U.S. Department of Energy
Office of Technology Transitions
Technology Commercialization Fund

Base Annual Appropriations

National Laboratory Call for Proposals
Core Laboratory Infrastructure for Market Readiness (CLIMR)

DE-LC-000L124

Fiscal Year 2025

This lab call is being issued as part of the Technology Commercialization Fund Base Annual Appropriations by the U.S. Department of Energy's (DOE's) Office of Technology Transitions, the Office of Cybersecurity, Energy Security, and Emergency Response, Office of Electricity, Office of Fossil Energy and Carbon Management, Office of Nuclear Energy, and the Office of Energy Efficiency and Renewable Energy (EERE), in particular: Advanced Materials and Manufacturing Technologies Office, Bioenergy Technologies Office, Building Technologies Office, Geothermal Technologies Office, Hydrogen and Fuel Cell Technologies Office, Industrial Efficiency and Decarbonization Office, EERE Grid Integration Program, Solar Energy Technologies Office, Vehicle Technologies Office, Water Power Technologies Office, and Wind Energy Technologies Office. This call solicits proposals from DOE National Laboratories, plants, and sites, in collaboration with partners across the DOE National Laboratory complex, to develop and implement programming to facilitate an improved and more impactful lab commercialization process as well as advance technology-specific laboratory intellectual property to market.

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Lab Call Modification History

Modifications will be distributed via email to the points of contact in Appendix C.

Mod. No.	Date	Modification Description
1	10/30/2024	Lab call modified to incorporate the EERE Grid Integration Program.
2	11/20/2024	Lab call modified to include clarification on partnership agreements.
3	11/20/2024	Updated Exchange email address in footnotes and Questions section of the lab call.
4	2/28/2025	Updated Cover sheet for full applications and Exchange full app template to include additional information about I-Corps participation.
5	2/28/2025	Removed all Community Benefits Plan (CBP) sections, which includes Section V.i General Information, Section VII.ii Full Application Merit Review, and Appendix B.
6	2/28/2025	Extended the full application deadline to March 27, 2025. Updated the date for concept paper decisions released to February 19, 2025.
7	2/28/2025	Updated language to topics and areas of interest to remain consistent with the administration's goals and priorities.

Questions

All communications to DOE including questions regarding this lab call must be sent to TCF@hq.doe.gov. To ensure fairness across all National Labs, individual DOE staff cannot answer questions while the lab call remains open, and any questions directed to individual DOE staff will be forwarded to TCF@hq.doe.gov for processing. DOE will post all questions and answers on Exchange.

To view lab call-specific questions and answers, applicants must visit Exchange and select the specific lab call number. The Q&A spreadsheet can be found under the documents section, with the date in the file name to indicate the most recent version. DOE will attempt to respond to a question within three business days unless a similar question and the answer have already been posted on the website. It is the expectation of DOE that applicants to this lab call will review the Q&A spreadsheet before submitting a question. Questions related to the registration process and use of the website should be submitted to eere-epichelpdesk@ee.doe.gov.

Answers to frequently asked questions for the Exchange system can be found at https://eere-exchange.energy.gov/FAQ.aspx. Should applicants experience problems with Exchange, the applicant should contact the EERE Exchange helpdesk for assistance (eere-epichelpdesk@ee.doe.gov) prior to the submission deadlines. The EERE Exchange helpdesk and/or the EERE Exchange system administrators will assist applicants in resolving issues.

For all email inquiries, please include the lab call title and number in the subject line.

I. Background and Context

This lab call represents the combined effort of fifteen distinct U.S. Department of Energy (DOE) programs and the Office of Technology Transitions (OTT). The DOE Technology Commercialization Fund (TCF) was established by Congress through the Energy Policy Act of 2005[1] and reauthorized by the Energy Act of 2020 to "promote promising energy technologies for commercial purposes."[2] The DOE TCF is a primary component of DOE's ongoing effort to commercialize the cutting-edge technologies in which DOE invests. These technologies, developed with taxpayer funding, comprise a portfolio of energy related technologies that have the potential to improve the lives of Americans and solve many of our country's most pressing economic, environmental, energy, and national security challenges.

Within DOE, OTT is charged with leading policy and programs related to technology commercialization, including TCF. The goal of TCF is to improve America's energy competitiveness and security by accelerating commercialization and shepherding critical energy technologies from the lab to the market, where the private sector will continue to innovate.

Tackling today's toughest energy problems requires a comprehensive approach to technology research, development, and commercialization. The research, development, demonstration, and commercial application continuum comprises a pipeline of innovation that connects cutting edge energy technologies to the marketplace. Leveraging the power of compounding, continuous government support of commercialization enabling programs is crucial to mitigate potential adoption risks and close the gap known in industry as the valley of death. Developing the necessary innovation avenues, resources, and programming to support the energy technology ecosystem is critical to ensure the U.S.'s position as a global power, setting precedent for the future of energy security. By pulling strategic programmatic levers, the government can support U.S. industrial players willing to collaborate on the development and commercialization of National Lab-developed technologies.

This solicitation offers an opportunity for external parties to partner with DOE's National Labs to advance energy-related National Lab-developed technology[3] toward

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[1] Energy Policy Act of 2005, Public Law 109–58, 109th Cong. (August 8, 2005), *Improved technology transfer of energy technologies*, 42 U.S. Code § 16391 (a).

[2] Consolidated Appropriations Act, 2021, Public Law 116–260, 116th Cong. (December 27, 2020), 134 Stat. 2597, Sec. 9003. https://www.congress.gov/116/plaws/publ260/PLAW-116publ260.pdf.

[3] To be considered a "National Lab-developed technology," at least 50% of the research and development (R&D) have been conducted at a National Laboratory, plant, or site.

commercialization and to reduce the barriers to commercializing lab-developed energy-related technologies and intellectual property (IP). The intent is to increase the volume and speed to which energy-related lab-developed technologies are integrated into the market from an improved lab commercialization ecosystem.

From this point on, "lab" or "National Lab" implies all DOE National Laboratories, plants, and sites. Additionally, where "technology" is referenced, it could also include data and software.

II. Vision for FY25 TCF Base and Moving Forward

For Fiscal Year 2025 (FY25), DOE continues to implement the previous year's (FY24) approach for TCF Base Annual Appropriations addressing persistent barriers, bridging known gaps that deter the commercialization of laboratory technologies, and identifying where improvements are still needed. The intent of the Commercialization Enabling Topics (Topics 1, 2, 3, 5, and 6 of this lab call) is to fill in missing infrastructure pieces and strengthen existing components by addressing core commercialization challenges, barriers, and gaps, as well as their root causes (inside and outside of the labs). Additionally, the lab call will seek proposals from DOE's National Labs to advance the commercialization of individual energy-related technologies (Topic 4), including supplemental project proposals for the Lab Embedded Entrepreneurship Program (LEEP). DOE TCF funding for this lab call is directly distributed to DOE National Laboratories to enable the advancement and commercialization of National Laboratory technologies. Examples of projects funded in FY24 can be found on DOE's TCF Base website[4].

The goal for FY25 is to identify opportunities to amplify successes and continue to make progress on improving the lab commercialization ecosystem and commercializing lab-developed technologies. The topic areas included in the FY25 Core Laboratory Infrastructure for Market Readiness (CLIMR) Lab Call are the following:

1. Topic 1: Market Needs Assessment
2. Topic 2: Curation of IP, Data, and Software
3. Topic 3: Matchmaking
4. Topic 4: Technology Specific Partnership Projects
5. Topic 5: Enhancing Laboratory Processes
6. Topic 6: Increasing Partnerships with External Commercialization Parties, Private Funders, Non-profits, and Agency- or Lab-Related Foundations

[4] DOE's TCF Base website

This lab call is being issued by DOE's OTT, Office of Cybersecurity, Energy Security, and Emergency Response (CESER); the Office of Electricity (OE); the Office of Fossil Energy and Carbon Management (FECM); the Office of Nuclear Energy (NE); and the Office of Energy Efficiency and Renewable Energy's (EERE's) Advanced Materials and Manufacturing Technologies Office (AMMTO), Bioenergy Technologies Office (BETO), Building Technologies Office (BTO), Geothermal Technologies Office (GTO), Hydrogen and Fuel Cell Technologies Office (HFTO), Industrial Efficiency and Decarbonization Office (IEDO), EERE Grid Integration (EGI) Program, Solar Energy Technologies Office (SETO), Vehicle Technologies Office (VTO), Water Power Technologies Office (WPTO), and Wind Energy Technologies Office (WETO).

Moving forward, OTT and all DOE program offices expect to learn from this FY25 approach and will incorporate lessons learned into future fiscal year TCF approaches and lab calls. The goal for the TCF lab calls and resulting projects or programs, as set forth in TCF's authorizing statute, will continue to be "promoting promising energy technologies for commercial purposes."[5]

III. Key Considerations and Requirements

i. Timeline

KEY DATES	
Lab call release date	October 17, 2024
Informational webinar for lab call overview	October 30, 2024, 3 PM ET
PROPOSAL DEADLINE AND DECISION DATES	
Submission deadline* for concept papers (see Section VI.ii)	December 12, 2024, 3 PM ET
Encourage/Discourage decisions on concept papers back to labs	February 19, 2025
Submission deadline* for full applications (see Section VI.iii)	March 27, 2025, 3 PM ET

[5] Energy Policy Act of 2005, Public Law 109–58, 109th Cong. (August 8, 2005), *Improved technology transfer of energy technologies*, 42 U.S. Code § 16391 (a).

Expected date for selection notifications	Q3 FY25

*Exchange is designed to enforce the deadlines specified in this lab call. The “Apply” and “Submit” buttons will automatically disable at the defined submission deadlines.

ii. Available Funding and Number of Selections

At the time of this solicitation release, Congress has not yet passed a full FY25 DOE appropriated budget. The estimated budget below is based on FY24. The total funding amount available for FY25 will be applied once an official FY25 DOE budget is passed. Based on FY24, approximately $30.1M–$36.8M is expected to be available to fund projects solicited in this lab call pending FY25 appropriations and program direction.

Estimated DOE funding available: $30.1M–$36.8M

Program	Estimated Funding Range (Millions)
Office of Electricity	$1.9 – $2.3
Office of Cybersecurity, Energy Security, and Emergency Response	$0.5 – $0.6
Office of Energy Efficiency & Renewable Energy	$15.6 – $19.1
Advanced Materials and Manufacturing Technologies Office	$1.3 – $1.5
Bioenergy Technologies Office	$2.1 – $2.6
Building Technologies Office	$1.3 – $1.6
Geothermal Technologies Office	$0.6 – $0.8
Hydrogen and Fuel Cell Technologies Office	$1.2 – $1.5
Industrial Efficiency and Decarbonization Office	$1.3 – $1.6
Solar Energy Technologies Office	$2.1 – $2.6
Vehicle Technologies Office	$3.4 – $4.1
Water Power Technologies Office	$1.5 – $1.8
Wind Energy Technologies Office	$0.7 – $0.9
EERE Grid Integration Program	$0.0 – $0.1
Office of Fossil Energy and Carbon Management	$5.1 – $6.3
Office of Nuclear Energy	$7.0 – $8.5

Budget per project: For the Commercialization Enabling Topics (Topics 1, 2, 3, 5, and 6), there is not a budget limitation, and all program offices involved in this lab call are contributing funds. For Topic 4, proposals should not request funding that is greater than the available program office(s) budget. Additionally, select program offices have included a funding limit within the Topic 4 Areas of Interest (AOIs), see Section V.

Estimated number of FY25 projects: 25 – 50

Estimated project duration: 1 – 3 years

The number of selections will depend on the number of meritorious proposals and the availability of congressionally appropriated funds in DOE program offices participating in this lab call. The budget level, tasks, scope, and duration of proposed projects can be adjusted by DOE during selections and negotiations but should be submitted and considered finalized at the time full applications are submitted.

iii. Lab and External Partnerships

DOE strongly encourages proposals that bring together multiple National Labs to meet the strategic goals of this lab call, leveraging multiple lab capabilities and scaling commercialization programs throughout the National Lab complex. To the extent possible and appropriate, DOE also seeks projects that involve industry engagement or partners to enhance the market pull aspects for commercialization. Industry partners must agree to engage in activities that focus on commercializing or deploying technologies in the marketplace and are highly encouraged to provide cost-share. Partners may find the Lab Partnering Service (LPS)[6] or the Visual Intellectual Property Search (VIPS)[7] resources helpful to find National Lab innovations.

All partnerships between the labs and outside partners must comply with individual lab requirements under their management and operating (M&O) contracts. Cooperative Research and Development Agreements (CRADAs) are not required by DOE; however, the DOE lab, plant, or site is required to follow both DOE and their respective policies and procedures with respect to any potential partnering mechanism they pursue e.g., CRADAs, Strategic Partnership Projects (SPPs) agreements, etc. Applicants can discuss specific cases with the technology transfer office at the lab, plant, or site. Applicants should work with lab partners to address any lab IP requirements.

To facilitate multi-lab or external partnerships, Appendix C includes all National Lab Technology Transfer Office (TTO) points of contact (POCs) for TCF. Additionally, DOE is compiling a Teaming Partner List (TPL) on Exchange. The TPL allows organizations that may wish to participate on an application, to express their interest to explore potential partnerships with National Labs.

[6] Lab Partnering Service | Department of Energy
[7] Visual Intellectual Property Search (pnnl.gov)

The TPL will be regularly updated to reflect new interested partners who provide their organization's information. Updates to the TPL will be available on the Exchange website as requesting parties are approved.

