U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy

Building Technologies Office
NATIONAL LABORATORY CALL FOR PROPOSALS

BTO Emerging Technologies FY 2022 AOP Lab Call

This Lab Call is being issued by the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Building Technologies Office (BTO).

I. Table of Contents

Lab Call Modification(s) History

Mod. No.	Date	Description of Modification
0001	2/25/2022	a) Corrected Project Timelines for Area 6, Building Energy Modeling b) Added Foreign Work Waiver requirements c) Added U.S. Manufacturing Plan Requirement
0002	3/4/2022	a) Updated expected application numbers for Topic Area 1B b) Updated expected application numbers for Topic Area 5B c) Updated full application page limit for Topic 2 d) Corrected DEI reference page references

II. Overview and Purpose

EERE National Laboratory Guiding Principles require all offices to pursue a merit review of direct-funded National Laboratory work. In line with these principles, the Building Technologies Office (BTO) is issuing this Lab Call for Fiscal Year 2022 (FY 2022) funding.

This Lab Call covers all of BTO's Emerging Technologies' (ET) competitive topics and some core topics.

Building a clean and equitable energy economy and addressing the climate crisis is a top priority of the Biden Administration. This Lab Call will advance the Biden Administration's goals to achieve carbon pollution-free electricity by 2035 and to "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050"[1] to the benefit of all Americans. The Department of Energy is committed to pushing the frontiers of science and engineering, catalyzing clean energy jobs through research, development, demonstration, and deployment (RDD&D), and ensuring environmental justice and inclusion of underserved communities. [2]

The research and development (R&D) activities to be funded under this Lab Call will support the government-wide approach to the climate crisis by driving the innovation that can lead to the deployment of technologies for decarbonizing the building sector. First, this Lab Call includes new heat-pump technology topics aimed at electrifying space- and water-heating and allowing them to be served by electricity—which can be generated in a clean and renewable way—rather than natural gas. Electrifying space and water heating will increase demand on the electricity grid. To offset this increased demand as well as anticipated demand increases due to electrification of other sectors and population and economic growth, this lab call also includes topics for technologies aimed at reducing overall building electricity use and increasing the temporal flexibility of this use in a controllable way. Reducing demand and increasing its controllable flexibility support decarbonization of the electricity grid via increasing integration of intermittent renewable sources such as solar and wind.

In addition, this Lab Call will emphasize increasing diversity of research staff, increasing diversity of voices in research design, and or increasing quantification and emphasis on supporting underserved communities.

[1] Executive Order 14008, "Tackling the Climate Crisis at Home and Abroad," January 27, 2021.

[2] The term "underserved communities" refers to populations sharing a particular characteristic, as well as geographic communities, that have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life, as exemplified by the list of in the definition of "equity." E.O. 13985. For purposes of this FOA, as applicable to geographic communities, applicants can refer to economically distressed communities identified by the Internal Revenue Service as Qualified Opportunity Zones; communities identified as disadvantaged or underserved communities by their respective States; communities identified on the Index of Deep Disadvantage referenced at https://news.umich.edu/new-index-ranks-americas-100-most-disadvantaged-communities/, and communities that otherwise meet the definition of "underserved communities" stated above.

A. Timeline and Process Logistics

Full Application Submission Deadline:	3/28/2022 at 11:59 PM Eastern
Review Comments Available to Applicants:	4/22/2022
Expected Dates for EERE Selection Notifications:	May 2022
Expected Beginning Award Issue Date:	June 2022

All communication to BTO regarding this Lab Call must use BTOLabCall@ee.doe.gov.

- **PROPOSAL SUBMISSIONS:** To apply to this Lab Call, lab personnel must register (and sign in) with their lab email address and submit application materials through EERE Exchange. Application materials must be submitted through EERE Exchange at https://eere-exchange.energy.gov, EERE's online application portal. Frequently asked questions for this Lab Call and the EERE Application process can be found at https://eere-exchange.energy.gov/FAQ.aspx. Applicants are responsible for meeting the submission deadlines. DOE strongly encourages all applicants to submit the required information at least 24 hours in advance of the submission deadline. Applicants should not wait until the last minute—internet and data server traffic can be heavy in the last hours before the submission deadline, which may affect the applicants' ability to successfully submit the required information before the deadline.
- **QUESTIONS DURING OPEN LAB CALL PERIOD:** Specific questions about this Lab Call should be submitted via e-mail to BTOLabCall@ee.doe.gov. BTO will provide answers related to this Lab Call on EERE Exchange at: https://eere-exchange.energy.gov. Please note that you must first select the specific opportunity number for this Lab Call in order to view the questions and answers specific to this Lab Call. EERE will attempt to respond to a question within 3 business days, unless a similar question and answer have 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. To ensure fairness for all lab participants, please do not ask individual BTO staff questions directly.

NOTIFICATION OF SELECTION: When selections are finalized, lab leads will receive an email from BTOLabCall@ee.doe.gov.

B. Key Considerations

- **AVAILABLE FUNDING:** There is approximately **25 million in annual funding** is available to fund **all** projects solicited in this Lab Call pending appropriations, program direction, and go/no-go decision points.

- **CRADAS AND FOA AWARDS:** The call for proposals below should **NOT** be construed as requiring the renegotiation of an existing Cooperative Research and Development Agreement (CRADA) or previously competed FOA award in which the lab is a prime or sub-recipient. Labs with CRADAs or FOA awards addressing any of the topic areas below may incorporate that work in proposals they submit in response to the Lab Call to demonstrate existing capability and leverage existing

partnerships with industry and other partners. If the proposal is not selected for funding under this Lab Call, the work under the CRADA or FOA award will continue—there is no additional risk to the provision of DOE funding.

- **ELIGIBILITY:** Applicants should pay close attention to eligibility restrictions listed in each Topic as they vary by Topic. Proposals that involve more than one laboratory are also allowed.

- **DIVERSITY, EQUITY, and INCLUSION:** It is the policy of the Biden Administration that:

  "The Federal Government should pursue a comprehensive approach to advancing equity[3] for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality. Affirmatively advancing equity, civil rights, racial justice, and equal opportunity is the responsibility of the whole of our Government. Because advancing equity requires a systematic approach to embedding fairness in decision-making processes, executive departments and agencies (agencies) must recognize and work to redress inequities in their policies and programs that serve as barriers to equal opportunity.

  By advancing equity across the Federal Government, we can create opportunities for the improvement of communities that have been historically underserved, which benefits everyone.[4]"

  As part of this whole of government approach, this Lab Call seeks to encourage the participation of underserved communities and underrepresented groups. Applicants are highly encouraged to include individuals from groups historically underrepresented[5,6] in STEM on their project teams. As

[3] The term "equity" means the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality.

[4] Executive Order 13985, "Advancing Racial Equity and Support for Underserved Communities Through the Federal Government" (Jan. 20, 2021).

[5] According to the National Science Foundation's 2019 report titled, "Women, Minorities and Persons with Disabilities in Science and Engineering", women, persons with disabilities, and underrepresented minority groups—blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives—are vastly underrepresented in the STEM (science, technology, engineering and math) fields that drive the energy sector. That is, their representation in STEM education and STEM employment is smaller than their representation in the U.S. population. https://ncses.nsf.gov/pubs/nsf19304/digest/about-this-report For example, in the U.S., Hispanics, African Americans and American Indians or Alaska Natives make up 24 percent of the overall workforce, yet only account for 9 percent of the country's science and engineering workforce. DOE seeks to inspire underrepresented Americans to pursue careers in energy and support their advancement into leadership positions. https://www.energy.gov/articles/introducing-minorities-energy-initiative

[6] See also. Note that Congress recognized in section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329:

part of the application, applicants are required to describe how diversity, equity, and inclusion objectives will be incorporated in the project. Specifically, applicants are required to reference, if available, the existing laboratory Diversity, Equity, and Inclusion Plan and describe within the technical volume the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM, advance equity, and encourage the inclusion of individuals from these groups in the project; and the extent the project activities will be located in or benefit underserved communities. See **Section IV.A** for specific application requirements. Because a diverse set of voices at the table in research design and execution has an illustrated impact on innovation, this implementation strategy for the lab-wide plan will be evaluated as part of the technical review process.

Further, to the extent the proposed project will include external partners, the applicant is encouraged to include Minority Serving Institutions[7], Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community. BTO may consider the inclusion of these types of entities as part of the selection decision.

- **EERE NATIONAL LABORATORY GUIDING PRINCIPLES:** To ensure continued alignment with EERE Lab Engagement Principles, applicants should consider the following when developing their proposals:
    - To the extent possible and appropriate, BTO encourages projects that bring together multiple labs in a consortia-based approach to meet a high-level strategic goal, leveraging multiple lab capabilities with strong, centralized leadership.
    - To the extent possible and appropriate, BTO seeks lab projects that involve industry engagement or industry partners.

(1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

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

III. Areas and Topics

A. Competitive Topics

The following areas and topics represent new projects and are open to all national laboratories, unless otherwise specified in the topic descriptions.

