams may use funding or property received from state or local governments to meet the cost share requirement, so long as the funding was not provided to the state or local government by the Federal Government.

The Prime Recipient may not use the following sources to meet its cost share obligations including, but not limited to:

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

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

Cost share contributions must be specified in the project budget, verifiable from the Prime Recipient's records, and necessary and reasonable for proper and efficient accomplishment of the project. As all sources of cost share are considered part of total project cost, the cost share dollars will be scrutinized under the same Federal regulations as Federal dollars to the project. Every cost share contribution must be reviewed and approved in advance by the Contracting Officer and incorporated into the project budget before the expenditures are incurred.

Applicants are encouraged to refer to 2 CFR 200.306 as amended by 2 CFR 910.130 & 10 CFR 603.525-555 for additional guidance on cost sharing.

iv. Cost Share Contributions by FFRDCs

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

v. Cost Share Verification

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

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

vi. Cost Share Payment

EERE requires Prime Recipients to contribute the cost share amount incrementally over the life of the award. Specifically, the Prime Recipient's cost share for each billing period must always reflect the overall cost share ratio negotiated by the parties (i.e., the total amount of cost sharing on each invoice when considered cumulatively with previous invoices must reflect, at a minimum, the cost sharing percentage negotiated). As FFRDC funding will be provided directly to the FFRDC(s) by DOE, Prime Recipients will be required to provide project cost share at a percentage commensurate with the FFRDC costs, on a budget period basis, resulting in a higher interim invoicing cost share ratio than the total award ratio.

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

C. Compliance Criteria

Concept Papers and Full Applications must meet all Compliance criteria listed below or they will be considered noncompliant. EERE will not review or consider noncompliant submissions, including Concept Papers, Full Applications, and Replies to Reviewer Comments that were: submitted through means other than

EERE Exchange; submitted after the applicable deadline; and/or submitted incomplete. EERE will not extend the submission deadline for applicants that fail to submit required information due to server/connection congestion.

i. Compliance Criteria

i. **Concept Papers**

Concept Papers are deemed compliant if:

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

ii. **Full Applications**

Full Applications are deemed compliant if:

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

iii. **Replies to Reviewer Comments**

Replies to Reviewer Comments are deemed compliant if:

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

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 Federally Funded Research and Development Centers (FFRDC) Listed as the Applicant

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

The following wording is acceptable for the authorization:

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

ii. Requirements for DOE/NNSA and non-DOE/NNSA Federally Funded Research and Development Centers Included as a Subrecipient

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

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

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

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

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

Authorization is granted for the [Enter Laboratory Name] Laboratory to participate in the proposed project. The work

proposed for the laboratory is consistent with or complementary to the missions of the laboratory, and will not adversely impact execution of the DOE assigned programs at the laboratory.

iii. **Value/Funding**

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

iv. **Cost Share**

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

v. **Responsibility**

The Prime Recipient will be the responsible authority regarding the settlement and satisfaction of all contractual and administrative issues including, but not limited to disputes and claims arising out of any agreement between the Prime Recipient and the FFRDC contractor.

vi. **Limit on FFRDC Effort**

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

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

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

G. Questions Regarding Eligibility

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

IV. Application and Submission Information

A. Application Process

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

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

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

review only the authorized number of pages and disregard any additional pages.

Applicants are responsible for meeting each submission deadline. **Applicants are strongly encouraged to submit their Concept Papers and Full Applications at least 48 hours in advance of the submission deadline**. Under normal conditions (i.e., at least 48 hours in advance of the submission deadline), applicants should allow at least 1 hour to submit a Concept Paper, Full Application, or Reply to Reviewer Comments. Once the Concept Paper, Full Application, or Reply to Reviewer Comments is submitted in EERE Exchange, applicants may revise or update that submission until the expiration of the applicable deadline. If changes are made, the applicant must resubmit the Concept Paper, Full Application, or Reply to Reviewer Comments before the applicable deadline.

EERE urges applicants to carefully review their Concept Papers, and Full Applications and to allow sufficient time for the submission of required information and documents. All Full Applications that pass the initial eligibility review will undergo comprehensive technical merit review according to the criteria identified in Section V.A.2 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 Application 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 issue with submissions that result in late submissions: In the event that an applicant experiences technical difficulties so severe that they are unable to submit their application by the deadline, the applicant should contact the 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, however, those applicants who are

unable to submit their application on time due to their waiting until the last minute when network traffic is at its heaviest to submit their materials will not be able to use this process.

B. Application Forms

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

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

C. Content and Form of the Concept Paper

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

i. Concept Paper Content Requirements

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

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

The Concept Paper must conform to the following content requirements:

Section	Page Limit	Description
Cover Page	1 page maximum	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Technology Description	2 pages maximum	Applicants are required to describe succinctly:

		• The proposed technology, including its basic operating principles and how it is unique and innovative; • The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target could be met); • The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; • The potential impact that the proposed project would have on the relevant field and application; • The key technical risks/issues associated with the proposed technology development plan; and • The impact that EERE funding would have on the proposed project.
Addendum	1 pages maximum	Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: • Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has worked together with its teaming partners on prior projects or programs; and • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities. Applicants may provide graphs, charts, or other data to supplement their Technology Description.

EERE makes an independent assessment of each Concept Paper based on the criteria in Section V.A.i of the FOA. EERE will encourage a subset of applicants to submit Full Applications. Other applicants will be discouraged from submitting a Full Application. An applicant who receives a "discouraged" notification may still submit a Full Application. EERE will review all eligible Full Applications. However, by discouraging the submission of a Full Application, EERE intends to convey its lack of programmatic interest in the proposed project in an effort to save the applicant the time and expense of

preparing an application that is unlikely to be selected for award negotiations.

EERE may include general comments provided from reviewers on an applicant's Concept Paper in the encourage/discourage notification posted on EERE Exchange at the close of that phase.

D. Content and Form of the Full Application

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

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

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

i. Full Application Content Requirements

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

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

Full Applications must conform to the following requirements:

Submission	Components	File Name
Full Application (PDF, unless	Technical Volume (See Chart in Section IV.D.2)	ControlNumber_LeadOrganization_TechnicalVolume
	Statement of Project Objectives (Microsoft Word format) (10 page limit)	ControlNumber_LeadOrganization_SOPO

stated otherwise)	SF-424: Application for Financial Assistance	ControlNumber_LeadOrganization_App424
	Budget Justification (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Budget_Justification
	Summary for Public Release (1 page limit)	ControlNumber_LeadOrganization_Summary
	Summary Slide (1 page limit, Microsoft PowerPoint format)	ControlNumber_LeadOrganization_Slide
	Subaward Budget Justification, if applicable (EERE 335) (Microsoft Excel format. Applicants must use the template available in EERE Exchange)	ControlNumber_LeadOrganization_Subrecipient_Budget_Justification
	Budget for FFRDC, if applicable	ControlNumber_LeadOrganization_FWP
	Authorization from cognizant Contracting Officer for FFRDC, if applicable	ControlNumber_LeadOrganization_FFRDCAuth
	SF-LLL Disclosure of Lobbying Activities	ControlNumber_LeadOrganization_SF-LLL
	Foreign Entity and Performance of Work in the United States waiver requests, if applicable	ControlNumber_LeadOrganization_Waiver
	U.S. Manufacturing Plans	ControlNumber_LeadOrganization_USMP
	Data Management Plan	ControlNumber_LeadOrganization_DMP
	Open Source Software Distribution Plan	ControlNumber_LeadOrganization_OSSDP
	Technical Potential and Payback Calculation	ControlNumber_LeadOrganization_TPP

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

ControlNumber_LeadOrganization_TechnicalVolume_Part_1
ControlNumber_LeadOrganization_TechnicalVolume_Part_2, etc.