TPL Submittal Instructions: Any organization that would like to be included on this list should find the TPL for this solicitation (TPL-0000059) on Exchange and submit the following information: organization name, organization type, website, contact name, contact address, contact email, contact phone, area of expertise, brief description of capabilities, and applicable topic and subtopic. Please refer to the Manuals section on Exchange for more detailed instructions on using the TPL.

Disclaimer: By submitting a request to be included on the TPL, the requesting organization consents to the publication of the submitted information. By enabling and publishing the TPL, DOE is not endorsing, sponsoring, nor otherwise evaluating the qualifications of the individuals and organizations that are identifying themselves for placement on this TPL. DOE will not pay for the provision of any information, nor will it compensate any applicants or requesting organizations for the development of such information.

iv. Cost-Share

This lab call is subject to Section 988 of the Energy Policy Act of 2005 regarding cost-share, which requires 50% cost-share for demonstration and commercial application projects.[8] Cost-share, sometimes referred to as "match" and "nonfederal share," is the portion of the costs of a federally assisted project or program not borne by the Federal government. As an example, a proposal with 20% cost-share commits to a nonfederal cost-share of 20% of the total budget; if the total project budget is $1M, the cost-share from the nonfederal partner is $200K and the federal funding requested is $800K.

DOE prefers all funded projects to meet the 50% cost-share requirement; however, DOE acknowledges that some potentially high-impact proposed projects may not be able to do so. As a result of this, DOE has approved a cost-share waiver so that National Labs may apply with less than 50% cost-share following the requirements by topic below. The scoring criteria reflect that providing cost-share will increase the likelihood of selection. DOE will evaluate the level of external industry engagement and collaboration as evidence by cost-share to ensure maximum impact of the selected projects.

Cost-share partner(s) can be any nonfederal entity, including private companies, state or local governments (or entities created by a state or local government), colleges, universities, tribal entities, nonprofit organizations and foundations, or private funders.

[8] Energy Policy Act of 2005, https://www.federalregister.gov/documents/2019/04/01/2019-06263/cost-sharing-energy-policy-act-of-2005

Cost-share partners must agree, at a minimum, to engage in activities that focus on commercializing or deploying technologies in the marketplace.

Cost-share for Topics 1, 2, 3, 5, and 6

Subtopic	Cost-share	Description
a	50% or more	Proposals commit to meet at least 50% cost-share of total project costs.
b	Less than 50%	Proposals seek less than 50% cost-share of total project costs.

Cost-share for Topic 4

Subtopic	Cost-share	Eligibility
a	50% or more	All applicants are eligible.
b	Less than 50%	To be eligible for this subtopic, National Labs must be partnered with at least one of the following: small business as defined by the U.S. Small Business Administration[9]; domestic institution of higher education; domestic nonprofit entities; U.S. state, local, or tribal government entities; early-stage startup company from LEEP; startup company or team that participated in the Energy Tech University Prize (EnergyTech UP)[10].

For topics 1.b, 2.b, 3.b, 4.b, 5.b, and 6.b, DOE may negotiate the cost-share amount. This may include re-categorizing a proposal from subtopic b to subtopic a if DOE deems there is insufficient cost-share. In addition, the selection official may establish a negotiation strategy that involves increasing cost-share for subtopic b proposals that lack adequate cost-share given the commercial and/or demonstrative nature of the project activities. In such cases, project selection would be contingent on the lab(s) committing to the negotiated cost-share amount or percentage for the project. If the lab(s) decline, DOE may not fund the project.

[9] U.S. Small Business Administration, "Size Standards." https://www.sba.gov/federal-contracting/contracting-guide/size-standards.
[10] EnergyTech University Prize | Department of Energy

For topics 4.b, where multiple partners are involved in a project, if any partner is involved that does not qualify for the lower than 50% cost-share subtopic, then the entire proposal's required cost-share defaults to the required 50% cost-share.

Some cost-share is required for commercial application and demonstration projects.

DOE recommends having a consistent cost-share percentage over the life of the project. The final cost-share requirements for each project will be set at the time of award and can only be adjusted following the modification process which requires DOE approval.

For additional information on cost-share, see Appendix A.

IV. Commercialization Enabling Topics

This section includes the commercialization enabling topics of the lab call, topics 1, 2, 3, 5, and 6. The descriptions for each topic are meant to serve as a guide. Creativity is encouraged and ideas outside from the examples mentioned below will be considered. Partnering with other labs is encouraged to enhance commercialization approaches. In addition, partnering with external parties is also encouraged. Scalability, adaptability, and sustainability should be clear considerations for proposals in these topics. DOE recognizes that every lab is unique and may require tailored solutions; as such, single-lab proposals are eligible and will be considered. However, partnership with other lab(s) is encouraged when applicable.

Additionally, when applicable, proposals should clearly describe how they are either building on existing infrastructure and programming or making changes or improvements. Redundant infrastructure, programming, and projects are unlikely to address the stated scoring criteria in Section VII. Proposed efforts should also help address any root causes (inside and outside of the labs) of existing challenges and barriers. Proposals must only include National Lab-developed technology or technologies[11].

The subtopic cost-share categories for topics 1, 2, 3, 5, and 6 proposals are as follows:

Subtopic a: Proposals commit to meet the 50% of total project cost-share funds requirement.

Subtopic b: Proposals meet less than the 50% of total project cost-share funds requirement.

[11] To be considered a "National Lab-developed technology," at least 50% of the R&D have been developed at a National Laboratory, plant, or site.

Topic 1: Market Needs Assessment

DOE investments in the National Laboratories generate a large quantity of energy-related technologies. Maintaining a deep understanding of market and industry needs and perspectives on the commercialization pathway for specific energy technologies is critical to maximize the impact of the National Lab IP portfolios, benefit to the American people, and pursuit of DOE mission.

Successful commercialization and scale-up of new technologies require deep understanding of dynamic and interacting issues that include:

1. Technology development, which leads to improved unit economics as technologies move down the cost curve.
2. End-use market characteristics and drivers, and the price that customers are willing to pay at the application level. Examples include electric vehicles competing in the consumer market; energy storage competing in wholesale electricity markets; low-emissions steel and cement production techniques competing in low-margin, highly commoditized global industrial sectors; and supply chain dynamics that include global supply chain stacks with asset-level unit economics and demand stacks by application.
3. The policy/regulatory landscape.
4. Public and private investment trends.

We define the analytical thread through these as Commercialization Analysis.

Three Core Components of Commercialization Analysis:

- Analysis of end-use application dynamics *tested via deep industry engagement* with a range of market-relevant stakeholders (customers, investors, regulators, equipment manufacturers, etc.).
- Development of a *shared understanding across the DOE* of the state-of-play in particular market sectors (via relevant real-world data, causal relationships, etc.).
- Development of innovative visualizations (charts, slides, whitepapers, etc.) that effectively communicate and sharpen DOE's understanding of the market dynamics and drivers that interact to create likely commercialization pathways.

This topic seeks proposals to build, augment, and coordinate market and commercialization analytical capabilities within or across the National Labs to maximize success in pursuing DOE's mission as it relates to bringing new technologies to market. The outcomes of proposed projects could inform DOE and lab policies and programs aimed at accelerating the commercial adoption of technologies in a range of important markets and sectors. Systematically identifying strategic priorities and developing a robust market-pull understanding would strengthen the ability of DOE and National Labs to support market-needed innovation.

Proposals should focus on approaches to develop, maintain, and leverage a robust analytical capability that *both* harmonizes existing market analysis expertise across the DOE complex *and* supports capacity-building across the lab complex. Proposals could include opportunities to maximize learning from commercialization analysis best practices across the National Labs.

Proposals could look to the recently released *Pathways to Commercial Liftoff Reports*[12] (referred to as Liftoff Reports) as examples of the type of work that could be coordinated and conducted, and to avoid re-work. Proposals could address ways to regularly apply and/or expand use of the adoption readiness level (ARL) framework[13] into existing or new practices.

Proposals under this topic could include development of:

- A mechanism to integrate commercialization analyses (such as from the Liftoff Reports or other market research reports) into R&D efforts across National Labs and share findings with the wider public.
- Tools and methodologies that build on the Liftoff Reports (or are similar to these reports if the technology is outside of them) to identify technology gaps and market needs for high Technology Readiness Level (TRL) but not yet commercially scaled technologies.
- A capability that utilizes the ARL framework to proactively address commercialization barriers by guiding technology R&D efforts towards market needs and away from adoption risks.

Topic 2: Curation of Intellectual Property, Data, and Software

Once emerging markets and industry needs have been identified, potential promising energy technologies can be selected and pursued for commercial purposes. A streamlining process for curating relevant lab IP, data, software, artificial intelligence (AI), machine learning (ML), etc. to support and enhance developing technologies is of interest. This is key for commercializing technologies in a timely, market-relevant manner, such as in support of DOE's Energy Earthshots Initiative[14].

This topic seeks bold ideas and significant improvements in how National Labs bring their technology to market by compiling lab IP, data, software, etc. and connecting it with

[12] https://liftoff.energy.gov/
[13] https://www.energy.gov/technologytransitions/adoption-readiness-levels-arl-complement-trl
[14] DOE's Energy Earthshots Initiative

commercialization partners. Proposals shall consider leveraging the ARL framework to evaluate technology risks, ecosystem economics, and private sector uptake potential. A tool that identifies low TRL and ARL technologies that have the potential to address critical gaps in U.S. energy infrastructure would be of interest. A program connecting lab developed technologies and IP with entrepreneurial talent to apply to the DOE Small Business Innovation Research (SBIR) or Small Business Technology Transfer (STTR) programs[15] is also of interest, especially if the technology areas are highlighted in topic 4 of this lab call (see Section V). This may only relate to DOE SBIR/STTR Release 2 Topics and not Release 1 Topics, based on the participating DOE program offices. Additionally, there are eligibility requirements to apply to DOE SBIR/ STTR which can be found on the DOE SBIR/STTR website.

Proposed projects could build on and expand successful, existing activities and programs already underway by labs' TTOs, such as Pacific Northwest National Laboratory's exploratory license[16] option. Applicants should propose programs and activities above and beyond existing lab efforts and/or to expand successful programs across the National Laboratory complex.

Applications that address barriers in finding partners should reference the requirements outlined in topic 6, "Increasing Partnerships with External Commercialization Parties, Private Funders, Non-profits, and Agency- or Lab-Related Foundations." Proposals should consider leveraging existing resources developed in this space, such as LPS, VIPS, and/or tools that utilize AI, ML, or natural language processing (NLP). Thus, proposed projects that find a strategy for these tools to be used in more impactful ways will likely better address the scoring criteria in Section VII than those proposing tools that are redundant or duplicative to tools already in existence.

Ideas for this topic include but are not limited to the following:

- Enhanced information sharing to bring awareness to the extensive suite of lab IP.
- A novel approach to categorize lab IP based upon use cases.
- Innovative lab IP marketing strategies.
- Assessing the relevant cross-lab IP, data, software, etc. opportunities.
- Understanding the level of historical and present knowledge at the labs relevant to these inventions.
- Gauging the interest level of the inventors in engaging in commercialization activities as well as the relative maturity and risk profile of the lab IP.

[15] SBIR Funding Opportunity Announc... | U.S. DOE Office of Science (SC) (osti.gov)
[16] Pacific Northwest National Laboratory's exploratory license

- Vetting with external industry, such as (but not limited to) via an advisory board or with industry partners under the program.
- With an informed understanding of industry needs, identifying the assets that are most relevant to these industry needs and their IP protection status.

Under this topic, proposed program lab IP reporting to the relevant DOE program offices may be required on a periodic basis, which could include, but not be limited to, updates on the following: overviews of the industry sectors and partners interested in the curated IP, possible applications of the IP both within and outside of the program office that funded its development, possible improvements requested by industry for full adoption of the IP, and feedback on the potential workforce needs that may result from implementing such IP at scale.

Proposals should incorporate this topic-specific required reporting and feedback mechanism into the proposed project plan to improve processes and matchmaking effectiveness over time. These topic-specific reporting requirements are in addition to all impact-tracking requirements for all topics and proposals under this lab call.

Past examples of projects selected include:

- FY22, VIPS, led by Pacific Northwest National Laboratory
- FY24, Rapid Artificial Intelligence Cycles for Energy (RAIICE), led by Sandia National Laboratories

Topic 3: Matchmaking

Successful technology commercialization is never simply about having the right technology; it requires having a team with the right vision, skills, understanding of the market, and ambition to bring that technology to market. Once multiple technology portfolios have been developed and vetted against market needs and industry interest, teams must be built to commercialize the selected technology and then take the necessary actions to bring the new technology-integrated product to market. This topic seeks proposals to create or expand business incubation programming that will result in the creation of teams that will move National Lab-developed technologies to market.

However, matching and building the team alone is not sufficient. Proposals should also address the additional needed programming and services such as business plan support, funding, business expertise and mentoring, investor and corporate connections, etc., that teams need as they bring their new product to market.

Proposals in this space could seek to leverage and learn from previous and existing relevant DOE programs as well as existing programs outside of DOE, such as the Defense

Advanced Research Projects Agency's Embedded Entrepreneurship Initiative[17], Energy I-Corps[18], and Energy Program for Innovation Clusters[19]. There are several external-to-lab programs in this area that could also be leveraged, built on, and expanded across the National Laboratory complex.