AREA 1: HVAC/WH

BTO Point of Contact: Isaac Mahderekal (isaac.mahderekal@ee.doe.gov)

BTO seeks to accelerate the development of next generation heating, ventilation, air-conditioning, and refrigeration (HVAC&R), water heating and appliance technologies. This represents more than half of the total energy used in U.S. residential and commercial buildings.[11] These represent more than half of the total energy used in U.S. residential and commercial buildings. HVAC is the largest energy end-use for U.S. buildings, consuming approximately 38% (14.3 Quads) of total building energy in 2021, 35% of building electricity use, and a very large share of peak power demand. Water heating (3.6 Quads) is primarily a residential function (81% of all water heating energy use). Commercial water heating occurs primarily in hotels, hospitals, and food service buildings.

The HVAC/WH sub-program focuses on developing technologies with improved materials or components, improving equipment design or engineering, developing lower cost manufacturing processes, or enabling easier installation. The research and development activities in this sub-program often include crosscutting technologies, and the sub-program justifies its integrated and multidisciplinary R&D efforts across several end uses.

To reduce emissions and advance energy efficiency, the sub-program pursues solutions that are systems-oriented to optimize energy use in the entire building. These efforts will result in innovative, energy-saving components and technologies for HVAC/WH that have the potential to fully replace or be integrated with conventional technologies, often across several end uses. Improved HVAC/WH technologies offer significant opportunity for energy and emission savings. Energy savings can be realized not only in individual end uses, but in optimizing and reducing building energy use through integrated systems. This requires improving the design and sizing of systems and integrating them into the building design.

The HVAC/WH sub-program uses the strategies outlined below to develop and advance affordable, cost-effective technologies that improve system energy consumption. R&D includes both early-stage research that advances traditional approaches and concepts, as well as the development of next-generation technologies that “leapfrog” existing technologies and practices. BTO aims to introduce next-generation technologies in the simplest applications first for the highest probability of success. BTO can utilize these approaches in more complex technologies with confidence through subsequent investments. For example, the sub-program would consider implementing advanced, non-vapor compression heat pump technologies into refrigeration systems before rollout to space-conditioning applications.

This sub-program places a strong emphasis on utilizing the Stage-Gate process. The proposed technical work plan must describe how this will be utilized for this set of R&D activities.[12]

Topic 1A: Commercial Low GWP Cold Climate Rooftop Heat Pump

Period of Performance: 3 years
Estimated Available Budget: $1,000K/year
Eligible labs: LBNL, NREL, ORNL, PNNL
Expected Number of Awards: 1

Description: The goal of this topic is to develop a commercial rooftop unit (RTU) for cold climates that uses a refrigerant with a GWP less than 100 with an emphasis on levels that are less than 5. A CRADA partner would be engaged to help with commercializing the RTU and early market entry.

Goal/Target Outcome: A cold climate rooftop heat pump capable of operation to 5F or less using a refrigerant with a GWP of less than 100, with a stretch goal of 5. This would enable the US to meet future HFC target reductions of 85% and ensure US competitiveness in the global market.

Explanation of Need: Commercial RTUs in the 10-20 ton range are typically comprised of electric air conditioning with a gas furnace. In support of the Biden administration's goals for electrification and reduced GHG emissions, BTO plans to engage industry, utilities, and efficiency organizations to promote the use of heat-pump RTUs to increase their market penetration in commercial buildings. Beyond electrification, additional GHG emission reductions can be achieved if the existing refrigerant, R410A, is replaced with a much lower GWP refrigerant and the unit operates at low ambient temperatures to reduce the amount of electrical resistance heat.

With the administration's goals for electrification and reduced greenhouse gas emissions, along with states, such as California and New York, setting goals for increased electrification, the market penetration rate for heat pumps is expected to increase substantially over the next few years. Presently, heat pumps use R410A as the refrigerant. Some manufacturers have already committed to switching to R32 or R454B to reduce the refrigerant GWP. However, these refrigerants have GWPs of 675 and 466, respectively. Additional GHG emission reductions can be achieved if these are replaced with a much lower GWP refrigerant. This project will focus on the development of a residential heat pump that uses a refrigerant with a GWP less than 100 with an emphasis on levels that are less than 5. It is anticipated that a CRADA partner would be engaged to help with commercialization and early market entry.

Topic 1B: Field Validation Partnership

Period of Performance: 3 years
Estimated Available Budget: $1,600K/year
Eligible Labs: LBNL, NREL, ORNL, PNNL
Expected Number of Awards: 1

Description: DOE will form a national Field Validation Partnership to address issues that encumber higher heat pump adoption rates. The partnership will serve the following functions:

- serve as a national clearinghouse for field test information from all entities

- identify gaps in field testing where additional information might enable higher adoption rates
- evaluate data and identify heat pump issues to inform research and development priorities
- identify means for more widespread dissemination of field test results
- develop and coordinate plans for collaborative field test efforts among stakeholders
- work with manufacturers and trade organizations to develop training for the skills necessary for new technologies and identify best practices for installation
- expand the knowledge base for best approaches to achieve market transformation

Goal/Target Outcome: A national HP partnership to address issues that hinder higher heat pump adoption rates, such as cost, installation problems, performance in various climates, and consumer acceptance.

Explanation of Need: The partnership will initially focus on known information gaps in the following

- cold-climate heat pumps
- 110-volt residential heat pump water heaters
- installation issues such as sizing and improper charge

DOE will form a national Field Validation partnership to address issues that hinder higher heat pump adoption rates. The alliance will include the following: 1) serving as a clearinghouse for field test information from DOE and other organizations to share results; 2) identifying gaps in field testing where additional information might enable higher adoption rates; 3) evaluating data and identifying heat pump deficiencies to inform research and development priorities to increase performance; 4) identifying means for more widespread dissemination of field test results; 5) developing and coordinating plans for field tests with emphasis on collaborative efforts among stakeholders; 6) working with manufacturers and trade organizations to develop training for the skills necessary for new technologies, identifying best practices for installation, and to inform of the value proposition for heat pumps; and 7) identifying and expanding the knowledge base for best approaches to achieve market transformation for heat pumps especially regarding benefits and lifetime ownership costs. The Alliance will initially focus on known gaps in information in the following specific areas: 1) variable-speed heat pumps for residential space conditioning; 2) cold-climate heat pumps, 3) commercial heat pumps for space conditioning in all climate zones, with an emphasis on rooftop units, and 4) 110-volt residential heat pump water heaters in all climate zones and space (garage, attic, etc.) locations. Other high priority gaps will be identified as the Heat Pump Alliance begins to assemble and assess all the information provided by members and other sources.

Topic 1C: Efficient Modular Smart Building Equipment (EMSBE)

Period of Performance: 3 years
Estimated Available Budget: $750K/year
Eligible labs: LBNL, NREL, ORNL, PNNL
Expected number of Awards: 1

Description: The proposed project is to develop an efficient modular smart building equipment system with grid integration capabilities. The end-product will inform early-stage R&D, accounting for energy and cost performance, and considerations across integration, use and installation. Stakeholders

(manufacturing partners, trades, utilities, end-users) will be engaged to aid in assessing the benefits and commercialization strategies.
Goal/Target Outcome: The goal is to provide a 50% reduction in CO2 emissions and 60% reduction in peak demand through an integrated systems approach. In addition, the system will allow for easy and low-cost installation, plug ang play modularity of components, easier retrofits, a singular compressor/condenser unit, and a low GWP refrigerant.

Explanation of Need: As building equipment becomes more expensive to install, an integrated systems approach needs to be evaluated to maintain occupant comfort and amenities (space conditioning, hot water), and reduce overall building energy consumption and demand. The proposed modular design enables flexibility in adding new grid-enabled equipment as it becomes available and addresses affordability through a staged integration approach.

Topic 1D: HVAC System Integration for Improved Performance and Decarbonization

Period of Performance: 3 years
Estimated Available Budget: $2,400K/year
Eligible labs: LBNL, NREL, ORNL, PNNL
Expected Number of Awards: 6

Description: This area will focus on three main projects to improve the performance of heat pumps: 1) Device-level control for integrating heat pumps with thermal energy storage; 2) Onboard control strategies for improved variable-speed heat pump performance; and 3) Hybrid heating system control strategies.

Goal/Target Outcome: The target outcome is control systems that enable optimum integration and control of heat pumps to improve efficiency and accommodate grid constraints (through control of thermal energy storage with the heat pump).

Explanation of Need: Presently, only premium, higher-cost heat pumps utilize advanced sensors and control strategies to improve performance. One of the projects will assess the sizing of thermal storage requirements and control to both enable heat pump operation at lower temperatures (cold-climate units) and provide a level of grid-responsiveness. The second project will address lower cost and improved control strategies to increase efficiency. The third project will stress low-cost solutions to enable control improvements to accommodate grid constraints.

Topic 1E: Low-Cost, Deployable, Continuous AFDD for HVAC

Period of Performance: 3 years
Estimated Available Budget: $1,300K/year
Eligible labs: LBNL, NREL, ORNL, PNNL
Expected Number of Awards: 3

Description: This topic will focus on development of low-cost strategies for automatic fault detection and diagnostics (AFDD) that will improve the efficiency through improved installations and ongoing operation over time. The project will evaluate the existing sensors to determine if certain faults can be

directly determined or even inferred that will alert the consumer or a service company to correct the fault before the unit fails or efficiency is significantly reduced due to refrigerant leaks, low airflow conditions, or other faults.