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

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

ii. Technical Volume

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

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

Except for enabling technologies and design tools, one performance metric used to evaluate applications will be the primary energy savings technical potential. Each application must describe a technology or an approach that leads to a minimum annual primary energy savings technical potential of at least 250 Trillion British Thermal Units (TBtu), i.e., 0.25 Quads for U.S. residential and/or commercial buildings. All applicants proposing a technology, again except for enabling technologies and design tools, will be required to use the BTO Baseline Energy Calculator (https://scout.energy.gov/baseline-energy-calculator.html) to compute the total market size in TBtu in 2030. Each applicant will enter the relevant building type (residential single-family, commercial food sales, etc.), end use (heating, cooling, lighting, cooking, refrigeration, etc.), climate zone(s) (1—5), and other information, from which the web tool will return the energy market size in TBtu. The applicants will also need to provide an estimate of the percent energy savings applicable to this market for their proposed technology innovation, with supporting analysis as described in Appendix F. The applicant will present the primary energy savings technical potential: the product of the percent energy savings and the energy market size as calculated by the Baseline Energy Calculator.

A second performance metric used to evaluate applications will be the cost effectiveness, as measured by the simple payback. Again, this will be applicable only to technology development proposals, and not to other proposals such as design tools or enabling technologies for which primary energy savings and/or payback are difficult to directly quantify. An explicit

approach is described in Appendix F, which applicants should follow to compute the payback for their proposed technology. An acceptable maximum payback (in years) will not be specified, since that can vary significantly depending on the end use.

All applicants will be required to provide an estimate of primary energy savings potentially resulting from their solution, even non-technological solutions. Such non-technological solutions must provide their own analysis of primary energy savings technical potential, and an analysis of their cost effectiveness. Applicants are strongly encouraged to provide references that support their analysis.

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

SECTION/PAGE LIMIT	DESCRIPTION
Cover Page	The cover page should include the project title, the specific FOA Topic Area being addressed (if applicable), both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Project Overview (This section should constitute approximately 10% of the Technical Volume)	The Project Overview should contain the following information: • Background: The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants are required to report two performance metrics: primary energy savings and cost effectiveness, as measured by the simple payback. Applicants are required to use the BTO Baseline Energy Calculator web tool to report the primary energy savings for the proposed technology. The web tool will allow applicants to compute total market size (in TBtu). The applicants will also need to provide an estimate of the % energy savings applicable to this market, with supporting analysis, and the product of the % energy savings and the energy market size yields the primary energy savings technical

	potential. 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. See section IV.D.2. Technical Volume and Appendix F for further guidance.
Technical Description, Innovation, and Impact (This section should constitute approximately 30% of the Technical Volume)	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the FOA, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state of the art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact on advancing the state of the art/technical baseline and the energy efficiency relative to the commercial sector energy consumption baseline if the project is successful and the technology is ultimately commercialized.
Workplan and Technology Transition Plan (This section should constitute approximately 40% of the Technical Volume)	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure, Milestones, Go/No-Go Decision Points, and Project Schedule. A detailed Statement of Project Objectives (SOPO) is separately requested. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes. • Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on go/no-go decision points). The applicant should describe the specific expected end result of each performance period. • Work Breakdown Structure (WBS) and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance

	period (approximately annual), task and subtasks, which is typical of a standard work breakdown structure (WBS) for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this FOA. The summary provided should be consistent with the SOPO. The SOPO will contain a more detailed description of the WBS and tasks. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be **S**pecific, **M**easurable, **A**chievable, **R**elevant, and **T**imely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified. The summary provided should be consistent with the Milestone Summary Table in the SOPO. • Go/No-Go Decision Points: The applicant should provide a summary of project-wide go/no-go decision points at appropriate points in the Workplan. A go/no-go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. Unless otherwise specified in the FOA, the minimum requirement is that each project must have at least one project-wide go/no-go decision point for each budget period (12 to 18-month period) of the project. The Applicant should also provide the specific technical criteria to be used to make the go/no-go decision. The summary provided should be consistent with the SOPO. Go/no-go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone. • End of Project Goal: The applicant should provide a summary of the end of project goal(s). Unless otherwise specified in the FOA, the minimum requirement is that each project must have one SMART end of project goal. The summary provided should be consistent with the SOPO.

	• Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and go/no-go decision points. • Project Management: The applicant should discuss the team's proposed management plan, including the following: o The overall approach to and organization for managing the work o The roles of each Project Team member o Any critical handoffs/interdependencies among Project Team members o The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices o The approach to project risk management o A description of how project changes will be handled o If applicable, the approach to Quality Assurance/Control o How communications will be maintained among Project Team members • The Technology Transition Plan section in the application should use plain language to describe the state of the technology and include a summary of the Value Proposition & Market Opportunity, Risk Mitigation Strategy, and Team. The significant impact sought by DOE depends upon successful projects finding a path to large-scale adoption. DOE projects are not required to achieve commercial deployment by the end of the project period, but the applicant should define a reasonable path for the proposed technology toward commercial success. • The Technology Transition Plan should contain the following information for all Topics except Topic #5, which does not require completion of the Technology Transition Plan section: o Value Proposition & Market Opportunity: Quantify the market opportunity and describe the value proposition and competitive differentiation. Include an explanation of why the proposed solution would be commercially relevant (e.g., what needs are you trying to address? How have previous solutions fallen short?) and how you plan to test and qualify your product concept in the market. o Risk Mitigation Strategy: Identify techno-economic challenges to be overcome for the proposed technology to be commercially relevant and discuss any scalability, regulatory, intellectual property (IP) or integration risks and considerations associated with the technology. Outline your mitigation strategies towards these challenges. Discuss any other factors key to the successful realization of energy savings potential, as well as any

	known or perceived barriers to market adoption/dissemination and your plans for enhancing or mitigating these. o Team: Identification of technology transition project team lead responsible for leading and coordinating all technology transition activities for the project.
Technical Qualifications and Resources (Approximately 20% of the Technical Volume)	The Technical Qualifications and Resources should contain the following information: • Describe the Project Team's unique qualifications and expertise, including those of key Subrecipients. • Describe the Project Team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project. • Attach one-page resumes for key participating team members as an appendix. Resumes do not count towards the page limit. Multi-page resumes are not allowed. • Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable. • Attach letters of commitment from all Subrecipient/third party cost share providers as an appendix. Letters of commitment do not count towards the page limit. • Attach any letters of commitment from partners/end users as an appendix (1 page maximum per letter). Letters of commitment do not count towards the page limit. • For multi-organizational or multi-investigator projects, describe succinctly: o The roles and the work to be performed by each PI and Key Participant; o Business agreements between the applicant and each PI and Key Participant; o How the various efforts will be integrated and managed; o Process for making decisions on scientific/technical direction; o Publication arrangements; o Intellectual Property issues; and o Communication plans

iii. Statement of Project Objectives

Applicants are required to complete a Statement of Project Objectives (SOPO). A SOPO template is available on EERE Exchange at https://eere-Exchange.energy.gov/. The SOPO, including the Milestone Table, must not exceed 10 pages excluding milestone table when printed using standard 8.5 x 11 paper with 1" margins (top, bottom, left, and right) with font not smaller than 12 point. Save the SOPO in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_SOPO".

