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

Industrial Technologies Office (ITO)
National Laboratory Call for Proposals

ITO FY25-FY27 Lab Call
DE-LC-0000122

National Lab Funding for Fiscal Years: 2025, 2026, 2027

This Lab Call is being issued by the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE), Industrial Technology Office (ITO).

ITO seeks to engage DOE national laboratories to provide leadership in building U.S. capabilities to develop and deploy technologies and support the competitiveness of America's industrial base. This Lab Call is focused on establishing and expanding capabilities, centers, and other support to advance ITO's goals for industry at the national labs.

Table of Contents

Lab Call Modification History

Substantive modifications to the FOA are HIGHLIGHTED in the body of the FOA.

Date	Modification Description
5/2/2025	Updated Lab Call for consistency with Administration priorities: • Updated program name to Industrial Technologies Office. • Updated Full Application Submission Deadline to 6/3/2025 5:00 PM ET, and Decision Date and Expected Beginning Award Issue Date to TBD. • Removed Community Benefits Plan (CBP) sections (Section I.B.i Key Considerations, Section II.A.iii Proposal Content, and Section II.B.ii Technical Review Criteria).

I. Lab Call Description

A. Background and Context

i. Overview and Purpose

Building a secure, competitive, and efficient energy economy is a top priority of this Administration. The Department of Energy is committed to pushing the frontiers of science and engineering; catalyzing energy jobs through research, development, demonstration, and deployment (RDD&D); and uniting the brightest minds from academia, industry, and government to chart a path forward for American energy and manufacturing.

EERE National Laboratory Guiding Principles require all offices to pursue a merit review of direct-funded national laboratory work. In line with these principles, ITO is issuing this Lab Call for fiscal year (FY) 2025, 2026, and 2027.

Some labs have continuing multi-year projects that have already gone through the merit review process. These will continue to be reviewed through the annual peer review process. Labs should work with ITO project and program managers to ensure that ongoing projects are included in the annual operating plans (AOP) to meet AOP deadlines. This Lab Call will only pertain to the new topic areas below.

The activities to be funded under this Lab Call will advance national laboratory capabilities to accelerate the development and adoption of transformational technologies that optimize industrial processes, increase energy efficiency, and enhance the competitiveness of U.S. industry in evolving global markets. In addition, this Lab Call will prioritize fostering a robust team of research experts to ensure that the new lab capabilities address the complexities of each industrial subsector and benefit American communities.

Innovation in the industrial sector provides the U.S. with a critical opportunity to grow our manufacturing workforce and sharpen our competitive edge and national security globally.

While some technologies are ready to deploy today, many of the technologies needed for a thriving industrial sector of the future either do not exist yet or are in the earliest stages of development. Additional RDD&D is essential to growing the industrial sector and increasing America's competitiveness in global markets.

This Lab Call covers opportunities to advance and optimize industrial processes across ITO's mission space. The topics covered in this Lab Call address priorities in one or more of the following ITO Program Areas:

- Energy-Intensive Industries (EII): Technology solutions tailored to the highest energy-intensive subsectors where novel technologies could have the greatest impact, including iron and steel, cement and concrete, chemical and petrochemicals, forest products, and food and beverage.
- Cross-Sector Technologies (CST): Technology solutions that address challenges common across all industrial subsectors, such as energy use associated with industrial heat.
- Technical Assistance & Workforce Development (TAWD): Tailored resources to foster the industrial workforce of the future and help manufacturers move cost-effective, market-ready technologies and energy savings practices to today's factory floors.

This funding will be for a three-year term with the intention to renew funding in support of these activities in future multi-year terms in the form of core capabilities and centers or as competitive calls. The goal of this long-term program is to establish high-impact capabilities supporting the advancement of technology solutions for industry.

This Lab Call is part of DOE's larger industrial strategy to support technologies across the innovation pipeline, from fundamental science and research to deployment and commercialization.

The activities of interest in this Lab Call are varied and include establishing and expanding capabilities, centers, and other activities to advance ITO's goals for industry at the national labs.

These activities can support accelerating transformational research and development (R&D) as well as new and increased demands for demonstration and deployment (D&D). Expanding the role of national laboratories in D&D is an important opportunity to leverage capabilities to accelerate the U.S. industrial sector.

ii. Lab Call Focus

This Lab Call is focused on enabling the national labs to support a competitive U.S. industrial sector through the creation and/or expansion of national lab capabilities that address RDD&D challenges.

Unless specifically recommended in topic areas, this call seeks proposals from individual national labs or from teams of national labs. The strength of a proposal will be based on the merits of the proposal in addressing the topic area(s), and national labs are encouraged to seek partnerships with other national labs only when this strengthens the proposal.

Applications should include how the labs can specifically address the needs of industry identified in the topics, including describing the relevancy to meeting needs in the markets and advancing U.S. competitiveness. The following are examples of industry relevance that can be included:

- Industry feedback and needs identification. The structure of the proposed capability or activities should address industry feedback and clearly articulate how the work will benefit industry.
- Industry (technology developers and users) partners involved as advisors, partners, or in any other capacity, in the establishment and operation of these capabilities.
- Potential industry, academic and/or national lab users of the capabilities.

National labs are expected to leverage and build on existing capabilities and focus areas. Applications should clearly identify existing capabilities and explain how this funding will enable significant expansion or improvement of support of the relevant topic area.

The capabilities targeted for development at the labs could include, but are not limited to, the following:

- **Facilities and infrastructure**, including space (office, test pads, etc.), security, workshops, lab and testing equipment, and utilities.
- **Personnel**, including scientists and engineers skilled to support activities, technical support, technicians/technologists, ES&H, FMEA, administrators, and management support.
- **Computational resources**, including dedicated or shared computational equipment, physics-based modeling and other needs for computation, and multi-modality resources to serve customer needs—from turnkey services to the provision of computing.
- **Facilitating access** for lab customers to address specific needs, such as customers constructing/installing their own experiments and demonstrations, customers controlling inflows and outflows, customized arrangements with lab personnel and services, and cost-effective solutions for customers at user facilities.

The national labs are home to specialized instrumentation, characterization, testing, analytical methods, and computing capabilities that are beyond those of universities and industrial companies. These capabilities are also uniquely accessible to all of U.S. industry, enabling what are often cost-prohibitive resources and solutions for individual companies to be shared. Lab scientists have world-class expertise and can translate existing scientific and engineering knowledge to developing solutions to new, complex challenges. Lab staff are positioned to guide the development of technical and programmatic solutions to solve difficult industrial challenges.

The focus of most topics is on developing capabilities at the lab(s) that can be used by lab personnel as well as project partners, where applicable. The development of enduring capabilities can be used by the lab for mission-related activities and can be a resource to be leveraged by ITO in future activities, such as Notices of Funding Opportunity (NOFOs).

Resources developed or expanded through this Lab Call should be made available to stakeholders, as applicable per topic area. **Proposals must explain how resources can be accessed and how they can serve stakeholders.** This Lab Call seeks to provide resources to stakeholders that are driven by commercial success. Proposals for topics related to capabilities should clearly define stakeholder access plans and limitations that cover the following:

- Proposed **cost structures** for access and use of capabilities by stakeholders, including how funds from this Lab Call and/or other funding sources and existing lab processes will be leveraged.
- Provision of **lab, workshop, office space, equipment and IT access** for non-lab personnel.
- Ability and limitations of **non-lab personnel to conduct work** on lab premises.
- Ability for stakeholders to **keep their work proprietary and protected**.
- Ability for stakeholders to **control all aspects of their projects** in recognition that their own control is a requirement of the advancement of their technology. This includes the flow of resources in and out of the lab as well as the construction and operation of experiments. The extent to which this is not possible should be clearly described.
- **Support mechanisms** for stakeholders including availability, prioritization and responsiveness of subject matter experts (SMEs), equipment, facilities (including a Labs Facilities division), utilities and space.
- The ability to offer an **expedited agreement process** for stakeholders, particularly those who have dependencies on private sector funding during or

after their involvement with the capability. While some items are not-negotiable, such as federal rights to IP, proposals should clarify how stakeholder rights can be preserved.

Collaborating with stakeholders from academia, independent researchers, industry end-users, equipment manufacturers, small businesses, trade associations, non-profits, contractors, standard bodies, other federal agencies, and others is strongly encouraged, where applicable.

Labs should leverage their convening power and stakeholder relationships to identify and develop the technical scope, strategy, and direction of specific efforts as part of this Lab Call. As part of proposed efforts, labs may convene a variety of stakeholders to assist with planning and implementation and may play a role in establishing public-private partnerships and coordinating interagency collaboration.

ITO recognizes that next-generation industrial technologies can only support American competitiveness if they eventually make it out of the lab and onto the factory floor. Therefore, applications should address how proposed capabilities and other work will advance technologies towards commercialization and industrial use at scale. Applications should also refer to ARL (Adoption Readiness Levels) factors and the ARL methodology.

The ITO Technical Assistance and Workforce Development (TAWD) subprogram leads several programs that may be relevant to applicants:

- *Better Plants*: This program includes a strong network of 270+ private industry partners, representing 14% of the U.S. manufacturing footprint, who commit to energy efficiency goals, are publicly recognized for their achievements, and engage in peer-to-peer learning and solution-sharing opportunities. **Applicants can consider leveraging the Better Plants network for exposure to private industry and to ensure continuous industry feedback on their research initiatives.**
- *Industrial Technology Validation (ITV):* This program objectively assesses the performance of emerging energy efficient technologies in industrial environments to explore their viability in real-world conditions. ITV shares field validation results through publicly available measurement and verification reports, providing 3rd party validation of new products. **Applicants can consider partnering with ITV to develop measurement and verification capabilities that support stakeholder product testing at industrial sites.**

- *Onsite Energy*: Onsite energy refers to electric and thermal energy generation and storage technologies that are physically located at an end-user site and provide energy services directly to the end user. The Onsite Energy Technical Assistance Partnerships (TAPs) provide resources to industrial facilities and other large end users interested in onsite energy and facilitate more widespread adoption of these technologies. **Applicants can consider leveraging the expertise of the Onsite Energy TAPs to understand barriers to industrial electrification and grid integration (particularly relevant to Topic 11, Industrial Load Flexibility).**

Applicants can also consider contributing to TAWD's mission of supporting industry move cost-effective, market-ready technologies and energy savings practices to today's industrial facilities by: developing educational materials about their research efforts; developing technical resources and analysis tools; or by helping facilities prepare for infrastructure upgrades required for the technologies of the future. At a minimum, it is recommended that the labs use the TAWD program networks to disseminate information and stay in communication with industry.

iii. Timeline and Process Logistics

Timeline

KEY DATES	
Lab Call Release Date:	1/7/2025
PROPOSAL DEADLINE AND DECISION DATES	
Letter of Intent Deadline:	2/05/2025 5:00 pm ET
Full Application Submission Deadline:	6/03/2025 5:00 pm ET
Decision Date:	TBD
Expected Beginning Award Issue Date:	TBD

Process Logistics

All communication to ITO regarding this Lab Call must use IEDOLabCall@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 IEDOLabCall@ee.doe.gov. ITO 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 direct questions to individual ITO staff.

- **NOTIFICATION OF SELECTION:** When selections are finalized, lab leads will receive an email from ITO.

B. Key Considerations and Topic Area(s)

i. Key Considerations

- **AVAILABLE FUNDING:** There is approximately **$80-150 million in funding** available to fund **all** projects solicited in this Lab Call pending appropriations, program direction, and go/no-go decision points for the next 3 years. The 3-year term could potentially be extended or renewed and may evolve into Core Capabilities. Follow-on funding through a future Lab Call or NOFO could be possible on a case-by-case basis and is contingent on appropriations.

- **COST SHARE:** Cost share for costs incurred by labs is not required by default. Cost share may vary by topic. It is up to the labs to determine the strategic value of cost share and to seek cost-share support for enhancing capabilities.
- **NON-LAB PARTNERS:** Labs partnering with industry, academia or other non-lab entities to perform work under this Lab Call must enter into CRADAs with those partners within time parameters set forth by the funding program.
- **ELIGIBILITY:** All DOE/National Nuclear Security Agency (NNSA) Federally Funded Research and Development Centers (FFRDCs), including the National Energy Technology Laboratory, are eligible to submit proposals as prime awardees, unless specified otherwise. Other U.S. government research laboratories that are not DOE national laboratories may be collaborators. Proposals may involve more than one laboratory. Multi-lab partnering is not required for a proposal, but may be considered when strategically sensible and valuable. Collaborative proposals from a common set of DOE labs in a specific topic area should only be submitted by one DOE laboratory. Labs will be limited to a maximum of two proposals per Topic Area or per Area of Interest, whether a lab applies as a prime or subrecipient. Duplicative proposals are discouraged, and labs are discouraged from submitting more than one proposal as prime recipient per Topic Area or per Area of Interest.

ii. Topic Area Descriptions

Summary of topics in this Lab Call:

Topic #	Topic Title	Estimated DOE Funding Available*	Number of Projects Expected
Energy-Intensive Industries (EII)			
1	Next Generation Cement and Concrete Materials	Up to $20M over FY25-27	1
2	Food and Beverage Industry Innovation	Up to $15M over FY25 -27	1
3	Chemicals Reactor Innovation	Up to $11.2M over FY25-27	2
4	Forest Products Industry Innovation	Up to $15M over FY25-27	1
5	Iron and Steel Industry Innovation	Up to $10M over FY25-27	2
Cross-Sector Technologies (CST)			
6	Capabilities for Process Heating Using Electrotechnologies	Up to $15M over FY25-FY27	1-2
7	Capabilities for High Temperature Heat Pump Systems	Up to $12M over FY25-FY27	1
8	Capabilities for Advanced Fuel Combustion Technologies	Up to $10M over FY25-FY27	1
9	Capabilities for Scale-Up of Membrane Fabrication and Testing	Up to $12M over FY25-FY27	1
10	Capabilities for Thermal Energy Storage Technologies	Up to $15M over FY25-FY27	1
11	Capabilities for Industrial Load Flexibility	Up to $12M over FY25-FY27	1-2
12	Computing for Industrial Efficiency	Up to $5M over FY25-FY27	1
13	Capabilities for Data Center Thermal Management and Energy Efficiency	Up to $6M over FY25-FY27	1
14	Lab-Identified Capabilities to Advance Industrial Efficiency	Up to $40M over FY25-FY27 (topic 14 uses funding from earlier topics and has no budget of its own)	0-3

* All funding and duration indications are subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction.

Energy-Intensive Industries Topics

Topic 1: Next Generation Cement and Concrete Materials

Summary

Establish a center to safely accelerate the development and adoption of new cement and concrete materials through advancing materials characterization and modeling and fostering collaboration between stakeholders.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $20M over 3 years, subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 1.
- Estimated Duration: 3 years. A renewal may be granted after 3 years to allow continuity on the most impactful elements. This may be subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction.

Background

Cement and concrete materials are critical to society and modern life but are also energy-intensive to produce. The production volume of these materials in the U.S. is high and is expected to grow into the future as the U.S. replaces aging infrastructure and expands its economy. Addressing efficiency needs of the industries that produce these materials is critical to ensuring the subsector's competitiveness in changing global markets. The development and adoption of next-generation cement and concrete materials represents a unique opportunity to increase the efficiency and competitiveness of the sector.

Concrete is strong, durable, and made from abundant raw materials, making it the second most used substance in the world after water. In 2022, 400 million cubic yards of ready-mix concrete was produced in the U.S., and demand is likely to continue

increasing due to the expanding need for infrastructure replacement and repair. Cement is the primary binding component in concrete, and its production is the most energy intensive element of concrete. To meet market demand, the U.S. produced approximately 93 MMT of cement in 2023.

DOE has previously identified clinker substitution through the use of novel cements and alternative supplementary cementitious materials (SCMs) as a key opportunity for the industry. However, early-stage innovations aimed at partial or complete clinker substitution face many barriers to commercialization and significant industry resistance due to the long-established, widespread, and successful use of conventional Ordinary Portland Cement (OPC).[1] Additionally, prescriptive standards and test methods designed solely around OPC have made it challenging for novel technologies to gather relevant and reliable data, develop new codes and standards, or gain commercial interest among potential stakeholders, many of which are highly averse to economic and safety risks.

This call for proposals seeks to establish a national laboratory-led center focused on supporting the cement and concrete industry's transition towards energy-efficient, next-generation technologies. Through collaborative partnerships and multi-disciplinary advancements, this initiative will create a foundation of knowledge and tools to accelerate innovation and overcome technical and non-technical barriers limiting acceptance across the industry.