Goal/Target Outcome: The target outcome is a low-cost AFDD system that continuously monitors the operation of the residential heat pump to address faults that can reduce performance either before or after installation.

Explanation of Need: Heat pumps are designed to operate efficiently for up to 20 years or more when properly sized and installed correctly. However, if installed incorrectly, such as with duct systems are too small or the charge is improper, the units will operate their entire lifetime at a suboptimal level, costing the homeowner thousands of dollars and increasing the greenhouse gas emissions from power plants due to higher use of electricity. In addition, faults that occur after installation, such as refrigerant leaks due to corrosion in the heat exchangers or connections loosening over time due to vibration, can result in higher energy consumption or even premature failure.

Topic 1F: HVAC/WH Cost Compression Solutions

Max Budget: $4,000K/year
Eligible labs: LBNL, NREL, ORNL, PNNL
Period of Performance: 3 years
Expected Number of Awards: 5

Description: This topic will focus reducing the costs (product and installation) to address more equitable heat pump and heat pump water heater solutions to increase market penetration, especially in cold, very cold regions, multifamily applications, and for low-income neighborhoods. Solutions are expected to use a refrigerant less than 750 GWP.

Goal/Target Outcome: The target outcomes are lower-installed cost heat pumps and heat pump water heaters that achieve DOE minimum efficiency standards for heat pumps and a UEF of 3.5 for heat pump water heaters.

Explanation of Need: Investigations have shown that heat pumps, especially in cold and very cold regions, have installed costs that are up to 50% higher than those in other regions. Heat pump water heaters in all regions are approximately $1000 - $1300 higher. There are also few solutions for multifamily housing. Addressing installation constraints and reducing product and installation costs will help drive market adoption, especially for low-income neighborhoods.

AREA 2: Thermal Energy Storage

BTO Point of Contact: Sven Mumme (sven.mumme@ee.doe.gov)

In direct support of the E3 Initiative, GEB Initiative, and Energy Storage Grand Challenge, BTO is focused on thermal energy storage (TES) research, development, demonstration, and deployment to accelerate the commercialization and utilization of next-generation energy storage technologies for building applications. TES is a critical enabler for the large-scale deployment of renewable energy and transition to a decarbonized building stock and energy system by 2050. Advances in TES can lead to increased energy savings, higher performing and more affordable heat pumps, flexibility for shedding and shifting building loads, and improved thermal comfort and resilience of occupants. Improvements in the

temporal and spatial control of heat flows, as well as new system architectures can further optimize the utilization of storage capacity and reduce overall system costs.

Topic 2A: 'Stor4Build' Building Energy Storage Consortium

Period of Performance: 5 years, subject to appropriations and Go/No-Go decisions
Estimated Available Budget: Up to $600K/year for Consortium operations, management, and support
Eligible labs: All
Number of Awards: 1

Overview:

Thermal end uses, such as space conditioning, water heating, and refrigeration, represent over 50% of building energy demand and is projected to increase in the years ahead. Currently, electrochemical energy storage systems make a major contribution to the implementation of sustainable energy, but still have many fundamental challenges ahead in order to make these technologies sufficient to respond to our future energy demands. Low-temperature **Thermal energy storage** (TES) can be a highly ***sustainable, scalable, and affordable*** complement to electrochemical energy storage, and is uniquely suited to meet our climate and energy sustainability goals in the building sector.

This Lab Call topic marks the official launch of the Stor4Build Building Energy Storage Consortium and seeks proposals for Consortium operations, management, and external market deployment partnership. Stor4Build seeks to establish an ***"innovate and deploy" ecosystem*** to help accelerate the pace of transformational TES sciences and technologies, leveraging the world-class capabilities at DOE national laboratories, industry, and academia to integrate R&D from discovery to scale-up.

The Stor4Build Consortium, envisioned by BTO to be part of the Energy Materials Network (EMN), aims to expedite the development of next-generation thermal energy storage materials and systems to enable greater adoption and deployment in buildings. Stor4Build is a new, multi-institution, cross-disciplinary Consortium that focuses on achieving an aggressive target for increasing efficiencies with materials, components, and systems, as well as integration within buildings and into communities, through a lens of energy equity. Stor4Build is expected to be funded at approximately $30 million over the next 5 years via a competitive request for proposals (RFP) subsequently issued by the Consortium, and in close collaboration with BTO, to solicit new projects from national laboratories that address BTO's high-priority areas

Based on stakeholder input and assumptions relevant to thermal energy storage operating conditions, BTO has set preliminary 2030 targets for the Consortium. These targets are subject to change based on outcome of BTO's building energy storage roadmap that is expected to be finalized later in 2022. It is expected that the Consortium use these targets to focus the community on specific, concrete actions to enable commercially viable TES systems and accelerate market adoption.

System-level Performance Targets (2030)		
Levelized Cost of Storage, $/kWh_electric	**<$0.05**	Identify technology pathways to achieve 2030 LCOS targets
System Capitol Cost, $/kWh_thermal	**< $15**	Increase performance across materials, component, and system-level to enable cost and footprint reduction and achieve 2030 LCOS targets.
90% Retained Energy Density after # of Cycles	**>10,000**	
Energy Density, kWh/m3	**>80**	

Consortium Work Scope

A preliminary order-of-magnitude analysis indicates the energy storage required to support thermal loads in the country from clean energy sources will be on the order of 2,570 GWh. This is substantially higher than current lithium-ion (Li-ion) battery production capacity of 3.8 GWh in the United States. This additional storage requirement puts significant pressure on critical material supply, such as Li, if Li-ion was used to support the thermal loads in buildings. As a result, the need for thermal energy storage solutions at scale and developed quickly presents a grand challenge for building technology innovations. In thermal energy storage applications, it is critical to use an integrated and iterative approach to develop advanced TES systems for buildings. Once up and running, Stor4Build is expected to utilize a "top-down" research approach by evaluating operational needs, defining system and materials requirements, and helping set the optimal performance targets at each level. Each level requires coordinated efforts for the development of standardized measurement protocols that help the progression from **materials** to **devices**, **components**, and **systems**, while maintaining the same performance level during scale up. This iterative approach of "top-down and bottom-up" as shown in Figure 1 below helps to identify unknown issues with the materials, components, and systems and allows for early identification of actionable steps to mitigate the issues.

Successful technology deployment and implementation strategies are integral to the market adoption of advanced TES systems in buildings. This includes a strong understanding of commercialization and market adoption barriers in the entire TES ecosystem and the policy, regulatory, financing, and workforce considerations that could have an important and outsized impact. Strategies that decrease market risks can enable an environment conducive to long-term investment and deployment.

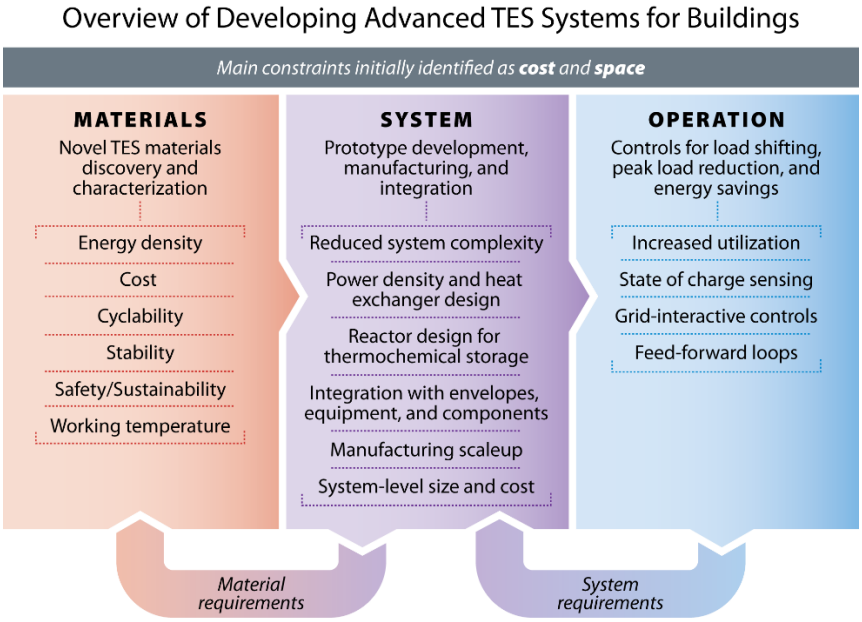


Figure 1. *The integrated and iterative research approach to develop advanced TES systems for buildings. Modified from ARPA-E.*

To advance the state-of-the-art TES materials and systems and their integration and deployment into buildings, the following four thrust areas have been identified. A future Consortium RFP will seek proposals in these technical areas, as well as those identified in the building energy storage roadmap. While this Lab Call topic seeks proposals for the Consortium governance, including partnering with an external organization with market deployment expertise, information on these thrust areas are meant to aid in setting up an effective governance and management structure for the Consortium.