iv. SF-424: Application for Federal Assistance

Complete all required fields in accordance with the instructions on the form. The list of certifications and assurances in Field 21 can be found at http://energy.gov/management/office-management/operational-management/financial-assistance/financial-assistance-forms, under Certifications and Assurances. Note: The dates and dollar amounts on the SF-424 are for the complete project period and not just the first project year, first phase or other subset of the project period. Save the SF-424 in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_App424".

v. Budget Justification Workbook (EERE 335)

Applicants are required to complete the Budget Justification Workbook. This form is available on EERE Exchange at https://eere-Exchange.energy.gov/. Prime Recipients must complete each tab of the Budget Justification Workbook for the project as a whole, including all work to be performed by the Prime Recipient and its Subrecipients and Contractors, and provide all requested documentation (e.g., a Federally-approved rate agreement, vendor quotes). Applicants should include costs associated with required annual audits and incurred cost proposals in their proposed budget documents. The "Instructions and Summary" included with the Budget Justification Workbook will auto-populate as the applicant enters information into the Workbook. Applicants must carefully read the "Instructions and Summary" tab provided within the Budget Justification Workbook. Save the Budget Justification Workbook in a single Microsoft Excel file using the following convention for the title "ControlNumber_LeadOrganization_Budget_Justification".

vi. Summary for Public Release

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

vii. Summary Slide

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

The Summary Slide template requires the following information:

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

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

Applicants must provide a separate budget justification, EERE 335 (i.e., budget justification for each budget year and a cumulative budget) for each 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. Save each subaward

budget justification in a Microsoft Excel file using the following convention for the title "ControlNumber_LeadOrganization_Subrecipient_Budget_Justification".

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

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE Field Work Proposal (FWP) in accordance with the requirements in DOE Order 412.1, Work Authorization System. DOE Order 412.1 and DOE O 412.1 (Field Work Proposal form) area available at the following link, under "DOE Budget Forms": https://www.directives.doe.gov/directives-documents/400-series/0412.1-BOrder-a-admchg1/@@images/file. Save the FWP in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_FWP".

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

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

xi. SF-LLL: Disclosure of Lobbying Activities

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

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

- An officer or employee of any Federal agency;
- A Member of Congress;
- An officer or employee of Congress; or

- An employee of a Member of Congress.

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

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

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

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

xiii. U.S. Manufacturing Plan

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

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

A U.S. Manufacturing Plan should contain the following or similar preamble: "If selected for funding, the applicant agrees to the following commitments as a condition of that funding:" and, after the preamble, the plan should

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

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

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

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

xiv. Data Management Plan

Applicants whose Full Applications are selected for award negotiations will be required to submit a Data Management Plan during the award negotiations phase. The Data Management Plan is a document that outlines the proposed plan for data sharing or preservation. Submission of this plan is required, and failure to submit the plan may result in the termination of

award negotiations. As a courtesy, guidance for preparing a Data Management Plan is provided in Appendix D of the FOA.

xv. Open Source Software Distribution Plan

BTO encourages the development of software that will broadly be used and impact the building energy market. Applicants that choose to propose the development of software that is open source are required to submit an Open Source Software Distribution Plan as part of their Full Application. This plan describes how software produced under this FOA will be distributed. Submission of an Open Source Software Distribution Plan is required; failure to submit a complete Plan may result in a determination of non-compliance for your Full Application. Guidance for preparing an Open Source Software Distribution Plan is included in Appendix E of the FOA.

xvi. Technical Potential and Payback Calculation

All applicants proposing a technology, except for enabling technologies and design tools, will need to provide an estimate of the percent energy savings applicable to this market for their proposed technology innovation, with supporting analysis as described in Appendix F. The applicant will present the primary energy savings technical potential: the product of the percent energy savings and the energy market size as calculated by the Baseline Energy Calculator.

A second performance metric used to evaluate applications will be the cost effectiveness, as measured by the simple payback. Again, this will be applicable only to technology development proposals, and not to other proposals such as design tools or enabling technologies for which primary energy savings and/or payback are difficult to directly quantify. An explicit approach is described in Appendix F, which applicants should follow to compute the payback for their proposed technology. An acceptable maximum payback (in years) will not be specified, since that can vary significantly depending on the end use.

E. Content and Form of Replies to Reviewer Comments

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

submit a Reply to Reviewer Comments. EERE will 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.

F. Post-Award Information Requests

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

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

G. Dun and Bradstreet Universal Numbering System Number and System for Award Management

Each applicant (unless the applicant is an individual or Federal awarding agency that is excepted from those requirements under 2 CFR §25.110(b) or (c), or has an exception approved by the Federal awarding agency under 2 CFR §25.110(d)) is required to: (1) Be registered in the System for Award Management (SAM) at https://www.sam.gov before submitting its application; (2) provide a valid Dun and Bradstreet Universal Numbering System (DUNS) number in its application; and (3) continue to maintain an active SAM registration with current information at all times during which it has an active Federal award or an application or plan under consideration by a Federal awarding agency. DOE may not make a Federal award to an applicant until the applicant has complied with all applicable DUNS and SAM requirements and, if an applicant has not fully complied with the requirements by the time DOE is ready to make a Federal award, the DOE may determine that the applicant is not qualified to receive a Federal award and use that determination as a basis for making a Federal award to another applicant.

H. Submission Dates and Times

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

I. Intergovernmental Review

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

J. Funding Restrictions

i. Allowable Costs

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

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

- FAR Part 31 for For-Profit entities; and

- 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

ii. Pre-Award Costs

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

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

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

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

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

EERE does not guarantee or assume any obligation to reimburse costs where the Prime Recipient incurred the costs prior to receiving written authorization from the Contracting Officer. If the applicant elects to undertake activities that may have an adverse effect on the environment or limit the choice of reasonable alternatives prior to receiving such written authorization from the Contracting Officer, the applicant is doing so at risk of not receiving Federal funding and such costs may not be recognized as allowable cost share. Likewise, if a project is selected for negotiation of award, and the Prime Recipient elects to undertake

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

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. Save the waiver request(s) in a single PDF

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

iv. Construction

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

v. Foreign Travel

If international travel is proposed for your project, please note that your organization must comply with the International Air Transportation Fair Competitive Practices Act of 1974 (49 USC 40118), commonly referred to as the "Fly America Act," and implementing regulations at 41 CFR 301-10.131 through 301-10.143. The law and regulations require air transport of people or property to, from, between, or within a country other than the United States, the cost of which is supported under this award, to be performed by or under a cost-sharing arrangement with a U.S. flag carrier, if service is available. Foreign travel costs are allowable only with the written prior approval of the Contracting Officer assigned to the award.