Additionally, the center is expected to be a dynamic organization capable of responding to the changing needs and advancements of the industry. Proposals to establish the center should plan for a flexible project structure and modular goals; they should be able to integrate new technologies, emerging best practices, and policy shifts over time to continuously serve the industry and its stakeholders. This initiative has the potential to expand beyond a single funding effort and should be structured to enable ongoing support over sustained, long-term operation and continuous alignment with evolving industry needs.

Objectives

The center is intended to accelerate the development and adoption of next-generation cement and concrete technologies by supporting research, development, and initial demonstration (RD&D) efforts, providing improved tools and protocols for driving

[1] "Cement and Concrete Sector Decarbonization- 2023 Peer Review Report and Materials | Department of Energy." Accessed December 2024. https://www.energy.gov/eere/iedo/2023-peer-review-report-and-materials

innovation and inspiring confidence in new technical solutions through careful and reliable testing. To accomplish these initiatives, the center will aim to:

- Advance material characterization techniques to enable a deeper understanding of fundamental properties and their impact on performance.
- Develop new techniques to monitor and predict the long-term durability of materials, including advancements in sensors and instrumentation as well as in predictive modeling capabilities.
- Support the development of new codes and standards through robust testing and data collection.
- Develop optimized analytical methodologies to track embodied material and processes to support evolving strategies for alignment with the marketplace as new technologies develop.
- Ensure long-term adoption and success of new technologies by equipping industry professionals with the skills and knowledge needed to implement and sustain the use of new materials and practices.
- Convene, lead, and collaborate with a broad coalition of stakeholders, including federal agencies, private sector innovators, universities, and other organizations inside and outside of government.

By addressing these primary objectives, the center will establish a supportive framework for advancing, validating, and scaling next-generation, energy-efficient technologies and will play a key role in demonstrating the safe use and durability of new materials. This will enable the adoption of new solutions and drive meaningful progress for the sector.

Structure

The center will be structured as a collaborative organization led by a single national laboratory with potential partnerships with other national labs, academic institutions, government agencies, and industry stakeholders. Cost share for center participants is not required but encouraged to demonstrate commitment to project success and promote ownership from participants.

Six core topical components have been identified based on industry needs, technological gaps, and long-term initiatives. These core areas are summarized below and include 1) materials characterization, 2) methods and standards development, 3) data collection and modeling, 4) sensors and instrumentation, 5) embodied materials and processes accounting, and 6) industry training.

Component 1: Materials Characterization

Applicants should develop a research plan that focuses on advancing techniques to analyze and understand the fundamental properties of new cementitious materials. Examining the physical, chemical, and microstructural characteristics of new materials, as well as established materials such as Ordinary Portland Cement (OPC) and Portland Limestone Cement (PLC), will provide insights into important macro-scale performance metrics such as strength, durability, and chemical resistance. This is important for accelerating both the innovation process (i.e., feedback to technology developers) and enabling safe adoption. The goal of this component is to develop comprehensive characterization protocols for non-traditional cementitious materials and to establish stronger correlations between material properties and performance.

Component 2: Methods and Standards Development

Applicants should survey current industry performance tests and laboratory standards and identify gaps where new methodologies, testing tools, and standards will help to integrate new materials into the industry. This component seeks to establish more robust and inclusive testing protocols for non-conventional cement and concrete materials while ensuring reliable, safe, and consistent performance.

Component 3: Data Collection and Modeling

Applicants should plan to establish a robust framework for data collection and data analysis, including advanced computational methods, which enables a comprehensive and holistic study of new materials as well as the development of models to predict long-term durability and performance. Building upon existing efforts by similar initiatives such as the Materials Genome Initiative (MGI) is encouraged. This area of focus will support failure analysis, enable risk assessments, inform application design, and accelerate innovation through data-driven research. A robust data infrastructure capable of disseminating results and information to partners and industry stakeholders will also facilitate the development of new codes and standards.

Component 4: Sensors and Instrumentation

Applicants should plan to advance sensors and instrumentation technologies that enable real-time monitoring of material behavior in the field and under accelerated testing conditions. This area of focus seeks to develop and deploy sensors for capturing important real-time application parameters (e.g., internal temperatures, moisture, carbonation, pH, mass transport, strain, and other key

metrics). Improved performance monitoring will be essential in studying non-conventional materials through accelerated development cycles and will supplement findings from other static or destructive test methods.

Component 5: Embodied Materials and Processes Accounting

Applicants should plan to establish protocols and best practices for accurate accounting of embodied materials and processes in relevant cement and concrete applications to strengthen industry competitiveness. This initiative will help to develop more consistent and transparent methods for measuring the impact of new binders and alternative SCMs. Improved accounting will facilitate more accurate communication with the marketplace through Life Cycle Assessments (LCAs), will satisfy Product Category Rules (PCRs), and will aid in the strategic implementation of new and impactful technologies.

Component 6: Industry Training

Applicants should formulate a strategy to support the development of training initiatives and industry outreach programs that will facilitate the adoption and deployment of best practices, new technologies, and innovative solutions. Work in this component should focus on creating training programs, certifications, or other resources to equip industry professionals with the knowledge and skills needed to support energy-efficiency efforts throughout the cement and concrete industry.

Composition

The center will assemble a highly qualified and representative group of experts across the breadth and scope of all six components. It should establish a leadership team of representatives leading each of its core research areas with clearly defined responsibilities, integrated management structures, and appropriate governance and outreach roles. Once awarded, the successful applicant will negotiate with ITO to set up the core structure of the center and to establish programmatic priorities.

Convening

A core function of the center, spanning all six components outlined above, is to convene, coordinate, and engage key stakeholders across the cement and concrete ecosystem. This includes groups involved in materials innovation, manufacturing, measurement and testing, codes and standards, end users, and training. Many organizations and consortia are already active in that space (e.g., NIST, FHWA, DOTs, ASTM). The center should strategically leverage the expertise and resources of these groups to achieve its primary objectives.

Capabilities

Proposals should outline how the framework of the center will be leveraged to enhance technical capabilities, address commercialization barriers, and provide a clear pathway for targeted advancements in all six of the core topical components. The necessary R&D, data analysis, and modeling as well as the key technical targets and performance metrics necessary to accomplish these goals should be considered. Applicants should plan to implement validation activities for field-testing technologies and to seek engagement with relevant federal and state agencies including the National Institute of Standards Technology (NIST), Federal Highway Administration (FHWA), Environmental Protection Agency (EPA), and Departments of Transportation (DOTs) as well as industry groups and other organizations. The center should also build on existing consortia and working groups where applicable.

Expected Outputs

The center will advance cement and concrete technologies by delivering key outputs across materials characterization and testing, data analytics, and embodied material and processes accounting. It will establish comprehensive protocols and datasets to better characterize next-generation materials and link their properties to critical performance metrics such as strength and durability.

The development of standardized methods and best practices will help to guide the evaluation, certification, and adoption of non-conventional materials supported by innovative testing and sensor technologies. Additionally, a centralized data infrastructure will enable predictive modeling and long-term performance analysis while refined accounting tools and protocols support consistent, industry-wide measurements.

Finally, the center will equip professionals with training programs, educational resources, and partnerships to accelerate the adoption of emerging technologies. These outputs will collectively accelerate innovation and energy efficiency across the cement and concrete industry.

Expected Industry Outcomes

The establishment of a center for the cement and concrete industry, focused on developing energy-efficient and innovative technologies, will have a transformative impact on the industry in several key ways:

- Accelerated Innovation and Adoption: By leading engagements across academia, industry, and national laboratories, the center will help to accelerate the development, testing, and commercialization of novel and energy efficient technologies. This will bring viable solutions to the industry

more effectively by bridging the gap between early-stage research and market-ready solutions; it may also encourage new innovations.

- Industrial Energy Efficiency: With the development of an extensive database of performance metrics and benchmarks for conventional materials and processes, the center will be able to provide data for gauging the success of materials produced from new energy efficient processes.
- Enhanced Industry Standards and Protocols: The center will contribute to the refinement of existing test methods and standards as well as the development of new standards tailored to next-generation cements and alternative SCMs. The center will accomplish this by helping to establish benchmarks for performance, durability, and sustainability. These advancements will ensure that new materials meet rigorous industry requirements and build confidence in their reliability and safety.
- Strengthened Knowledge Base: Through educational initiatives, the center will equip industry professionals with the skills and knowledge needed to implement and maintain new technologies.
- Global Leadership and Competitiveness: Establishing a dedicated center to support innovation throughout the industry will position the U.S. as a global leader in technology development.

Overall, the center will help to catalyze a shift throughout the cement and concrete industry towards energy-efficient practices and enable the sector to play a pivotal role in achieving broader economic goals and industry growth.

Not of Interest

The center is not intended to fund projects focused on the direct production or manufacturing of cement and concrete materials. Additionally, fundamental research without immediate application to pre-commercial testing and validation or standalone projects without integration into the collaborative framework are outside the scope of interest.

Candidate Metrics and Targets

Applicants should propose quantifiable metrics aligned with center goals such as clear expansion of core capabilities, including intellectual and physical assets, which are designed to address long-term challenges associated with technology development and adoption within the cement and concrete industry.

Topic 2: Food and Beverage Industry Innovation

Summary

The awarded lab(s) will establish a center which catalyzes innovation and enables adoption of next-generation process and equipment technologies for efficient, cost effective, market-attractive, and low-energy production of food and beverage products. A key function of the center is to convene and collaborate with sector stakeholders to inform direction and operation to meet the objectives of the center. The center will include 1) relevant sector-specific expertise, 2) physical assets including laboratory and pilot equipment and facilities, and 3) ability to support and/or execute relevant RD&D activities to achieve center objectives. The work will occur in two phases: formation of the center and program development in Phase 1 and execution in Phase 2.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $15M over 3 years subject to go/no-go decisions, annual appropriation, programmatic priorities, approval of Phase 1 output, and congressional direction. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 1.
- Estimated Duration: up to 3 years, subject to go/no-go decisions, annual appropriation, and congressional direction. Renewable for future multi-year terms subject to performance, annual appropriation, programmatic priorities, and congressional direction.

Background

While the food and beverage (F&B) sector has a wide array of processes and products, many F&B processing facilities currently rely on and operate using off-the-shelf equipment and generic crosscutting processes (heating and cooling, drying and dehydration, etc.) that, in many cases, are inefficient and suboptimal. Sector research, development, and initial demonstration (RD&D) activities are inadequate, jeopardizing U.S. competitiveness.

ITO's focus reflects the variability of the F&B sector and ranges from post-harvest activities (e.g., tree nuts drying, washing, etc.) to F&B processing (e.g., baking, brewing, cooking, etc.) to post-processing activities (e.g., packaging, refrigeration, etc.).

Because of the multiple segments of the F&B sector, there is no single stakeholder that can lead and oversee the research, development, and demonstration of product-specific approaches and innovative technologies that would be attractive for adoption by industry. A lab(s)-based program can help build capabilities that will serve various F&B subsectors, and this Lab Call leverages the labs' convening powers to engage stakeholders and ensure its work focuses on industrial innovations with a high likelihood of ultimate market adoption.

Objectives

The objective of this topic is to establish a center for F&B manufacturing process innovation with specialized and dedicated expertise and strong capabilities that support and drive energy efficiency and other performance improvements across the F&B sector.

The center will serve as a national resource for the F&B industry to achieve the following:

- Develop partnerships among key stakeholders in the F&B space including academic researchers, food scientists and engineers, original equipment manufacturers (OEMs), food producers, and other relevant organizations and entities.
- Undertake effective coordination and collaboration activities.
- Enhance or build capabilities including expertise, data resources, and facilities to serve the various F&B subsectors and address their respective technological and market challenges.
- Provide access to those capabilities.
- Work collaboratively with F&B stakeholders to accelerate market adoption of emerging and innovative technologies and best practices.
- Enable applied research, development and multi-scale demonstration of sector-specific, designed-for-purpose, and industrially relevant technical solutions that are innovative, efficient, cost-effective, and market-attractive to optimize energy use across the F&B production landscape.

A fully successful center will lead an industry-wide transition to the next level of energy efficiency and stay abreast of global market transitions, positioning the U.S. F&B industry as the most competitive and efficient in the world.

Structure

As currently envisioned, the work undertaken here will be in two phases. In Phase 1, the lab(s) will identify, convene, and gain commitment from key center stakeholders across the sector, including industrial food or beverage processors, equipment manufacturers, suppliers, and academic and non-profit researchers. Engagement with industrial food or beverage processors and OEMs is a required component of a successful program under this call to assist in understanding the goals, needs, and constraints for successful solutions. Interagency collaboration (e.g., USDA, FDA, DoD, etc.) is not required but strongly encouraged to utilize networks, programs, connections, and/or capabilities that already exist within the F&B industry.

During Phase 1, lab(s) should utilize their convening power and stakeholder relationships to develop and determine the center's technical scope and strategy as well as the direction of specific efforts to pursue food and beverage-specific RD&D targets with high impacts on energy intensity and air quality. Lab(s) should also use their convening power and stakeholder relationships to ensure that the center's work focuses on technical innovations with a high likelihood of ultimate adoption and significant market impact.

In Phase 2, the established center will begin executing the scope and strategy developed in Phase 1. Advancement to Phase 2 will be dependent on the output of Phase 1. The center's work in Phase 2 will likely follow a plan-do-check-adjust process; that is, center stakeholders will provide substantial input and direction to develop plans for process and equipment design improvements, then provide a check by testing the design change, possibly via a pilot-level or other suitably scaled adoption, and provide feedback to make adjustments. Collaboration with research and engineering communities across the industry, academia, not-profit, and government is required.

The lab(s) will also inform the center's work through studies of the targeted F&B products or production processes, including relevant physical characterization of the selected F&B products and data collection to establish the baseline performance and efficiency of incumbent processes and equipment. Other aspects relevant to manufacturers such as food safety, food quality, production rate, and cost must be considered and validated as well.

The awarded team should plan for steering involvement from ITO and should expect that ITO will be most interested in innovative technology solutions that specifically support the F&B industry (as opposed to crosscutting innovations that are not F&B-specific) and align with the EII F&B strategy. Three key areas of interest include technology innovations that:

1. Reduce energy intensity.
2. Reduce process-based air pollutants.
3. Improve performance efficiency by recovering waste energy and water for cost-effective reuse within the plant boundaries.

Some illustrative examples of approaches that could be of interest to ITO are given below. This list is not exhaustive and is only intended to communicate the types of approaches that could align with the EII F&B strategy:

- Deep thermal energy recovery (both latent and sensible thermal energy) from mixed exhaust streams containing water vapor, oil droplets (and/or other types of complex streams) using advanced heat exchanger and/or separations technologies. Reuse of recovered heat, water, and oil within the plant boundaries.
- Electrification strategies specific to the F&B sector that reduce energy demand, increase production rate, and reduce cost while maintaining food quality and food safety.
- Use of safe chemical, biological, thermal, or irradiative approaches (or a combination of these) to reduce the energy requirement for sterilizing equipment, processing food/beverage ingredients, or otherwise processing/producing products.
- Integration of advanced heat pumping technologies into food processing in a way that is novel and solves specific technical challenges, including coupling waste heat use with heating and/or cooling demand (this should exclude generic standalone heat pump innovations).
- Innovative approaches to capture, reduce, and/or eliminate volatile organic compounds (VOCs) generated in food production (e.g., ethanol production during bread making), especially in places where this innovation avoids the energy-intensive and expensive destruction of VOCs by means such as Regenerative Thermal Oxidizers (RTOs)
- Energy efficient, low waste, and economical alternatives to seasonal, post-harvest processing, including operations performed in the field or at seasonally operated facilities where efficiency and yield are low.

Expected Output

The desired output of an awarded program in this topic includes both the establishment of a center that will be a capability of lasting value to industry (Phase 1) and project-specific accomplishments (in Phase 2), such as the development of

equipment or process designs with demonstrated performance efficiency improvements over incumbents and a justified expectation for adoption at scale.

Expected outputs related to the center include but are not limited to the following:

- Staff with dedicated expertise in F&B processes, equipment, engineering, operation, and innovation.
- Established and growing collaborations among key F&B stakeholders (e.g., university partners, F&B producers, OEMs) as well as inter-departmental and interagency collaboration.
- The addition of equipment and/or other capabilities ranging from comprehensive analysis to sophisticated experimental and performance testing efforts (e.g., dedicated RD&D/piloting and testbeds) that result from the center's program and are necessary to enable the lab(s) and external entities to continue collaborative work in this direction to support the ITO's mission and objectives.