1. **Materials optimization and manufacturing.** New materials with improved cyclability and energy performance are needed to reduce the cost and size of TES installations.
2. **Modeling and analysis.** Accurate methods and tools that integrate materials- and system-level performance with operational needs allow technology developers to model energy delivery, grid-flexibility, cost savings, and carbon impact reductions. Deployment economic analyses and deign guides allow solutions to be optimized for maximum cost/performance and impact.
3. **System optimization and integration.** New Integrated and packaged solutions designed for ease of integration and installation are needed, including solutions that improve the performance of heat pumps in cold climates, and reduce overall system capital cost. Field validation and pilot programs address installation challenges and expand market demand.
4. **Market and policy.** While a key barrier to deployment is high capital cost, it is imperative that market and regulatory barriers hindering deployment of next-generation TES solutions are addressed. Such activities include educational outreach and awareness building of consumer benefits, codes and standards, sustainable financing and pricing-signal mechanisms, workforce development and training, and data-driven policy formulations and implementation.

Stor4Build is expected to coordinate efforts, collaborate and provide technical advice and support to industry/university-led projects selected through competitive funding opportunity announcements (FOAs) and other potential funding mechanisms such as Prizes.

The applicant should propose a well thought out and detailed consortium operation and management structure that emphasizes strong partnering with external stakeholders for the entire intial 5-year term of Stor4Build. It is strongly recommended that the applicant partner with market/policy organizations with experience in energy storage deployment to direct and lead the market and policy thrust area. These partner organizations can include non-profit research and energy efficiency organizations. An overall five year plan, including a more detailed plan for the first two years should be provided, including specific tasks, key team members, and funding by task and lab. Early efforts should include RFP development to solicit proposals in key technical areas that will fill in knowledge gaps and identify and address critical technical and deployment challenges. One of the first tasks in the work scope should be obtaining industry feedback on the relevance and appropriateness of the targets. Risks should be identified and mitigation strategies should be described. The applicant should propose annual Go/No-Go milestones. Budgets should be commensurate with the proposed scope.

To accomplish the aggressive 2030 system-level performance targets, Stor4Build needs a high functioning multi-disciplinary team that works collaboratively with many diverse stakeholders and freely shares information. The intentional engagement of industry is emphasized. The consortium is expected to engage industry, industry associations, private foundations, nonprofits, venture capitalists, community organizations, professional/trade unions, quasi-government research, federal government, state governments, and local governments.

The applicant should propose a data sharing plan similar to other EMN Consortia DataHubs so that testing conditions and results are compiled into a database and maintained for public use. Other relevant documents, including presentations, should also be included in the database. It is also important that the Consortium have a strong presence in the energy storage community. The applicant should propose an outreach plan that includes a website to highlight Stor4Build's capabilities (other ideas are welcome).

Consortium Structure

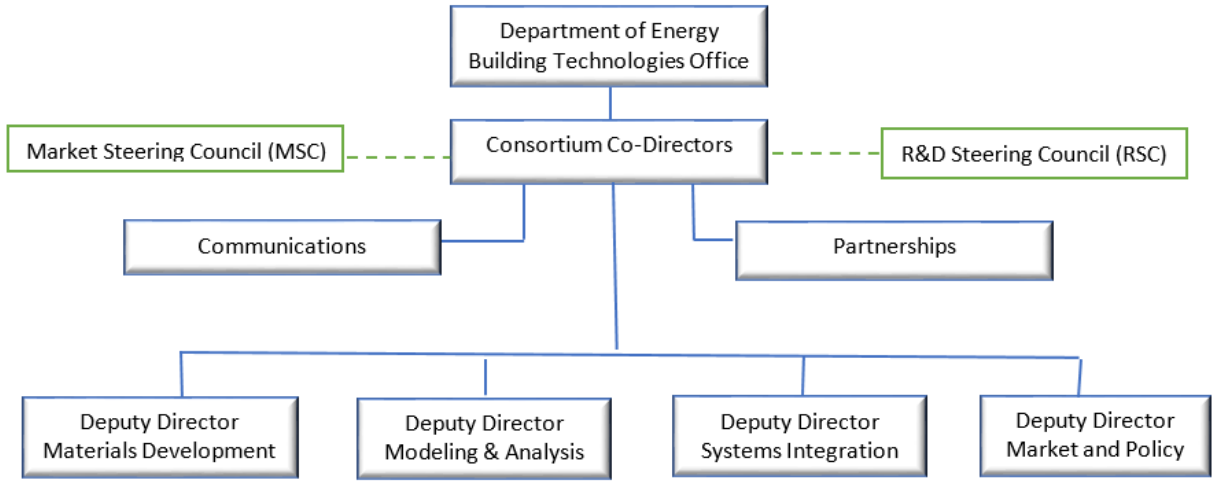
This Lab Call aims to create a Consortium that synergistically and collaboratively brings together DOE national laboratories with technology developers, utilities, federal, state, and local governments, and other key market and policy stakeholders to strategically and substantially advance TES development, demonstration, and deployment. Entities that provide key expertise and capabilities not available within the national laboratories can be proposed as subcontractors. BTO strongly encourages labs to work collaboratively, partner with external entities that focus on market adoption, education, financing mechanisms, policy formulations and implementation plans, and submit one coordinated application.

Given the success of EMN, labs involved with EMN are highly encouraged to participate in Consortium governance, as funding is not intended for duplicating such capabilities. Existing capabilities such as those in EMN should be utilized, rather than re-developed. The Consortium will be funded using annual

appropriations. Competitively selected projects from future FOAs and CRADAs may be added to the Consortium on an on-going basis to cover R&D and market development objectives.

The Consortium seeks to bring together a number of national laboratories with demonstrated leadership in the topic area, creating a high-functioning team to advance applied research and development leading to improved designs and better performing thermal energy systems in buildings. To help ensure successful execution of Stor4Build operational, management, and support, the governance structure of the Consortium needs to be clearly defined. An example of the Consortium structure is illustrated in Figure 3. In this example, the Consortium is guided by a Market Steering Council (MSC) and R&D Steering Council (RSC) to provide direct input regarding the consortium structure, strategy, key approaches, and major implementation, and vetting of priorities. The MSC and RSC are be made up of experts from industry and research, along with other representatives approved by BTO.

BTO intends to review the structure and approach after the first year and solicit industry feedback on potential modifications to maximize success. Based on this feedback, the Consortium may be requested to make adjustments. The consortium will be fully recompeted after 5 years.



Research Areas
Materials Development and Manufacturing: Materials discovery, optimization, characterization, process scaleup, and measurement protocol development Modeling and Analysis: Simulation and modeling, tools, techno-economic modeling, deployment economics, and design guides System Optimization and Integration: Integrated and packaged solutions, component optimization, design for integration and installation, advanced controls, and field validation and demonstrations Market and Policy: Workforce development and training, educational outreach, policy considerations, market adoption and deployment efforts, codes and standards, valuation, and financing

Consortium Expected Activities in Initial Year: Roadmap Development and Request for Proposals (RFP)

- Upon award, the applicant and BTO will convene a Consortium Kickoff meeting.
- The applicant will hold a consortium workshop to solicit input, industry engagement, and crystalize the direction and structure of the consortium within approximately the first 4 months of award.
- Upon completion of the building energy storage RDD&D roadmap, Stor4Build, in close collaboration with BTO, will develop and issue a competitive request for proposals (RFP) to solicit new projects from national laboratories that address high-priority areas identified in the roadmap. The consortium must develop a consistent, competitive RFP process to solicit proposals. Submitted project proposals will undergo an independent merit review. BTO will approve project selections.
- Before the end of each FY, Stor4Build must develop a continuation application/AOP with BTO

for incorporating consortium management and operational scope of work and budgets for the next FY, including general scope that will continue into subsequent years.

- Stor4Build must develop a plan to work with consortium members on general coordination activities including outreach, project management, oversight, stakeholder engagement, hosting and convening consortium-related workshops and meetings, developing overall communications and publications which includes periodic updating of the roadmap, and organizing quarterly technical updates to assess progress against roadmap and BTO priorities. Stor4Build must agree to work with subrecipients, selected through this Lab Call and future RFPs and FOAs, to establish consistent project-level reviews, tracking and reporting of progress and with members to establish consistent guidelines, policies, agreements, processes, and strategic documents for the Consortium.

AREA 3: Windows

BTO Point of Contact: Marc Lafrance (marc.lafrance@ee.doe.gov)

Windows are responsible for about 10% of energy use in buildings and influence end uses that comprise 40% of building energy use. R&D is needed to enable next-generation windows that have the same thermal performance of most existing buildings' insulated walls, while also harvesting passive heating contributions in winter and rejecting unwanted solar heat gain in summer. Windows have a significant influence on a building's overall energy performance. They also provide an opportunity for efficiency improvement and comfort. Advanced and novel window technologies could yield substantial energy savings while also reducing peak electricity demand in a building's energy performance. The Windows area features three key areas of technology R&D:

- Highly Insulating Windows
- Dynamic Solar Control
- Daylighting and Shading.

Windows comprise the transparent portion of the building envelope, and thus serve many of the same functions as the opaque envelope. Windows serve additional functions not shared with the opaque envelope: admitting daylight, views to the outdoors, natural ventilation, and solar heating that can offset heating energy requirements in cold weather. High performance windows have significant price premiums that research is focused on reducing as much as possible; however, to improve the value proposition, the benefits need to be fully valued.