vi. Equipment and Supplies

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

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

vii. Lobbying

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

Recipients and Subrecipients are required to complete and submit SF-LLL, "Disclosure of Lobbying Activities" (https://www.grants.gov/web/grants/forms/sf-424-individual-family.html) to ensure that non-Federal funds have not been paid and will not be paid to any

person for influencing or attempting to influence any of the following in connection with your application:

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

viii. Risk Assessment

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

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

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

ix. Invoice Review and Approval

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

- Summary of costs by cost categories
- Timesheets or personnel hours report
- Invoices/receipts for all travel, equipment, supplies, contractual, and other costs
- UCC filing proof for equipment acquired with project funds by for-profit recipients and subrecipients

- Explanation of cost share for invoicing period
- Analogous information for some subrecipients
- Other items as required by DOE

V. Application Review Information

A. Technical Review Criteria

i. Concept Papers

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

Criterion 1: Technical Merit, Innovation, and Impact **Weight: 50%**

- The applicant clearly describes the proposed technology, how the technology is unique and innovative, and how the technology will advance the current state-of-the-art.
- Method used to identify current state of the art technology.
- If successful, proposed idea would significantly improve technical and economic performance relative to the state of the art.
- The applicant has used the appropriate quantitative technical methodology to calculate the impact that EERE funding and the proposed project would have on the relevant field and application.
- The proposed work, if successfully accomplished, would clearly meet the objectives as stated in the FOA.

Criterion 2: Overall Project Approach **Weight: 30%**

- The applicant clearly describes the overall soundness, adequacy, and completeness of the proposed project.
- The applicant has shown how the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application.
- The applicant has identified risks and challenges, including possible mitigation strategies associated with the proposed technology development plan.

Criterion 3: Team Qualifications and Capabilities **Weight: 20%**

- The applicant team and partners have the qualifications, experience, capabilities and other resources necessary to complete the proposed project.

- The likelihood that the applicant will effectively and efficiently accomplish the work and meet the objectives.

ii. Full Applications

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

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

Technical Merit and Innovation

- Extent to which the proposed technology or process is innovative;
- Degree to which the current state of the technology and the proposed advancement are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state of the art to the proposed advancement; and
- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and revolutionary, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work.

Impact of Technology Advancement

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

Criterion 2: Project Research and Technology Transition Plan (30%)

Research Approach, Workplan and SOPO

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

Identification of Technical Risks

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

Baseline, Metrics, and Deliverables

- The level of clarity in the definition of and the technical methodology used to calculate 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.

Technology Transition Plan

- Comprehensiveness of Technology Transition Plan including but not limited to articulating a clear understanding of the market opportunity, competitive advantage, and value proposition.
- Demonstrated understanding of the major market and commercialization issues, barriers, and risk areas involved in the development and eventual deployment or dissemination of the proposed solution, and the quality of the mitigation strategies to address them.
- Comprehensiveness of Data Management Plan and U.S. Manufacturing Plan.

Criterion 3: Team and Resources (20%)

- The capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. The qualifications, relevant expertise, and time commitment of the individuals on the team;
- The sufficiency of the facilities to support the work;
- The degree to which the proposed consortia/team responds to the topic area objectives and demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies;
- The level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan; and
- The reasonableness of the budget and spend plan for the proposed project and objectives.

iii. Criteria for Replies to Reviewer Comments

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

B. Standards for Application Evaluation

Applications that are determined to be eligible will be evaluated in accordance with this FOA, by the standards set forth in EERE's Notice of Objective Merit Review Procedure (76 Fed. Reg. 17846, March 31, 2011) and the guidance provided in the "Department of Energy Merit Review Guide for Financial Assistance," which is available at: https://energy.gov/management/downloads/merit-review-guide-financial-assistance-and-unsolicited-proposals-current.

C. Other Selection Factors

i. Program Policy Factors

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

- The degree to which the proposed project exhibits technological diversity when compared to the existing DOE project portfolio and other projects selected from the subject FOA;
- The degree to which the proposed project, including proposed cost share, optimizes the use of available EERE funding to achieve programmatic objectives;
- The level of industry involvement and demonstrated ability to accelerate commercialization and overcome key market barriers;
- The degree to which the proposed project is likely to lead to increased employment and manufacturing in the United States;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty;
- Whether the proposed project team includes cost share commitments from partners that enable the team to rapidly meet the objectives of the topic including utilities and commitments for the use of laboratory facilities and large portfolios of buildings.

D. Evaluation and Selection Process

i. Overview

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

ii. Pre-Selection Interviews

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

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

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

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

iii. Pre-Selection Clarification

EERE may determine that pre-selection clarifications are necessary from one or more applicants. Pre-selection clarifications are distinct from and less formal than pre-selection interviews. These pre-selection clarifications will

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

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

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

iv. Recipient Integrity and Performance Matters

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

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

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

v. Selection

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

E. Anticipated Notice of Selection and Award Dates

EERE anticipates notifying applicants selected for negotiation of award by August 2018 and making awards by September 2018.

VI. Award Administration Information

A. Award Notices

i. Ineligible Submissions

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

ii. Concept Paper Notifications

EERE will notify applicants of its determination to encourage or discourage the submission of a Full Application. EERE will post these notifications to EERE Exchange.

Applicants may submit a Full Application even if they receive a notification discouraging them from doing so. By discouraging the submission of a Full Application, EERE intends to convey its lack of programmatic interest in the proposed project. Such assessments do not necessarily reflect judgments on the merits of the proposed project. The purpose of the Concept Paper phase is to save applicants the considerable time and expense of preparing a Full Application that is unlikely to be selected for award negotiations.

A notification encouraging the submission of a Full Application does not authorize the applicant to commence performance of the project. Please refer to Section IV.J.2 of the FOA for guidance on pre-award costs.

iii. Full Application Notifications

EERE will notify applicants of its determination via a notification letter by email to the technical and administrative points of contact designated by the applicant in EERE Exchange. The notification letter will inform the applicant whether or not its Full Application was selected for award negotiations. Alternatively, EERE may notify one or more applicants that a final selection determination on particular Full Applications will be made at a later date, subject to the availability of funds or other factors.

iv. Successful Applicants

Receipt of a notification letter selecting a Full Application for award negotiations does not authorize the applicant to commence performance of the project. If an application is selected for award negotiations, it is not a commitment by EERE to issue an award. Applicants do not receive an award until award negotiations are complete and the Contracting Officer executes the funding agreement, accessible by the Prime Recipient in FedConnect.

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

Please refer to Section IV.J.2 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:

i. **EERE Exchange**

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

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

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

ii. **DUNS Number**

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

iii. **System for Award Management**

Register with the System for Award Management (SAM) at https://www.sam.gov. Designating an Electronic Business Point of Contact (EBiz POC) and obtaining a special password called an MPIN are

important steps in SAM registration. Please update your SAM registration annually.

iv. **FedConnect**

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

v. **Grants.gov**

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

vi. **Electronic Authorization of Applications and Award Documents**

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

ii. Award Administrative Requirements

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

iii. Foreign National Access to DOE Sites

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

the foreign national(s) to satisfy compliance with all of the requirements for access approval.

iv. Subaward and Executive Reporting

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

v. National Policy Requirements

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

vi. Environmental Review in Accordance with National Environmental Policy Act (NEPA)

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

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

vii. Applicant Representations and Certifications

1. **Lobbying Restrictions**
   By accepting funds under this award, the Prime Recipient agrees that none of the funds obligated on the award shall be expended, directly or indirectly, to influence Congressional action on any legislation or appropriation matters pending before Congress, other than to communicate to Members of Congress as described in 18 U.S.C. §1913. This restriction is in addition to those prescribed elsewhere in statute and regulation.

ii. **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.

iii. **Nondisclosure and Confidentiality Agreements Representations**
In submitting an application in response to this FOA the applicant represents that:

a. It **does not and will not** require its employees or contractors to sign internal nondisclosure or confidentiality agreements or statements prohibiting or otherwise restricting its employees or contactors from lawfully reporting waste, fraud, or abuse to a designated investigative or law enforcement representative of a

Federal department or agency authorized to receive such information.