Ideas for this topic include but are not limited to the following:

- Entrepreneurial matchmaking: Programs to connect qualified entrepreneurs to labs that can provide support through various programs and services, such as business plan support, funding, business expertise and mentoring, investor and corporate connections, etc., that will yield commercialization of promising, lab-developed technology.
- Incubators, accelerators, and other entrepreneurial support programs: A program that is designed to support innovators and small businesses further develop their technologies and products toward market adoption, grow their businesses, attract capital and provide networking opportunities. Proposed projects could consider how to better leverage these networks and develop a program for pairing lab-developed technology with commercialization partners (e.g., qualified entrepreneurs, corporate partners, manufacturers, industry leaders, and NLP tools).
- Proposals could include recruitment of talent outside of the National Lab, matchmaking programs to connect entrepreneurs with lab staff and resources, and additional support that will yield commercialization of promising, lab-developed technology. Proposals must only include National Lab-developed technology or technologies[20].

Past example of project selected include:

- FY22, Cradle to Commerce (C2C), led by Lawrence Berkeley National Laboratory

Topic 5: Enhancing Laboratory Processes

Effective and efficient processes are critical to enable and support activities for successful technology transition out of National Labs. Lack of robust processes across the labs can be a major barrier to external partners wanting to commercialize lab-developed

[17] https://eei.darpa.mil/.
[18] Energy I-Corps | Department of Energy
[19] Energy Program for Innovation Clusters | Department of Energy
[20] To be considered a "National Lab-developed technology," at least 50% of the R&D have been developed at a National Laboratory, plant, or site.

technology. DOE also recognizes that some labs may not have adequate infrastructure to support the development of effective processes or a cohesive commercialization approach at their lab. This topic seeks proposals from National Labs to address the barriers to implementing effective and efficient National Lab processes to facilitate advancing lab-developed, promising energy-related technologies toward commercialization.

DOE encourages the National Labs to work together to identify and exchange best practices as well as implement new solutions, including streamlining opportunities, to address lab's commercialization- and technology transfer-related process challenges. DOE envisions that these improvements could connect with and inform new or enhanced programming described in Topics 1 through 3 and Topic 6.

Applications under this topic must seek input from their respective field office(s) and/or other interested DOE organization(s) and office(s) regarding their proposal and potential impacts if the offices and/or organizations have oversight or ownership responsibility over those processes or procedures being addressed by their proposal.

Proposed projects could include but are not limited to:

- Streamlining processes to accelerate and reduce transaction costs of moving from lab to market, for instance—
    - Improving processes for effective implementation of multi-lab agreements and Lab Master Scopes of Work.
    - Identifying best practices and improvements to internal lab contracting processes and mechanisms, e.g., agreements to facilitate access and licensing to IP bundling within and across labs.
    - Enhancing lab policies and processes that facilitate streamlined engagements between lab researchers and industry, including ways to manage conflicts of interest and create/improve upon partnership strategies.
    - Creating and harmonizing solutions across labs and sharing practices on the use of AI/ ML and other tools, data, lab cybersecurity processes (such as data creation, sharing, protection), and platforms to support technology transfer and commercialization activities, such as invention evaluation, licensing and contract management, and IP protection.
    - Improving the use of existing or development of new infrastructure (e.g., websites) or processes to better promote labs' expertise, facilities, capabilities, etc.
- Addressing organizational barriers or identifying gaps in lab innovation culture, organizational visibility, and/or leadership recognition of lab researchers and

technology transfer staff and implementing solutions that develop entrepreneurial and intrapreneurial mindsets, cultures, and/or recognition.
    - Identifying and developing best practices and programs for training, education, and expanding commercialization expertise in lab TTOs. An example could include developing new or expanding ARL tools and capabilities to grow commercialization understanding and better guide lab technologies around adoption risks and to market adoption.
- Improvements to lab-level processes and strategies for protecting discoveries and addressing research, technology, and economic security concerns, including solutions to facilitate lab review processes and sharing related information across labs.
- Performing evaluations that include multi-method approaches, such as quantitative and qualitative data analyses and/or case studies that address lab impact. Proposals may answer to what extent the research, development, demonstration, and deployment (RDD&D), technology transfer, and commercialization processes and activities conducted at and with labs have led to broad technological, economic, and/or social impacts.

Past examples of projects selected include:

- FY24, Leveraging SRNL's Advanced Manufacturing Collaborative (AMC) for Commercialization and Innovation, led by Savannah River National Laboratory
- FY24, AI Technology Licensing Accelerator Solution (ATLAS), led by Idaho National Laboratory

Topic 6: Increasing Partnerships with External Commercialization Parties, Private Funders, Non-profits, and Agency- or Lab-Related Foundations

Increasing partnerships with external commercialization parties, private funders, non-profits, and agency- or lab-related foundations is critical for effective technology transition out of National Labs. This topic seeks proposals to explore how various commercialization stakeholders can offer unique capabilities, resources, or access to support technologies to overcome barriers to commercialization. Goals of this topic area are to decrease barriers to working with the labs, increase the number of partners, and accelerate and deepen connectivity with commercialization stakeholders. Proposals should identify the relevant stakeholder type and entity, outline the specific activities, capabilities, and resources involved, define the partnership scope, and detail how it will streamline and accelerate commercialization. These activities are meant to improve how labs attract, recruit, and retain external partners to further develop and commercialize technologies. DOE envisions that these activities could connect and flow into the new or enhanced programming described in Topics 1 through 3 as well as Topic 5.

Proposed projects could include but are not limited to:

- Program to improve connections between a National Lab and industry partners and/or small businesses, for example, partners working alongside researchers to improve and commercialize lab-developed technologies, using AI to increase licensing with partners, etc.
- Streamlining and standardizing the partnering process across multiple labs.
- Industry-led and -funded incubation or acceleration programming to attract, recruit, and retain external partners to further develop and commercialize National Lab technologies.
- Industry/lab mentor and advisor programming focused on commercialization.
- Best practices guidance for how industry can engage with National Labs to license lab-developed technologies efficiently and effectively.
- Industry day events or teaming events between National Lab(s) and external parties that tie into a larger project or series. Single, standalone events will not be considered without a sustainability plan.
    - Organizing lab-run, sector-specific demonstration or innovation days paired with relevant conferences, such as in support of DOE's Energy Earthshots Initiative.
    - Place-based partnership innovation including identifying region(s) of growth opportunity for lab partnerships, and a plan to identify and engage with potential partners in a region. This could include creating metrics that indicate existing prospects as well as future growth opportunities.
    - Agency- or lab-related foundation or nonprofit partnerships that could further support standing up and scaling successful commercialization programs.

Past examples of projects selected include:

- FY22, Lab MATCH Prize, led by National Renewable Energy Laboratory
- FY23, TCF coLABoratory Open Voucher Call, led by National Renewable Energy Laboratory

V. Technology Specific Topic

This section includes the technology specific areas of interest (AOIs) of the lab call within topic 4. Applications including team members or technologies who have completed Energy I-Corps, a Technology Commercialization Internship Program (TCIP) feasibility study, EnergyTech UP (ETUP), or similar programs are strongly encouraged. Applicants with active projects seeking additional funding to complete their original scope of work are excluded from applying under this topic unless a new scope of work is proposed that meets the intent of this lab call. Determining what that could mean (a phase II effort, a different market, etc.) is at DOE's discretion, but the intention is that applicants cannot use this lab call to ask for additional funding on an existing project. Proposals must only include National Lab-developed technology or technologies[21].

The cost-share structure breakdown for the technology specific projects are as follows, unless otherwise stated in each AOI:

Subtopic a: Proposals commit to meet the 50% of total project cost-share funds requirement.

Subtopic b: Proposals commit to cost-share less than 50% of total project cost. See cost-share Section III.iv for eligibility.

Topic 4: Technology Specific Partnership Projects

This topic will seek proposals from National Labs to advance the commercialization of individual energy-related National Lab-developed technologies. Projects funded under this topic will need to incorporate lab-developed technology (which may include software and data), that are at a stage that will generate private sector interest and should be at a higher TRL. Proposed projects must be commercialization focused, with tasks included in the work plan that involve commercialization and may inform research and development of the lab-developed technology. Proposals must demonstrate clear evidence of commercial potential that combines technology progress with market pull or interest.

Examples of evidence of technology progress include:

- Demonstrated analytical and experimental proof of concept in a laboratory environment.
- Experiments or modeling and simulation validating the functional performance of the technology.

[21] To be considered a "National Lab-developed technology," at least 50% of the R&D have been developed at a National Laboratory, plant, or site.

Examples of evidence of market pull or interest include:

- Market analysis demonstrating the technology's current or expected future cost and/or performance advantages with respect to incumbent or competing technologies.
- Demonstrated interest from private industry partners or investors.

The application must address what the project intends to accomplish in terms of advancing the technology's readiness for commercialization, including current and end project targeted ARL and TRL. Applications must clearly demonstrate the market need the technology will meet, differences that make the technology more competitive than similar technologies, and the feasibility of moving the technology to market. Proposals shall consider leveraging the ARL framework[22,23] to evaluate technology risks, ecosystem economics, and private sector uptake potential.

Applications for this topic must address one or more of the technology areas listed below. Applicants should consult the mission statement for the program(s) from which they are seeking funding. Crosscutting technology applications are encouraged, and applicants are encouraged to apply to multiple AOIs when applicable. Crosscut applications must fully demonstrate how the proposed project addresses each listed technology area. DOE reserves the right to move crosscut concepts to a single technology area or to move concepts submitted for a single technology area to crosscutting (e.g., more than one AOI).

Lab Embedded Entrepreneurship Program

DOE is also seeking proposals for supplemental funding for maturation and commercialization of National Lab-developed technology that leverages LEEP. Proposals under this category must be partnered with a previously selected participant in LEEP and must involve National Lab-developed technology. All applications for new funds must focus on how the project will further the commercialization of National Lab-developed technology, ideally through new scope beyond the base project. Cross-office overlap is highly encouraged (e.g., applicability to multiple AOIs). Applications must specify which AOI(s) and technology area(s) for which they are applying. Applications are not limited to the labs with existing LEEP node programs, all DOE labs are eligible to submit proposals as prime awardees. A single fellowship, as per how LEEP currently exists, is a paid two-year fellowship for one person involved in the leadership of the associated start-up that participates in the program. TCF funds can only be used to fund the National Lab and cannot be used to fund the innovator's associated start-up company. A portion of TCF

[22] https://www.energy.gov/technologytransitions/adoption-readiness-levels-arl-complement-trl
[23] ARL training recording: Adoption Readiness Levels - Overview

funds may be used to extend an existing ORISE LEEP fellowship if the funds are used for the fellow's stipend and the work completed is within the scope of the TCF statement of work. A recommended total budget for projects applying to this option is $250,000–$500,000.

Areas of Interest (AOIs)

AOI 4.01: Office of Cybersecurity, Energy Security, and Emergency Response (CESER)

Overview of Major Mission Areas:

The mission of the Office of Cybersecurity, Energy Security, and Emergency Response (CESER) is to strengthen the security and resilience of the U.S. energy sector from cyber, physical, and climate-based risks and disruptions. CESER addresses the emerging threats of tomorrow while protecting the reliable flow of energy to Americans today by improving energy infrastructure security and supporting DOE's national security mission. CESER's focus is preparedness and response activities to natural and man-made threats, such as cyber threats, climate risks, physical threats, EMP & GMD events, and supply chain.

Outline of Eligible Technology Areas:

1. **Tools and Technologies for Threat Mitigation and/or Response**

Summary of Technology Area #1:

This topic area is specifically focused on commercializing technologies that have direct impacts on the areas of cyber security, energy security, and emergency response for the U.S. energy sector. Proposed solutions may address one or more of the following functions:

- The mitigation of threats to cyber security, energy security, or emergency response for the U.S. energy sector.
- The commercial/industrial sectors' ability to respond to threats to cyber security, energy security, or emergency response.

Applications must demonstrate both technological and commercialization progress. Priority will be given to projects with a TRL of 4 or higher. At a minimum, the proposed component and/or process has been validated in a laboratory environment.

Key Challenges in the Technology Area:

- Adoptability of tools and technologies.

- Scalability of tools and technologies.
- Interoperability of tools and technologies.

AOI 4.02: Office of Electricity (OE)

Overview of Major Mission Areas:

The Office of Electricity (OE) leads the Department's efforts in developing new technologies to strengthen, transform, and improve electricity delivery infrastructure so consumers have access to resilient, secure, and sustainable sources of electricity. OE provides solutions to technical, market, institutional, and operational failures that go beyond any one utility's ability to solve. To accomplish this critical mission, OE engages stakeholders throughout the sector on a variety of innovative technology solutions to modernize the electric grid and enhance key characteristics of the U.S. electric transmission and distribution systems:

- Resilience—the ability to cope with and quickly recover from disruptions and maintain critical function, while maintaining capacity for adaptation and transformation
- Reliability—consistent and dependable delivery of high-quality power
- Flexibility—the ability to accommodate changing supply and demand patterns and new technologies
- Affordability—more optimal deployment of assets to meet system needs and minimize costs
- Efficiency—low losses in electricity delivery and more optimal use of system assets.

Outline of Eligible Technology Areas:

1. **New Grid Scale Long Duration Energy Storage Technologies: Improvement of the performances of sodium/zinc ion batteries at the pouch cell level**

Summary of Technology Area #1:

Studies for next-generation batteries (e.g. sodium ion batteries and aqueous zinc ion batteries) at pouch cell level is vital for practical applications since the performances of materials in coin cells cannot be directly translated in the pouch cells. This study, we will identify the possible failure mechanisms at the pouch cell level via non-destructive, real-time electrochemical approaches. The proposed new approaches will be validated by advanced post-mortem characterizations. Based on the discovered failure mechanisms, this research will further improve the pouch cell performances through rational and systematic experimental design, like external stacking pressure applied onto the pouch cells, the optimum porosity of electrodes for pouch cells, the optimum amount of electrolyte to balance the wetting/diffusion and energy density, testing conditions etc.