Topic 3A: Fully Documenting the Value Proposition of Window Upgrades

Period of Performance: 18-36 months
Estimated Available Budget: $500k/yr
Eligible Labs: LBNL, NREL, ORNL, PNNL
Number of Awards: 1

During energy audits in both residential and commercial buildings, windows are often rejected without ever conducting a full energy, cost, and performance evaluation. Furthermore, when they are assessed, the evaluation process is very limited to just basic U value improvements and potentially SHGC

improvements. Most windows are treated like an opaque wall with a typical UA evaluation. This is insufficient since windows have significant potential to reduce air leakage and have a major contribution to building design loads, peak load reduction, comfort, and non-energy benefits. BTO's window RFI asked several questions related to this issue and the response from stakeholders showed strong support for DOE to pursue this effort (Laboratories seeking to respond to this request can get access to the RFI responses if they currently do not have them). It is expected that industry should be able to contribute in-kind resources to help a laboratory(s) conduct this work. The submissions should have three major components:

Assessment - Evaluate the most common tools being utilized by efficiency and auditing practitioners in both the residential and commercial sectors. The intent is to apply the 20/80 rule to find the largest market of users of existing tools based on the number of homes and buildings evaluated per year. This is likely to include proprietary tools and may include tools that DOE does not currently collaborate with. The intent of this effort is to work with partners to update existing tools, not to develop new DOE tools. If existing DOE tools are within the highest utilized tools, then they should be included. This is intended to be a fully market driven process. However, special emphasis should be placed on tools that are being used for weatherization, along with state and local programs that seek to upgrade homes and buildings in disadvantaged communities.

Partnership Development/Analysis – The project should seek partnerships with auditing and rating tool developers and tool certification organizations such as RESNET to improve the evaluation of window solutions including window replacement and window attachments. Manufacturers and other stakeholders should be included as collaborators in the project with in-kind contributions. At lease 1/3 of the funding and preferably half should be provided to private entities/partners as part of this effort. The overall effort should be leveraged with the private sector. The project should include the development of a workplan based on the ease of additional elements to be assessed/improved relative to the potential large impact they may have to increase the value proposition for window system investments. The following list is provided as an example, but the final list should be derived by analysis and in consultation with stakeholder's interest, and non-energy benefit activities should have the greatest financial leverage from partners:

- System level benefits – elimination of the perimeter conditioning zone, downsizing of HVAC, elimination of ducts to perimeters, abandonment of ducts, alternate HVAC systems, etc
- Full energy benefits – air leakage reduction, thermostat changes due to comfort, peak demand reduction, etc
- Non-energy benefits – carbon emissions related to peak load, productivity, noise abatement, etc

Implementation – The proposal should clearly show how such tools will be updated and how they will be used to fully assess windows that will lead to increased sales of high-performance windows (e.g. R5, dynamic solar control) and window attachments (e.g. secondary glazing systems, ENERGY STAR storm windows, exterior shades, cellular shades). The proposal should assess the potential impact that this effort will have on increasing the sales of highly efficient window systems. The outcome of this effort

should also be disseminated to the PAWS community and to help get greater adoption of tools that have improved window valuation capability.

AREA 4: Supervisory Building Controls

BTO Point of Contact: Brian Walker (brian.walker@ee.doe.gov)

Supervisory control systems have significant near-term potential to reduce the carbon footprint of existing buildings at scale. Retuning outdated control sequences provides 29% energy savings and 19% peak load reduction, while more advanced model predictive control installations can provide 15-50% energy savings. Despite the benefits, energy management control systems exist in only 14% of the US commercial building stock. Adoption especially suffers in small and medium commercial buildings with only 26% of buildings with less than 100k sq.ft. implementing this technology. Through the topics below, BTO seeks to maximize the energy efficiency and carbon-saving potential of energy management control systems for commercial buildings and advance adaptive and optimized controls, while understanding and addressing the primary adoption barrier – high installation and maintenance costs.

Topic 4A: Machine Learning (ML) for Building Energy Management and Control Systems

Period of Performance: 3 years
Estimated funding: $1,200k/yr
Eligible labs: all
Number of Awards: 1 or 2

Machine learning has the potential to address long-standing deployment and adoption barriers while providing significant performance headroom. This topic seeks proposals for application of machine learning techniques to building control objectives. The resulting work should be easy to install and operator friendly, address novel/diverse system configurations and performance objectives, and dramatically outperform the state-of-the-art rule-based methods. Proposed projects should deliver cost-effective and scalable retrofit solutions for large-scale non-convex optimization problems while conforming to the physical systems' operational constraints. Areas of special interest include:
(1) techniques that make commercial building energy management control systems cost-effective and enable its integration into market-available control products for energy efficiency and grid services; (2) implementation of concepts in practice (e.g. through field demonstrations) that validate performance, scalability, and cost effectiveness; and (3) solutions suited especially for small and medium commercial buildings. Note that these areas are not exclusive, and successful proposals may address all three.

Proposals that include involvement and cost-share from partners who can aid with solution delivery at scale, including but not limited to cooperative research and development agreements (CRADAs) and/or viable commercialization channels, are highly encouraged.

Topic 4B: Observational Research to Address Advanced Control Deployment Barriers

Period of Performance: 3 years
Estimated Available Budget: $800k/yr
Eligible labs: PNNL with other labs joining at their request
Number of Awards: 1 or 2

Advanced control approaches are often customized, brittle, and complex and their practicality is addressed too late in development. This topic seeks to gain a first-hand understanding of barriers and issues that hinder the deployment of energy management control systems. By understanding the deployment issues, replicable solutions can be developed to enable more widespread deployment, such as with solid-state lighting and solar PV. Proposals to this topic should aim for improved firsthand understanding (versus current practice) of barriers and issues that hinder the deployment of advanced controls in commercial buildings. Observational research can be used to evaluate issues, such as cost, installation complexity, and installer familiarity that prevent more widespread use of advanced controls, including automated fault detection and diagnostics, that could significantly improve carbon savings, efficiency, comfort, reliability, and life of HVAC systems. The results of the work will support industry and R&D community in targeting barriers and inform on-going standardization, market alignment, and technology development efforts, and proposal(s) should be designed accordingly.

AREA 5: Building Electric Appliances, Devices, and Systems

BTO Point of Contact: Wyatt Merrill (wyatt.merrill@ee.doe.gov)

Topic 5A: Strategies for utilizing existing electrical panel capacity for new electrical equipment installations

Period of Performance: 2 years
Estimated Available Budget: $1,000k/yr
Eligible labs: All
Number of Awards: 1 or 2

For a significant portion of the existing residential building stock, the capacity of electrical panels may constrain decisions to electrify certain end uses (primarily heating, vehicles,
stoves, and clothes dryers). For instance, heat pump installation may require a new 30-Amp circuit and double-pole breaker. In this case, the breaker box must have room for the new breaker, and operation of the heat pump coincident with existing building loads must not result in overcurrent for periods of time long enough to trip the main breaker. The permitting and installation of new electrical service may be unacceptably long, particularly during winter months in the event of unexpected furnace failure. In short, electrical panel upgrades are costly and time-consuming, and their marginal impact on

the installation of new electrical equipment may be prohibitive to homeowners.

A variety of potential solutions exist to avoid electrical panel upgrades for homes operating near the capacity of their existing infrastructure, but the optimal solution will depend on building characteristics and homeowner goals. Building enclosure improvements such as air leakage sealing, insulation, and window replacements can reduce the electrical strain of a new heat pump. Autonomous control solutions such as smart breakers or automatic circuit sharing can limit current through the main breaker by ensuring large power draws (from clothes dryers, stoves, water heaters, EV chargers, etc.) do not occur simultaneously. On-site solar as well as battery or thermal storage may be adequate to avoid peak-loads that would otherwise trip the main breaker. In some homes, replacing or repairing inefficient appliances may be sufficient—home energy monitoring or load disaggregation can help identify such cases and may be additionally useful in properly sizing new HVAC systems or identifying faults in existing HVAC.

The diversity of options and needs specific to each building is inherently complex. Successful applicants for this topic may develop a simplifying framework for assessing appropriate solutions dependent on building characteristics and geography. Solutions should be characterized quantitatively in terms of power-savings and cost, either through modeling, field studies, or (ideally) both. Building characteristics and geographic categories should be diverse and represent broad constituents of the US residential building stock.

Alternatively, applications may pursue significant improvements in efficiency or viability of solutions to avoid electrical panel upgrades. Such solutions should accompany technoeconomic analysis for the proposed innovation that demonstrates the scale of potential deployment in buildings and identifies barriers to adoption. Applications aimed at modifying the electrical infrastructure of a home should make explicit whether their approach is aligned with existing electrical code and incorporate workforce outreach or development as a supporting feature of the proposal.

B. Core Topics

The following topics represent continuing projects and are open only to the specified labs.

Topic 5B: Major Electric Appliances

Period of Performance: 3 years
Estimated Available Budget: Up to $900k/yr
Eligible labs: ORNL
Number of Awards: 1-5

ORNL has led many in-depth projects on major appliance energy performance, frequently in partnership with industry, leading to the commercialization of numerous ENERGY STAR technologies available today. Their expertise in heat-pump integration and extensive experience modeling, prototyping, and testing these technologies constitutes a unique capability with a history of success advancing major appliance

efficiency. As such, ORNL is the core lab for the major appliance R&D BTO pursues as a component of building decarbonization.