Outputs related to project accomplishments should be demonstrated at pilot scale, achieve impactful and significant improvement in energy-intensity, and have a justified expectation for commercial adoption resulting from the participation of and partnership with F&B processors and OEMs.

Expected Industry Outcomes

By establishing a center for food and beverage innovation and performance efficiency enhancement, ITO expects the awarded lab(s) to 1) establish partnerships with F&B producers, researchers, and OEMs and 2) establish strong and dedicated capabilities for addressing the specific challenges of F&B industry efficiency, achieving high-impact sector-specific integration of cross-cutting technologies. Building these capabilities and enhancing partnerships will play an important role in ITO's ongoing effort to bolster the competitiveness of the U.S. F&B sector through innovation.

Not of Interest

Agricultural farming; projects focused solely on food safety; process heating or cooling, drying, membrane development, fuel switching (including electrification), and other crosscutting innovations that lack significant energy intensity process benefits or that are not tailored specifically to the F&B sector; heat pump innovation not beneficially integrated into a F&B process or processes.

Candidate Metrics and Targets

The center should focus on developing innovative processes, unit operations, or pieces of equipment with a justified expectation of significant commercial uptake to reduce

energy intensity and increase overall competitiveness and performance efficiency. The proposed programmatic scope should be justified within an overall, subsector-wide framework that prioritizes potential activities with respect to the following:

- Overcoming barriers for market introduction of innovative technologies by OEMs.
- Resolving operational challenges and improving product quality for end users.
- Developing technology innovations that offer significant economic benefits for food processors relative to incumbent processes.

Proposals will be evaluated to the extent that they propose a clear strategy to establish the center and develop a stakeholder-informed programmatic strategy and scope that prioritizes the most impactful activities for the F&B sector.

Topic 3: Chemicals Reactor Innovation

Area of Interest 1: Scaling Advanced, Efficient Non-Electrochemical Reactors
Area of Interest 2: Scaling Advanced, Efficient Electrochemical Reactors

Summary

Awarded lab(s) will address the fundamental chemistry and chemical engineering challenges to scale non-electrochemical (i.e., thermal catalytic or other) reactors (Area of Interest 1) and electrochemical reactors (Area of Interest 2) through tool development, characterization techniques, and subject matter expertise at the national labs. This topic will establish centers for advanced reactor innovation and position the labs to support industry in scaling the next generation reactor technologies.

- Eligibility: No restrictions.
- Estimated DOE Funding Available:
  - Area of Interest 1: Up to $1,200,000 in first year with the potential for continued, expanded support.
  - Area of Interest 2: Up to $10M over 3 years.
  - All funding is subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call

supports user access and what direct and in-kind costs users are expected to cover.

- Estimated Number of Awards Expected: 1 award per Area of Interest.
- Estimated Duration:
  - Area of Interest 1: Up to 1 year with the potential to continue; negotiated based on the output of year 1.
  - Area of Interest 2: up to 3 years.
  - The duration of both areas of interest, including potential continuation and/or renewal for future multi-year terms, is subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction.

Background

The IEA estimates that advanced catalysts and related process improvements could reduce the energy intensity of producing the highest-energy-intensive chemicals by 20% to 40% by 2050.[2] ITO's chemicals & fuels program includes an emphasis on bringing advanced computational and *in situ* tools for predictive modeling from national laboratories and/or academia to industry. Thus, a significant portion of the current chemicals R&D portfolio is performed by and in conjunction with our national labs and focuses on reactor development, rational design of catalysis, use of alternative feedstocks, and electrification as promising pathways to produce high volume energy-intensive chemicals.

These awards will establish centers for advanced electrochemical, thermochemical, or other reactors and position the labs to support industry in scaling the next generation reactor technologies.

National laboratories play a critical role in DOE's mission to accelerate the innovation and adoption of cost-effective energy-efficient technologies for the U.S. industrial sector. The labs are home to specialized instrumental, characterization, and computational capabilities that are beyond those of universities or industries. Labs should utilize their convening power and stakeholder relationships to develop and determine the technical scope, strategy, and direction of specific efforts as part of this Lab Call. As part of proposed efforts, labs may convene representative stakeholders to

[2] Technology Roadmap - Energy and GHG Reductions in the Chemical Industry via Catalytic Processes. Accessed December 2024. https://www.iea.org/reports/technology-roadmap-energy-and-ghg-reductions-in-the-chemical-industry-via-catalytic-processes

assist with planning and implementation and may play a role in establishing public-private partnerships and coordinating interagency collaboration.

Objectives

These centers for advanced reactor innovation will develop catalytic and reactor tools to address fundamental chemistry and chemical engineering challenges for the scaling of electrochemical, thermal catalytic, or other reactors and provide insight into multiple chemical reactions and dynamic industrial chemical processes used in the production of energy-intensive chemicals.

Structure

Interested labs may apply to one or both Areas of Interest. The awards may go to a single lab or multiple labs with justified complementary expertise among partnering labs. A single lab is expected to lead each effort; collaboration across labs is encouraged but not required.

Technology developed in this Lab Call should consider prior input from stakeholders, including those on catalysts, sustainable chemistry, and electrochemistry.

Structure Specific to Area of Interest 1: Scaling Advanced, Efficient Non-Electrochemical Reactors

In Area of Interest 1 (thermal catalytic and other reactor tool development) the awarded lab will first identify and plan for the appropriate research approaches and capabilities, including paper and hands-on research (e.g., proof-of-concept studies), with the potential to move forward and execute on those plans.

The selected lab will perform convening work such as networking across the chemicals and fuels sector ecosystem; that is, government agencies, innovators, academia, and industry. The lab will scope critical enabling technologies for thermal catalytic or other advanced reactors. This scoping effort may include but is not limited to the following:

- Paper studies such as literature reviews.
- Hands-on research, including proof-of-concept studies, that contributes to the development of reactor engineering principles with cross-cutting technology applications.
- Preliminary capability establishment.
- Network development through workshops, information gathering, one-on-one discussions with experts in the field, etc.

Efforts should lead to the development of plans for a center for advanced reactor innovation, including plans for further research and capability development (e.g., a high

level multi-generational technology plan for public and private stakeholder partnership to drive technology advancement utilizing tools developed). These plans should have justified expectations of high impact in energy efficiency and economic co-benefits to drive U.S. competitiveness in chemical manufacturing. Multi-stakeholder convening is an anticipated necessary step to ensure utilization of capabilities and integration of new technologies upstream and down.

Advancement to the establishment and operation of an advanced non-electrochemical reactor innovation center is dependent on results of these efforts, funding availability, and programmatic priorities.

Structure Specific to Area of Interest 2: Scaling Advanced, Efficient Electrochemical Reactors

For Area of Interest 2 (electrochemical reactor tool development), the awarded lab's proposal should include plans for a center for advanced electrochemical reactor innovation with plans for research and capability development (e.g., a high level multi-generational technology plan for public and private stakeholder partnership to drive technology advancement) and should identify a prioritization of tools to be developed.

Expected Output

This topic focus is on the reactor unit operation and chemical processes but is product agnostic. However, of high interest are the most energy-intensive chemicals, products made through the utilization of feedstocks such as industrial waste, and specialty chemicals that serve as first movers. The goal of developing catalytic and reactor tools is to address research needs sector-wide to enable breakthroughs to reduce energy intensity while advancing substantial improvements in economic co-benefits.

Expected Output Specific to Area of Interest 1: Scaling Advanced, Efficient Non-Electrochemical Reactors

The expected output of an award in Area of Interest 1 includes a robust plan for the creation of a center for advanced reactor innovation, including preliminary capability establishment and plans for further research and capability development (e.g., a high level multi-generational technology plan for public and private stakeholder partnership that will drive usage of the tools developed). This plan should have a justified expectation of high impact in energy efficiency to drive U.S. competitiveness in chemical manufacturing and be the result of stakeholder convening that will ensure utilization of tools and integration of new technologies upstream and down. Justified expectations can reference existing capabilities and examples of collaborative tool utilization.

Expected Output Specific to Area of Interest 2: Scaling Advanced, Efficient Electrochemical Reactors

The expected output of an award in Area of Interest 2 is the creation of a center for advanced reactor innovation for electrochemical reactors. This center's work will include the development of characterization tools and techniques to advance the scaling of electrochemical reactors. These tools can include high performance computing (HPC), *in situ* characterization and/or on-line instrumentation, component and reactor testing protocols, automated experimentation, high throughput screening, and/or artificial intelligence (AI). The techniques could include advanced characterization techniques and modeling to rapidly predict material short-term properties and long-term performance.

Another expected output is the cultivation of subject matter expertise at the lab and at its partners in the development and usage of reactor tools and techniques. The goal is to make these resources accessible to public and private sector stakeholders for chemicals technology advancement.

Expected Industry Outcomes

The centers for advanced reactor innovation are expected to drive innovation in chemical reactor design to improve industrial process efficiency and enable the scaling of novel, energy-efficient technologies in the chemicals and fuels sector to further the global competitiveness of the U.S. chemicals industry. Successful adoption of the centers' output should include improvements in chemistry of reactions (e.g., conversion, selectivity, and stability), optimization in the design of reactor systems (e.g., heat transfer, mass transport/flow, and catalyst component stability/integration, including but not limited to electromagnetic, surface science, and material design technologies), and testing and validation of equipment and components for scaling reactors. Testing and validation of equipment and components for scaling may benefit from collaboration with the FECM/BETO CO2Rue consortium that has recently launched and will include significant focus on testing and validation of electrochemical conversion of CO_2.

Not of Interest

Responses not of interest to this call include basic science and/or concept-level technologies and technologies unrelated to electrochemical, thermocatalytic, or other advanced reactor tools or design.

Candidate Metrics and Targets

Proposals will be evaluated based on their execution of the expected outputs and impacts. Additionally, proposals should target goals such as the following:

- Demonstrate energy efficiency in reactor technology scale-up
    - Conduct research in reactor technologies that enable energy efficiency and that can be scaled from lab/prototype to pilot/demonstration stages.
- Demonstrate approaches to cost-effective manufacturing of reactor technology
    - Conduct research in reactor technologies that maximize product output versus cost input, including considerations such as reactor materials (cost of catalyst, vessel, etc.) and energy sources.
- Build industrial partnerships and ecosystems
- Build pathways to self-sustainment to establish capabilities and mechanisms to allow for direct financial engagement by industry and universities in order to utilize the capabilities and allow for financial support from private and public entities in RD&D for scaling reactors.

Topic 4: Forest Products Industry Innovation

Summary

The awarded lab(s) will provide needed leadership in fostering collaborative innovation to ensure the competitiveness of the U.S. forest products industry. In Phase 1, awarded lab(s) will establish a center that will identify a specific, relevant technology focus and develop a plan to address that focus, including necessary capabilities. In Phase 2, the awarded lab(s) will execute that plan and build out those capabilities, creating a long-term resource.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $15M over 3 years, subject to go/no-go decisions, annual appropriation, programmatic priorities, approval of Phase 1 output and advancement to Phase 2, and congressional direction. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 1.
- Estimated Duration: Up to 2 years for Phase 1, subject to go/no-go decisions, annual appropriation, and congressional direction. Phase 2 duration will be negotiated based on output of Phase 1. Renewable for future multi-year terms

subject to performance, annual appropriation, programmatic priorities, and congressional direction.

Background

While research in efficiency and advanced technologies for the forest products sector is underway at universities and companies, years of commoditization pressure in this sector have diminished R&D activity. Today the sector has limited ability to perform R&D at the scale needed to maintain global competitiveness. U.S.-based leadership in the forest products industry is needed to spur innovation and competitiveness and increase energy efficiency. Leveraging lab expertise and resources can fill the R&D gap, support technical advancement, and help U.S. companies accelerate innovation – improving our global competitiveness.

National research programs have exhibited successful models for leadership and consortia-building through technology development programs for the forest products industry, with a recent example being The Emission Free Pulping research program created by VTT Technical Research Centre of Finland (VTT) and RISE Research Institutes of Sweden (RISE).

Objectives

This call is intended to build an energy-efficient forest products center and research program to improve U.S. industry competitiveness. The program will develop novel and/or improved processes in pulping and chemical recovery or to reduce energy consumed in dewatering and drying. The focus is on products such as pulp (excluding dissolving pulp), paper, and packaging materials.

The national labs will contribute both a convening power and – if advanced to Phase 2 – a budget to execute on a course of research, development, and initial demonstration (RD&D) and U.S.-based buildout of capabilities. The emphasis on convening and planning in Phase 1 will ensure that the technical scope selected by the center to pursue will be worthwhile and appropriate for the lab(s) and that the plan is well thought through.

Structure

In Phase 1, the selected lab(s) will provide sector-level leadership to organize center stakeholders and achieve the following: determine a suitable technical focus for the forest products innovation center and research program, identify both existing and needed new resources to address the technical focus, and propose a path to assemble and use the capabilities to address the selected technical focus. Phases 1a, b, and c outlined below are a notional structure, and we expect some iteration between those

main activities.

After a successful advancement to Phase 2, the selected lab(s) will execute their Phase 1 plan and build out the identified capabilities, preferably in close collaboration with external partners. Advancement to Phase 2 is dependent on ITO's approval of Phase 1 results, funding availability, and programmatic priorities. The center should expect steering input and other involvement from ITO.

***Phase 1a:** Establishing a Center*

Selected lab(s) will establish a center of interested parties from industry, associations, academia, and national labs. The effort should include outreach to and discussions with existing organizations that might be interested in participating in an innovation center, including but not limited to those listed below:

- Renewable Bioproducts Institute (RBI), Alliance for Pulp and Paper Technology Innovation (APPTI), American Forest and Paper Association (AF&PA), National Counsel for Air and Stream Improvement (NCASI), American Council for an Energy-Efficient Economy (ACEEE)
- Other appropriate government agencies such as the USDA Forest Service and the Forest Products Laboratory
- Academia, particularly with relevant expertise in the technical focus areas being considered.

Phase 1b: Selecting a Technical Focus Area

The center will select a high-priority technology need as its technical focus. The focus selected by the center during this phase should be addressable by and appropriate for the selected lab(s) and of broad and significant interest to center members. The technical focus could be in one of two areas: 1) novel and/or improved processes and strategies to reduce energy consumed in dewatering and drying processes, including capturing waste heat from those processes and utilizing that heat efficiently in the plant; or 2) novel and/or improved pulping and chemical recovery. Whichever focus is selected by the lab-assembled center will likely include energy- and material- efficiency improvement strategies through a combination of improvements to unit operations, processes, and facility-wide approaches and may also allow for use of new, potentially less expensive feedstocks or supply materials.

As examples, potential technical focus areas could include but are not limited to the following:

- **U.S. Innovative Pulping Program** – modeled after other national programs but focused on innovations in the production of pulp in the U.S. from wood

sources relevant to U.S. producers like Southern Pine. In addition to building the U.S. public-private partnership, collaborative opportunities with other national programs could be explored to bring state-of-the-art technologies onshore.

- **High Temperature Heat Pumps in Pulp and Paper** – focused on capturing and using low-grade waste heat in a beneficial way in both integrated and non-integrated mills. A program in this area could include development of cost-effective, economically viable heat pumping technology in the 150-200°C range (a cross-sector technology) but with a major focus on overall process integration and plant optimization, which can be a significant challenge particularly in the summer months for mills located in the southern United States. Successfully addressing this topic area would involve developing a comprehensive understanding of U.S. pulp and paper facilities and a systems approach to facility optimization, which would be beneficial to identify opportunities beyond application of heat pumps.

Phase 1c: Proposing a Plan:

The center will propose an RD&D program to address their chosen focus and identify capabilities needed to execute the program such as:

- advanced analytical techniques
- pilot scale equipment (e.g., continuous pulping and bleaching equipment)
- staff-scientists, technicians.

The center will determine whether the identified capabilities exist and can be made available at partner organizations as well as determine and scope additional capability needs. The center will also propose a structure for organizing and managing access to these capabilities that supports the proposed RD&D program, is conducive to addressing the chosen technical focus (even beyond the proposed RD&D program), and that will allow access for a broad range of relevant researchers across the academic, national lab, and private-sector communities. The center's plan should ensure, to the highest extent possible, that capabilities built during Phase 2 will be used by sector stakeholders towards advancement of the forest products industrial sector, establishing a long-term resource for the sector.

Expected Output

By the end of Phase 1, the awarded lab(s) should have established a working, ongoing center that has selected a technical focus and outlined an RD&D program within that focus. The center should produce a full identification of capabilities (techniques, expertise, equipment, etc.) required to address that RD&D program and technical

focus; a plan for securing those capabilities (expanding existing capabilities and/or adding new capabilities), along with associated costs by item; and a structure for organizing and managing access to these capabilities that is conducive to addressing their chosen technical focus and that will allow access for researchers from other institutions.