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

(1) *''These provisions are consistent with and do not supersede, conflict with, or otherwise alter the employee obligations, rights, or liabilities created by existing statute or Executive order relating to (1) classified information, (2) communications to Congress, (3) the reporting to an Inspector General of a violation of any law, rule, or regulation, or mismanagement, a gross waste of funds, an abuse of authority, or a substantial and specific danger to public health or safety, or (4) any other whistleblower protection. The definitions, requirements, obligations, rights, sanctions, and liabilities created by controlling Executive orders and statutory provisions are incorporated into this agreement and are controlling.''*

(2) The limitation above shall not contravene requirements applicable to Standard Form 312, Form 4414, or any other form issued by a Federal department or agency governing the nondisclosure of classified information.

(3) Notwithstanding the provision listed in paragraph (a), a nondisclosure or confidentiality policy form or agreement that is to be executed by a person connected with the conduct of an intelligence or intelligence-related activity, other than an employee or officer of the United States Government, may contain provisions appropriate to the particular activity for which such document is to be used. Such form or agreement shall, at a minimum, require that the person will not disclose any classified information received in the course of such activity unless specifically authorized to do so by the United States Government. Such nondisclosure or confidentiality forms shall also

make it clear that they do not bar disclosures to Congress, or to an authorized official of an executive agency or the Department of Justice, that are essential to reporting a substantial violation of law.

viii. Statement of Federal Stewardship

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

ix. Statement of Substantial Involvement

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

1. EERE shares responsibility with the recipient for the management, control, direction, and performance of the Project.
2. EERE may intervene in the conduct or performance of work under this Award for programmatic reasons. Intervention includes the interruption or modification of the conduct or performance of project activities.
3. EERE may redirect or discontinue funding the Project based on the outcome of EERE's evaluation of the Project at that the Go/No Go decision point(s).
4. EERE participates in major project decision-making processes.
5. EERE promotes and facilitates technology transfer activities, including disseminating Technology Office results through presentations and publications.
6. EERE participates in project management planning activities, including risk analysis, to ensure EERE Technology Office requirements or limitations are considered in performance of the work elements.

7. EERE reviews and approves in a timely manner project plans, including project management, testing and technology transfer plans, and recommending alternate approaches, if the plans do not address the critical programmatic issues.

x. Intellectual Property Management Plan

Within the first quarter of award execution, applicants may be required to submit an executed IP Management Plan between the members of the consortia or team, if directed by the technology manager assigned to the award. Complex consortia or teaming arrangements may warrant an IP Management Plan to avoid potentially debilitating IP disputes from arising. Such disputes have occurred in the past, drastically affecting these projects.

The award will set forth the treatment of and obligations related to intellectual property rights between EERE and the individual members. The IP Management Plan should describe how the members will handle intellectual property rights and issues between themselves while ensuring compliance with Federal IP laws, regulations, and policies (see Sections VIII.L-VIII.O of this FOA for more details on applicable Federal IP laws and regulations). Guidance regarding the contents of IP Management Plans is available from EERE upon request.

The following is a non-exhaustive list of examples of items that the IP Management Plan may cover:

- The treatment of confidential information between members (i.e., the use of non-disclosure agreements);
- The treatment of background IP (e.g., any requirements for identifying it or making it available);
- The treatment of inventions made under the project (e.g., any requirements for disclosing to the other members, filing patent applications, paying for patent prosecution, and cross-licensing or other licensing arrangements between the members);
- The treatment of data produced, including software, under the project (e.g., any publication process or other dissemination strategies, copyrighting strategy or arrangement between members);
- Any technology transfer and commercialization requirements or arrangements between the members;
- The treatment of any intellectual property issues that may arise due to a change in membership of the consortia or team; and

- The handling of disputes related to intellectual property between the members.

xi. 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.

xii. Intellectual Property Provisions

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

xiii. Reporting

Reporting requirements are identified on the Federal Assistance Reporting Checklist, attached to the award agreement. The checklist can be accessed at http://www1.eere.energy.gov/financing/resources.html. In addition, all awarded projects will be required to submit data for analysis using the BTO Scout software program (http://scout-bto.readthedocs.io/en/latest/), to consist of the following for the proposed technology: baseline market, anticipated market entry year, absolute performance (e.g., COP, U-value) or, if appropriate, relative efficiency improvement compared to the baseline technology it replaces, total installed cost, expected service lifetime, and other ancillary descriptive information, as well as supporting reference information for these data, if available. Awardees may use the Scout ECM Definition Reference (http://scout-bto.readthedocs.io/en/latest/ecm_reference.html#ecm-definition-reference) to understand the requested data format. Following review by BTO, these data may be made publicly available via the Scout energy conservation measure (ECM) database on GitHub (https://github.com/trynthink/scout/tree/master/ecm_definitions), although

they will be presented in an anonymous manner without identifying the applicant.

xiv. Go/No-Go Review

Each project selected under this FOA will be subject to a periodic project evaluation referred to as a Go/No-Go Review. Federal funding beyond the Go/No Go decision point (continuation funding), is contingent on (1) the availability of funds appropriated by Congress for the purpose of this program and the availability of future-year budget authority; (2) meeting the objectives, milestones, deliverables, and decision point criteria of recipient's approved project and obtaining approval from EERE to continue work on the project; and (3) the submittal of required reports in accordance with the Statement of Project Objectives.

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

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

xv. 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.

xvi. 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: BENEFIT18@ee.doe.gov. Questions must be submitted not later than 3 business days prior to the application due date and time.

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

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

VIII. Other Information

A. FOA Modifications

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

B. Informational Webinar

EERE will conduct one informational webinar during the FOA process. It will be held after the initial FOA release but before the due date for Concept Papers.

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

C. Government Right to Reject or Negotiate

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

D. Commitment of Public Funds

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

E. Treatment of Application Information

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

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

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

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

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

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

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

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

F. Evaluation and Administration by Non-Federal Personnel

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

G. Notice Regarding Eligible/Ineligible Activities

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

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

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

I. Notice of Potential Disclosure Under Freedom of Information Act (FOIA)

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

J. Requirement for Full and Complete Disclosure

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

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

K. Retention of Submissions

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

L. Title to Subject Inventions

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

- Domestic Small Businesses, Educational Institutions, and Nonprofits: Under the Bayh-Dole Act (35 U.S.C. § 200 et seq.), domestic small businesses, educational institutions, and nonprofits may elect to retain title to their subject inventions.
- All other parties: The Federal Non-Nuclear Energy Act of 1974, 42. U.S.C. 5908, provides that the Government obtains title to new inventions unless a waiver is granted (see below).
- Class Patent Waiver:

  DOE has issued a class waiver that applies to this FOA. Under this class waiver, domestic large businesses may elect title to their subject inventions similar to the right provided to the domestic small businesses, educational institutions, and nonprofits by law. In order to avail itself of the class waiver, a domestic large business must agree that any products embodying or produced through the use of a subject invention first created or reduced to practice under this program will be substantially manufactured in the United

States, unless DOE agrees that the commitments proposed in the U.S. Manufacturing Plan are sufficient.