The aim of this topic is to merit review project proposals that employ ORNL capabilities on major appliances for FY22-25. BTO will use this review, as well as alignment with DOE priorities and BTO decarbonization strategy, to select the most impactful projects for future core work. Proposals may target energy performance of any major electric appliance, including refrigerators, freezers, clothes washers and dryers, dishwashers, and cooking ranges. Proposals should quantify energy-savings potential, address likely barriers to adoption, and ideally include support from or collaboration with OEMs. Additional priorities for selection include enabling factors for building electrification, grid-responsiveness, and energy justice.

AREA 6: Building Energy Modeling

BTO Point of Contact: Amir Roth (amir.roth@ee.doe.gov)

Physics-based whole-building energy modeling (BEM) is a decision-support tool with many applications in the building energy-efficiency space. BEM for specific, individual building supports integrated design for new construction and retrofit projects, optimizing performance metrics such as annual energy use, peak demand, and occupant comfort while minimizing cost. Within design, BEM is a key tool for selecting and sizing HVAC equipment and evaluating control strategies. It also supports performance rating and documentation for regulatory and financial transactions like code compliance, green certification, and tax and program incentives. BEM on archetypal buildings supports large scale evaluation and planning applications including code development, energy efficiency program development, product development, R&D portfolio management, technology roadmapping, and impact evaluation. In all use cases, the energy calculations performed by BEM are components of larger calculations such as energy cost and cost burden, measure cost-effectiveness, CO2 emissions, resilience and others.

BTO has been funding and managing the development of BEM software since the founding of the office. The current portfolio includes established tools that form the basis of both national model codes and private sector design and compliance applications and services (EnergyPlus and OpenStudio), new tools that target emerging use cases in controls, district systems, and DER integration (Spawn and URBANopt) and ASHRAE Standards that govern BEM tools and their use.

BTO is seeking proposals for shepherding these projects through the next 3 years with a renewed focus on adoption and deployment.

Topic 6A: EnergyPlus Development, Maintenance, and Support

Period of Performance: 3 years
Estimated Available Budget: $2,800k/yr

Eligible labs: NREL, LBNL, ORNL, PNNL, SNL
Number of Awards: 1

EnergyPlus is BTO's flagship state-of-the-art open-source whole-building energy modeling engine, supporting national code and standard development (e.g., ASHRAE Standard 90.1 and California Title24 Non-Residential), DOE building ratings (Asset Score and now Home Energy Score) and a growing number of commercial tools for architects, engineers, and energy consultants (e.g., DesignBuilder, Trane TRACE 3D Plus, Sefaira Architecture and Systems, Autodesk Systems Analysis for Revit and FormIt).

BTO is soliciting a single multi-lab proposal for the continued development and maintenance of EnergyPlus for the period of FY23-25. The lead awardee is expected to:

- Deliver two update releases of EnergyPlus annually
- Maintain, update, and enhance EnergyPlus' development, testing, and distribution infrastructure
- Implement processes for improving code quality and developer productivity
- Implement processes for soliciting community feedback, suggestions, and priorities
- Coordinate the tracking and resolution of bugs and defects
- Coordinate support and technical assistance to third-party application developers and, as appropriate, users
- Coordinate with and support other BTO funded software projects as appropriate
- Competitively solicit, select, contract with, and manage development contractors as needed
- Provide quarterly updates to BTO

FY23-25 development priorities include:

- Improving execution performance
- Refactoring code to improve maintainability, modularity, and reusability
- Improving utility and usability of existing features
- Implementing new features to support industry needs, codes and standards, and BTO R&D priorities
- Updating and developing new examples and documentation

Topic 6B: Spawn Development, Maintenance, and Support

Period of Performance: 3 years
Estimated Available Budget: $1,500k/yr
Eligible labs: LBNL, PNNL, NREL
Number of Awards: 1

Spawn is BTO's next-generation BEM-controls engine that bridges traditional energy simulation workflows with control design and implementation workflows. Spawn leverages the FMI (Functional Mockup Interface) standard to support co-simulation in a deep way and to create a flexible, modular,

and extensible architecture that can integrate with third party models and with other simulation tools. It also uses the Modelica declarative equation-based modeling and simulation language to support simulation at dynamic time scales, to enable implementation and simulation from a single code base, and to leverage international efforts in both domain specific modeling content (Buildings Library, District Systems Library) and domain-agnostic advances in compilation and simulation technology.

BTO is soliciting a single multi-lab proposal for the continued development and maintenance of Spawn for the period of FY23-25. The lead awardee is expected to:

- Deliver one update release of Spawn annually
- Maintain, update, and enhance Spawn's development, testing, packaging, and distribution infrastructure
- Implement processes for improving code quality and developer productivity
- Implement processes for soliciting community feedback, suggestions, and priorities
- Coordinate the tracking and resolution of bugs and defects
- Coordinate support and technical assistance to third-party application developers and, as appropriate, users
- Coordinate with and support other BTO funded software projects as appropriate
- Competitively solicit, select, contract with, and manage development contractors as needed

FY23-25 priorities include:

- Improving compilation and execution performance
- Extending the Modelica Buildings Library to cover additional building systems
- Updating and developing new examples and documentation
- Enhancing unit, regression, and performance testing
- Supporting early adopters
- Collaborating with the EnergyPlus and OpenStudio projects to better integrate Spawn into BTO's BEM ecosystem, and facilitate adoption and migration

Topic 6C: OpenStudio Development, Maintenance, and Support

Period of Performance: 3 years
Estimated Available Budget: $2,200k/yr
Eligible labs: NREL, LBNL, PNNL, ORNL
Number of Awards: 1

OpenStudio is a key component of BTO's BEM ecosystem. As a software development kit (SDK) for EnergyPlus, OpenStudio supports application and service development (DOE's Asset Score and Home Energy Score, Autodesk's Systems Analysis for Revit and FormIt, Ladybug Tools' Honeybee, Perkins&Will's SPEED), process automation (systematic Measure application, ASHRAE 90.1 Appendix G "baseline" transformation), interoperability (gbXML and HPXML import, daylighting simulation using Radiance), and large-scale analysis (Measure analysis, optimization, calibration). OpenStudio includes a

core distribution consisting of the OpenStudio Model API (Application Programming Interface), OpenStudio CLI (Command Line Interface) and Meta CLI, and OpenStudio Server. It also includes a significant amount of shared content—both code and data—that is not part of the distribution, but supports a wide variety of use cases. Content includes Components, Measures, and Gems that are warehoused in online data stores such as the BCL (Buildings Component Library) and RubyGems.org.

BTO is soliciting a single multi-lab proposal for the continued development and maintenance of OpenStudio for the period of FY23-25. Given the scope and breadth of the project, BTO will accept specific pieces of the project, e.g., the OpenStudio-Standards gem. The lead awardee is expected to:

- Deliver two update releases of the OpenStudio core distribution annually
- Maintain, update, and enhance the OpenStudio development, testing, and distribution infrastructure
- Implement processes for improving code quality and developer productivity
- Implement processes for soliciting community feedback, suggestions, and priorities
- Coordinate the tracking and resolution of bugs and defects
- Coordinate support and technical assistance to third-party application developers and, as appropriate, users
- Coordinate with and support other BTO funded software projects as appropriate
- Competitively solicit, select, contract with, and manage development contractors as needed
- Provide quarterly updates to BTO

FY23-25 priorities include:

- Improving execution performance
- Supporting integration of the Spawn engine into the OpenStudio ecosystem
- Supporting Python workflows
- Supporting the EnergyPlus Python Plugin feature
- Stabilizing and extending OpenStudio-Standards
- Implementing new features to support industry needs, codes and standards, and BTO R&D priorities
- Updating and developing new examples and documentation

Topic 6D: URBANopt Development, Maintenance, and Support

Period of Performance: 3 years
Estimated Available Budget: $1,200k/yr
Eligible labs: LBNL, NREL
Number of Awards: 1

URBANopt is the latest addition to BTO's BEM ecosystem, a co-simulation toolkit for buildings, district systems, DERs (distributed energy resources), and electrical distribution systems. URBANopt builds on

BTO BEM tools EnergyPlus, Spawn, and OpenStudio and adds support for co-simulating district thermal systems using the Modelica Buildings Library and DERs and electrical distribution with REopt Lite and OpenDSS. URBANopt is a master planning and design tool for efficient and flexible urban districts.

BTO is soliciting a single multi-lab proposal for the continued development and maintenance of URBANopt for the period of FY23-25. The lead awardee is expected to:

- Deliver one update release of URBANopt annually
- Maintain, update, and enhance the URBANopt development, testing, and distribution infrastructure
- Implement processes for improving code quality and developer productivity
- Implement processes for soliciting community feedback, suggestions, and priorities
- Coordinate the tracking and resolution of bugs and defects
- Coordinate support and technical assistance to third-party application developers and users
- Coordinate with and support other BTO funded software projects as appropriate
- Competitively solicit, select, contract with, and manage development contractors as needed
- Provide quarterly updates to BTO

FY23-25 priorities include:

- Promote adoption of URBANopt SDK by vendors and users

Topic 6E: BEM ASHRAE Standard Development, Maintenance, and Support

Period of Performance: 3 years
Estimated Available Budget: $1,500k/yr
Eligible labs: ANL, NREL, ORNL, PNNL
Number of Awards: 1

BTO supports the development and maintenance of a number of ASHRAE Standards that apply to BEM and its use. These include ASHRAE Standard 140 “Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs” and ASHRAE Standard 205 “Representation of Performance Data for HVAC&R and Other Facility Equipment”. BTO will also support the recently approved update of ASHRAE Standard 209 “Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings”. The bulk of the funding ($1,200k/yr) is earmarked for ASHRAE Standard 140.