Key Challenges in the Technology Area:

The properties of battery materials are usually tested through small-scale coin cells. However, the performances obtained in coin cells cannot be repeated in large-scale pouch cells testing. The performances at pouch cell level are usually limiting, since some engineering problems would only appear or existing in large-scale pouch cells. These problems, such as electrolyte wetting, non-uniformity of electrochemical reaction across large-scale electrode, local stress accumulation, poor contact, etc., which would significantly lower pouch cell performances, leading to much more failure modes (beyond the small-scale coin cell level). Hence, the main failure mechanisms should be identified with a simple, real-time approach without damaging the cells, thereby warranting the development of new testing approach to improve the pouch cell performances corresponding to the discovered failure modes. The studies on how to assemble the pouch cells (e.g. optimizing electrode porosity, electrolyte amount, separators, etc.) and operate the pouch cells (e.g. testing conditions, external pressures) of sodium/zinc ion batteries are urgently required to accelerate their commercialization.

2. **Risk-Informed Resilience Analytics**

Summary of Technology Area #2:

Commercialization of technologies, tools, and analytical platforms to enable risk-informed resilience-enhancing investment decisions. Proposed analytics should illustrate or inform value of investments across all phases of resilience including preparation, response, recovery, adaptation, and transformation. Impacts to system resilience could include, but are not limited to, slow-onset hazards (e.g., extreme temperatures, droughts, sea level rise, etc.) and rapid-onset hazards (e.g., hurricanes, tornados, floods, etc.). Consideration of compound weather and climate risks are encouraged.

Key Challenges in the Technology Area:

In developing commercial technologies to enhance grid resilience, work must be done to address the following challenges:

- Conducting credible treatments of uncertainty (both aleatory and epistemic).

- Communicating the sensitivity of results to the core assumptions of the technology.
- Considering and assessing evolving interdependencies within the energy sector.

3. **Microgrid Planning and Design Tools (MPDTs)**

Summary of Technology Area #3:

A suite of MPDTs has been developed by DOE's National Laboratories to determine how and where to deploy microgrids based on their techno-economic feasibility and operational analyses. These tools are developed to meet various user-defined objectives for the microgrid. MDPTs generate alternative design considerations, help planners improve or optimize their designs while considering tradeoffs between different objectives, and guide the operation of the designed microgrids. While these objectives may vary, they center on resilience, reliability, economics, emissions reduction, and energy efficiency. A representative list of MPDTs is documented in the DOE Microgrid Program Strategy White paper, titled "Integrated Models and Tools for Microgrid Planning and Designs with Operations,"[24] along with descriptions of their capabilities and uses. This topic seeks projects that broaden the use of these tools in the real world of microgrid deployments to provide value to stakeholders. Technology validation, via partnered demonstrations with commercial entities (industry and vendors) in actual field environments, should be a key part of the proposed commercialization effort.

Key Challenges in the Technology Area:

Key challenges to be addressed in this topic include:

- Interoperability with commercial tools/systems with complementary capabilities and clear value propositions; and
- Combining new and existing capabilities that span and support coupling across the multiple time, spatial, and domain scales of planning and design for different performance metrics, requirements, and environments of microgrids.

Technology validation on real use cases or scenarios must demonstrate the tool's value from both blue-sky and black-sky applications and provide sound commercialization pathways to transition the tool into broad commercial use.

[24] https://www.energy.gov/sites/default/files/2022-12/Topic6%20Report.pdf

4. **Grid Enhancing Technologies (GETs)**

Summary of Technology Area #4:

Grid Enhancing Technologies (GETs) are hardware and software solutions that help increase the capacity, efficiency, and/or reliability of our nation's transmission and distribution system. These technologies may come in the form of dynamic line ratings, power flow controllers, topology optimization, or other technologies that could reduce congestion or other constraints at important locations on the grid. While the use of GETs is situational and often unique to a utility, these technologies can assist in getting needed renewable energy and other generation to customers and interconnecting large loads for the upcoming evolution of the grid.

Key Challenges in the Technology Area:

In applying GETs, utilities are often faced with the following challenges:

- Higher initial costs with uncertain return on investment.
- Newer technologies with uncertain lifetime performance.
- The holistic integration of grid enhancing technologies into system planning. including an understanding of how GETs could impact market dispatching mechanisms.
- Equipment installation requirements, estimated schedule, as well as any supply chain challenges.
- Uncertainty on the quantitative and qualitative impact of GETs on system efficiency and reliability.

5. **Advanced Applications for Grid Level Power Electronics**

Summary of Technology Area #5:

Power electronics (PE) refers to the broad set of technologies (e.g., materials, components, subsystems, and systems) necessary for the control and conversion of electricity. A power electronic system (PES) is a self-contained, fully functional collection of hardware and software that safely and efficiently converts current-type (e.g., AC to DC, DC to AC), voltage (e.g., DC to DC), frequency (e.g., AC to AC), or any combination thereof, and conditions electric power according to application-specific requirements. PES are one of the key solutions to modernize the electric grid. These advanced technologies—including solid-state transformers, fault current limiters, high-voltage direct current (HVDC), and power flow controllers—can reduce transmission and distribution (T&D) losses, optimize power delivery, protect critical assets, and enhance resilience.

Key Challenges in the Technology Area:

Some of the key challenges in this area are:

- Thermal management due to the high temperature and high voltage environments of the grid.
- Higher costs compared to conventional technologies.
- Uncertain long-term reliability and lifetime.
- Better quantitative analyses on the benefits and impact of grid level power electronics.

AOI 4.03 Office of Fossil Energy and Carbon Management (FECM)

Overview of Major Mission Areas:

The Office of Fossil Energy and Carbon Management (FECM) uses research, development, demonstration, and deployment approaches to advance technologies to reduce carbon emissions and other environmental impacts of fossil fuel production and use, particularly the hardest-to-decarbonize applications in the electricity and industrial sectors. Priority areas of technology work include point-source carbon capture, hydrogen with carbon management, methane emissions reduction, critical mineral production, and carbon dioxide removal to address the accumulated CO2 emissions in the atmosphere. The Office is also committed to supporting a healthy economic transition that accelerates the growth of good-paying jobs.

Below is a table with the FECM office number and corresponding name which are referenced in the eligible technology areas.

Office Number	Office Name	Technology Areas
FE-221	Hydrogen with Carbon Management	1–3
FE-222	Carbon Transport and Storage	4–5
FE-223	CO2 Removal	6–7
FE-224	Carbon Conversion	8
FE-225	Point Source Carbon Capture	9–12
FE-321	Advanced Remediation Technologies	13
FE-322	Minerals Sustainability	14–16

Outline of Eligible Technology Areas:

1. **FE-221: Technologies for High Purity Oxygen Separation from Air**

Summary of Technology Area #1:

The FECM Gasification Program looks for innovative, flexible and small-scale, modular systems for converting diverse types of blended wastes with biomass into syngas to enable the production of affordable, reliable and low-cost electricity, hydrogen, high-value chemicals, liquid fuels and a market-flexible slate of by-products with greatly reduced greenhouse gas emissions. The small-scale modular systems offer distinct advantages against big commercial scales, expediting technology deployment, cutting capital investment and operating costs, improving availability and offering flexibility in meeting location-specific needs.

Air-blown gasifiers also have bigger systems than oxygen-blown gasifiers due to the high volume of nitrogen in air. The dilution effect of the nitrogen increases the size (and thus cost) and decreases the effectiveness of the CO2 removal equipment. Commercially available cryogenic distillation-based oxygen separation from air is costly and energy-intensive for small, modular systems. Cryogenic systems cannot be scaled down cost-effectively because of huge balance of plant costs. Innovative technologies for oxygen separation from air for small-scale, modular gasification systems are encouraged to increase deployment opportunities.

Key Challenges in the Technology Area:

- Develop and demonstrate a small pilot (lab scale) to have high purity oxygen (above 99%) from air that can show significant capital cost reduction compared with a commercial/conventional cryogenic distillation-based oxygen separation technologies from air, in application of smaller, modular systems.

2. **FE-221: Accelerating Hydrogen and Natural Gas/Hydrogen Blend Gas Turbine Combustion Simulations with Stiff and Detailed Kinetics Using Machine Learning Tools**

Summary of Technology Area #2:

The H2 based gas turbine systems are being developed by many industries. However, computational tools to effectively capture combustion of pure H2 and blends of H2 with Natural gas or NH3, are not fully matured to be used for design purposes. For example, computational tools are currently challenged to capture flame position correctly or correctly predict important pollutants like oxides of nitrogen. One specific challenge is with regards to combustion modeling and stiff chemical kinetics that may be associated with detailed reaction mechanisms. Solving for stiff chemistry adds significant computational cost to already expensive computational fluid dynamics calculations. There is opportunity to use machine learning tools to accelerate combustion simulations with stiff and detailed kinetics. Developing, validating, and subsequently implementing computational tools for combustion modeling in commercial codes used by industry are of interest.

Key Challenges in the Technology Area:

- Large chemical kinetics mechanisms with stiff kinetics that increase the computational cost of gas turbine combustor simulations
- Availability of sufficient experimental data to perform robust validation of simulations
- Transfer of computational tools to software vendors and subsequent adoption by gas turbine industry.

3. **FE-221: Lower Cost Alloys for High Performance Energy Materials in Challenging Applications**

Summary of Technology Area #3:

The FECM Advanced Energy Materials Program looks for innovative, lower cost, high strength advanced alloys to reduce capital costs and improve performance of energy systems. Several DOE National Labs have developed modified alloy compositions to reduce cost and improve performance, and these can be attractive for deployment by commercial partners.

Deployment of affordable, durable heat-resistant steels, superalloys, and other advanced alloys with improved high temperature strength and oxidation/corrosion resistance compared to commercial alloys can improve the efficiency, reliability, and safety of advanced energy systems at reduced costs. For example, martensitic-ferritic or austenitic stainless steels with increased temperature capability compared to commercially available steels are a low-cost substitute for more costly high temperature alloys. Improving the high temperature strength of superalloys will decrease the mass of components (e.g., thinner tube walls, thinner heat exchanger surfaces, etc.) resulting in reduced system cost and increased system efficiency. High entropy (or multi-principal element) alloys offer thermodynamic stability, and thus can be more stable and resist degradation at elevated temperatures compared to conventional alloys. Stainless steels[25], and advanced alloys[26,27,28] are examples of alloys developed at the national labs and supported by the FECM program. The properties of these alloys make them attractive for use in hydrogen and other extreme and harsh service environments.

Key Challenges in the Technology Area:

- Qualifying and/or certifying an alloy for specific use applications. This may require generating performance data on alloy properties that may have not been evaluated during development but are required for application.
- Upscaling alloy production to industrial scale for ingots and powders.
- Demonstrating the joinability and manufacturability (including advanced manufacturing) of components produced from the alloy composition.

4. **FE-222: Tools for Advancing the Deployment of CO2 Transport and Storage**

Summary of Technology Area #4:

The goal of the FECM Carbon Transport and Storage (CT&S) program is to ensure that carbon capture and storage (CCS) and carbon dioxide removal (CDR) project developers and operators have a comprehensive suite of commercial-ready tools for enabling safe and secure operations of carbon transport and storage in the nation's diverse on- and offshore carbon storage resources. To meet this goal the CT&S program is investing in research, development, and demonstration projects that advance technologies related to all aspects of the safe transport and secure geologic storage of CO2. The CT&S program-supported commercial storage facility projects and large regional transport and storage hubs are establishing the initial infrastructure upon which the emerging CCS and CDR industries can grow to national deployment scale. The program's RD&D strategy is to invest in a diverse portfolio of next-generation technology development projects, ranging from proof-of-concept to applied field validation and testing that advance low-cost, high-performance technologies for eventual commercial adoption by CCS and CDR project developers.

Key Challenges in the Technology Area:

[25] 24FECM_AEM_Chen.pdf (doe.gov)
[26] NETL Advanced Alloy Development
[27] Nickel Based Superalloy development
[28] Predictive Design of Novel Ni-Based Alloys

FECM CT&S program seeks projects that substantially improve upon the current state of the art in the following carbon storage technology areas (as applied to both on- and offshore carbon storage):

- Detection and location of potential transmissive pathways in storage resource caprocks.
- High-resolution, real-time monitoring technologies and intelligent monitoring systems (IMSs) for CO_2 plume monitoring.
- Continuous, accurate, high-resolution measurement of evolving stress-state away from the wellbores.
- Capability to quantify and verify CO_2 storage efficiency and containment in fractured basalts, shales, coals beds, karst, and other reservoirs that depart from the traditional clastic saline aquifer paradigm.
- Geophysical monitoring technologies to measure and/or infer in-situ dynamic pressure in fractured basalts.

5. **FE-222: CO_2 Transportation System Leak Detection and Monitoring**

Summary of Technology Area #5:

To achieve long-term, high performance of CO_2 transportation systems it is paramount to minimize any potential, unplanned releases to the environment through rapid identification and response. Advancing the current state of the art in leak detection and monitoring capabilities in CO_2 transportation supports the reduction in large, unplanned releases through leak and rupture mechanisms. DOE is seeking proposals to address potential challenges in leak detection and monitoring systems by investigating and demonstrating improvements to leak detection performance through enhanced digital and physical metering tools and equipment, surveillance systems at facilities, transportation system mass balancing, and infield leak detection sensors.