By the end of Phase 2, the awarded lab(s) should have 1) secured those identified capabilities, 2) made sure those capabilities are accessible and leveraged by participants outside of the labs (industry, academia, etc.) as well as the labs, 3) made significant progress in their proposed RD&D program, and 4) established some model of technical center, possibly with external partners, to tackle the identified technical focus and move technology developments in that focus area from low TRL to demonstration-readiness.

Expected Industry Outcomes

This program will bolster the competitiveness of the U.S. forest products industry by extending U.S. capabilities to develop and deploy technologies to improve energy efficiency in the manufacturing processes used to produce pulp, paper, or packaging materials. The desired impact of this Lab Call is for the awarded lab(s) to provide leadership in the U.S. forest products industry. The center and the output of its capability development and other RD&D work should enable the lab(s) and their partners to advance efficiency developments toward commercialization.

Not of Interest

Technologies for the production of dissolving pulp and topics in support of biomass use in fuels and chemicals production without addressing forest products such as pulp, paper, or packaging materials are not of interest for this Lab Call.

Candidate Metrics and Targets

Proposals submitted to this topic must define relevant baselines and metrics for assessment and indicate potential impacts from project efforts depending on the specific high-priority technology focus. Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed. The relevant metric will depend on the technology focus proposed.

The center should focus on developing processes, unit operations, or pieces of equipment with a justified expectation of significant commercial uptake to reduce energy intensity and increase overall competitiveness. The scope of research proposed should be justified within an overall, sector-wide framework that prioritizes potential activities with respect to the following:

- Overcoming barriers for original equipment manufacturers (OEMs) to bring innovative technologies to market.
- Resolving operational challenges for end users.
- Developing technology innovations that offer significant cost savings relative to incumbent processes.

Proposals will be evaluated to the extent that they propose a plan of research, or a strategy to develop a stakeholder-informed plan of research, that prioritizes the most impactful activities for the forest product sector.

Topic 5: Iron and Steel Industry Innovation

Summary

This topic seeks to establish up to two distinct efforts: 1) an iron ore and steel scrap resource center to deliver characterized lab- and pilot-scale samples of iron ore and steel scrap material to researchers and 2) a decopperization incubator to promote early-stage breakthrough innovations in the removal of copper, tin, and other tramp elements from the steel recycling stream.

- Eligibility: No restrictions.
- Estimated DOE Funding Available:
  - Area of Interest 1: Up to $5.0M over 3 years.
  - Area of Interest 2: Up to $5.0M over 3 years.
  - All funding is subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 2 (1 per Area of Interest).
- Estimated Duration:
  - Area of Interest 1: 3 years to start followed by expansion and maintenance.
  - Area of Interest 2: 3 years with potential for renewal and expansion.
  - Both area of interest durations are subject to go/no-go decisions, annual appropriation, programmatic priorities, and congressional direction.

Area of Interest 1: Iron Ore & Steel Scrap R&D Material Sampling

Build out a material sampling center housed either at a national lab or with an external partner.

Background

Academic researchers and technology developers outside of the core steel industry currently do not have ready access to lab- or pilot-scale quantities of iron ore or steel scrap needed for research or demonstration purposes. This barrier is a key limitation to bringing innovation to commercially relevant iron and steel process development.

Industrially realistic materials are challenging to obtain at appropriate volumes without an existing relationship with a steel producer, and the detailed levels of analytical characterization required can be cost prohibitive. A centralized sampling resource center for steel scrap and iron ore will support research, development, and initial demonstration (RD&D) programs nationwide in several important ways: shorten sample acquisition and characterization time, ensure appropriate comparisons can be made between emerging technologies (having been tested on comparable materials relevant to industrial scale), and catalyze development and technology assessment of emerging technologies.

As a national resource themselves, the labs are well-positioned to stand up a national resource center for iron and steel research samples. This resource center may benefit from partnerships for different aspects of establishing, housing, and maintenance.

Objectives

The awarded lab will partner to create, maintain, and manage an iron ore and steel scrap library and sampling center, giving researchers nationwide access to standardized, characterized bench and pilot-sized quantities of iron ore and steel scrap samples. The sampling center would allow a researcher to order discrete quantities of desired materials and receive a safety data sheet (SDS) and specification sheet developed by the lab with their order.

Structure

The awarded lab will partner to create, maintain, and manage an iron ore and steel scrap library and sampling center and will both leverage existing and add additional material analysis capabilities to perform and document material characterizations.

Operational models exist for this purpose for other industries, such as for coal specimens,[3] but no equivalent resource exists for iron and steel.

Sample materials should include various mineralogical ores and typical steel scrap profiles such as key domestic commercial iron ores and concentrates. Samples should not necessarily be limited to active commercial operations, to allow research on materials that may be commercially relevant if enabled by innovative processes. Non-conventional or currently non-commercial ore bodies and tailings, as well as international, bulk traded iron ores, may also form part of the sample library. For scrap, while broad 'industry wide' benchmarks are unrealistic due to geographic variation, samples should look to reasonably replicate common merchant ferrous scrap streams in form and chemical composition (e.g., shredded scrap resulting from processing end-of-life automotive products).

These samples should be sourced commercially wherever possible and rigorously characterized, including information on variability of material streams. To ensure that profiles are typical and to minimize sample-to-sample variation within a category, the awarded lab may need to develop or identify sampling, characterization, or other methodologies. The sample library may expand over time to include red mud, tailings, and more divergent scrap or shred materials.

Material library design for data science applications is within scope, and a single lab is expected to lead this effort. The awarded team should include experience with libraries or other user centers and should plan for steering involvement from ITO. While the lab will be instrumental in standing up and leading the management of this resource, they are welcome to work with external partners to physically house and manage operations of the center. Samples are expected to be offered to researchers for some modest fee to minimize frivolous requests.

Expected Output

While success of the center will be evaluated based on the use of samples by researchers, lab scientists may collaborate on resulting research and should require that, at a minimum, the resource center be credited in publications or other research outcomes as a condition of material use.

Wherever possible, chemical compositions and other physical characteristics of sample materials should be made available in an open access manner to facilitate

[3] Penn State University. "Coal Sample Bank." Accessed December 2024. https://www.energy.psu.edu/services/penn-state-coal-sample-bank.

technoeconomic and life cycle assessment studies, data science, and other referencing by external researchers. Samples may be anonymized if necessary due to commercial sensitivities.

Expected Industry Outcomes

The iron ore and steel scrap resource center aims to support innovation in iron and steel research. It will provide access to standardized, well-characterized materials for bench- and pilot-scale RD&D to researchers nationwide, enabling multiple RD&D avenues needed for the global competitiveness of the U.S. iron and steel industry, including research into cost-effective energy efficient technologies.

Not of Interest

Specific R&D projects are outside of the scope of this current call, although this call may position the lab to respond to future R&D funding calls.

Candidate Metrics and Targets

Proposals will be evaluated based on relevance, comprehensiveness, clarity, and the degree to which they are responsive to the Expected Outputs and Impacts (above). As part of the operation of the center, the lab will develop metrics to measure the impact to the broader steel research enterprise. These metrics can include publications acknowledging the center's role in facilitating RD&D, patents granted to center collaborators, or other indicators as appropriate.

Area of Interest 2: Incubating Breakthrough Steel Scrap Decopperization Technologies

Establish a lab-managed technology incubator of early-stage technologies to remove tramp elements from scrap steel. Leverage existing internal and external capabilities through different funding and external engagement mechanisms as well as add new lab capabilities, if needed, to achieve the goals.

Background

Steel scrap is the leading raw material for crude steel production in the U.S., and maximizing utilization of the domestic scrap supply is key to American steel industry competitiveness. However, contamination with copper, tin, and other tramp elements deteriorates the material quality of recycled steel—a growing issue currently addressed by dilution of contaminants with the addition of excess primary iron, which has significant cost and energy use penalties. Removal of these tramp elements is the barrier to increasing recycling rates for scrap in the United States. While ITO has previously published a funding opportunity to address the challenge of copper and tramp element removal, there is a clear need to develop more ambitious technology to solve this issue, as many existing approaches only provide incremental improvements.

A lab-managed technology incubator would provide the targeted effort needed to develop unique and innovative approaches. A national lab can leverage its creativity and convening power, including relationships with external researchers, to focus on early-stage R&D. Further, by adding to and/or making pyrometallurgical capabilities available to external collaborators, a lab can engage with and support researchers working on breakthrough efficiency-improvement technology.

Objectives

The incubator's objectives are to identify and incubate foundational R&D on game-changing technologies for the removal of tramp elements such as copper and tin from the steel recycling stream. These technologies can take the form of scrap pretreatment processes, novel steel treatment processes to refine tramp elements from liquid metal, or others. Of particular interest is the development of technologies capable of removing tramp elements in solution within steel, which is the most impactful approach to addressing contamination already in the steel scrap supply.

Structure

The selected lab will identify and incubate unique and innovative early-stage approaches to tramp element removal from scrap steel. Target concepts will be at early stage.

Applicants should identify and collaborate with external researchers and developers, potentially by running RFPs, to recruit and select partners and technologies. The incubator will leverage national lab capabilities to develop these early-stage ideas into lab-scale proven approaches that would be competitive for further development and scaling through other funding opportunities. The selected lab should support external awardees with, at minimum, access to the lab's pyrometallurgical capabilities to test and verify separation. The lab may also provide mentorship, collaboration, or other support. The lab should also proactively engage with industry through convening or other efforts to foster relationships to develop a commercial pipeline for technologies being developed.

A portion of the award may be directed to develop new or extend existing metallurgical capabilities for the awarded lab. The awarded team should plan for steering involvement from ITO.

Expected Output

This incubator is expected to develop a suite of decopperization and/or other tramp element removal technologies that have been demonstrated at the lab scale and are

well positioned to apply to conventional DOE, or other organizations' funding mechanisms for further development.

Expected Industry Outcomes
This program, like others in this Lab Call, aims to accelerate the innovation and adoption of cost-effective technologies that promote competitiveness of the U.S. manufacturing sector by increasing energy efficiency and maximizing scrap utilization rates.

The expected long-term impact is the successful deployment of one or more cost-effective technologies that will unlock the opportunity to produce a greater quantity of high-quality steel through electric arc furnaces with a higher proportion of steel scrap.

Not of Interest
High TRL decopperization and tramp element removal techniques. Physical scrap sorting techniques such as image recognition sorting. Design of hot shortness tolerant steel grade chemistry. Elimination of hot shortness through reheat furnace process changes.

Candidate Metrics and Targets
Proposals will be evaluated based on relevance, comprehensiveness, clarity, and the degree to which they are responsive to the Expected Output and Industry Outcomes (above).

The target success metric for this Area of Interest is a suite of at least three decopperization and/or other tramp element removal technologies that have been demonstrated at the lab scale and are well positioned to apply to conventional funding mechanisms for further development.

Cross-Sector Technologies Topics

Topic 6: Capabilities for Process Heating Using Electrotechnologies

Summary
Establish or expand capabilities that help to enable testing and evaluation of electrotechnologies at sufficient scale to address industrial process heating applications.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $15 million for 3 years. Funds are not required to be evenly distributed across the 3-year budget scope.

- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 1-2
- Estimated Award Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

Process heating, or thermal processing, is essential to manufacture a wide variety of industrial and consumer products. Process heating represents the largest energy use in the manufacturing sector. The Thermal Process Intensification Workshop Report highlights the significant opportunity across several industries to improve the efficiency of thermal processing.[4] Within a portfolio of industrial heating technologies, electrification will be an essential strategy for improving efficiency and productivity.

In addition to energy efficiency improvements, application of electrified heating technologies may offer reduced heating time, improved temperature uniformity, reduced manufacturing cost, improved product quality, higher product yield, reduced waste byproducts, and other co-benefits. Technologies of interest include, but are not limited to, furnaces, boilers, ovens, heaters, and other thermal processing equipment powered by electric resistance, induction, electric arc/plasma, electric infrared heating, or other electrified approaches.

Objectives

This topic seeks applications to advance existing or new lab capabilities for equipment, associated components, and supporting expertise to electrify thermal processes across the industrial sector. Proposals should address technologies that can be utilized for multiple industries and application spaces. Potential capabilities can include but are not limited to equipment, testing capabilities, sensing and process control solutions, modeling and analytics, and staff resources. Hybrid systems that utilize a combination of process heating technologies based on different heating principles and/or energy sources (at least one of which is electricity) may be considered, but the associated

[4] DOE. 2022. "Thermal Process Intensification: Transforming the Way Industry Uses Thermal Process Energy." Accessed December 2024. https://www.energy.gov/sites/default/files/2022-05/TPI%20Workshop%20Report_AMO.pdf.

capabilities should focus predominantly on electrification. For all applications, to the extent feasible, capabilities should complement, but not duplicate, other ITO efforts related to electrotechnologies across the EII, CST, and TAWD subprograms, including the EPIXC Institute.[5]

Structure
Proposals should clearly describe the capabilities to be developed and the approach to be undertaken. Collaboration among labs is encouraged only when a clear benefit is shown. Partnering and collaborating with industry in all phases of application through project completion is strongly encouraged.

Expected Output
Proposals should clearly describe the capabilities to be developed. Proposals should provide clear justification for the motivation and expected output of all proposed capabilities.

Expected Industry Outcomes
Proposals should clearly describe the capabilities to be developed. Proposals should provide clear justification for the motivation and expected impact of all proposed capabilities based on technology assessment, market analysis, and/or stakeholder engagement.

Not of Interest
For this topic, the following types of applications will be deemed nonresponsive and will not be reviewed or considered:

- Technologies or processes relevant to only a single subsector or application.
- Technologies pertaining solely to electrified thermal energy storage solutions.
- Technologies pertaining solely to industrial heat pumps.
- Electrochemical process technologies.

Candidate Metrics and Targets
Proposals submitted to this topic must define relevant baselines and metrics for assessment and indicate potential impacts from project efforts. Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed. The relevant metric will depend on the capability proposed. Examples are shown below but are not exhaustive.

- Operational capacity (in terms of kilowatt input).

[5] The EPIXC website (https://epixc.org/) and ITO project map (https://www.energy.gov/eere/iedo/iedo-project-database) provide information on key focus areas.

- Throughput capability (in terms of size or speed).
- Range and types of materials to be processed.
- Anticipated energy impacts for multiple heating processes (compared to existing conventional processes).

Topic 7: Capabilities for High Temperature Heat Pump Systems

Summary

Establish or expand testbed-based capabilities to enable standardized testing and evaluation of industrially relevant high temperature heat pump (HTHP) components and systems, enabling accelerated development and adoption of industrial HTHP systems.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $12 million for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 1.
- Estimated Award Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

Industrial heat makes up an estimated 19% of global energy demand, nearly 27% of which is delivered between 100°C and 200°C.[6] This temperature range is a prime candidate for electrification of process heating via high temperature heat pumps (HTHP). Applications include industrial usage of steam in subsectors, including paper and pulp, chemicals, food, petroleum and coal, and primary metals.[7] Commercially

[6] K. Adamson, T. G. Walmsley, J. K. Carson, Q. Chen, F. Schlosser, L. Kong, & D. J. Cleland. 2022. "High-temperature and Transcritical Heat Pump Cycles and Advancements: A Review." Renewable and Sustainable Energy Reviews. *167*, 112798. Accessed December 2024. https://doi.org/10.1016/j.rser.2022.112798.

[7] D. B. Fox, D. Sutter, & J. W. Tester 2011. "The Thermal Spectrum of Low-temperature Energy Use in the United States." Energy & Environmental Science, 4(10), 3731. Accessed December 2024. https://doi.org/10.1039/c1ee01722e.

available heat pumps are available in the market for temperatures up to 90°C. For higher temperature applications, highly efficient HTHP development is currently limited to prototype scale and highly customized projects.

Despite having the potential of increased efficiency for heat production compared to resistive heating technologies, there are barriers limiting the development and wider adoption of HTHPs, including low level of familiarity, lack of knowledge on integration of HTHPs to industrial processes, lack of suitable refrigerants, market competition from fuel-based heating technologies, and a lack of demonstration systems.[8]

Additional complications for the adoption of HTHP technology comes from 1) the shift in the global refrigerant market towards the use of alternative refrigerants and the variation within them as well as 2) a lack of standardized performance testing and evaluation procedures that enable comparison of various HTHP technologies that can operate on various thermal cycles and configurations. Alternative refrigerants such as natural refrigerants, hydrocarbon-based refrigerants, and hydrofluoroolefin (HFO) blends with reduced potential for per- and polyfluoroalkyl substances (PFAS) production come with their own suite of complexities from higher pressure systems to high flammability issues that must be mitigated.