BTO is soliciting a single multi-lab proposal for the continued development and maintenance of these standards for the period of FY23-25. Given the breadth and scope of the work, BTO will accept separate for individual pieces of the project, e.g., a separate proposal for each standard. The lead awardee is expected to:

- Deliver one updated edition of each standard during the performance period in compliance with ASHRAE update timelines

- Provide analysis and technical assistance to inform standard development and update
- Competitively solicit, select, contract with, and manage support contractors as needed
- Provide quarterly updates to BTO

Priorities for ASHRAE Standard 140 include:

- Expanding the standard along the lines recommended by the PNNL "PRM Sensitivity Testing Requirements" report
- Updating existing diagnostic test suites and developing new diagnostic test suites
- Expanding the list of engines providing reference results to include most of the engines used in commercial modeling
- Improving automation associated with standard development and compliance demonstration
- Improving coordination with adjacent ASHRAE Standards including 90.1, 205P and 229P
- Improving coordination with partially overlapping standards and programs from organizations such as RESNET, IBPSA-USA and the California Energy Commission
- Promoting Standard adoption by energy-efficiency and other programs using BEM

Priorities for Standard 205 include:

- Improving automation associated with standard development, compliance demonstration and adoption
- Improving coordination with adjacent ASHRAE Standards including 90.1, 140, and 229P
- Improving coordination with partially overlapping standards and programs from organizations such as RESNET, IBPSA-USA and the California Energy Commission
- Promoting Standard adoption by BEM vendors, equipment manufacturers and energy-efficiency and other programs using BEM

Priorities for Standard 209 include:

- Promoting Standard adoption by energy-efficiency and other programs using BEM

IV. Application Submission and Review Information

A. Application Submission Details

Application Process

Proposals must be submitted via EERE Exchange by the submission deadline 3/28/2022 at 11:59 PM Eastern.

Proposal Length

For all Lab Call topics, the proposal length shall not exceed 15 pages except topic area 2 which is allowed a 25 pages. Approved appendices do not count towards the above noted page limits. Refer to "Proposals" section below for details. Additional pages beyond that will not be reviewed.

To apply to this Lab Call, applicants must register with their lab email address and submit application materials through EERE Exchange at https://eere-exchange.energy.gov, EERE's online application portal.

All submissions must conform to the guidelines for format and length, and be submitted at, or prior to, the deadline listed.

General Proposal Requirements

Proposals should be formatted for 8.5 x 11 paper, single spaced, and have 1-inch margins on each side. Typeface size should be 11-point font, except tables and figures, which may be in 10-point font.

Proposals

Applicants must include all content they wish to have reviewed in the proposal. Applicants are required to submit 1-page resumes for key participating team members (multi-page resumes are not allowed), as well as letters of commitment from all subrecipient and third-party cost share providers. If applicable, also include any letters of commitment from partners/end users (1-page maximum per letter). Resumes, commitment letters, and any references should be included in the application as an appendix, which will not count towards page limits as limited by topic area. Additional pages beyond that will not be reviewed.

- BTO will not review or consider ineligible applications.
- Individual proposals must be submitted in PDF format as a single file (do not bundle multiple proposals in a single file).

Project Specific Implementation of lab-wide DEI plan

As part of the application, applicants are required to describe how diversity, equity, and inclusion objectives will be incorporated in the project. Specifically, applicants are required to submit a description of how the project will support or implement the lab-wide Diversity, Equity, and Inclusion Plan and describe the actions the applicant will take to foster a welcoming and inclusive environment, support people from groups underrepresented in STEM, advance equity, and encourage the inclusion of

individuals from these groups in the project; and the extent the project activities will be located in or benefit underserved communities. The plan should include SMART milestones supported by metrics to measure the success of the proposed actions.

The following is a non-exhaustive list of actions that can serve as examples of ways the proposed project could incorporate diversity, equity, and inclusion elements. These examples should not be considered either comprehensive or prescriptive. Applicants are encouraged to propose appropriate actions not covered by these examples.

a. Diversity on the research team
    a. Include persons from groups underrepresented in STEM as PI, co-PI, and/or other senior personnel;
    b. Include persons from groups underrepresented in STEM as student researchers or post-doctoral researchers;
    c. Implement evidence-based, diversity-focused education programs (such as implicit bias training for staff) in your organization;
    d. Identify Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses and Veteran Owned Businesses to solicit as vendors and sub-contractors for bids on supplies, services and equipment
    e. Include faculty or students from Minority Serving Institutions as PI/co-PI, senior personnel, and/or student researchers;
    f. Enhance or collaborate with existing diversity programs at your home organization and/or nearby organizations;
    g. Collaborate with students, researchers, and staff in Minority Serving Institutions;
b. Explicit diversity in research impact
    a. Illustrated outcome impact in underserved communities
    b. Disseminate results of research and development in Minority Serving Institutions or other appropriate institutions serving underserved communities;
c. Explicit diversity in research design. Inclusion of a broad community, academic, policymaking staff in research design and execution phase.

The Diversity, Equity and Inclusion Implementation Plan should be integrated into the technical volume.

Full Applications must conform to the following requirements:

Technical Volume

The Technical Volume must be submitted in PDF format. The Technical Volume must conform to the following content and form requirements, including maximum page lengths. If applicants exceed the maximum page lengths indicated below, EERE will review only the authorized number of pages and disregard any additional pages. Save the Technical Volume in a single PDF file using the following convention for the title “ControlNumber_LeadOrganization_TechnicalVolume”.

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

The Technical Volume to the Full Application may not be more than **15** pages for all topic areas except topic area 2 which is allowed **25** pages, including the 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 when preparing the Technical Volume.

SECTION / PAGE LIMIT	DESCRIPTION
Cover Page (1 page, NOT included in total page limit)	The cover page should include: • Project title • Lab Call Topic Area being addressed • Technical and business points of contact • Names of all team member organizations (internal and external) • 200-word abstract • Budget summary • Any statements regarding confidentiality.
Technical Description, Innovation, and Impact Approximately 40% of the Technical Volume	The Technical Description should contain the following information: • Relevance and Outcomes: Describe in detail the technology, including the scientific and other principles and objectives that will be pursued during the project. Describe the relevance of the proposed project to the goals and objectives of the Lab Call topic, including the potential to meet specific DOE technical targets or other relevant performance targets. Clearly specify the expected outcomes of the project. • Feasibility: Clear 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: Describe the current state-of-the-art in the applicable field, the specific proposed advancement, the advantages of the proposed advancement over the state-of-the-art and any emerging alternatives, and the overall impact on the state-of-the-art if the project is successful. • Diversity, Equity, and Inclusion: Describe the impacts (including social and environmental) of the proposed project on underserved communities. Describe how diversity, equity, and inclusion objectives will be incorporated in the project.
Project Approach and Workplan Approximately 40% of the	The Workplan should include detailed Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go Decision Points, and Project Schedule. The Workplan should contain the following information:

Technical Volume	• Project Objectives: Clearly and concisely state the goals and objectives of the project as well as the expected outcomes. • Technical Scope: Describe the overall work scope and approach to achieve the objective(s). Divide the overall work scope into performance periods that are separated by discrete, approximately annual decision points (see below for more information on Go/No-Go decision points). State the specific expected end result of each performance period. • WBS and Task Description: 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. Structure the Workplan with a hierarchy of (approximately annual) performance period, task and subtasks, which is typical of a standard WBS for any project. Concisely describe the specific activities to be conducted over the life of the project. The description should 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 Lab Call. • Milestone Descriptions: Provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be Specific, Measurable, Achievable, Relevant, and Timely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the Lab Call, 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). Specify the means by which milestones will be verified. • Go/No-Go Decision Points: Provide a summary of project-wide Go/No-Go decision points at appropriate points in the Workplan. A Go/No-Go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. At a minimum, each project must have at least one project-wide Go/No-Go decision point for each annual budget period of the project. Provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone. • Risks Mitigation Plan. Provide a summary (in tabular form) of project risks, describing the risk, response plan to mitigate or retire the risk, the team member who is tasked to best address the risk, a description of the severity of

	the risk if it were to happen, and the probability of the risk happening during the course of the project. • End of Project Goal: Provide a summary of the end of project goal(s). At a minimum, each project must have one SMART end of project goal. • Schedule (Gantt Chart or similar): Provide a schedule for the project, including task and subtask durations, milestones, and Go/No-Go decision points.