Key Challenges in the Technology Area:

FECM CT&S program seeks projects that substantially improve upon the current state of the art in the following CO_2 transport technology areas:

- Digital and physical metering systems for CO_2 service conditions and potential compositional impurities.
- Transportation system-wide mass balancing technologies to account for various sources and offtakes.
- Transportation facility leak detection and monitoring systems (e.g., metering, pigging, valving, multimodal transfer facilities).
- Field deployable leak detection sensors along transportation routes and corridors.

- Hand-held sensors and monitoring technologies for first responders and general public.
- AI/ML computational tools and methods to enhance traditional leak detection and monitoring tool performance and capabilities.

6. **FE-223: Direct air capture supply chain mapping**

Summary of Technology Area #6:

Scaling up direct air capture will involve significant amounts of raw material inputs to produce the sorbents, solvents, and equipment required to support gigaton-scale removal. These inputs range from basic chemical precursors required to produce common amine- and hydroxide-based capture materials to manufacturing of equipment commonly used in direct air capture processes including fans, air contactors, monoliths, vacuum pumps, and compressors. FECM is seeking a full supply chain mapping and analysis for a range of direct air capture technologies at progressively larger scales with a focus on gaps and corresponding interventions to proactively address them.

Key Challenges in the Technology Area:

- Implementing direct air capture facilities at scale will generate significant upfront and ongoing demand for a variety of materials and equipment. Supply bottlenecks could therefore emerge that increase the time and cost to reach and maintain larger operating scales. Identifying these bottlenecks early could help develop cost-effective mitigation strategies and inform early direct air capture design choices.
- Direct air capture plants involve a wide variety of novel and off-the-shelf materials and equipment, all of which may have different capacities to absorb excess demand generated by increasing direct air capture deployments. Coordination will be required across these supply chains to ensure that facilities can be efficiently constructed and scaled up. This may involve increasing manufacturing capacities or establishing new production capabilities, both of which may require advance planning.
- Technology developers are continually innovating on direct air capture systems, and some design decisions may be influenced by supply chain considerations. This adds a level of complexity and dynamism to supply chain analysis, requiring further study.
- The U.S. has existing manufacturing capabilities to produce some of the needed materials and equipment types domestically, but production and transportation will need to be coordinated with regional project development.

- Similarly, the U.S. has an opportunity to develop an even stronger manufacturing base that can serve domestic and international direct air capture scale-up, but this requires an assessment of existing and needed production capabilities.
- Removing carbon dioxide via direct air capture is still fairly expensive, and cost declines will be a function of economies of scale, which are driven by supply chain efficiencies. Supply chain assessments would help inform optimal cost reduction strategies for direct air capture technologies.
- Nascent direct air capture technology developers may not have the time or resources to conduct comprehensive supply chain mapping and analysis on their own.

7. **FE-223: Mechanism to assess commercialization and market viability of CDR suppliers**

Summary of Technology Area #7:

CDR technologies will rely on carbon credit markets (both voluntary and compliance), coproducts, and environmental remediation/co-benefits to generate the revenue and finance necessary to scale. Little assessment has been done regarding the adoption readiness levels (ARL)[29] and market viability of different CDR pathways. FECM is seeking a willingness to pay and adoption readiness level assessment of multiple CDR technologies to understand and address barriers to commercialization. Specifically, considerations of workforce, market size, delivery cost/willingness to pay, capital flow and investment landscape, and permitting and siting will all inform the commercial viability of CDR technologies.

Key Challenges in the Technology Area:

- Carbon removal technologies without sufficient market readiness may fail to be commercialized and thus assist with achieving U.S. climate goals. Accordingly, an assessment of market viability is needed so DOE can structure cost-share programs and other efforts to address commercialization bottlenecks.
- Carbon Dioxide Removal (CDR) credits are different than many other types of commodities given that no physical product is delivered. Additionally, much of the CDR business model is predicated on future technological and market developments. Identifying key barriers to market entrance would be useful to CDR

[29] Adoption Readiness Levels (ARL): A Complement to TRL | Department of Energy

companies looking to develop bankable business models and to others seeking to develop foundational strategies for the CDR ecosystem.

- Deeper analysis is required to understand the impact of co-products/by-products and co-benefits from CDR processes on assisting the industry's scaling ambitions.
- The CDR market itself is still nascent and more analysis is needed to identify key barriers to market participation across the CDR portfolio. The value of CDR credits on the voluntary carbon market is still needed to understand competitiveness and value propositions within the broader carbon offset and CDR credit market.

8. **FE-224: Emerging Thermochemical CO2 Conversion technologies**

Summary of Technology Area #8:

Thermochemical CO2 conversion is one of the CO2 conversion routes that has shown the most near-term potential. Demonstrations for some of these technologies, such as reverse water-gas shift and CO2 methanation or hydrogenation, have seen some demonstration or commercialization at scale. This topic area specifically targets novel thermochemical CO2 catalysis technologies **that go beyond those that have already been demonstrated at high TRL**. This could include novel metal catalysts, advanced reactor designs, or innovative downstream process technologies to enable the production of fuels and chemicals from CO2 via thermochemical routes. *All applicants must clearly articulate the advantages of their technology compared to other existing CO2 thermochemical conversion routes to the same products (if applicable) in terms of cost or carbon intensity improvements.*

Key Challenges in the Technology Area:

- Intensifying thermochemical processes in a single stage instead of two; this presents the potential to be a more economical and efficient process. This could include multifunctional catalysts or tandem catalysis.
- Improving catalyst selectivity to specific molecules.
- Improving catalyst robustness to poisoning by impurities, coproducts, or water.
- Techniques that can help overcome the equilibrium constraints of thermochemical conversion yields, such as in situ product removal.
- Process integration and scale-up, including integrating new reactor designs or downstream separations.

Areas not of interest for this Topic Area include:

- Any route that uses a method of CO_2 reduction besides thermochemical (i.e., electrochemistry, plasma catalysis, biocatalysis, etc.).
- Any carbon feedstock other than CO_2.
- Reactive carbon capture technologies.
- Processes that are limited to laboratory-scale operation without potential for future commercialization.

9. **FE-225: Enabling technological and engineering solutions to achieve high purity CO_2 product streams for carbon transport and storage (CT&S)**

Summary of Technology Area #9:

To ensure that point source carbon capture (PSC) systems can be easily, safely, and systematically integrated with carbon transport and storage systems, it is crucial that the exiting product CO_2 steams adhere to the guidance of transportation and storage specifications. These requirements can vary based on the methods of transportation (e.g., steel pipeline, land or ocean shipping) or storage (e.g., saline aquifers, depleted oil and gas fields, coal beds, and other geologic formations). In the U.S., the current and future predominant method of CO_2 transport will likely be pipeline infrastructure.[30] In order to meet pipeline regulatory requirements and provide pipeline feed CO_2 which allows for safe operation, certain feed gas components need to be kept under narrow volume percent (vol%) ranges. Ancillary components or pollutants of interest to reduce and/or remove include water, non-compressible gases, acid gases, amines/nitrosamines, ammonia, mercury, carbon monoxide, and any other volatiles or un-combusted hydrocarbons. DOE is seeking conceptual designs for PSC carbon capture materials, processes, or systems which can lead to significant reductions of key impurities or enable direct injection of CO_2 streams into pipeline.

Key Challenges in the Technology Area:

- Design and develop cost effective PSC technologies, systems, or process configurations which can achieve over 95% CO_2 purity and lower the content of the impurities in the CO_2 product, including but limited to: water, O_2, SO_x, NO_x, H_2, residual amines or degradation products (if applicable). For guidance on CO_2

[30] Building Our Way to Net-Zero: Carbon Dioxide Pipelines in the United States. *Global CCS Institute*. 2024.

specification, please refer to NETL "Quality Guidelines for Energy System Studies: CO2 Impurity Design Parameters."[31]

- Demonstrate the potential for the configuration and design of these materials, systems, or technologies to achieve a capture rate of no less than 95% while meeting the CO2 quality specifications required for the proposed application.
- Identify and highlight key technology gaps which require additional R&D to achieve the purity conditions stated above.
- Accommodate various flue gas compositions, flows, and makeups from different point-source users such as stationary coal/natural gas power facilities or industrial emitters (e.g., cement and concrete, petrochemicals, pulp and paper, iron and steel, and glass) and predict and report how the capture system will respond to impurity fluctuations to continue to meet the strict CO2 purity requirements.
- Identify potential co-benefits within materials, systems, or process configurations which can simultaneously capture CO2 and deal with the mitigation of other ancillary pollutants found in the flue gas of stationary powerplants and industrial facilities such as NOx, SOx, Hg, ammonia, un-combusted hydrocarbons (CxHy), particulate matter, aldehydes, and mercury.

10. **FE-225: Advancing the co-design membranes, accelerated testing, and advanced manufacturing techniques for adoption of membrane-based CCS technologies**

Summary of Technology Area #10:

Among the point source carbon capture technologies that DOE aims to advance from bench-scale to pilot-testing scale, membranes for CO2 capture show promise when compared to other mature technologies, such as solvents, due to their reduced plant footprint with lower capital costs, tolerance to flue impurities such as elevated SOx and NOx, simple operation with no rotating or moving parts, and modular design which can simplify scale-up and plant retrofit designs.[32] While there are significant efforts in advanced membrane designs for high CO2 permeance and CO2 selectivity, one challenge for membrane adoption and scale-up for PSC is lack of membrane system co-design, accelerated membrane testing, and the development of dedicated manufacturing techniques to scale-up CO2 capture membranes. The DOE is seeking applications to tackle the challenge through 1) co-design of membranes, with process technology and systems

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[31] Quality Guidelines for Energy System Studies: CO2 Impurity Design Parameters (Technical Report) | OSTI.GOV

[32] Membranes for Carbon Capture, National Energy Technology Laboratory (NETL), 2023.

engineering approaches, to assist in easier technology integration at the pilot scale and de-risking; 2) accelerated and high-throughput membrane testing systems and configurations for PSC will allow for enhanced quantification of membrane performance and provide a robust platform for membrane scalability; 3) advanced manufacturing systems and techniques which can enable higher throughput of new membrane materials in addition to roll-to-roll (R2R) skids for pilot-testing.

Key Challenges in the Technology Area:

- Co-design of membranes and membrane technologies for PSC applications:
  - Propose membrane materials, systems, and technologies which are co-designed utilizing systems analysis and engineering tools such as process modeling, AI/ML, etc., to inform the membrane chemistries and predict performance.
  - The ease of manufacturability, sourcing, and processability of chemicals, membranes, solvents, systems, modules, and components of the proposed technology is highly desired.
  - Integration of new membranes into existing process technologies and engineered systems should be considered and any potential bottlenecks should be identified and discussed.
- Accelerated and high-throughput membrane testing for PSC applications:
  - Demonstrate lab-scale/bench-scale membrane testing systems which can assess the following parameters in a rapid manner:
    - Membrane permeance and gas selectivity.
    - Sensitivity to particulates and other flue gas contaminants (NOx, SOx, CO, etc.).
  - Demonstrate capabilities for “accelerated field” tests which can assess the following variables:
    - Aging and membrane performance over time.
    - Fouling, clogging, and pressure drop.
    - Preliminary energy cost calculations.
  - Utilize integrated approaches for assessing membrane performance, such as AI/ML algorithms for data analysis.
- Proliferation of advanced manufacturing techniques and systems for scaling membranes:
  - Development, testing, and scaling of novel membrane assembly and manufacturing techniques to improve production time, cost, and feasibility.

- Membrane cost and yield, manufacture operating costs, and quality should be considered and optimized.
- Goal should be to increase R2R efficacy and efficiency.

Areas not of interest for this Topic Area include:

- Fluorinated polymers, supports, or membrane components should be highly limited, and their use is discouraged (e.g., PFAS).

11. **FE-225: Integrated CCS system digital twins**

Summary of Technology Area #11:

The diversities of point sources of CO_2 emissions and offtake options for the captured CO_2 pose significant challenges to cost-effective customization of carbon management solutions. They also add to the complexity in engineering and operations of integrated carbon capture, transport and storage systems and hinder the ability to reduce the costs of CCS system design and operations. Digital twins, combined with artificial intelligence (AI), has great potential to help accelerate the development of commercially deployable CCS solutions for diverse emission sources, optimize the CCS value chain, and enable CCS system to evolve with the ever-changing energy system to stay relevant and effective to the world's decarbonization needs. In this topic area, DOE seeks proposals to develop conceptual designs for integrated CCS system digital twins that can identify carbon capture technology pathways for specific fossil fuel power plants or industrial facilities and CO_2 offtake (including transport) solutions. The technology pathways/solutions should minimize the system cost of capturing a minimum of 95% of the emissions from point sources with impurity levels meeting the requirements of pipeline transport of CO_2. The digital twins should be able to assist with flexible operation of the integrated CCS system by analyzing large volumes of data, predicting the effect of load/environmental changes on the physical systems, detecting defects, and developing actionable information to support decision making.

Key Challenges in the Technology Area:

- Methodologies to identify suitable approaches (techniques, tools, platforms, etc.) to model, simulate, and optimize the design and operations of integrated CCS systems at power plants and industrial facilities.
- Innovative approaches to obtaining high-quality information required to enhance the digital twins, e.g., overcoming the challenge of data confidentiality, assembling

data from diverse carbon capture systems and emission sources, and processing the raw data to be analysis ready.