Objectives

This topic seeks proposals to establish a testbed to address the testing and validation of HTHP components and systems that utilize alternative working fluids and blends in industrially relevant configurations. The implementation of standard, accredited testing and evaluation methods will aid in the validation of industrially relevant HTHP projects and boost industrial acceptability of such systems.

The capability will accelerate testing and scale-up of HTHP components and systems that utilize alternative working fluids to achieve large temperature lifts and sink temperatures at or above 200°C.

Structure

The testbed is expected to serve as a resource for current and future ITO-funded HTHP RD&D projects as well as a user facility for external, third-party clients and internal lab projects. The capability should include capabilities relevant to advancing mid-TRL technologies and encouraging adoption of high-TRL technologies. The proposal should

[8] C. Arpagaus, F. Bless, M. Uhlmann, J. Schiffmann, & S. S. Bertsch. 2018. "High Temperature Heat Pumps: Market Overview, State of the Art, Research Status, Refrigerants, and Application Potentials." *Energy*, *152*, 985–1010. Accessed December 2024. https://doi.org/10.1016/j.energy.2018.03.166.

clearly describe how the capability will enable this range of users to access its resources.

Collaboration among labs is not required but is encouraged where there is clear value-add from additional labs' participation. Partnering and collaborating with industry in all phases of application through project completion is strongly encouraged.

Expected Output

Proposals should clearly describe the capabilities to be developed in terms of ability to test and evaluate heat pump technologies. Proposals should provide clear justification for the motivation and impact of all proposed capabilities based on technology assessment, market analysis, and/or stakeholder engagement. Example capabilities shown below are not inflexible or exhaustive.

Core Capabilities

Capability Type	Examples
Standardized Testing	• Efficiency for various temperature lifts at component level • Efficiency for various temperature lifts at system level • Various heat pump (HP) system configurations and cycles (cascaded, Stirling, mechanical vapor recompression) • Turn down performance • Startup time to set temperature • Multiple scales (e.g., 10 kW, 50 kW, and 500 kW).
Working Fluids	• Availability of and compatibility with multiple classes of alternative working fluids • Facilities designed to safely accommodate high-flammability and/or toxic working fluids • Testing of refrigerant blends.
Technology Evaluation	• Develop standardized evaluation methods and procedures • Pursue accreditation of testing procedures.
Market Transformation	• Publication of case studies and technical resources • Technology assessment, technoeconomic analysis, and lifecycle assessment • Stakeholder engagement and convening.

Additional Capabilities of Interest

Capability Type	Examples
Integrated Systems	• Air-source, Water-sources, Ground-sourced and Exhaust Air

	• Integration with plant environment for components such as Heat Exchangers (high humidity, oil-steam mix in F&B plants, etc.) • Simultaneous heating and cooling • Simulation platform • Integration with thermal energy storage or renewable thermal energy systems.
Non-Vapor Compression HPs	• Absorption and adsorption HPs • Thermoelectric, caloric, and other solid-state HPs.

Expected Industry Outcomes

The testbed is expected to achieve the following impacts:

- Provide trusted, third-party evaluation and validation of HTHP technologies at both prototype and industrially relevant scales.
- Accelerate RD&D, scale-up, and adoption of HTHP technologies to improve energy efficiency associated with process heating.
- Accelerate the adoption of alternative working fluids.
- Enhance U.S. contributions to global HTHP RD&D by establishing competitive research infrastructure and fostering growth of the U.S. HTHP RD&D enterprise.
- Support component/system testing and validation for ITO-funded HTHP projects as well as external, third-party users.

Not of Interest

For this topic, the following types of applications are not of interest and will be deemed nonresponsive:

- Applications only focused on development of heat pump components.
- Applications focused on testing only at smaller scales (e.g., less than 25 kW).
- Residential heat pumps.
- Applications focused only on general simulation platform capability of components and systems without physical testing capability of developed components.

Candidate Metrics and Targets

Proposals submitted to this topic must define relevant baselines and metrics for assessment and indicate potential impacts from project efforts. Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be

developed. The relevant metric will depend on the capability proposed. Examples are shown below but are not exhaustive.

- Source and sink temperature ranges
- Thermal capacity, in terms of kilowatt output
- Types of heat pump components, systems, configurations, and cycles that can be tested
- Working fluid compatibility.

The schedule for obtaining, installing, and making available the proposed capability will also be considered a project metric.

Topic 8: Capabilities for Advanced Fuel Combustion Technologies

Summary

Establish or expand capabilities at national lab/labs to provide a shared facility to study, test, demonstrate and derisk alternative fuels and fuel blends combustion, and accelerate scale-up of technologies that can provide solutions for high temperature industrial process heating, cogeneration, and other power-source applications by simplifying adoption of new combustion technologies.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $10 million for FY25-FY27. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 1 award.
- Estimated Award Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

The U.S. industrial sector heavily relies on fuel combustion to provide heat for many operations, including direct firing in furnaces to melt materials such as metals, in kilns to calcine limestone, in boilers to produce steam, and many others. While primarily

sourced from a limited number of existing fuels, availability for a broader range of less common fuels has been growing.

For example, apart from the barrier related to supply of hydrogen, energy-intensive industrial sectors face challenges related to retrofitting of existing processes that can utilize this fuel option.[9] Similar challenges can be extended to the utilization of other alternative fuels and fuel blends in industrial combustion systems. The de-risking of these technologies for ease of adoption into existing processes by minimizing the required modifications to the existing processes is seen as a key enabler to adoption of alternative fuels.

Areas of importance include exploring fuels and fuel blend mixes that have the potential to deliver comparable performance in terms of flame dynamics and heating performance for various configurations of combustion systems, including industrial burners, internal combustion (IC) engines and turbines. Additionally, the research into the ability of such technologies to scale are currently cost prohibitive. This necessitates the development of assessment capabilities that can inform scaling requirements without the need to develop at-scale systems. There is also a lack of safety and process control related auxiliary components for newer fuels and blends, such as advanced sensors, that will be of importance for the uptake of alternative fuel-based combustion technologies in the industry.

Objectives

This topic seeks proposals from a national lab(s) for a project to establish testbed capabilities for accelerating the development and adoption of alternative fuel-based combustion technologies in industry. The primary objective is to provide a platform to test technologies that increase the uptake and utilization of alternative fuels in existing processes with minimal retrofitting requirements.

This call intends to establish a national lab capability to enable the substitution of existing fuel fired technologies with comparable alternative fuel blend mixes. In particular, priorities should focus on developing on-ramps for alternative fuels that utilize as much existing infrastructure and equipment as possible. While the availability of multiple alternative fuels (e.g., hydrogen, ammonia, etc.) is currently being developed, the capability of safely handling the transportation and utilization of these

[9] M. Bampaou & K. Panopoulos. 2024. “An Overview of Hydrogen Valleys: Current Status, Challenges and Their Role in Increased Renewable Energy Penetration.” *Renewable and Sustainable Energy Reviews*, *207*, 114923. Accessed December 2024. https://doi.org/10.1016/j.rser.2024.114923.

fuels will be key for providing support to technology developers to advance these technologies.

A mature ecosystem for next generation fuels must include capabilities to validate all aspects of a full system. This includes ancillary equipment for real-time performance verification methods, such as advanced sensors and modeling to inform safety and control feedback mechanisms for new fuel and fuel blends in industrial environments.

Capabilities to validate burner performance must account for significant variability in the type of systems utilized in the industry. Configurations of burner systems vary based on firing orientations, flame-product/flame-process air interaction, type of premix, flame safety, and other process derived constraints. The ability to accommodate the broad variety in industrial burner systems will be a key factor in enhancing the relevance of the testbed. Additionally, the ability to test multiple burner interactions will be critical for replicating real-world applications of burners, increasing confidence in the technology.

Similar limitations and challenges exist for the use of alternative fuels in internal combustion engines and turbines but not to the same extent as burners and furnaces. A crucial limitation for development of fuel firing systems is the cost-prohibitive nature of installing higher-scale testing systems. The testbed should develop a strategy to use partial assessment capabilities that can evaluate a fuel firing system in parts instead of installing a full-scale system. This capability should be able to provide a realistic performance representation at larger scales, potentially through strategies such as a firing enclosure for a scaled burner component test (instead of a fully instrumented furnace to validate flame characteristics) or through a near-scale single cylinder setup with additional equipment.

Additional capabilities of interest include NOx reduction capabilities apart from flue-gas recirculation (FGR); for example, integration of membranes for concentrating oxygen. The potential for integrating energy recovery systems to improve energy efficiency and overall system performance of the thermal system utilizing the alternative fuel is also considered as an additional capability. The lab should describe the proposed capabilities in terms of both resources available as well as plans for industry access to those resources.

Structure

The primary goal of this topic is to establish capabilities for testing and evaluation of combustion systems that utilize alternative fuels for accelerating their industrial uptake, and have been demonstrated at a lower TRL. Preference will be given to

proposals that clearly demonstrate capabilities that include commercially relevant scales. Proposals should clearly describe the testbed capabilities to be developed. Proposals should provide clear justification for the motivation and expected output of all proposed capabilities based on technology assessment, market analysis, and/or stakeholder engagement. This topic intends to establish testbed capabilities for accelerating the development and adoption of alternative fuel-based technologies. Collaboration among labs and industrial partners is encouraged but not required.

Expected Output

Establishment of a new alternative fuel combustion testing capability, or improvement of existing capabilities to develop infrastructure, technology, and expertise-based capabilities for advancing industrially relevant alternative fuels combustion technologies, including auxiliary equipment, scale-up, interaction of combustion products in industrial environments, and equipment handling.

Expected Industry Outcomes

The testbed is expected to achieve the following impacts:

- Accelerate the substitution of existing fuel fired technologies by alternative fuels and increasing their utilization.
- Enable the development and verification of advanced sensors and control systems for improved safety and operational feedback mechanisms in combustion systems.
- Accelerate the scale-up of advanced combustion systems that utilize alternative fuels.
- Advance the study of flame characteristics and interactions to improve industrial adoption of novel fuels.
- Support testing and validation for ITO-funded advanced fuels projects as well as external, third-party users.
- Establish competitive alternative fuels research infrastructure and fostering growth of U.S. alternative fuels combustion enterprise.

Not of Interest

For this topic, the following types of applications will be deemed nonresponsive and will not be reviewed or considered:

- Applications focused on testbed capability with single alternative fuel utilization.
- Applications focused on membrane development instead of membrane integration for contaminant reduction.
- Applications focused on study and simulation of flame characteristics alone.

- Applications focused on combustion systems at scales that will not have significant impact on energy-intensive industrial applications.
- Applications proposing testbeds without mechanisms for incorporating crucial industry needs such as novel sensors testing etc.
- Applications focused on integrating energy recovery to enhance the energy efficiency of a process without increasing the efficiency of the alternative fuel utilizing technology alone.

Candidate Metrics and Targets: Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed, especially in the context of any existing capabilities. The relevant metric will depend on the capability proposed. Examples are shown below but are not exhaustive.

Objective/Goal	Capability Type	Example Metrics
Testbed capabilities for development of alternative fuel technologies	Required Capability: Alternative Fuel Combustion Testing and Evaluation	• Industrially relevant scales (e.g., multiple smaller and larger scale testing capability for timely and efficient testing) • Accommodation to test and validate auxiliary equipment (Sensors and controls)
	Required Capability: Simulation and Performance Measurement	• Flame characteristics study and simulation • Industrially relevant simulation of combustion system (multiple burner interaction, simulation of combustion gas-product interaction, flame propagation) • Evaluation of scaled components (Partial assessment at larger scales) • System (Burner and/or IC engine and/or Turbine) performance measurement and analysis
	Required Capability: Combustion Technologies	• Range of industrially relevant complexity of combustion system • Range of compatible fuels and oxidizers gas (ammonia, natural gas, hydrogen, biogas, air, oxygen, etc.)

	Additional (Good to have) Capability: Post Combustion Equipment	• Range of Energy Recovery Device Compatibility (To allow preheated air and/or fuel combustion) • Non FGR NOx reduction technologies (e.g., membranes integration).

The schedule for obtaining, installing, and making available the proposed capability will also be considered a project metric. A clear description of needs and targeted areas of industrial challenges to be solved should be presented with evidence of industry interest.

The primary goal of this topic is to establish capabilities for testing and evaluation of combustion systems that utilize alternative fuels for accelerating their industrial uptake and have been demonstrated at a lower TRL level. Preference will be given to proposals that clearly demonstrate capabilities that include commercially relevant scales.

Topic 9: Capabilities for Scale-Up of Membrane Fabrication and Testing

Summary

Establish a shared facility to solve scale up challenges and enable the cost-effective fabrication of innovative membranes that can be used in industrial separations to significantly reduce energy use.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $12 million for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Projects Expected: 1.
- Estimated Project Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

Chemical separations have been estimated to use about half of U.S. industrial energy consumption, or 10-15% of energy consumption nationwide.[10] The vast majority are energy-intensive thermal separations, such as distillation and drying, primarily driven by the combustion of strategic fuels. Improving the energy efficiency of separation processes, and, therefore, the energy demand of separations, is crucial to improving competitiveness of the industrial sector.

A key strategy to reduce demand from thermally intensive processes is to replace them with low- or no-heat alternatives, eliminating energy wasted on unnecessary heating and phase transitions. Membrane separations are one possible way to lower or eliminate the heating needed in traditional thermal separations either by total replacement of a unit operation or via hybridization with the conventional approach.[11] The impact opportunity is significant and estimated to have the potential to reduce energy consumption by about 8 quads/year (about 8%) in the United States.

Hundreds of new membranes are reported in the scientific literature each year; however, scale-up remains a major obstacle to the commercialization of membrane technologies and their integration into industrial processes.[12] Even small manufacturing lines and module test systems can be cost-prohibitive for small businesses and are not typically available for academic researchers. Contract manufacturers of membranes are typically running at full capacity, which leads to high costs for R&D when availability exists at all. Successful applied R&D in this area has a significant need for purpose-built facilities to support the scale-up of innovative membrane technologies from the lab to commercial manufacturing.

Objectives

This topic seeks to establish capabilities that address the membrane fabrication scale-up gap. The expertise and resources at a lab can help establish U.S.-based membranes manufacturers as leaders in improving the energy efficiency of separations.

Funding is intended to establish the national lab(s) as accelerators of lab-to-manufacturing line scale-up of membrane technologies for advanced separations.

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[10] D. Sholl & R. Lively. 2016. "Seven Chemical Separations to Change the World." *Nature* **532**, 435–437. Accessed December 2024. https://doi.org/10.1038/532435a.

[11] DOE Advanced Manufacturing Office. "Thermal Process Intensification: Transforming the Way Industry Uses Thermal Process Energy." Accessed December 2024. https://doi.org/10.2172/1867992.

[12] U. Beuscher, E. J. Kappert, & J. G. Wijmans. 2022. "Membrane Research Beyond Materials Science." *Journal of Membrane Science*, **643**. Accessed December 2024. https://doi.org/10.1016/j.memsci.2021.119902.

Proposals should target fabrication using industrially relevant methods (e.g., roll-to-roll, hollow fiber spinning) at scales suitable for the creation of an industrially relevant module type (e.g., spiral wound, hollow fiber cartridge) and/or the design and testing of such modules. Developing cost effective methods is essential.

Structure

The selected lab(s) will plan, implement, and test new capabilities supporting membrane fabrication scale-up. Capabilities may be for the following:

- Membrane fabrication
- Module fabrication
- Permeation testing
- Analysis (e.g., postmortem, in-line during fabrication, *in situ* during permeation testing).

The focus is on translating known lab-demonstrated membranes to a more relevant manufacturing environment. Establishing new capabilities and enhancing existing capabilities are both of interest for this topic. In the latter case, the proposal should describe the existing capabilities available and how further development of the capabilities will enhance their operation and scale-up R&D.

Proposed capabilities may target any membrane technology relevant to advanced separations, including organic, inorganic, mixed-matrix, and molecular sieves. To the extent feasible, proposals should target capabilities that can flexibly accommodate a range of membrane materials. The range of membrane materials compatible with the proposed capabilities should be described, and examples of relevant industrial applications should be provided.

The lab should describe the proposed capabilities in terms of both resources available for applied R&D toward scale-up as well as plans for industry access to those resources. Collaboration among labs and industrial partners is encouraged but not required.