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.
	• Include relevant, previous work efforts, demonstrated innovations, and describe how these enable the applicant to achieve the project objectives.
	• Describe the time commitment of the key team members to support the project.
	• Describe the technical services to be provided by DOE/NNSA FFRDCs, if applicable.
	• For multi-organizational or multi-investigator projects, describe succinctly:
	  ○ The roles and the work to be performed by each PI and Key Participant;
	  ○ Business agreements between the applicant and each PI and Key Participant;
	  ○ How the various efforts will be integrated and managed;
	  ○ Process for making decisions on scientific/technical direction;
	  ○ Publication arrangements;
	  ○ Intellectual Property issues; and
	  ○ Communication plans.

Summary Slide

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

The Summary Slide template requires the following information:

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

Save the Summary Slide in a 1-page MS Powerpoint file using the following convention for the title "ControlNumber_LeadOrganization_Slide".

Budget Summary

Applicants are required to provide budget information for lead laboratory, partner laboratory, and subrecipient that is expected to perform work. Please complete the budget summary tables below.

Save budget information in a MS Excel file using the following convention for the title "ControlNumber_LeadOrganization_Budget".

Lab info

Please add a separate table for each partner laboratory.
*Please note, info for Years 2026 and 2027 only needed for Topic 2A.

Lead Laboratory Name:

Year	Planned Project Costs
2022	_
2023	_
2024	_
2025	
2026*	
2027*	
Subtotal	_

Partner Laboratory (If Applicable) Name:

Year	Planned Project Costs
2022	_
2023	_
2024	
2025	_
2026*	
2027*	
Subtotal	_

Total Planned Project Costs:

Subrecipient Info

Please add subrecipient detail for lead laboratory and partner laboratory, if applicable. Add a separate table for each partner laboratory.
*Please note, info for Years 2026 and 2027 only needed for Topic 2A.

Lead Laboratory Name:

Subcontractor Name	Sub Type	Start Date	End Date	2022 Planned Costs	2023 Planned Costs	2024 Planned Costs	2025 Planned Costs	2026 Planned Costs*	2027 Planned Costs*	Total Funding
Subcontractor Subtotal										

Partner Laboratory (If Applicable) Name:

Subcontractor Name	Sub Type	Start Date	End Date	2021 Planned Costs	2022 Planned Costs	2023 Planned Costs	2025 Planned Costs	2026 Planned Costs*	2027 Planned Costs*	Total Funding
Subcontractor Subtotal										

Total Planned Project Costs:

Waiver Requests: Foreign Entities and Foreign Work (if applicable)

1. Foreign Entity Participation:

All prime recipients receiving funding under this Lab Call must be incorporated (or otherwise formed) under the laws of a State or territory of the United States.

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

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 A lists the necessary information that must be included in a foreign work waiver request.

Save the Waivers in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Waiver".

U.S. Manufacturing Commitments

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

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

Due to the lower technology readiness levels of this Lab Call, DOE does not expect the U.S. Manufacturing Plans to be tied to a specific product or technology. However, in lieu of the U.S. Competitiveness Provision, an applicant may propose a U.S. Manufacturing Plan with more specific commitments that would be beneficial to the U.S. economy and competitiveness. For example, an applicant may commit specific products to be manufactured in the U.S., commit to a specific investment in a new or existing U.S. manufacturing facility, keep certain activities based in the U.S. or support a certain number of jobs in the U.S. related to the technology. An applicant which is likely to license the technology to others, especially universities for which licensing may be the exclusive means of commercialization the technology, the U.S. Manufacturing Plan may indicate the applicant's plan and commitment to use a specific licensing strategy that would likely support U.S. manufacturing.

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

Save the U.S. Manufacturing Plan in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_USMP".

Content and Form of Replies to Reviewer Comments

If replies to reviewer comments are applicable, EERE will provide applicants with reviewer comments following the evaluation of all eligible Full Applications. Applicants will have a brief opportunity to review the comments and to prepare a short Reply to Reviewer Comments responding to the comments however they desire or supplementing their Full Application. The Reply to Reviewer Comments is an optional submission; applicants are not required to submit a Reply to Reviewer Comments. EERE will post the Reviewer Comments in EERE Exchange. The expected submission deadline is on the cover page of the Lab Call; 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. 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 4 page[s] in length, EERE will review only the first 4 page[s] and disregard any additional pages.

SECTION	PAGE LIMIT	DESCRIPTION
Text	3	Applicants may respond to one or more reviewer comments or supplement their Full Application.
Optional	1	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.

Please make sure to preface the responses with a short note about the context of what is being addressed. For example: Concerns regarding our assumption around cost reduction – We used the following methodology to calculate the reduction in cost…

Reviewers will not have a list of comments in front of them to match with short rebuttals. In other words DO NOT do the following as reviewers will not be able to reference the specific comment: Reviewer 3 comment 5 - We used the following methodology to calculate the reduction in cost…

It is important to note that it is usually best to use the allotted space to address a few of the most critical comments well, rather than try to respond to all of them.

B. Application Review Details

Merit Review and Selection Process

Upon receipt and review for initial compliance with requirements, all proposals received in Exchange by the deadline will undergo a thorough technical review. BTO will use expert reviewers familiar with the BTO portfolio, goals, and objectives. BTO will collect and collate review scores and comments for use in making final project selections. The BTO Selection Official will consider the merit review results to make the final project selections. For transparency, BTO will provide summaries of the review results to assist labs in understanding how their submission reviewed and aid in improving future work. Applications will be evaluated against the merit review criteria shown below:

Criterion 1: Technical Merit, Innovation, and Impact (Weight: 40%)

- Degree to which application describes the state-of-the-art;
- Degree to which the proposed advancement over the state-of-the-art is innovative;
- Degree to which the application specifically and convincingly demonstrates how the applicant achieve the proposed advancement over the state-of-the-art; and
- Degree to which proposed advancement is scientifically meritorious. The application should include sufficient detail to make this assessment, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work.

Criterion 2: Project Approach (Weight: 30%)

- Degree to which the application clearly describes approach and critical path;
- Degree to which the task descriptions are clear, detailed, timely, and reasonable, resulting in a high likelihood that the proposed Workplan will succeed in meeting project goals;
- Degree to which the application discusses and demonstrates understanding of key technical and market risk areas involved in the proposed work and the quality of the mitigation strategies to address them;
- Degree to which the application describes clearly defined quantifiable baselines, metrics, milestones; mid-point deliverables, and strength thereof, such that meaningful interim progress can be made and evaluated; and
- Degree to which the approach incorporates industry engagement and a comprehensive technology-to-market plan with associated activities, including transition paths for accelerated market deployment.

Criterion 3: Team and Resources (Weight: 20%)

- Capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. Qualifications, relevant expertise, and time commitment of the individuals on the team;

- Sufficiency of available facilities to support the work;
- Degree to which the proposed consortia/team demonstrates the ability to facilitate and expedite further development and commercial deployment of the proposed technologies;
- Level of participation by project participants as evidenced by letter(s) of commitment and how well they are integrated into the Workplan; and
- Reasonableness of budget and spend plan for the proposed project and objectives.

Criterion 4: Diversity, Equity, and Inclusion (Weight: 10%)

- Degree to which the application identifies how the proposed advancement will impact underserved communities, including social and environmental impacts.
- Degree to which the application identifies how the proposed advancement will benefit disadvantaged or low-income communities by increasing access to clean energy and/or energy-efficiency technologies, creating clean-energy and/or energy-efficiency jobs, etc.
- Manner and degree to which diversity, equity, and inclusion objectives will be incorporated into the proposed project. See **Section IV.A** for more information on the contents on the Diversity, Equity, and Inclusion Implementation Plan.

Selection for Award Negotiation

BTO carefully considers all information obtained through the proposal process and makes an independent assessment of each compliant and responsive proposal based on the criteria set forth in this Lab Call. BTO may select or not select a proposal for negotiations. BTO may also postpone a final selection determination on one or more proposals until a later date, subject to availability of funds and other factors. BTO will notify applicants if they are, or are not, selected for award negotiation. Notice of selection is not an authorization to begin performance. BTO reserves the right to request additional or clarifying information before proceeding with negotiations for any selection.

Selection Notification

BTO anticipates completing the project selection process and notifying labs of selections in May 2022. BTO will notify lab leads of selection results from BTOLabCall@ee.doe.gov and will provide lab leads with summaries of anonymized review comments for each proposal submitted.

Questions and Agency Contacts

Specific questions about this Lab Call should be submitted via e-mail to BTOLabCall@ee.doe.gov. To ensure fairness across all labs, individual BTO staff cannot answer questions while the Lab Call remains open. To keep all labs informed, BTO will post all questions and answers on EERE Exchange. Please note that you must first select the specific opportunity number for this Lab Call in order to view the questions and answers specific to this Lab Call. We will attempt to respond to a question within three business days unless a similar question and answer have already been posted. Questions related to the registration process and use of the EERE Exchange website should be submitted to: EEREExchangeSupport@hq.doe.gov.

Appendix A: Waiver Requests and Approval Processes:

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

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 Lab Call 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;
- How the foreign work aligns consistently with the strategic interests and foreign policies of the U.S.;
- A description of how the foreign work is legally sound and compliant with U.S. laws and regulations;
- A description of considerations regarding risks associated with the sharing of DOE research and technologies, taking into account access to the laboratory, research

activities, information, and technology, as well as protection of classified and sensitive unclassified information;

- 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;
- Address any counterintelligence and national security considerations;
- 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.