- Advance and Identified Waivers: Applicants may request a patent waiver that will cover subject inventions that may be invented under the award, in advance of or within 30 days after the effective date of the award. Even if an advance waiver is not requested or the request is denied, the recipient will have a continuing right under the award to request a waiver for identified inventions, i.e., individual subject inventions that are disclosed to EERE within the timeframes set forth in the award's intellectual property terms and conditions. Any patent waiver that may be granted is subject to certain terms and conditions in 10 CFR 784.
- Determination of Exceptional Circumstances (DEC): Each applicant is required to submit a U.S. Manufacturing Plan as part of its application. If selected, the U.S. Manufacturing Plan shall be incorporated into the award terms and conditions for domestic small businesses and nonprofit organizations. DOE has determined that exceptional circumstances exist that warrants the modification of the standard patent rights clause for small businesses and non-profit awardees under Bayh-Dole to the extent necessary to implement and enforce the U.S. Manufacturing Plan. For example, the commitments and enforcement of a U.S. Manufacturing Plan may be tied to subject inventions. Any Bayh-Dole entity (domestic small business or nonprofit organization) affected by this DEC has the right to appeal it.

M. Government Rights in Subject Inventions

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

i. Government Use License

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

ii. March-In Rights

The U.S. Government retains march-in rights with respect to all subject inventions. Through "march-in rights," the Government may require a Prime Recipient or Subrecipient who has elected to retain title to a subject

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

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

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

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

N. Rights in Technical Data

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

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

Government rights in Technical Data Produced Under Awards: The U.S. Government normally retains unlimited rights in technical data produced under Government financial assistance awards, including the right to distribute to the public. However, pursuant to special statutory authority, certain categories of data generated under EERE awards may be protected from public disclosure for up to five years after the data is generated ("Protected Data"). For awards permitting Protected Data, the protected data must be marked as set forth in the awards intellectual property terms and conditions and a listing of unlimited rights data

(i.e., non-protected data) must be inserted into the data clause in the award. In addition, invention disclosures may be protected from public disclosure for a reasonable time in order to allow for filing a patent application.

O. Copyright

The Prime Recipient and Subrecipients may assert copyright in copyrightable works, such as software, first produced under the award without EERE approval. When copyright is asserted, the Government retains a paid-up nonexclusive, irrevocable worldwide license to reproduce, prepare derivative works, distribute copies to the public, and to perform publicly and display publicly the copyrighted work. This license extends to contractors and others doing work on behalf of the Government. In addition, for those awards requiring distribution of software as Open-Source Software (OSS), the additional information in Appendix E must be addressed in the application.

P. Personally Identifiable Information (PII)

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

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

Q. Annual Independent Audits

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

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

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

APPENDIX A – COST SHARE INFORMATION

Cost Sharing or Cost Matching

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

How Cost Sharing Is Calculated

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

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

- Formula: Total Project Cost ($) minus Federal share ($) = Non-federal share ($)
  Example: $1,250,000 minus $1,000,000 = $250,000

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

What Qualifies For Cost Sharing

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

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

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

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

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

General Cost Sharing Rules on a DOE award

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

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

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

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

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

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

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

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

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

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

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

a. For-profit organizations. Allowability of costs incurred by for-profit organizations and those nonprofit organizations listed in Attachment C to OMB Circular A–122 is determined in accordance with the for-profit cost principles in 48 CFR Part 31 in the Federal Acquisition Regulation, except that patent prosecution costs are not allowable unless specifically authorized in the award document. (v) Commercial Organizations. FAR Subpart 31.2—Contracts with Commercial Organizations

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

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

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

(B) Valuing and documenting contributions

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

a. The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation; or
b. The current fair market value. If there is sufficient justification, the Contracting Officer may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project. The Contracting Officer may accept the use of any reasonable basis for determining the fair market value of the property.

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

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

(4) Valuing property donated by third parties.

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

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

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

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

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

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

Appendix B – Sample Cost Share Calculation for Blended Cost Share Percentage

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

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

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

Each task must be calculated individually as follows:

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

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

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

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

The calculation may then be completed as follows:

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

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

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

1. Waiver for Foreign Entity Participation as the Prime Recipient

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

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

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

EERE may require additional information before considering the waiver request.

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

2. Waiver for Performance of Work in the United States

As set forth in Section IV.J.3, all work under EERE funding agreements must be performed in the United States. This requirement does not apply to the purchase of supplies and equipment, so a waiver is not required for foreign purchases of these items. However, the Prime Recipient should make every effort to purchase supplies and equipment within the United States. There may be limited circumstances where it is in the interest of the project to perform a portion of the work outside the United States. To seek a waiver of the Performance of Work in the United States requirement, the applicant must submit an explicit waiver request in the Full Application. A separate waiver request must be submitted for each entity proposing performance of work outside of the United States.

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

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

EERE may require additional information before considering the waiver request.

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

APPENDIX 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 – OPEN SOURCE SOFTWARE

Open Source Software Distribution Plan.

Applicants that are applying to one or more Topic Areas for which open source software distribution is required must submit a plan describing how software produced under this FOA will be distributed. For a DOE National Laboratory or a FFRDC, the data rights clause, including rights and requirements pertaining to computer software, in its Management and Operating (M&O) Contract shall apply and shall take precedence over any requirement set forth in this Appendix. The plan must include the following elements:

1. A complete description of any existing software that will be modified or incorporated into software produced under this FOA, including a description of the license rights. The license rights must allow the modified or incorporated software to be distributed as open source.

2. A discussion of the open source license that the applicant plans to use for the software it plans to produce under the FOA, and how that choice furthers the goals of this FOA. The discussion must also address how the license conforms to the conditions listed below.

3. A method for depositing the software in a source code repository.

4. A method for sharing and disseminating the software and other information to team members or others when multiple parties will contribute to the development of the software or the FOA requires that the software or other information be shared or disseminated to others.

Open Source Definition: Open source licenses must conform to all of the following conditions:

Free Redistribution
The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale. The rights attached to the software must apply to all to whom the software is redistributed without the need for execution of an additional license by those parties.

Source Code
The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable

reproduction cost preferably, i.e., downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code and intermediate forms such as the output of a preprocessor or translator are not allowed.

Derived Works
The license must allow modifications and derived works, and permit the option of distributing the modifications and derived works under the same terms as the license of the original software.

Integrity of the Author's Source Code
The license may restrict source-code from being distributed in modified form only if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.

No Restriction Against Fields of Endeavor
The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.

License Must Not Be Specific to a Product or Technology
The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution. No provision of the license may be predicated on any individual technology or style of interface.

License Must Not Restrict Other Software
The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software.