Expected Output

Expected outputs are primarily the design, acquisition, and installation of new pilot or large lab-scale:

- Membrane manufacturing line(s)
- Module fabrication capabilities
- Permeation testbed(s)
- Analysis equipment.

Whichever capability is proposed, it should be sized to develop scaled-up methods for membrane fabrication at industrially relevant volumes and/or test the resulting membranes. R&D to solve scale-up challenges and hiring or training staff may also be included.

Expected Industry Outcomes

This topic targets improvements in translation of advanced membrane materials from the lab benchtop toward commercialization. The proposed capabilities should assist users in overcoming barriers to scale-up and demonstrating a commercially viable product.

Applicants should demonstrate impact through analysis of the potential improvements in productivity, energy efficiency, cost effectiveness, etc. obtainable from examples of membrane technologies targeted by or compatible with the proposed capabilities. However, as the primary goal of this topic is to establish capabilities for scale-up of materials that have been demonstrated in the lab, preference will be given to proposals that clearly demonstrate scaling capabilities.

Not of Interest

For this topic, the following types of applications will be deemed nonresponsive and will not be reviewed or considered:

- Applications focused on membrane material discovery or on capabilities only suitable for membrane material discovery.
- Applications focused on membranes suitable only for fuel cells, electrolyzers, or water treatment or desalination.
- Applications focused on capabilities at small lab scales.
- Applications proposing acquisition of general-purpose spectroscopy or analytical capabilities. Proposals with a heavy focus on off-line, *ex situ* analysis equipment should clearly justify how adding these capabilities will help accelerate fabrication scale-up when combined with existing capabilities.

Candidate Metrics and Targets: Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed in terms of the scale and breadth of the membrane technologies supported. The relevant metric will depend on the capability proposed. Examples are shown below but are not exhaustive.

Objective/Goal	Capability Type	Example Metrics
Scale-up membrane fabrication from lab scale	Fabrication (e.g., roll-to-roll, hollow fiber spinning)	• Range of compatible membrane materials • Minimum, maximum size of membrane • Throughput/time to fabricate at maximum size • Time to fabricate sufficient material for a single module
	Module fabrication	• Minimum, maximum size of module
	Permeation testing	• Range of compatible membrane materials • Size of membranes or modules that can be tested • Range of compatible chemical conditions for permeate (temperature, pressure, pH, etc.) • Permeate throughput
	Analysis	• Size/percentage of membrane inspected/analyzed • Minimum feature size • Minimum line speed.

The schedule for obtaining, installing, and making available the proposed capability will also be considered a project metric.

Topic 10: Capabilities for Thermal Energy Storage Technologies

Summary

This topic seeks proposals for testbed-based capabilities for evaluating, de-risking, and validating thermal energy storage (TES) technologies, inclusive of thermochemical technologies.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $15 million for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Projects Expected: 1.

- Estimated Project Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

Industrial heat represents close to half of all industrial energy consumed. This heat is used in many ways, ranging from drying to process steam to the high temperature processes of smelting and production of cement. With increasingly large and varying loads at industrial sites, as well as an increasing number of energy sources from the grid and onsite resources, cost effective and energy efficient thermal energy storage is emerging as a significant technology category for increasing industrial competitiveness. Thermal energy storage options include sensible, latent, and thermochemical technologies and comprise multiple pathways where the input and output energy are either heat or electricity. Thermal energy storage offers the potential to provide cost competitive energy supply for industrial heating applications as well as deliver a large volume of flexible, controllable demand for balancing the power grid.

Every major industrial subsector uses heat in different ways, and there is no one-size-fits-all solution for process heat alternatives. However, thermal energy storage technologies can serve to improve operational resilience by coupling with more specific solutions such as cogeneration, waste heat recovery, energy arbitrage or onsite renewable energy generation. By varying the storage material, thermal energy storage technologies can span a wide range of operating temperatures making them applicable to a wide range of applications.

This topic seeks to build on existing energy storage capabilities at one or more national labs to facilitate the integration of thermal energy storage technologies, inclusive of thermochemical technologies. Particularly, this topic seeks proposals that would be capable of testing near- or sub-scale systems to validate performance against electrical or thermal inputs, output temperature ranges, and/or integration with low-cost energy inputs. Labs should consider where they can couple this with their existing materials characterization work and ways that failure testing could integrate in cases where technologies fail validation tests.

Objectives

This topic seeks proposals from individual Labs or teams of Labs to establish capabilities that address the testing and validation of varying TES technologies for industrially relevant applications. The implementation of standard testing and evaluation methods will aid in the validation of industrially relevant TES projects and boost industrial acceptability of such technologies. The focus is on accelerating the development and

adoption of TES technologies; this includes serving as a trusted third party to conduct assessments and minimize risk by allowing for the identification of technical, operational, and safety issues before being deployed at a large scale with large capital investment. Performance evaluation is also necessary to identify operational and technical areas of improvement to drive down costs and increase power output.

Additional capabilities may include evaluating utilization of TES technologies to improve industrial process efficiencies by coupling with waste heat that may enable increased industrial adoption or increase utilization of renewable energy sources. The lab should describe the proposed capabilities in terms of both resources available as well as plans for industry access to those resources. Collaboration among labs is encouraged only when a clear benefit is shown. Partnering and collaborating with industry in all phases of application through project completion is strongly encouraged.

Structure

One national laboratory, or a team of national laboratories, will be expected to support the topic. A controlled environment should be provided for assessing performance, reliability, and safety under realistic operating conditions that will support accelerated development and market adoption of thermal energy storage technologies in the industrial sector. In particular, applicants are encouraged to consider detailing their experiences related to energy storage validation, testbed administration, and how they anticipate integrating this testbed with existing complementary initiatives within their facility to maximize the impact of the testbed with existing and new user bases.

Expected Output

It is expected that the testbed developed will allow for validation of the following components of thermal energy storage devices:

Objective/Goal	Capability Type	Examples
Evaluation and validation of TES devices	Standardized Testing	• Operating Temperature Range (°C) • Consistency of delivered heat temperature / self-discharge rate (heat loss rate correlates with the temperature of the storage medium) • Thermal Conductivity (W/m-K) • Thermal Capacity (MWh) • Round Trip Efficiency (RTE; energy output/energy input, %) • Thermal Cycles (charge-discharge cycles) • Thermal Reliability (retained energy density after cycling, % over X cycles) • Discharge time (hours)

		• Response time (s or min)
	Failure Testing	• Integration with any existing materials characterization work to evaluate any material failures, when necessary
	Integrated Systems	• Integration with at least two heat inputs or outputs that are not emulated, such as, but not limited to, renewable thermal energy system (solar thermal, geothermal, etc.), nuclear, waste heat recovery, combined heat and power, etc.

Expected Industry Outcomes

The capability is expected to have an impact as an accelerator for testing and scale up of TES technologies and advance technologies toward adoption. The ability for technology companies and/or end users to test, verify, and improve their TES technologies at scale and potentially with integration and controls to represent industrial applications can support this growing sector.

Candidate Metrics and Targets

Proposals will be evaluated based on relevance, comprehensiveness, clarity, and the degree to which they are responsive to the Expected Outputs and Impacts (above).

Topic 11: Capabilities for Industrial Load Flexibility

Summary

Establish research, development, and initial demonstration (RD&D), analysis, and technical assistance capabilities to develop and demonstrate innovative approaches to a future grid-interactive industrial sector and to address barriers to industrial electrification and grid integration.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $12 million for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Projects Expected: 1-2.

- Estimated Project Duration: Up to 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

With economic growth, emergence of new industries (e.g., data centers for artificial intelligence (AI)), increasing economy-wide electrification, expanded adoption of distributed energy resources, and increased reliance on intermittent generation, the U.S. electric grid faces challenges in load growth, complexity, and the need for coordination. Grid edge technologies, particularly those capable of bidirectional communication and interaction between industrial customers and the grid, will likely play a crucial role in the needed grid evolution. In 2021, utilities reported the largest potential peak demand savings—approximately 13,871 MW—from the industrial customer class, representing 47% of the total reported potential peak demand savings.[13] Yet scenarios for industrial electrification and its impact on the grid are poorly understood,[14] and the role of industrial energy resources are often overlooked in planning for an increasingly interactive grid.

Adoption of distributed energy resources (e.g., onsite generation and storage), flexible industrial energy use, and integration of digital technologies that enable "smart" interaction can help facilitate a grid-interactive industry that is responsive to operational and market drivers. Furthermore, these technologies can avoid the need for additions to the distribution system at the expense of all ratepayers and reduce the cost of building new power facilities to meet significant increases in demand across the system.

Objectives

To support the evolving needs of the industrial sector in an era of significant load growth, ITO seeks to advance RD&D, analysis, and technical assistance capabilities to develop and demonstrate innovative approaches to a future grid-interactive industrial sector and to address barriers to industrial electrification and grid integration.

Structure

These targeted, partner-focused set of activities are designed to demonstrate innovative approaches and accelerate research and development in certain focus areas. As described below, the focus can include a range of RD&D capabilities,

[13] 2023 Assessment of Demand Response and Advanced Metering | FERC.

[14] NREL Electrification Futures Study: End-Use Electric Technology Cost and Performance Projections through 2050. Accessed December 2024. nrel.gov/docs/fy18osti/70485.pdf.

analysis/modeling, and technical assistance activities that advance the grid-interactive industrial facility of the future.

Successful applications will be expected to work closely with the ITO Technology Manager overseeing industrial grid integration initiatives to jointly develop a focused work plan and work products that meet ITO's priorities and define specific milestones and deliverables.

Expected Output

These efforts will support ITO strategy development and demonstrate capabilities that achieve the expected impacts below. Activities should advance progress in some or all of the following areas:

1. Support research, development, and demonstration of emerging distributed technologies that enable flexible interaction between industrial process loads and the electric grid. Activities may include establishment of hardware and/or software capabilities as well as exploratory work to identify and map out RD&D priorities. Possible focus areas include integration of on-site energy technologies, development of flexible industrial processes, and use of AI to support industry-grid integration.
2. Expansion of existing grid edge-related capabilities to address industrial loads and on-site energy technologies.
3. Conduct modeling and analysis of the impacts of industrial electrification on the electric grid to better understand future regional grid needs and opportunities for industrial loads to serve the grid.
4. Collect industrial energy data so that researchers, modelers, rate designers, manufacturers, technical assistance providers, and others can access transparent data sets to develop strategies that optimize use of onsite renewables and storage and lower risk/gain value from demand flexibility and grid integration. Applicants are encouraged to describe the mechanism for data collection, possibly including a funded solicitation.
5. Define the value proposition to industrial customers to deliver flexible loads; include rate structures and tariffs, utility program models, aggregated portfolios managed by third parties, etc.
6. Partner and engage with strategic stakeholders, including utilities, grid-related organizations, and state and local policymakers to identify and reduce barriers to industrial electrification, industrial load flexibility, and demand response.
7. Other relevant, highly impactful activities identified by the applicant.

Proposals should provide clear justification for the motivation and impact of all proposed activities based on technology assessment, market analysis, and/or stakeholder engagement.

Expected Industry Outcomes
These efforts are expected to achieve the following impacts:

- Increased awareness of research and development needs, emerging technologies, and industrial process loads that enable greater interaction between industrial facilities and the electric grid.
- Improved understanding of regional impacts of industrial electrification on the grid.
- Availability of new tools and resources to encourage load flexibility in industry.
- Strengthened partnership and engagement between utilities, grid operators, and industrial customers on policies, programs, and price signals that enable industrial load flexibility. This should preferably be coordinated with other DOE grid initiatives.

Not of Interest: N/A

Candidate Metrics and Targets
Proposals submitted to this topic must define relevant metrics for assessment and indicate potential impacts from project efforts. Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed, especially within the context of any existing, complementary capabilities of this type.

Proposals will be evaluated based on relevance, comprehensiveness, clarity, and the degree to which they are responsive to the Expected Outputs and Industry Outcomes (above). The schedule for standing up the proposed capability will also be considered a project metric.

Topic 12: Computing for Industrial Efficiency

Summary
Establish people-focused capabilities via a national lab center in Computing for Industrial Efficiency to foster an innovation ecosystem around the use of computational resources to improve industrial efficiency, solve difficult industrial technology challenges, and complement the High-Performance Computing for Manufacturing (HPC4Mfg) program.

- Eligibility: No restrictions.

- Estimated DOE Funding Available: Up to $5 million for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Projects Expected: 1.
- Estimated Project Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

Computer modeling, simulation, and optimization are critical tools to support the development of industrial technologies with lower energy intensity, improved operational performance, and increased productivity – especially in energy-intensive manufacturing sectors. Computational approaches can explore the physics underlying industrial processes, can reduce the need for costly and time-consuming physical experimentation, can probe harsh environments inaccessible to current sensors, and can extract key insights from complex systems; all combining to speed development and de-risking of new technologies. In addition to traditional computational tools, the recent rapid growth of artificial intelligence (AI) capabilities represents a new opportunity to further accelerate innovation and enhance national economic competitiveness.

ITO supports modeling, simulation, and optimization work through the HPC4Mfg program[15] and as tasks in projects funded through other mechanisms (e.g., Notices of Funding Opportunities, Technology Commercialization Fund). Additionally, EERE and its constituent offices support Labs' installation of high-performance computing hardware, such as NREL's Kestrel.[16] More broadly, DOE supports the deployment of next generation exascale computing capabilities across the national lab complex.[17]

[15] "High-Performance Computing for Energy Innovation (HPC4EI)." Accessed December 2024. https://hpc4energyinnovation.llnl.gov/.
[16] NREL. "Kestrel Computing System / High-Performance Computing." Accessed December 2024. https://www.nrel.gov/hpc/kestrel-computing-system.html.
[17] Department of Energy. "Supercomputing and Exascale." Accessed December 2024. https://www.energy.gov/supercomputing-and-exascale.

Objectives

Through this topic, ITO aims to expand beyond its current support for individual projects and physical high-performance computing (HPC) infrastructure by establishing a national lab center in Computing for Industrial Efficiency. The goal of this topic is to accelerate the design and development of industrial efficiency technologies through more extensive adoption of computational tools, including HPC, AI, and other modeling and simulation tools. The objective of the topic is to fill several gaps that are seen in existing DOE programs:

- Provide thought leadership to identify and promote high-impact opportunities to move beyond incremental advancements in manufacturing processes to accelerate nascent revolutionary technologies for industrial efficiency.
- Identify and execute on code development opportunities with high relevance to industrial efficiency technologies.
- Provide a clear point of engagement for external researchers interested in smaller-scale, non-HPC modeling capabilities similar to points of engagement for national labs' HPC capabilities.
- Leverage emerging AI methods and resources to accelerate industrial technology development. The center will cultivate expertise in AI and serve as a resource for researchers.

Development of these capabilities will enhance the impact of the HPC4Mfg program and other ITO funding mechanisms.

Structure

The center is primarily a people-focused capability intended to foster an innovation ecosystem around the use of computational resources to advance industrial efficiency and productivity. It is expected that the workplan may include an initial phase focused on stakeholder engagement, opportunity assessment, and scoping. The center will be expected to work closely with ITO to jointly develop a focused work plan and work products that meet ITO's priorities and define specific milestones and deliverables. The center will coordinate activities with the HPC4Mfg program.

Expected Output

The center will serve as a resource for industry, academia, national labs, government, and other stakeholders. Proposals should provide clear justification for the motivation and impact of all proposed activities. Potential activities include but are not limited to the following:

- Serve as a centralized source of national lab expertise on the use of HPC, AI, and other computational tools to advance industrial efficiency.

- Act as a clearinghouse to connect stakeholders with relevant funding opportunities.
- Publish whitepapers and other resources that identify high-impact opportunities to advance industrial efficiency through the use of modeling, simulation, optimization, and AI. Opportunities to be explored include both technical focus areas that can be advanced through computational R&D as well as code development needs.
- Conduct stakeholder engagement and host convenings to identify high-impact opportunities and to build collaborations across industrial technology and computing domains.
- Develop new simulation capabilities in an area of mutual interest to both the laboratory and industrial partners to improve efficiency or productivity of an energy intensive process.
- Explore mechanisms to provide rapid-response support for computational projects, including small-scale, non-HPC projects.
- Publish training, guides, certifications, and other resources to support development of industrial technology modeling expertise.

Expected Industry Outcomes

The center is expected to achieve the following impacts:

- Support an innovation ecosystem around modeling, simulation, and optimization of the design of energy efficient and sustainable products and processes.
- Accelerate innovation for industrial technologies by increasing the use of modeling, simulation, and AI.
- Increase awareness of and access to national lab expertise in computing for ITO project performers and other external users.
- Strengthen connections between the industrial technology and the computing enterprises.