- Strategies to use AI to reduce the cost and enhance the robustness of analyzing complex systems and dynamics.
- Framework to generate high-quality data products and dedicated tools tailed to power plants and industrial facilities, respectively, to perform tasks including but not limited to:
    - Historical and real-time data management to support regulatory reporting, performance analysis, and development of future digital/AI tools
    - Scenario/Sensitivity analysis to support process intensification, heat integration, predict both plant and entire process (e.g., industrial source, carbon capture unit, transportation, and storage) responses to start-up, turndown, turnaround, and potential upset/flare cases
    - Process monitoring and evaluation to help identify potential issues, determine optimal operational parameters in response to process and environmental variations
    - Risk assessment on equipment/infrastructure maintenance needs to minimize downtime and extend asset life
    - Enabling virtual testing of new materials and processes and visual representation of integrated CCS systems for stakeholder engagement.

Areas <u>not</u> of interest for this Topic Area include:

- Component twins that cover less than one segment of the CCS value chain in addition to the point source of emissions and carbon capture

12. **FE-225: Innovative cryogenic methods for CO2 purification from power or industrial point source facilities**

Summary of Technology Area #12:

Cryogenic processes for PSC from power or industrial facilities use low temperatures to separate and purify CO2 from flue gas sources. The most common methods are currently cryogenic distillation, where CO2 is separated based on boiling point differences, and de-sublimation, where CO2 is separated as a solid based on thermodynamics. Cryogenic methods for CO2 capture are advantageous as they can be more tolerant to other components in the flue gas, produce a very high purity CO2 product, and not require the use of potentially harmful chemicals or solvents; however, scale-up of cryogenics can be challenging due to the energy-intensive nature of the low-temperature processes. Additionally, higher capital costs are generally expected due to cryogenic cooling which necessitates compression and higher material costs. The DOE is soliciting applications that help reduce energy and capital costs of cryogenic PSC through new and innovative materials, technologies, and systems and support technology scale up advanced cryogenic CO2 capture technologies.

Key Challenges in Technology Area:

- Innovative material designs which can assist in the development of novel cryogenic carbon capture systems from point-source emission flue gases. This can include, but is not limited to:
  - Cryogenic sorbent materials
  - Cryogenic packing materials for enhanced distillation/de-sublimation
  - Cryogenic membrane materials
  - Hydrate-formation systems
  - Non-aqueous cryogenic solvents (e.g., deep eutectic solvents, ionic liquids).
- Innovative systems which consider new process configurations, heat exchangers, compressors, cold box designs, etc., to lower CapEx/OpEx, and energy requirements for cryogenic PSC.
- Design of hybrid capture systems involving cryogenic PSC as a means to enhance and improve the efficiency of cryogenic processes:
  - Membrane systems + cryogenic capture
  - Solvent systems + cryogenic capture
  - Sorbent systems + cryogenic capture
  - Other novel technology systems + cryogenic capture.
- Carbon capture efficiency should be >95% and the CO2 purity should be >99.8 vol% (min).
- Cryogenic systems should be able to tolerate a wide range of CO2 concentrations observed from power to industrial facilities (3–25 vol%). Cryogenic systems which can operate at lower CO2 concentrations (i.e., <5 vol%) without compromising energy costs are especially of interest.

13. **FE-321: AI/ML Applications for Induced Seismicity Management in Oil and Gas Producing Basins of West Texas**

Summary of Technology Area #13:

FECM's Advanced Remediation Technologies Division invests in developing new technologies to fully treat produced water and enable (1) the beneficial reuse of treated water outside of the oil industry, and (2) a reduction in the volumes of produced water disposal through deepwater injection wells. Produced water disposal has been linked to a significant increase in the frequency and magnitude of seismic activity in West Texas. However, the relationship between saltwater injection and associated earthquake activity in the region is not well understood.

This topic area focuses on developing artificial intelligence/machine learning assisted approaches for both managing and forecasting induced seismicity in West Texas. Developed methods will improve subsurface data analysis which, coupled with saltwater disposal injection information and other relevant data (e.g., 3D seismic data), will help provide insights from historical seismic activity and its association with dynamic reservoir/fault conditions.

Key Challenges in the Technology Area:

- Ability to access proprietary data: produced water disposal rates, subsurface data.
- Ability to accurately process and integrate sparse datasets for AI/ML based applications that rely on sufficient quality data.

14. **FE-322: Technologies for Converting Stranded and Underutilized Natural Gas to Sustainable Industrial Chemicals and Carbon Products**

Summary of Technology Area #14:

This topic area focuses on developing technologies that are capable of transforming stranded natural gas or underutilized natural gas waste streams into marketable chemicals with a focus on low emissions and sustainability, with a particular focus on laboratory validation of technologies that can eliminate waste streams such as natural gas flaring and that enable the beneficial use of other sources of underutilized or stranded natural gas through sustainable conversion to industrial chemicals. This will require multidisciplinary breakthroughs in nanoscale material design for single-site catalysts, catalyst support structures, gas separation membranes, and sorbents. Developments in nano and microscale process intensification, advanced reactor equipment design and manufacturing methods, and the development of new chemical pathways and processes will also be needed. Programs should focus on component and full system validation in a laboratory environment that accelerates future commercialization efforts in collaboration with an industry partner.

Key Challenges in the Technology Area:

In maximizing the benefits of existing oil and natural gas resources including waste streams, work must be done to address the following challenges:

- Associated gas streams are intermittent, have large variation in total gas volume from well to well, and experience transient feed flow rates and field gas pressures over time.
- Rather than being pure methane that would be more ideal for most conversion methods and catalysts, underutilized natural gas streams are typically minimally processed casinghead gas streams that contain higher chain hydrocarbons, other nonhydrocarbon gases, moisture, and other contaminants.
- Modular systems deployed at well sites do not have the "economy of scale" or the supporting infrastructure that centralized natural gas to liquids conversion facilities benefit from allowing them to successfully compete in existing commodity markets.
- Economic pressure motivates natural gas flaring when oil is present in high volumes and is produced in areas where no infrastructure is in place to transport the associated gas, severely limiting the adoption of modular conversion technologies with even moderate capital and operating costs.
- Locations where these technologies would be most beneficial can be remote, with limited or no access to utilities, make-up water, and other services.
- Typical products created from methane conversion methods like pyrolysis may have limited market size or require high purity, such as carbon nanotubes, or suffer from potential market saturation, like amorphous carbon black.
- Catalytic approaches that directly convert methane to other chemicals typically suffer from low catalyst activity or fast catalyst deactivation, create unwanted side products, or require high severity of operation.
- Oxidative chemical pathways for converting methane typically require the costly operation of an air separation unit and can suffer from overoxidation.

Areas not of interest for this Topic Area include:

- Biological conversion based on gas fermentation.
- Processes that utilize single function catalysts and require multiple steps to convert methane into a sustainable chemical.

- Processes that are limited to laboratory-scale operation without potential for future field-based validation and commercialization for use at well sites as an alternative to non-safety related flaring.
- Natural gas processing technologies that do not include chemical conversion, such as condensate removal, natural gas liquid (NGL) separation, and contaminant removal.
- Technologies centered on hydrogen production as the primary product and do not create a marketable carbon product or hydrocarbon chemical.

15. **FE-322: Capabilities Enhancements for Clean Hydrogen Production from Produced Water**

Summary of Technology Area #15:

The Natural Gas Decarbonization and Hydrogen Technologies (NGDHT) program seeks to demonstrate the production of hydrogen from the processing of produced water and mineral substances from upstream oil and natural gas systems. The two most common methods for producing hydrogen are steam-methane reforming (reforming methane to separate hydrogen and carbon molecules) and electrolysis (splitting water with electricity), which both require significant quantities of high-purity water. As a clean hydrogen economy grows, water demand will increase, and new sources of clean water need to be identified as clean hydrogen feedstocks. The production of oil and natural gas resources are directly connected with the use of water, where water makes up most of the fluid used to drill wells and fracture oil- or gas-bearing formations. Water is also an important co-product that is brought to the surface with hydrocarbons, known in industry as produced water. Depending on the geochemistry of the rocks in the targeted reservoirs, produced water may contain many different chemical constituents (i.e., dissolved mineral salts), or it may be mixed with organic compounds (i.e., acids, waxes, and mineral oils). It may also be mixed with inorganic metals and byproducts, or with trace amounts of heavy metals and naturally occurring radioactive materials.

Key Challenges in the Technology Area:

In maximizing the benefits of existing oil and natural gas resources produced water waste streams, work must be done to address the following challenges:

- Develop relevant water treatment methodologies for clean hydrogen production pathways.

- Enhance existing treatment and conversion technologies for novel end uses and site-specific hydrogen consumption.
- Improve characterization methodologies for produced water to achieve levels of water purity necessary for clean hydrogen production.
- Enhance technical capabilities for assessing the potential of suitable produced water resources in proximity to industrial or power sector end-users.
- Quantify the potential of the proposed technology for significant improvement in the economic performance measured against those established by the DOE Hydrogen Shot Goal of $1 per kilogram of clean hydrogen production by 2030.
- Report techno-economic modeling in a manner that enables direct comparison of cost and efficiency to a relevant baseline.
- Encourage technology transfer of any site-specific insights to related produced water management organizations, systems, and enterprises.

Areas not of interest for this Topic Area include:

- Biological conversion based on gas fermentation.
- Processes requiring multiple steps to convert methane into a hydrogen.
- Processes that are limited to laboratory-scale operation without potential for future field-based validation and commercialization for use at well.
- Hydrogen technologies that do not include utilizing produced water conversion, such as condensate removal and NGL separation.

16. **FE-322: Subsurface Monitoring Capabilities Enhancements for Underground Hydrogen Storage (UHS) Evaluation**

Summary of Technology Area #16:

The NGDHT program seeks to advance opportunities to demonstrate underground hydrogen storage (UHS) monitoring technologies. Preliminary evaluations of long-term hydrogen storage potential are being undertaken at laboratory scales, however, future field-based research focused is required for the development of large-scale UHS like DOE's Hydrogen Hub projects. Fossil-based Hub projects are targeted towards the safe and efficient conversion of natural gas into clean hydrogen; the safe, emissions-free transportation of hydrogen using existing natural gas infrastructure to end-users; and the injection, storage, and extraction of hydrogen from subsurface reservoirs – activities all necessary to achieve Administration goals by 2035. Critical to technology maturation and demonstration are ongoing challenges related to effective geomechanical, geochemical, and geophysical evaluations within subsurface storage systems to understand injection and withdrawal cycles and optimize gas recovery.

Key Challenges in the Technology Area:

By advancing geomechanical, geochemical, and geophysical assessment tools and technologies to:

- Demonstrate state-of-the-art technologies for in-field monitoring for UHS pilot projects.
- Improve characterization methodologies for the impact of hydrogen on formation fluids, reservoir rock, and wellbore materials to mitigate hydrogen losses.
- Develop evaluation approaches that improve storage permanence and long-term hydrogen extraction potential within the subsurface.
- Provide more effective characterization pathways for commercial-scale evaluation of UHS reservoir performance.
- Define metrics for subsurface monitoring technologies to interpret reservoir characteristics during injection and withdrawal cycles of hydrogen from the subsurface.
- Enhance technical capabilities for assessing the potential of suitable depleted oil and natural gas reservoirs, saline formations, or salt structures for long-term storage in proximity to industrial or power sector end-users.

Areas not of interest for this Topic Area include:

- Aerial or satellite-based monitoring of hydrogen.
- Monitoring technologies beyond the site of hydrogen and injection/withdrawal.
- Non-permanent or non-continuous monitoring technologies.
- Processes that are limited to laboratory-scale operation without potential for future field-based validation and commercialization.

AOI 4.04: Office of Nuclear Energy (NE)

Minimum Recommended Technology Readiness Level (TRL): 5

Maximum Recommended Risk Level Associated with the "License to Operate" Core Risk Area within the Adoption Readiness Level (ARL) Framework: "Medium Risk"

Overview of Major Mission Areas:

The Office of Nuclear Energy's (NE) mission is to advance nuclear energy science and technology to meet United States energy, environmental, and economic needs. Specifically, NE has identified the following goals to address the challenges in the nuclear energy sector: enabling the continued operation of the nation's existing commercial nuclear fleet, accelerating development and deployment of advanced nuclear reactor concepts, securing and sustaining the global nuclear fuel cycle, and expanding international cooperation while maintaining U.S. leadership in nuclear energy technology. With the Technology Commercialization Fund, NE aims to directly advance the commercialization of nuclear technologies as well as to promote the development of commercialization enabling technologies. Direct commercialization involves the advancement of products that can be sold on the market today or in the near-term future. However, considering the large number of technical, regulatory, construction, and financial barriers that the nuclear industry is currently facing, a broad set of tools are required to enable the deployment of nuclear energy technologies. This category of innovations includes the establishment of risk and safety assessment methods, accurate cost analysis tools and materials characterization models, among many others.

Outline of Eligible Technology Areas:

1. **Reactor Concepts Research, Development and Demonstration (Reactor Concepts RD&D) (NE-RCRDD)**

Summary of Technology Area #1:

The Reactor Concepts Research, Development, and Demonstration program supports conducting research on existing and advanced reactor designs to enable the industry to address technical and regulatory challenges associated with maintaining the existing fleet of commercial nuclear reactors, promoting the development of a robust pipeline of advanced reactor designs and technologies and associated supply chains, and progressing these advanced reactor designs and technologies towards demonstration, when ready. Program activities are focused on addressing technical, economic, safety, and security enhancement challenges associated with the existing commercial light water reactor fleet and advanced reactor technologies, covering large, small, and micro-sized designs and an array of reactor types including advanced light water reactors, fast reactors using liquid metal coolants and high temperature reactors using gas or molten salt coolants.

The key challenges in this Technology Area include improving the affordability of nuclear energy technologies, enhancing safety and reducing technical and regulatory risks, minimizing proliferation risks of nuclear materials, and improving the economic outlook for the U.S nuclear industry.