Examples of Acceptable Licenses
Apache License, 2.0
http://www.apache.org/licenses

The 2.0 version of the Apache License was approved by the Apache Software Foundation (ASF) in 2004. The goals of this license revision were to reduce the number of frequently asked questions, to allow the license to be reusable without modification by any project (including

non-ASF projects), to allow the license to be included by reference instead of listed in every file, to clarify the license on submission of contributions, to require a patent license on contributions that necessarily infringe the contributor's own patents, and to move comments regarding Apache and other inherited attribution notices to a location outside the license terms

The result is a license that is compatible with other open source licenses, while remaining true to and supportive of collaborative development across both nonprofit and commercial organizations.
All packages produced by the ASF are implicitly licensed under the Apache License, Version 2.0, unless otherwise explicitly stated.

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http://www.gnu.org/licenses/gpl.html

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The GPL is the first copyleft license for general use, which means that derived works must be distributed under the same license terms. Under this philosophy, the GPL grants the recipients of a computer program the rights of the free software definition and uses copyleft to ensure the freedoms are preserved, even when the work is changed or additions are made. This aspect distinguishes the GPL from permissive free software licenses, including the BSD licenses.
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The LGPL places copyleft restrictions on the program governed under it but does not apply these restrictions to other software that merely link with the program. There are, however, certain other restrictions on this software.

The LGPL is primarily used for software libraries, although it is also used by some stand-alone applications, most notably Mozilla and OpenOffice.org.

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Software packages that use one of the versions of the MIT License include Expat, PuTTY, the Mono development platform class libraries, Ruby on Rails, Lua (from version 5.0 onwards), and the X Window System, for which the license was written.

Mozilla Public License 2.0 (MPL-2.0)
http://www.mozilla.org/MPL/2.0/

The Mozilla Public License (MPL) is a free and open source software license. Version 1.0 was developed by Mitchell Baker when she worked as a lawyer at Netscape Communications Corporation and version 1.1 at the Mozilla Foundation. Version 2.0 was developed in the open, overseen by Baker and led by Louis Villa. The MPL is characterized as a hybridization of the modified BSD license and GNU General Public License.

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APPENDIX F – TECHNICAL POTENTIAL AND PAYBACK CALCULATION

One performance metric used to evaluate applications will be the 2030 primary energy savings technical potential. Each application must describe a technology or approach that leads to a minimum annual primary energy savings technical potential in 2030 of at least 250 Trillion British Thermal Units (TBtu), i.e., 0.25 Quads. All applicants proposing a technology innovation should provide the *Primary Energy Savings Technical Potential* (TBtu), and the *Simple Payback* (years). The *Primary Energy Savings Technical Potential* is calculated from Eq. F1:

$$\left[\begin{array}{c}\text{Primary Energy Savings}\\ \text{Technical Potential}\\ \text{(TBtu)}\end{array}\right] = \left[\begin{array}{c}\text{\% Energy Savings}\\ \text{Over Typical New}\\ \text{Technology}\end{array}\right] \times \left[\begin{array}{c}\text{2030 Energy Market}\\ \text{Size}\\ \text{(TBtu)}\end{array}\right] \qquad \text{(F1)}$$

The *2030 Energy Market Size* (TBtu) can be determined from the building type addressed by the technology (residential or commercial), the end use (cooling, lighting, cooking, refrigeration, etc.), the climate zone (1 – 5), and other information. The BTO Baseline Energy Calculator tool facilitates the determination of the *2030 Energy Market Size*. If a proposed technology or approach affects energy use in multiple end uses (e.g. an HVAC technology that operates in both heating and cooling modes), the Baseline Energy Calculator will need to be run multiple times to obtain the market size for each affected end use. Detailed instructions on how to use the Baseline Energy Calculator are provided on the website.

The "Typical New Technology" in Eq. F1 is the technology that is being replaced. For "covered" technologies, that is, technologies subject to minimum efficiency standards,[49] Applicants should assume the efficiency of the "Typical New Technology" to be greater than or equal to the applicable efficiency standard. For "covered" and other technologies, Table F1 presents the projected 2030 stock and average stock efficiency for a variety of residential equipment that may be used in this calculation. Corresponding 2030 average stock efficiencies for commercial units are provided in Table F2. In all cases applicants should ensure that if a "covered" technology is being replaced, the efficiency of the "Typical New Technology" is equal to or greater than the applicable efficiency standard.

[49] http://www1.eere.energy.gov/buildings/appliance_standards/standards_test_procedures.html

Table F1 2030 Residential equipment stock and average efficiency[50]

Equipment Class	Stock (million units)	Stock Average Efficiency
Main Space Heaters		
Electric Heat Pumps (HSPF)	15.74	9.85
Natural Gas Heat Pumps (GCOP)	0.38	1.30
Geothermal Heat Pumps (COP)	1.52	3.78
Natural Gas Furnace (AFUE)	67.57	0.86
Distillate Furnace (AFUE)	5.60	0.88
Space Cooling		
Electric Heat Pumps (SEER)	15.75	17.19
Natural Gas Heat Pumps (GCOP)	0.38	0.67
Geothermal Heat Pumps (EER)	1.52	19.14
Central Air Conditioners (SEER)	77.46	14.54
Room Air Conditioners (EER)	47.16	11.20
Water Heaters		
Electric (EF)	60.02	0.99
Natural Gas (EF)	65.94	0.63
Distillate Fuel Oil (EF)	1.66	0.65
Propane (EF)	2.63	0.62
Refrigeration		
Refrigerators (kW.hr/yr.)	167.35	466.89
Freezers (kW.hr/yr.)	43.63	409.36

[50] Residential Sector Equipment Stock and Efficiency, AEO 2017 Reference case: https://www.eia.gov/outlooks/aeo/data/browser/ - /?id=30-AEO2017&cases=ref2017&sourcekey=0

Table F2 2030 Commercial equipment average efficiency[51]

Equipment Class	Stock Average Efficiency[52]
Space Heating	
Electricity	1.79
Natural Gas	0.79
Distillate Fuel Oil	0.81
Space Cooling	
Electricity	3.90
Natural Gas	0.80
Water Heating	
Electricity	1.09
Natural Gas	0.87
Distillate Fuel Oil	0.79
Ventilation (cfm/Btu)	0.71
Refrigeration	3.10

If the provided information is not used to calculate the *Energy Market Size* (TBtu), then a comparable approach can be applied, with corresponding justification.

A second performance metric used to evaluate applications will be the cost effectiveness, as measured by the *Simple Payback*. This will be applicable only to technology innovations, and not to other innovations such as design tools or enabling technologies for which primary energy savings and/or payback are difficult to describe. Proposers should compute the *Simple Payback* for their proposed technology innovation per Eq. F2:

[51] Commercial Sector Energy Consumption, Floorspace, and Equipment Efficiency, AEO 2017 Reference case: https://www.eia.gov/outlooks/aeo/data/browser/#/?id=32-AEO2017&cases=ref2017&sourcekey=0. Note that the stock (millions of units) are not available from this source.