Not of Interest

For this topic, the following types of applications are not of interest and will be deemed nonresponsive:

- Applications focused on hardware capabilities (e.g., acquisition of HPC equipment).
- Applications focused on executing individual RD&D projects rather than building up foundational capabilities.

Candidate Metrics and Targets

Proposals submitted to this topic must define relevant metrics for assessment and indicate potential impacts from project efforts. Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed, especially within the context of any existing, complementary capabilities of this type.

Proposals will be evaluated based on relevance, comprehensiveness, clarity, and the degree to which they are responsive to the Expected Outputs and Impacts (above). The schedule for standing up the proposed capability will also be considered a project metric.

Topic 13: Capabilities for Data Center Thermal Management and Energy Efficiency

Summary

Physical testbed and data collection capabilities for development and demonstration of efficient thermal management technologies to be applied to new or existing data centers.

- Eligibility: No restrictions.
- Estimated DOE Funding Available: Up to $6 Million for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged and will be reviewed as part of the proposal evaluation process as indications of alignment with industry. If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Projects Expected: 1.
- Estimated Project Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Background

The rapid increase in data center facilities and associated energy demand that has happened recently and is anticipated to continue over the next several years has generated a significant increase in procurement activity to ensure that those facilities

have sufficient electricity to power their operations.[18, 19] Today, there are more than 5,000 data centers in the United States alone,[20] and most modern data centers can consume anywhere from 100 MW to 1,000 MW or more.[21] If the load growth presented by data centers is not managed effectively, data centers could consume more than 9% of the total United States electricity production in 2030.[18]

The majority of the energy consumed by data centers is utilized by IT infrastructure (e.g., servers, storage, networking) for the computational loads; however, almost 30-40% of that energy is required for cooling.[18 22, 23] The Power Usage Effectiveness (PUE) metric serves as a useful measure of the cooling efficiency.[18] Two main reasons for this plateau are the need for rapid deployment of data centers to meet artificial intelligence (AI) demand as well as limited cost-incentive for the adoption of modern, advanced thermal management technologies.[18] Furthermore, the PUE of individual data centers can vary widely. Data centers focusing on, for example, AI or other highly computationally demanding workloads use efficient liquid cooling technologies that not only enable these workloads but also dramatically reduce the PUE.[24] Newer data centers also tend to adopt more modern cooling technologies in their facilities than do older, existing data centers.[25] Additionally, larger hyperscale data centers tend to

[18] EPRI. 2024. "Powering Intelligence." Accessed December 2024. https://www.epri.com/research/products/000000003002028905.
[19] DOE. 2024. "Electricity Demand Growth Resources HUB." Accessed December 2024. https://www.energy.gov/policy/electricity-demand-growth-resource-hub.
[20] Statista. 2024. "Leading Countries by Number of Data Centers as of March 2024." Accessed December 2024. https://www.statista.com/chart/24149/data-centers-per-country.
[21] Dgtl Infra. 2023. "Types of Data Centers: Enterprise, Colocation, Hyperscale." https://dgtlinfra.com/types-of-data-centers/.
[22] Uptime Intelligence. 2024. "Uptime Institute Global Data Center Survey 2024." https://uptimeinstitute.com/resources/research-and-reports/uptime-institute-global-data-center-survey-results-2024.
[23] Energy Innovation: Policy and Technology. 2024. "How much energy do data centers really use?" https://energyinnovation.org/2020/03/17/how-much-energy-do-data-centers-really-use/.
[24] Blinklist. 2024. "Preparing Data Centers for AI: The Role of High-Density Colocation and Liquid Cooling."Accessed December 2024. https://blinklist.com/tech/preparing-data-centers-for-ai-role-of-high-density-colocation-liquid-cooling.
[25] Uptime Institute. 2023. "Global PUEs – Are They Going Anywhere?" Accessed December 2024 https://journal.uptimeinstitute.com/global-pues-are-they-going-anywhere.

operate more efficiently than do smaller data centers. In fact, Google, AWS, and Microsoft claim to have data centers with PUEs less than 1.2.[26]

While these hyperscale corporations tend to have the resources available to expand computational capabilities, utilize efficient thermal management technologies, and procure firm electricity supplies, smaller and older data centers have limited incentives to do so. Therefore, it is necessary to advance the research, development, and demonstration (RD&D) of cost-effective thermal management technologies that can also be retrofitted to existing data centers. Newer thermal management technologies should also lead to lower water use. These technologies can reduce the PUE and overall energy demand of data centers and the amount of new generation needed to power them.[27] Additionally, increasing the energy resilience of data centers domestically benefits national security and the nation's competitiveness in AI technologies on the global stage.

Objectives

The focus of this topic is to develop a physical testbed at a national lab for accelerated piloting and demonstration of critical data center infrastructure that improves thermal management and overall energy efficiency. The emphasis of this topic is on the RD&D of cost-effective technologies that can be retrofitted to existing data centers but does not exclude more innovative technologies that require greater monetary support or can only be adopted at new data center builds. This type of capability is crucial to de-risk these technologies as the data center industry tends to be risk-averse due to concerns related to data handling, security, and latency as well as costs associated with violating strict service level agreements.

A data center-related physical testbed builds on ongoing energy efficiency work at the national labs. Examples include:

- The Lawrence Berkeley National Lab (LBNL) Center of Expertise for Energy Efficiency in Data Centers provides technical assistance, trainings, tools, and

[26] Uptime Institute. 2024. "Large Data Centers are More Efficient, Analysis Confirms." Accessed December 2024. https://journal.uptimeinstitute.com/large-data-centers-are-mostly-more-efficient-analysis-confirms.

[27] ACEEE. 2024. "Turning Data Centers into Grid and Regional Assets: Considerations and Recommendations for the Federal Government, State Policymakers, and Utility Regulators." Accessed December 2024. https://www.aceee.org/policy-brief/2024/10/turning-data-centers-grid-and-regional-assets-considerations.

certifications.[28] Additionally, LBNL reports on the current and projected energy use of data centers.

- The National Renewable Energy Laboratory (NREL) has implemented and published on energy efficiency projects.[29] NREL also collaborates with other national labs, universities, and companies on energy efficiency projects.
- The Argonne Leadership Computing Facility maintains a rack-scale AI testbed to test machine learning and high-performance computing (HPC) models on various AI accelerator technologies.[30]
- The ARPA-E COOLERCHIPS program brings together national labs and other public and private stakeholders to develop highly efficient and reliable cooling technologies for data centers.[31]

Structure

This capability will establish a physical testbed that addresses the development of efficient thermal management technologies with an emphasis on those that are low cost and amenable to retrofits. The testbed must focus on hardware (i.e., physical server racks) capable of testing various cooling technologies, whether they are air-assisted, liquid-assisted, or immersion, and heat management and recovery technologies (research into design changes, such as insertion of baffles or rearrangement of servers in a rack, can be included in the scope of the capability). It should integrate advanced sensors to collect appropriate physical metrics (e.g., temperatures, pressures, and heat and fluid flow with spatial and temporal variance). Companion modelling and software capabilities may also exist to utilize physical data for development of simulations of multiple racks or an entire data center. Lastly, the testbed should support collaboration and enable the testing and validation of technologies developed by both internal and external users, including other national labs, universities, and the private sector.

Applicants must describe a clear strategy to advance development and promote adoption of energy- and water-efficient thermal management technologies. The core

[28] LBNL. 2024. "Center of Expertise for Energy Efficiency in Data Centers." Accessed December 2024. https://datacenters.lbl.gov/.

[29] NREL. 2024. "High-Performance Computing Data Center." Accessed December 2024. https://www.nrel.gov/computational-science/hpc-data-center.html.

[30] Argonne Leadership Computing Facility. 2024. "ALCF AI Testbed." https://alcf.anl.gov/alcf-ai-testbed.

[31] ARPA-E. 2022. "Cooling Operations Optimized for Leaps in Energy, Reliability, and Carbon Hyperefficiency for Information Processing Systems." https://arpa-e.energy.gov/technologies/programs/coolerchips.

focus of this capability is on thermal management; however, the overall capability may address improvements at the chip and algorithmic level as well as the promotion of other innovative technologies. The testbed may include capability to test innovative, energy efficient IT equipment (processors, networking chips, memory, and more) at the node level as well as algorithms for improved IT energy management. This capability may include additional technical assistance in the form of tools, trainings, certifications, and expertise. Applicants should clearly describe a strategy for partnership with the private sector to enhance impact and, potentially, to leverage private capital (e.g., equipment or external funding).

Expected Outputs

The core capability to be developed is a physical testbed to support RD&D of thermal management technologies, including technologies for liquid and immersion cooling, air-assisted cooling, and heat recovery, with an emphasis on low-cost and retrofittable technologies. The testbed may also include modeling/software capabilities as well as the ability to evaluate chip- and algorithmic-level improvements. Proposals should provide clear justification for the motivation and impact of all proposed capabilities based on technology assessment, market analysis, and/or stakeholder engagement. Applicants should describe a clear strategy to leverage the capabilities to drive market transformation.

With the development of a physical testbed aimed at thermal management in data centers, a variety of pertinent data can be collected that could be useful in the development and demonstration of a variety of cooling and heat recovery technologies. The physical data collected will allow for validation of technologies and provide insight into any shortcomings. Computational and modelling software can also help extend the impacts of the technologies to the data center scale. In addition, the testbed may be amenable to testing of innovative software, algorithms, and hardware, which will allow for a vertically integrated understanding of efficiency improvements from software to energy use and thermal management.

Expected Industry Outcomes

The testbed is expected to achieve the following impacts:

- Accelerate development of technologies to allow for effective load management of data centers.
- Increase national lab collaboration with the private sector, the public sector, and universities and increase knowledge and technology transfer across organizations working in the data center efficiency space.

- Improve the resilience and security of the U.S. grid and energy supply, promote domestic development of efficient data centers, and secure U.S. competitiveness in AI technologies.
- Reduce the burden of data centers on the water and energy systems of surrounding communities.

Not of Interest

Proposals limited to only advancing chip-level or algorithmic improvements or developing technical assistance tools are not of interest. Additionally, proposals that do not place primary emphasis on cost-effective and retrofittable technologies will not be considered responsive.

Candidate Metrics and Targets

Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed in terms of the scale and breadth of the technologies. The relevant metric will depend upon the capability proposed. All capability types should include metrics related to reliability, energy efficiency, cost, and feasibility for retrofits. In all capability areas, clear demonstration of technology de-risking and scale-up should be demonstrated. Other capability-specific examples are shown below but are not exhaustive.

The schedule for obtaining, installing, and making available the proposed capability will also be considered a project metric.

Objective/Goal	Capability Type	Example Metrics
Physical testbed for RD&D of thermal management technologies	Liquid & immersion cooling technologies	• Fluid flow and heat flow • Energy of auxiliary equipment to power liquid and immersion cooling • Liquid temperature at inlet/outlet • Quantity of liquid used • Liquid/water reuse rate • Other physical metrics of interest (e.g., pressure) • Spatial and temporal variance of measurements across the server rack • Material properties and environmental impact
	Air-assisted cooling technologies	• Air flow and heat flow

		• Energy of auxiliary equipment to power air-assisted cooling • Air temperature at inlet/outlet • Other physical metrics of interest (e.g., pressure) • Spatial and temporal variance of measurements across the serve rack
	Heat recovery and utilization technologies	• Heat transfer rates and overall heat flow, especially at reuse point • Temperature measurements at outlet and reuse point • Liquid/water use and energy use of heat recovery technology.
Improvements at the chip and algorithmic level	Chip-level efficiency improvements	• Chip-level metrics relevant to efficiency • Server utilization rate • Thermal Design Power (TDP) • Temperature of the IT equipment • Energy use of the IT equipment
	Algorithmic efficiency improvements	• Software-level metrics relevant to efficiency • Temperature of the IT equipment • Energy use of the IT equipment.
Promotion of Innovative Technologies	Technical assistance and promotion of innovative technologies	• Analysis of commercialization of demonstrated technologies • Dissemination of results from research and projects using the testbed • Development of tools, trainings, certifications, and personnel expertise.

Topic 14. Lab-Identified Capabilities to Advance Industrial Efficiency

Summary

This is an open topic where the national labs can propose an area of focus to address one or more priority areas identified by industry and based on existing capabilities at labs that present a unique value not described by other topic areas and/or a

combination of earlier topic areas. Labs have unique expertise and insight gained from work in mission-related activities and with external stakeholders that can be further developed through this opportunity. This Lab Call is thematically focused on developing new or expanded capabilities at the national labs with an emphasis on industry-driven capabilities, and other resources that can have an enduring impact on solving difficult challenges and achieving efficiency and competitiveness goals. Here we solicit an additional impactful topic area(s), relevant to these themes, and not otherwise identified above in this Lab Call, that applicants would like to pursue.

- Eligibility: A limit of one proposal as prime per national lab and one as subrecipient.
- Estimated DOE Funding Available: Refer to estimated funding levels in earlier topic areas, noting that the budget for each earlier topic can be combined. Funding is up to the combined earlier applicable topic area funding levels and preferably not to exceed $40M for three years. Funds are not required to be evenly distributed across the 3-year budget scope.
- Cost Share: Not required for national labs. Direct and in-kind cost share from non-national lab partners is encouraged; this will be reviewed as part of the proposal evaluation process as indications of alignment with industry . If applicable to this topic, proposals should also clarify how funding of this call supports user access and what direct and in-kind costs users are expected to cover.
- Estimated Number of Awards Expected: 0 – 3.
- Estimated Duration: 3 years, pending appropriations, program direction, and go/no-go decision points. Renewable for future multi-year terms subject to performance, annual appropriation, and congressional direction.

Objective

Proposals can address multiple topic areas included in this Lab Call simultaneously. Labs may also propose one or more new topic areas, provided they are relevant to the ITO mission. However, the importance and impact must be compelling and leverage existing national lab capabilities in support of the ITO mission. Given the primary focus on capabilities development, R&D activities should be limited only to those earlier topics describing R&D activities.

Structure

A lab can lead this effort and/or can partner with other labs. As with other topic areas, involving stakeholders and end-users directly is encouraged—their needs and considerations must be included.

Proposed capabilities and other structures should clearly show how combining and/or adding different topics is done in a holistic manner where topics relate or offer leverage in some manner. This open topic should not be used to propose multiple unconnected capabilities and should only be done for compelling cases.

Labs that submit proposals for this topic do not need to submit separate proposals for earlier topics when an earlier topic is comprehensively described in this topic and the lab intends to also submit to that earlier topic. Instead, the open topic proposal should identify the topic number, proposal content, and budget for those elements that can stand alone as an earlier topic application. This style of submission will not impact the merits of the open topic proposal or the earlier topic proposal. Labs that also intend to submit proposals to another topic offering a different mode (such as being a subrecipient in another proposal) may do so.

The open topic does not have its own budget. Successful proposals to this topic will reduce available funds in other topic areas.

Expected Outputs

As an open topic, labs should clearly define how the efforts advance a technological need, the timeframe for development, and include all the other factors as described in earlier topics needed to evaluate this opportunity.

Expected Impacts

The impacts should be described and quantified as much as possible. This alternative topic area (or areas) should make a significant impact on the advancement of technologies that improve energy efficiency and increase competitiveness of U.S. industry within ITO's mission space. The proposed activity should provide a meaningful improvement in industrial efficiency, both in terms of the ultimate outcome of the resulting R&D and market adoption activities and in terms of the laboratory's execution of the award towards that end over the 3-year funding period.

Not of Interest

Earlier topic areas are the primary interest of this open topic, but other topics may be considered. Topics not of interest include the following:

- Directly funded R&D activities in the Cross-Sector Technologies capabilities.
- Water and waste-water topics not included in other topic areas.
- Capabilities to support the advancement of renewable energy technologies not directly related to integration with industrial facilities or processes.

Candidate Metrics and Targets

Refer to relevant metrics and targets of other topic areas where relevant.

Proposals submitted to this topic must define relevant metrics for assessment and indicate potential impacts from the proposed efforts. Proposals should clearly and, to the extent possible, quantitatively describe the capabilities to be developed, especially within the context of any existing, complementary capabilities of this type.

Proposals will be evaluated based on relevance, comprehensiveness, clarity, and the degree to which they are responsive to the Expected Outputs and Impacts (above). The schedule for standing up the proposed capability will also be considered a project metric.