Commercialization Priorities in Technology Area #1:

NE has identified the following activities as priorities to enable the successful commercialization of technologies for the maintenance of the existing reactor fleet and development of advanced reactor concepts:

- Advanced construction materials and methods.
- Advanced materials, materials monitoring and repair, characterization and testing methods that support high temperature radiological operations and enable novel coolants, such as liquid metals and molten salts.
- Commercial reactor instrumentation and controls (I&C) digitalization to improve the efficiency of the existing reactor fleet.
- Deliberate motion analytics technologies which are designed to be combined with low-cost sensor technologies to replace existing and more expensive intrusion detection technologies.
- Commercialization of high TRL microreactor technologies (e.g., MARVEL and PELE).
- Advanced reactor fuel development, production, testing and/or validation (e.g., coated particle, nitride, metallic, or molten salts).
- Feasibility studies, technical analyses and/or assessment frameworks enabling the determination of suitable locations for siting nuclear reactors.

2. **Fuel Cycle Research and Development (NE-FCR&D)**

Summary of Technology Area #2:

The Fuel Cycle Research and Development (FCR&D) program presently has three focus areas. In the first, the program conducts applied research and development on advanced fuel cycle technologies that have the potential to enhance safety, improve resource utilization and energy generation, reduce waste generation, and limit proliferation risk. Advancements in fuel cycle technologies support the enhanced availability, economics, safety, and security of nuclear-generated electricity in the U.S., further enhancing U.S. energy independence and economic competitiveness. In the second area, the program conducts system analyses of advanced fuel cycle options to help guide decision-making and prioritization of R&D

activities. In the third focus area, the FCR&D program also contributes to the Department's policies and programs for ensuring a secure, reliable, and economic nuclear fuel supply for both existing and future reactors.

The key challenges in this Technology Area include enhancing fuel cycle safety and reducing technical and regulatory risk, improving resource utilization and energy generation, reducing waste generation, and limiting proliferation risk.

Commercialization Priorities in Technology Area #2:

NE has identified the following activities as priorities to enable the successful development of the U.S. nuclear fuel cycle:

- LEU and HALEU production.
- Accident tolerant fuels.
- Recycling and reuse of nuclear fuel and materials.
- Nuclear materials control and accounting for domestic fuel cycle.
- Domestic uranium mining and production.
- Fuel cycle system analysis and options.
- Cost efficient HALEU transportation packaging.
- Laser enrichment.
- Support for Lead Test Assemblies (LTA) in commercial reactors.
- Support for higher enrichment levels in commercial reactors.

3. **Spent Nuclear Fuel and High-Level Waste Disposition R&D (NE-SFWD)**

Summary of Technology Area #3:

The Spent Nuclear Fuel and High-Level Waste Disposition (SFWD) R&D program conducts scientific research and technology development to enable long-term storage, transportation, and disposal of spent nuclear fuel (SNF) and high-level wastes (HLW). The primary focus of this subprogram supports the development of disposition-path-neutral waste management systems and options in the context of the current inventory of SNF and HLW.

The key challenges in this Technology Area include development of a collaborative-based siting process, long-term storage options, transportation methods, and ultimate disposal systems.

Commercialization Priorities in Technology Area #3:

NE has identified the following activities as priorities to ensure the development of a reliable, safe, and robust program for transporting, storing, and disposing of spent nuclear fuel:

- Federal consolidated interim storage facility development for spent nuclear fuel using a collaborative-based siting process.
- Collaborative based siting of a permanent repository for spent nuclear fuel.
- Demonstration tests highlighting the safety of SNF storage and transportation systems.
- Develop models and field tests to understand the fate and transport of relevant radioactive isotopes within crystalline, argillite, and/or salt host rocks and to inform the Environmental Performance Assessment for disposal.
- Develop technologies, models, and/or analytical approaches for qualifying existing SNF dry storage canisters for ultimate disposal.
- Develop technologies for investigating the environmental and/or structural internals of an SNF dry storage canister.
- Develop technologies for structural health monitoring of the SNF dry storage canister wall.
- Develop technologies for verifying acceptability of disposal for spent fuel or high-level waste packages.
- Develop durable instrumentation for long term geologic characterization measurements (e.g., temperature, pressure, acoustic measurements) in harsh environments (high temperature or caustic environments).

4. **Nuclear Energy Enabling Technologies (NE-NEET)**

Summary of Technology Area #4:

The Nuclear Energy Enabling Technologies (NEET) program conducts R&D and makes strategic investments in research capabilities to develop innovative and crosscutting nuclear energy technologies to resolve nuclear technology development challenges. The crosscutting research focuses on innovative research that directly supports the existing fleet of nuclear reactors and enables the development of advanced reactors and fuel cycle technologies, including topical areas such as advanced sensors and instrumentation, advanced materials and manufacturing technologies, and others. Also, NEET invests in modeling and simulation tools for existing and advanced reactor and fuel system technologies. Further, the program provides U.S. industry and universities, and National Laboratories access to unique nuclear energy research capabilities through the Nuclear Science User Facilities (NSUF). In addition, NEET-sponsored activities support the goals, objectives, and activities of the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative to make these technology advancements accessible to U.S. industry through private-public partnerships.

The key challenges in this Technology Area include the development of advanced sensors and instrumentation, advanced materials and manufacturing technologies, and modeling and simulation tools.

Commercialization Priorities in Technology Area #4:

NE has identified the following activities as priorities to facilitate the widespread deployment of nuclear energy technologies:

- Commercialization of novel or enhanced sensor types for measurement of temperature, radiation flux, pressure, flow rate, thermal conductivity, vibration, and/or displacement, which can support advanced reactor designs (e.g., advanced light water reactors, gas-cooled reactors, molten salt reactors, and/or liquid metal reactors).
- Commercialization of wireless (e.g., acoustic, inductive, optical and/or radio-frequency) network architectures (e.g., mesh network, multimodal, and/or frequency hopping) which allow for secure and increased data bandwidth inside adverse signal environments (i.e., transmission in reinforced concrete structures, minimal line-of-sight applications).
- Commercialization of artificial intelligence and machine learning augmented applications such as optimizing/enhancing: (A) reactor core loading, (B) sensor set placement, (C) sensor data analysis, (D) reactor operations, and (E) prognostic/diagnostic applications.
- Commercialization of in-process monitoring capability for advanced manufactured materials and components.
- Commercialization of high throughput non-destructing examination capabilities.
- Commercialization of materials developed through advanced manufacturing methods.
- Application of NE's advanced modeling and simulation tools[33] to industry problems for increased adoption and use by light-water reactor (LWR) or non-LWR reactor industries, including:

[33] NE's advanced modeling and simulation tools

- Facilitating access to NE's advanced modeling and simulation tools for inexperienced users.
- Applying the results of high-fidelity simulations to inform the improved use of lower-order models for improved use of fast-running design tools.
- Providing capabilities for automated verification of numerical solutions, including mesh refinement studies.
- Using the tools with existing plant operational data to demonstrate the value for real-world industry applications.

AOI 4.05: Advanced Materials and Manufacturing Technologies Office (AMMTO)

Overview of Major Mission Areas:

The Advanced Materials and Manufacturing Technologies Office (AMMTO) is focused on research, development and deployment of next-generation materials and manufacturing technologies needed to increase domestic industrial competitiveness and supply chain resiliency for energy applications. AMMTO seeks proposals from the National Laboratories in areas related to the commercialization of technologies relevant to this mission. AMMTO encourages lab researchers to work with external partners from industry, end users, entrepreneurs and other relevant groups towards these commercialization efforts. Description of specific technology areas of interest is provided below.

Outline of Eligible Technology Areas:

1. **Next Generation Materials & Processes**

Summary of Technology Area #1:

AMMTO pursues novel materials and manufacturing processes to support energy and manufacturing competitiveness/resiliency. AMMTO focuses on advanced materials, processes, and digital systems that improve manufacturing capability, enhance material and energy efficiency of manufacturing, and deliver benefits throughout the economy. These advances can also improve the resiliency of domestic supply chains for all products, including for energy technologies. The Next-Generation Materials & Processes subprogram focuses RD&D support on evolving advanced manufacturing materials and processes that increase U.S. advanced manufacturing competitiveness, with an emphasis on advanced materials and innovative manufacturing processes that benefit multiple energy technology applications and, strengthen domestic supply chains. Technologies of interest under this technology area include A) smart manufacturing to enhance product quality or/and accelerate materials and process innovation for energy application; B) solid phase or/and additive processing for large scale components for multiple industry applications; and C) roll to roll processes for energy systems components.

2. **Energy Technology Manufacturing and Workforce (ETMW)**

Summary of Technology Area #2:

AMMTO invests in manufacturing innovations for key energy system-enabling technologies, such as energy storage and conversion technologies, semiconductor manufacturing technologies, power electronics, and microelectronics, to reduce manufacturing costs as well as improve performance, lifecycle energy efficiency, and ultimately competitiveness to accelerate market deployment. Technologies of interest under this technology area include field-assisted manufacturing approaches such electro-static-, electromagnetic- (including light), magnetic, acoustic-, mechanical-field-assisted approaches. Proposals should identify specific applications or markets the proposed work will target, such as semiconductor and energy storage manufacturing processes. The commercialization strategy in the proposal should enable the technology to become the basis for platform manufacturing.

3. **Secure and Sustainable Materials**

Summary of Technology Area #3:

AMMTO makes investments to advance the material supply chains and product lifecycles that support a robust manufacturing sector, supply chain security, and a reliable energy system. This includes developing processing capabilities for domestic mineral and material resources necessary to manufacture important technologies and supporting innovation in technologies that extend the useful life of products and materials. Technologies of interest under this technology area include processes and processing technologies for recycling of complex materials (e.g., alloys, composites, e-scrap) critical to energy applications.

AOI 4.06: Bioenergy Technologies Office (BETO)

Overview of Major Mission Areas:

The Bioenergy Technologies Office (BETO) within the U.S. DOE's Office of Energy Efficiency and Renewable Energy supports the research, development, and demonstration of technologies aimed at mobilizing domestic biomass and waste resources to produce biofuels and biobased products, while providing revenues to agriculture and industry sectors across the US economy.

BETO recognizes the urgency of developing innovative solutions for the transportation, industrial, and agriculture sectors. Bioenergy technologies build resilient, diverse, domestic energy supply chains that can integrate into existing infrastructure and enable a more secure energy economy, create high-quality jobs, support rural economies, and spur innovation in renewable energy and chemicals production – the bioeconomy.

BETO funding supports innovation in non-road transportation sectors, including aviation, marine, and heavy-duty long-haul transport and prioritizes work on the scale-up of biofuels that can meet market demand in the near term. BETO balances these priorities along with investments in technologies that have longer-term potential, such as algae-based fuels and products while also pursuing uses of biomass that will have positive impacts sooner, such as producing renewable base load electricity and clean hydrogen.

Outline of Eligible Technology Areas:

The research and development activities to be funded under this AOI will support the government-wide approach to unleashing American energy dominance by driving the innovation that can lead to the deployment of secure, reliable and abundant energy technologies. Specifically, this AOI focuses on commercialization of technologies that will lower cost, secure supply chains and increase global competitiveness of the transportation, industrial, and/or agriculture sectors. Examples include production of synthetic aviation fuel (SAF), fuels in the diesel or marine range, chemicals or other products with the potential for near-term cost-effective commercialization significant emission reductions, and biomass-mediated soil carbon storage.

Technology maturity under the following Technology Areas may range from TRL 4–6. Thermochemical, biochemical, electrochemical, and hybrid pathways are acceptable. Acceptable feedstocks include traditional agricultural and forestry wastes, purpose-grown energy crops other lignocellulosic resources, algae, organic wet waste, sorted municipal solid waste, construction and demolition waste, food waste, biogas, grain starch, oilseed crops, industrial waste gases, and CO2 by direct air capture.

For all technology areas, applications should include targets for improvements in energy intensity, cost-reduction, and other relevant metrics. Projects should also provide a justified, quantitative estimate of the national-scale, long-term domestic energy supply chain impacts that are expected because of the proposed work.

Projects funded under any of the following Technology Areas will have a performance period of **12–36 months**. The target award amount is **$500,000–$2,000,000** in federal funding.

1. **Developing Transportation Sector Energy Resources**

Summary of Technology Area #1:

Projects funded under this technology area will seek to commercialize technologies that bring energy and transportation innovation to the US economy.

Successful projects under this Technology Area will lead to the commercialization of technologies to enable the production of drop-in transportation fuels that serve non-road transportation modes such as aviation, marine, rail, off-road, and heavy-duty trucks.

Key Challenges in the Technology Area:

- Proposed technologies will support the production of transportation fuels from acceptable domestic biomass and waste feedstocks through biochemical, thermochemical, electrochemical, or hybrid conversion pathways.
- Projects may focus on one or more-unit operations within a pathway.
- Technologies must ultimately target production pathways for transportation fuels that are more efficient and/or provide benefits such as lower emissions or measurable waste reduction.
- Target fuels may be liquid or gaseous at standard temperature and pressure.
- Applications proposing co-processing with an existing petroleum refinery must address how at least 50% of the biogenic carbon would be converted to a biofuel and how this would be measured.

2. **Industrial Sector Innovation: Biobased Chemicals**

Summary of Technology Area #2:

Projects funded under this Technology Area will aim to commercialize technologies that produce biobased chemicals to contribute to secure domestic supply chains for products and materials.