[52] Unless noted otherwise, efficiencies are in units of Btu of energy output divided by Btu of energy input.

$$\left[\begin{array}{c}\text{Simple}\\ \text{Payback}\\ (\text{Yr})\end{array}\right]=\frac{\left[\begin{array}{c}\text{Incremental Initial}\\ \text{Cost of Proposed}\\ \text{Technology at Scale }(\$)\end{array}\right]}{\left[\begin{array}{c}\text{Cost}\\ \text{Savings}\left(\frac{\$}{\text{Yr}}\right)\end{array}\right]}$$

$$=\frac{\left[\begin{array}{c}\text{Incremental Initial}\\ \text{Cost of Proposed}\\ \text{Technology at Scale }(\$)\end{array}\right]}{\left[\begin{array}{c}\text{Unit Energy Consumed by}\\ \text{Typical New Technology}\\ \text{Per Year }(\text{kWh/Yr})\end{array}\right]\left[\begin{array}{c}\text{Energy}\\ \text{Cost}\end{array}\left(\frac{\$}{\text{kWh}}\right)\right]\left[\begin{array}{c}\text{\% Energy Savings}\\ \text{Over Typical New}\\ \text{Technology}\end{array}\right]} \qquad \text{(F2)}$$

where the *Incremental Initial Cost of Proposed Technology at Scale ($)* is computed from

$$\left[\begin{array}{c}\text{Incremental Initial}\\ \text{Cost of Proposed}\\ \text{Technology at Scale }(\$)\end{array}\right]=\left[\begin{array}{c}\text{Unit Cost of}\\ \text{Proposed Technology}\\ \text{at Scale }(\$)\end{array}\right]-\left[\begin{array}{c}\text{Unit Cost of}\\ \text{Typical New}\\ \text{Technology }(\$)\end{array}\right] \qquad \text{(F3)}$$

Note that the *% Energy Savings Over Typical New Technology* term in Eq. F2 is the same as that in Eq. F1. The "Energy Cost" can be specified alternatively in $/MMBtu (i.e., for natural-gas-fired systems), or in whatever units are most appropriate. The nationally averaged energy costs specified in Table F3 *must* be used for this calculation. The proposer should describe, and provide supporting documentation, what they consider to be an acceptable maximum payback (in years), which can vary significantly depending on the end use.

Table F3 Retail energy 2015 pricing (year-to-date)

Sector	Electricity, ¢/kWh[53]	Natural Gas	
		$/Thousand Cubic Feet[54]	$/MMBTU[55]
Residential	12.64	12.36	12.02
Commercial	10.65	8.15	7.93

[53] http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_3
[54] http://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PCS_DMcf_a.htm
[55] http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8

Proposers of non-technological solutions, e.g., modeling approaches, are also required to provide an estimate of primary energy savings potentially resulting from their innovation, as well as an analysis of their cost effectiveness. The approaches used in these analyses need to be appropriately justified.

APPENDIX G – TOPIC AREA REFERENCES

References below notated with a number refer to a specific footnote in the applicable topic area. These were relocated to this section in an attempt to improve the legibility of the topic areas. References below notated by a bullet point are additional references for the relevant topic area.

iii. Topic Area 1:

- Energy Savings Potential and RD&D Opportunities for Commercial Building Appliances Report (2015 Update), https://energy.gov/eere/buildings/downloads/energy-savings-potential-and-rdd-opportunities-commercial-building-0
- Research & Development Roadmap: Emerging HVAC Technologies, https://energy.gov/eere/buildings/downloads/research-development-roadmap-emerging-hvac-technologies
- Research & Development Roadmap: Next-Generation Appliances, https://energy.gov/eere/buildings/downloads/research-development-roadmap-next-generation-appliances
- Research & Development Roadmap: Emerging Water Heating Technologies, https://energy.gov/eere/buildings/downloads/research-development-roadmap-emerging-water-heating-technologies
- Non-Vapor Compression HVAC Technologies Report, https://energy.gov/eere/buildings/downloads/non-vapor-compression-hvac-technologies-report
- Energy Savings Potential and RD&D Opportunities for Residential Building HVAC Systems, https://energy.gov/eere/buildings/downloads/energy-savings-potential-and-rdd-opportunities-residential-building-hvac
- Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC, https://energy.gov/eere/buildings/downloads/energy-savings-potential-and-rdd-opportunities-commercial-building-hvac

7. U.S. Energy Information Administration. Annual Energy Outlook 2014 with Projections to 2040. DOE/EIA-0383(2014). Washington, DC: U.S. Energy Information Administration, 2014.
8. R&D Opportunities for Membranes and Separation Technologies in Building Applications, https://energy.gov/sites/prod/files/2017/11/f46/DOE-BTO%20Membranes%20Separations%20Report%20Nov%202017.pdf

iv. Topic Area 2:

- Existing Roadmap: https://energy.gov/eere/buildings/downloads/research-and-development-roadmap-windows-and-building-envelope

- Recent Roadmap Meeting Summary – https://energy.gov/eere/buildings/downloads/windows-envelope-rd-opportunities-workshop
- Geoff Wehmeyer, Tomohide Yabuki, Christian Monachon, Junqiao Wu, and Chris Dames, (201), "Thermal diodes, regulators, and switches: Physical mechanisms and potential applications." Applied Physics Reviews **4**, 041304.

9. https://energy.gov/sites/prod/files/2014/02/f8/BTO_windows_and_envelope_report_3.pdf

v. Topic Area 3:

- Arasteh, Dariush K., Howdy Goudey, and Christian Kohler, 2008, Highly Insulating Glazing Systems Using Non-Structural Center Glazing Layers, In 2008 Annual ASHRAE Meeting, Salt Lake City, UT, 2008. (http://eetd.lbl.gov/sites/all/files/publications/611e.pdf)
- Arasteh, D., Selkowitz, S., Apte, J., and Marc LaFrance, 2006, Zero Energy Windows, ACEEE Summer Study on Energy Efficiency in Buildings, Pacific Grove, CA, 2006. (http://eetd.lbl.gov/sites/all/files/publications/60049.pdf)
- Portland field validation of dynamic glazings here
- Sacramento field validation of dynamic glazings here
- Thermochromic R&D needs: https://eta.lbl.gov/sites/default/files/publications/6376e.pdf
- NIR Thermochromic performance & R&D needs: https://eta.lbl.gov/sites/default/files/publications/lbnl-187530.pdf
- Existing Roadmap: https://energy.gov/eere/buildings/downloads/research-and-development-roadmap-windows-and-building-envelope
- Recent Roadmap Meeting Summary – https://energy.gov/eere/buildings/downloads/windows-envelope-rd-opportunities-workshop

vi. Topic Area 4:

13. American Institute of Architects (2017), "2030 by the Numbers: The 2016 Summary of the AIA 2030 Commitment", http://aiad8.prod.acquia-sites.com/sites/default/files/2017-07/2016BytheNumbers-AIA2030CommitmentFinal_0.pdf
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- http://eis.lbl.gov/auto-mv.html
- https://www.energy.gov/eere/buildings/building-energy-data-exchange-specification-bedes
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viii. Topic Area 6:

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- Research & Development Roadmap: Emerging HVAC Technologies, https://energy.gov/eere/buildings/downloads/research-development-roadmap-emerging-hvac-technologies
- Research & Development Roadmap: Next-Generation Appliances, https://energy.gov/eere/buildings/downloads/research-development-roadmap-next-generation-appliances
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- Non-Vapor Compression HVAC Technologies Report, https://energy.gov/eere/buildings/downloads/non-vapor-compression-hvac-technologies-report

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