II. Application Submission and Review Information

A. Application and Submission Details

i. Application Process

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. Potential applicants will be required to have a Login.gov account to access EERE eXCHANGE. As part of the eXCHANGE registration process, users will be directed to create an account in https://login.gov/. Please note that the email address associated with Login.gov must match the email address associated with the eXCHANGE account. For more information, refer to the Exchange Multi-Factor Authentication (MFA) Quick Guide in the Manuals section of eXCHANGE.

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

Applicants will be required to include project information and details in eXCHANGE that will be used to develop and accelerate negotiations of AOPs if selected. Appendix A provides a worksheet to guide applicants through this process in eXCHANGE. Any information the applicant considers to be of significance for the review process must be included in the proposal, as reviewers will not have access to the AOP development information entered in eXCHANGE.

ii. 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 12-point font, except tables and figures, which may be in 10-point font.

iii. Proposal Content

Proposal content aligns with content required in the EERE AOP project forms, with additional information to assist reviewers in evaluating technical details. The narrative should build on the information provided as part of the EERE eXCHANGE template. **Applicants must include all content they wish to have reviewed in the proposal (proposal reviewers will not review any information provided in eXCHANGE for AOP development).**

Letter of Intent

Applicants are required to submit a 1-page Letter of Intent (LOI) along with a supplemental concept slide by the submission deadline of February 5, 2025 at 5:00 pm Eastern. Applicants must submit a LOI to be eligible for full proposal submission. To submit the LOI, applicants must register with their lab email address and submit application materials through EERE Exchange's Pre-Application Section on https://eere-Exchange.energy.gov, EERE's online application portal.

The LOI shall include the following information:

- Topic area and area of interest, if applicable
- Project title
- Lead laboratory and project director
- Partner institutions (if any), including labs, companies, universities, non-profits, etc.
- Federal and cost-share budget
- A short narrative description of the proposed project, including a clear explanation of the proposed new capability and/or how this complements existing capabilities. Limit of 200 words.

The supplemental concept slide should complement the short narrative and provide any information deemed useful to reviewers. Limit of 4 images and 100 words.

Full Applications

- EERE will not review or consider ineligible Full Applications.
- Each Full Application shall conform to the relevant topic area definition and scope.

Full Applications must conform to the following requirements:

SECTION	FILE FORMAT	PAGE LIMIT	FILE NAME
Technical Volume	PDF	11	ControlNumber_LeadOrganization_TechnicalVolume
Resumes	PDF	3 pages each	ControlNumber_LeadOrganization_Resumes
Letters of Commitment	PDF	25	ControlNumber_LeadOrganization_LOCs
Budget Justification Workbook(s)	MS Excel	N/A	ControlNumber_LeadOrganization_BudgetJustification
Technical Work Plan	MS Word	10	ControlNumber_LeadOrganization_TWP
Summary/Abstract for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary
Summary Slide	MS PowerPoint	1	ControlNumber_LeadOrganization_Slide
User Access Management Plan, if applicable	PDF	4	ControlNumber_LeadOrganization_FacilitiesPlan
Foreign Entities and Foreign Work	PDF	N/A	ControlNumber_LeadOrganization_Waiver
Data Management Plan, if applicable	PDF	1	ControlNumber_LeadOrganization_DMP

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 11 pages, including the cover page, table of contents, and all citations, charts, graphs, maps, photos, or

other graphics, and must include all of the information in the table below. The applicant should consider the weighting of each of the evaluation criteria when preparing the Technical Volume.

The Technical Volume must conform to the following content requirements:

SECTION / PAGE LIMIT	DESCRIPTION
Cover Page	The cover page should include the project title, the specific Lab Call Topic Area being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Project Overview Approximately 10% of the Technical Volume	The Project Overview should contain the following information: • Background: The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted capabilities to be developed and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact Approximately 45% of the Technical Volume	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the capabilities and associated technologies, including scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the Lab Call, including the potential to meet specific end user or DOE technical and technoeconomic targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed capabilities and associated technologies and ability to achieve the anticipated performance metrics and targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state-of-the-art in the applicable field, the novelty of the proposed capabilities and associated technologies to be developed, the advantages of the capabilities and associated technologies over current and emerging technologies, and the

	overall impact on advancing the state-of-the-art/technical baseline if the project is successful.
Workplan and Market Transformation Plan Approximately 20% of the Technical Volume	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, go/no-go Decision Points, and Project Schedule. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes. • Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on go/no-go decision points). The applicant should describe the specific expected end result of each performance period. • WBS and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard WBS for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this Lab Call. • Milestone Summary: The applicant should provide a summary of appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be Specific, Measurable, Achievable, Relevant, and Timely, and must demonstrate a technical achievement rather than simply completing a task. Unless otherwise specified in the 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). The applicant should also provide the means by which the milestone will be verified. • Go/no-go Decision Points: The applicant should provide a summary of project-wide go/no-go decision points at appropriate points in the Workplan. A go/no-go decision point is a risk management tool and a project management best practice to

	ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. At a minimum, each project must have at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of the project. See Section VI.B.xiv. The applicant should also provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone.
	• End of Project Goal: The applicant should provide a summary of the end of project goal(s). At a minimum, each project must have one SMART end of project goal.
	• Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points.
	• Project Management: The applicant should discuss the team's proposed management plan, including the following:
	  ○ The overall approach to and organization for managing the work, including a structure for organizing and managing access to the capabilities
	  ○ The roles of each project team member
	  ○ Any critical handoffs/interdependencies among project team members
	  ○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices
	  ○ The approach to project risk management
	  ○ A description of how project changes will be handled
	  ○ If applicable, the approach to Quality Assurance/Control
	  ○ If applicable, a communication/outreach plan to convene or engage stakeholders relevant to the project, including targets associated with the number and type of partners.
	  ○ How communications will be maintained among project team members
	• Market Transformation Plan: The applicant should provide a market transformation plan, including the following where applicable:
	  ○ Identification of target market, competitors, and distribution channels for proposed technologies along with known or perceived barriers to market penetration, including a mitigation plan.
	  ○ Identification of a product development and/or service plan, commercialization timeline, financing, product marketing, legal considerations including intellectual property, infrastructure requirements, data dissemination, and product distribution.

	○ Involvement by industry (including technology developers, end users and industry in general) in defining the needs of this application and how such stakeholders have a role during and after project completion.
Technical Qualifications and Resources Approximately 25% of the Technical Volume	The Technical Qualifications and Resources should contain the following information: • Describe the project team's unique qualifications and expertise, including those of key subrecipients. • Describe the project team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project. • Describe the technical services to be provided by DOE/NNSA FFRDCs. • 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

Resumes

Applicants are required to submit 3-page resumes for key participating team members. Individual resumes in excess of this limit are not allowed. Save the resumes in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Resumes".

Letters of Commitment

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

Summary/Abstract for Public Release

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

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 for applicants and proposed direct and in-kind cost share.

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

Budget Justification Workbook

Applicants are required to complete the Budget Justification Workbook. This form is made available on EERE eXCHANGE, attached to this opportunity. Prime recipients must complete each tab of the Budget Justification Workbook for the project as a whole, including all work to be performed by the prime recipient and its subrecipients and contractors. Applicants should include costs associated with required annual audits

and incurred cost proposals in their proposed budget documents. The "Instructions and Summary" included with the Budget Justification Workbook will auto-populate as the applicant enters information into the Workbook. Applicants must carefully read the "Instructions and Summary" tab provided within the Budget Justification Workbook. Save the Budget Justification Workbook in a single Microsoft Excel file.

Technical Work Plan

The Technical Work Plan (TWP) is available on EERE eXCHANGE. Applicants should fill out the template according to the instructions within the document.

User Access Management Plan

Applicants submitting proposals to establish, develop, or upgrade test facilities or other capabilities as described in the topic areas intended for long-term use are required to submit a plan that describes how these capabilities will be utilized, managed, and operated during and after the end of the proposed project. The user access management plan is expected to incorporate two elements: an operations and maintenance plan identifying the capabilities anticipated requirements (in terms of material, labor, funding, repairs, and equipment replacement) and a future strategy for using the capability that includes:

- Plans for engaging external stakeholders,
- A description of the applicant's preparedness and requirements to run future testing or evaluation campaigns,
- A vision for future facility use and description of the applicant's ability to execute that vision, and
- A description of the anticipated capability flexibility for testing beyond the funded ITO project.

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

1. Foreign Entity Participation:

Please reference DOE Directive DOE P 485.1A, Foreign Engagements with DOE National Laboratories.

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 B 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".

Data Management Plan

Each proposal under this Lab Call must have a data management plan (DMP). A DMP explains how, when appropriate, data generated in the course of the proposed work will be shared and preserved in order to validate the results of the work or how the results could be validated if the data is not shared or preserved. The DMP must provide a plan for making all research data displayed in publications resulting from the proposed work digitally accessible at the time of publications.

[Provision for data protection for users of the capabilities]

A Lab may have a previously DOE approved DMP, such as a lab-wide DMP, and to the extent that the DMP applies to the proposal submitted under this Lab Call, the Lab may rely on that DMP to satisfy the DMP requirement of this Lab Call. If there is no existing DMP that can apply and the applicant fails to submit a DMP as part of the proposal, then the default DMP for the proposal is the following:

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

Save the DMP in a single Microsoft Word file using the following convention for the title "ControlNumber_LeadOrganization_DMP".

Treatment of Application Information

Proprietary Information

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

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

Proposals containing confidential, proprietary, or privileged information must be conspicuously marked as described below. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under the Freedom of Information Act or otherwise. The U.S. Federal Government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose.

If a proposal contains confidential, proprietary, or privileged information, it must include a cover sheet marked as follows identifying the specific pages containing confidential, proprietary, or privileged information:

> **1. Notice of Restriction on Disclosure and Use of Data:**
> Pages [List Applicable Pages] of this proposal may contain confidential, proprietary, or privileged information that is exempt from public disclosure. Such information shall be used or disclosed only for the purposes described in this Lab Call. The government may use or disclose any information that is not appropriately marked or otherwise restricted, regardless of source. In addition, (1) the header and footer of every page that contains confidential, proprietary, or privileged information must be marked as follows: "Contains Confidential, Proprietary, or Privileged Information Exempt from Public Disclosure" and (2) every line and paragraph containing proprietary, privileged, or trade secret information must be clearly marked with double brackets or highlighting.

B. Application Review Details

i. 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. ITO will use expert reviewers familiar with the ITO portfolio, goals, and objectives. ITO will collect and collate review scores and comments for use in making final project selections. The ITO Selection Official will consider the merit review results to make the final project selections. For transparency, ITO will provide summaries of the review results to assist labs in understanding how their submission reviewed and aid in improving future work.

ii. Technical Review Criteria

Full Applications

Applications will be evaluated against the merit review criteria shown below:

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

Technical Merit and Innovation

- Extent to which the proposed capabilities and associated technology to be developed are innovative;
- Degree to which the current state of the technology and the proposed capabilities and associated technology are clearly described;
- Extent to which the application specifically and convincingly demonstrates how the applicant will transform the current state of the technology; and
- Sufficiency of technical detail in the application to assess whether the proposed work is scientifically meritorious and impactful, including relevant data, calculations and discussion of prior work in the literature with analyses that support the viability of the proposed work.
- Extent to which the proposal addresses relevancy to manufacturers and meeting manufacturers' needs for future adoption of emerging technologies.

Anticipated Impact

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

Criterion 2: Project Research and Market Transformation Plan (30%)
This criterion involves consideration of the following factors:

Research Approach and Workplan

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

Identification of Technical Risks

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

Baseline, Metrics, and Deliverables

- The level of clarity in the definition of the baseline, metrics, and milestones; and
- Relative to a clearly defined experimental baseline, the strength of the quantifiable metrics, milestones, and a mid-point deliverables defined in the application, such that meaningful interim progress will be made.

Market Transformation Plan

- Evidence that proposed capabilities will be relevant, valuable, and reasonably available to external users and other stakeholders such as industry, academic, or other researchers.
- Identification of target market, competitors, and distribution channels for proposed technology along with known or perceived barriers to market penetration, including mitigation plan; and
- Comprehensiveness of market transformation plan including but not limited to product development and/or service plan, commercialization timeline, financing, product marketing, legal considerations including intellectual property, infrastructure requirements, etc., and product distribution.

Criterion 3: Team and Resources (20%)

This criterion involves consideration of the following factors:

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

iii. Selection for Award Negotiation

ITO carefully considers all of the 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. ITO may select or not select a proposal for negotiations. IDEO may also postpone a final selection determination on one or more proposals until a later date, subject to availability of funds and other factors. ITO will notify applicants if they are, or are not, selected for award negotiation.

iv. Selection Notification

ITO does not have a current estimate for the timing of completing the project selection process and notifying labs of selections.

Once complete, ITO will notify lab leads of selection results from IEDOLabCall@ee.doe.gov and will provide lab leads with summaries of anonymized review comments for each proposal submitted.

v. Questions and Agency Contacts

Specific questions about this Lab Call should be submitted via e-mail to IEDOLabCall@ee.doe.gov. To ensure fairness across all labs, individual ITO staff cannot answer questions while the Lab Call remains open. To keep all labs informed, ITO will post all questions and answers on EERE eXCHANGE.

Appendix A: Lab Call Full Application Worksheet for eXCHANGE

Lab Call Full Application Worksheet

IMPORTANT: This document is provided as a courtesy to allow Lab Call applicants to collaborate offline to develop Full Applications for Lab Calls. All information must be entered into the eXCHANGE system and cannot be submitted with this document.

Please contact ITSIHelp@ee.doe.gov with any questions.

Project General Information

Control Number:

Applicant (Name and Email):

Organization Name:

Project Title:

Topic:

Project Start Date:

Project End Date:

Partner Laboratories:

Partner Laboratory	Email	First Name	Last Name

Is this a continuation of an existing project?

WBS Number:

Fiscal Year Existing Project:

Project Overview (Multi-year):

Project Objectives (Multi-year):

Contact Information

Lab Lead Point of Contact and Business Contact Information

Name:

Email:

Title:

Address:

Phone:

Fax:

Financials

Please add a separate table for each partner laboratory.

Lead Laboratory Name:

Year	Planned Project Costs
2025	
2026	
2027	
Subtotal	

Partner Laboratory (If Applicable) Name:

Year	Planned Project Costs
2025	
2026	
2027	
Subtotal	

Total Planned Project Costs:

Performers

Please add a separate table for each partner laboratory.

Lead Laboratory Name:

Subcontractor Name	Sub Type	Start Date	End Date	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	2025 Planned Costs	2026 Planned Costs	2027 Planned Costs	Total Funding
Subcontractor Subtotal							

Total Planned Project Costs:

Project Plan

Project Tasks:

Task Number	Title	Description	Team Members	Planned Costs	Start Date	End Date

Project Milestones:

Item Number	Type	Title	Description	End Date	Team Members	Criteria

Risks

Project Tasks:

Risk Name	Description	Response Plan	Severity	Probability	Response	Source	Classification	Team Members	Target Completion Date

Modalities/TRL

Modalities:

Modality Number	Modality	FY25 Weight (%)	FY25 Planned Costs ($)
Total:			

Current TRL of the proposed technology (1-9):

Estimated TRL the technology will reach at project end (2-9):

Project Impacts

Deliverable/Product or "Output" Description:

Audience/Customer:

Audience/Customer Use:

Communications/Outreach Strategy:

Does this project involve significant industry engagement?

Description of Engagement:

Associated CRADAs?

CRADA Text

Appendix B: Waiver Requests and Approval Processes

1. Foreign Entity Participation

Please reference DOE Directive DOE P 485.1A, Foreign Engagements with DOE National Laboratories.

2. 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 best interest of the DOE programmatic objectives, is in the economic and energy security interests of the United States, and does not pose an undue foreign influence risk to perform work outside of the United States. A request to waive the *Performance of Work in the United States* requirement must include the following:

- The rationale for performing the work outside the U.S. ("foreign work");
- A description of the work proposed to be performed outside the U.S.;
- An explanation as to how the foreign work is essential to the project;
- A description of the anticipated benefits to be realized by the proposed foreign work and the anticipated contributions to the U.S. economy;
- The associated benefits to be realized and the contribution to the project from the foreign work;
- How the foreign work will benefit U.S. research, development and manufacturing, including contributions to employment in the U.S. and growth in new markets and jobs in the U.S.;
- How the foreign work will promote domestic American manufacturing of products and/or services;

- A description of the likelihood of Intellectual Property (IP) being created from the foreign work and the treatment of any such IP;
- The total estimated cost (DOE and recipient cost share) of the proposed foreign work;
- The countries in which the foreign work is proposed to be performed; and
- The name of the entity that would perform the foreign work.

EERE may require additional information before considering the waiver request.

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