Most of the organics, petrochemicals, and polymer resins produced and used in the U.S. today will remain carbon-based for the foreseeable future and are critical to address from an energy perspective. Production of intermediate chemicals to complement intermediates from petroleum and natural gas will lead to more abundant and secure domestic supply chains. In addition, because biobased production routes can be chemically distinct from fossil routes and allow access to affordable production of new types of chemicals with performance advantages, innovations in this space can lead to enhanced U.S. manufacturing competitiveness. Successful projects under this Technology Area will lead to the commercialization of technologies to produce chemicals and cost/performance-advantaged bioproducts from biomass and waste feedstocks that can complement those currently derived from petroleum.

Key Challenges in the Technology Area:

- Proposed technologies will support the production of organic chemicals and/or bioproducts from acceptable renewable carbon and waste feedstocks through biochemical, thermochemical, electrochemical, or hybrid conversion pathways.
- Both drop-in complements and novel performance-advantaged bioproducts are eligible. If a project is targeting a performance-advantaged bioproduct improved metrics should be clearly articulated.
- Projects may focus on one or more-unit operations within a pathway.
- Production technologies should be energy and resource efficient.
- Target chemicals should have a current U.S. production volume >0.5 million short tons or justify the ability for the technology to have broader decarbonization potential within the chemicals sector.
- Applications for production of recyclable bio-based plastics should target ≥75% carbon utilization from waste plastics to encourage material-efficient processes and provide ≥50% energy savings relative to virgin material production.

3. **Advancing Regional Biomass Resource Mobilization Technologies**

Summary of Technology Area #3:

Projects funded under this technology area will seek to commercialize technologies that accelerate the mobilization of domestic biomass resource to create biofuels and biobased products, while providing additional revenue to farmers, foresters, and industry.

BETO performance goals supporting this strategic goal include enabling delivery, preprocessing, and deconstruction of sufficient volumes of biomass and waste feedstocks to biofuel intermediates and biobased products that can meet industry-relevant cost and performance requirements. Additionally, work in this area will support the BETO performance goal to demonstrate more than three place-based strategies for agriculture, forestry management and forest fire prevention, waste management, environmental remediation, or other beneficial uses of renewable carbon resources.

Mobilizing domestic carbon resources can contribute to improving the economy growth of the agricultural and forestry sectors through practices including, but not limited to, diverting organic agricultural, forestry and municipal waste, and utilizing abundant and affordable domestic purpose grown energy crops across varied regional agronomic landscape toward bioenergy applications, producing alternative proteins and biobased products, and improving soil carbon management through the application of biochar from renewable resources.

Key Challenges in the Technology Area:

- Improvement of planting, harvesting, collection, and on-farm or on-field transport equipment for bioenergy feedstock production or bio-intermediate production
- Development of advanced preprocessing strategies and technologies that reduce overall logistics cost, reduce energy usage, and prepare one or more varieties of feedstocks for conversion.
- Transportation logistics and feedstock handling improvements related to a centralized processing facility or collection facility/feedstock blending depot.
- Identify pathways and resource mobilization strategies for mobilization of biomass (as defined in BT23) towards increasing the overall value of feedstocks and supporting wildfire mitigation strategies.
- The applications should demonstrate the benefits of the biomass resource mobilization strategies via techno-economic analysis (TEA) and evaluate the impact on carbon intensity reduction via life-cycle analysis (LCA).

AOI 4.07: Building Technologies Office (BTO)

Overview of Major Mission Areas:

The Building Technologies Office (BTO) develops, demonstrates, and accelerates the adoption of cost-effective technologies, techniques, tools, and services that enable high performing, resilient and affordable residential and commercial buildings in both the new and existing markets.

Outline of Eligible Technology Areas:

1. **Cost-effective and safe deployment of hydrocarbon as a refrigerant for heat pump water heaters**

Summary of Technology Area #1:

Different policies and regulations have emphasized the migration towards low to ultra-low Global Warming Potential (GWP) refrigerants in heat pump equipment. In today's market Refrigerant R-134a (GWP 1300) is the deployed choice for most HPWH products. DOE is focused on developing equipment using much lower GWP refrigerants. This project's goal is to investigate the use of propane (R290) and isobutane (R600a), whose thermophysical properties are comparable to R134a, however, they have very low GWPs (3 and 4 respectively). They are flammable refrigerants (ASHRAE Class A3) and consequently, per UL 60335-2-40[34], their allowable charge is currently set at 114g. This low charge is one of the major obstacles to the extensive deployment of these refrigerants in indoor residential installations. BTO is seeking proposals to design, develop, and demonstrate an integrated residential heat pump hot water unit (HPWH) using hydrocarbon refrigerants with a total charge <114g that can achieve a uniform energy factor (UEF) of>4.

Key Challenges in the Technology Area:

- Safety classification. It is critical to note that both R290 and R600a belong to the A3 safety class, which indicates that these refrigerants are flammable and dictates that appropriate modification to the infrastructure is essential to accommodate them if the charge exceeds 114g (UL 60335-2-40).
- Reduction in refrigerant charge: Reduce required refrigerant volume to better accommodate UL A3 charge limits. Total refrigerant in the system depends on several factors including heat exchanger design and the overall system

[34] Updated Requirements for Refrigerant Detection Systems | UL Solutions

configuration. A goal for this work is to deliver major technological advancements in the development and deployment of a smaller diameter evaporator coil and novel condenser designs.

- Condenser Design: In current systems 60% of the refrigerant charge resides in the condenser and the key to reducing the charge is to re-design the condenser. For the US market, code requires the condenser be a double wall (DW) design, ensuring that the refrigerant/oil mixture never mixes with the potable water. To accommodate this and other considerations, the focus will be on configurations which provide the needed performance & compactness at lower costs.
- Condensate removal: Heat pump produced condensate limits installation applications. Proposals should seek to commercialize technologies to mitigate/eliminate the issue.
- Noise & Vibration: Goal is to meet a <40 dB noise criteria.
- Design of A3 refrigerant components: BTO is seeking proposals to demonstrate experience with A3 refrigerant component design and equipment performance.

2. NO2 monitors

Summary of Technology Area #2:

Recent research has shown nitrogen dioxide as a primary pollutant of concern within indoor environments as well, particularly in homes and apartments. While there are a variety of monitors/alarms for detecting carbon monoxide in homes available, there are few that detect NO2. To educate and protect home occupants, BTO is interested in consumer grade NO2 monitors with +/-25% expanded uncertainty at 100 ppb NO2. To protect worker health, BTO is also interested in NO2 alarm that can be worn by trades people when they are working in homes/apartments. Either should have a retail price of no more than $100.

Key Challenges in the Technology Area:

To realize BTO's goal on this topic, work must be done in the following areas:

- Develop and bring to market consumer grade NO2 monitors with sensors with +/-25% expanded uncertainty at 100 ppb NO2 with a retail price of $100 or less.
- Create a testing and evaluation system to determine the accuracy of consumer grade NO2 sensors to ensure minimum accuracy parameters are met.
- Other opportunities for improvement, not identified here.

3. **Snap refrigerant connections for Heat Pumps**

Summary of Technology Area #3:

There are some refrigerant connections that do not required specialized tools, flaring or brazing to attach refrigerant lines to the outdoor compressor or indoor air handler. These no-specialized-tool refrigerant connections allow for DIY installations of heat pumps, typically mini-splits, reducing installation costs. These snap connections have been tested to leak less than field-customized connections. However, with new requirements for low-GWP refrigerants, the connections will need to be modified.

Key Challenges in the Technology Area:

To overcome technical barriers from the increased use of low-GWP refrigerants in heat pumps, and to lower the installation costs of heat pumps, work must be done in the following areas:

- Develop snap refrigerant connections for low-GWP refrigerants.
- Partner with OEMs to use these connections on their products and bring them to market.
- Other opportunities for improvement, not identified here.

4. **Heat pumps for manufactured houses**

Summary of Technology Area #4:

BTO is supportive of the development of heat pumps for use in manufactured homes. To date, efforts have focused on a single OEM and developer of manufactured housing as a proof-of-concept. BTO would like to expand this to an OEM-agnostic HVAC conversion system for all new manufactured homes. In addition, BTO would seek a ducted heat pump 'add-on' (either underbelly or overhead) for existing manufactured homes.

Key Challenges in the Technology Area:

To better facilitate the use of heat pumps in new and existing manufactured homes, work must be done in the following areas:

- Develop OEM-agnostic HVAC conversion systems to facilitate their use in new and existing manufactured homes
- Creation of heat pump systems that physically fit in the available space and can be integrated seamlessly with the existing duct system.
- Other opportunities for improvement, not identified here.

5. **Easier & More Accurate Manual J Technology**

Summary of Technology Area #5:

Load calculations determine the heating and cooling design load for a home or apartment. An accurate load calculation allows for the proper sizing and specification of heating and cooling systems, increasing the system's efficiency, performance and durability. However, sizing using home-specific features is not often done due to the time/cost to perform this analysis. ACCA Manual J is a commonly used load sizing methodology. BTO believes a streamlined Manual J calculation tool, which requires less time to complete than the current options, will increase the frequency that load calculations are performing for new and existing homes.

Key Challenges in the Technology Area:

To better facilitate the use of Manual J load calculations, work must be done to address the following challenges:

- Creation of a Manual J load calculation tool that decreases the time to complete by 50% over standard practice for HVAC technicians working in existing homes, while maintaining the accuracy of the calculation.
- Seamless integration with Manual S equipment selection
- Other opportunities for improvement, not identified here.

6. **Serviceable Mini-Split/PTHP/PTAC**

Summary of Technology Area #6:

Hotels, motels, assisted living facilities, dormitories, and other applications requiring individual zone space conditioning commonly use packaged terminal ACs and HPs. In residential buildings, split system ACs and HPs are the most common type of central space conditioning product. Among these products, ductless units are particularly susceptible to accumulation of 1) dirt due to poor air filtration and 2) mold, bacteria, and other biotoxin as the blower operates below dewpoint and collects condensate while cooling. These two factors can yield poor indoor air quality and adverse health effects without regular, time-consuming, labor-intensive, and expensive cleaning.

Key Challenges in the Technology Area:

To mitigate adverse indoor air quality impacts for products including, but not limited to, 1) non-ducted single- or multi-split ACs and HPs and 2) non-ducted split packaged terminal ACs and HPs are used, BTO seeks to:

- Develop and demonstrate AC/HP designs—with comparable or better energy efficiency than currently available models—with lower propensity of contamination even while operating in humid climates, including through heads and coils that can be easily cleaned in less than 15 minutes per head.
- Support market adoption of these designs, with OEM partnerships as needed.
- Other opportunities for improvement, not identified here.

7. **Advanced Air Leakage Detection and Air Sealing Technologies**

Summary of Technology Area #7:

Air leakage through the building envelope in the U.S. accounts for about 4 quads of energy annually, costing approximately $10 billion per year. In aggregate, infiltration accounted for higher energy losses than any other component of the building envelope.

More than 70% of the existing buildings were built before 1980. While many of these buildings have some level of airtightness incorporated into their designs, there are still many buildings with no designed air control. The buildings from this era have air leakage levels two to ten times above what is required in current buildings.

- BTO seeks the development and validation of: Fast, accurate, affordable, and portable air leakage detection technologies that identify the location and extent of leakage and could be widely used among different income groups. Technology should employ readily available, low-cost hand-held hardware (i.e., smart phone) and an easy-to-use app/interface to identify air leakages in residential and/or commercial buildings.
- Advanced, cost-effective air-sealing retrofit technologies that are designed specifically for use in existing, occupied buildings and hard to remediate areas, such as attics, walls, finished basements, and crawlspaces. These air-sealing technologies and approaches should minimize or eliminate the need for envelope disassembly, and be easy, fast, and much more affordable to implement than traditional approaches. Productivity tools that aid workers to complete air-sealing jobs faster are also of interest.

Key Challenges in the Technology Area:

- Current practices to identify air leakage in buildings can be time-consuming and require specialized equipment run by a trained professional.
- Current practices for effective air sealing often require envelope disassembly and reassembly, which can be disruptive, expensive, and time-consuming for the occupant, even requiring the occupant to leave the premises in some instances.

- Commonly, some of the leakiest parts of a building that need to be sealed are in hard-to-reach areas like attics, walls, finished basements, crawlspaces, and more, which further exacerbates cost and time challenges described above.

8. **High Performance Insulated Cladding for Residential Field Applied Applications**

Summary of Technology Area

Summary of Technology Area #8:

Today, approximately 2 million homes are resided each year with minimal insulation such as "fan fold" foam board offering R1 performance. Insulated vinyl siding improves this performance to roughly R2.5-R3 but installed cost tends to have a high price premium and performance falls short of at least R5 continuous insulation that is routinely installed in new construction per building code requirements. BTO seeks innovative solutions that offer at least R5 insulating cladding solutions for one or all of the typical siding products including vinyl, wood, fiber cement, engineered wood, etc. The additional R-value added by the cladding system should be equivalent to adding a layer of continuous insulation of identical R-value, i.e., a cladding system adding R5 should increase the overall wall assembly R-value by R5. The designs should focus on at least R5 performance and be easy to install with consideration of interfaces including fenestration, roof to wall, wall to foundation, and typical construction penetrations. The overall system should ensure that proper moisture control and air sealing can be applied, potentially even as part of the insulated cladding system itself, while ensuring the building will have long term performance without degradation. Long-term predicted performance through modeling programs such as WUFI are highly encouraged. Finally, cladding selection is driven by aesthetic considerations that need to be considered during the development process. The total installed re-cladding system price premium over existing cladding systems should be affordable based on life-cycle-cost basis with preferred simple pay back of less than 15 years when installed on homes in cold climates that have R11 cavity insulation.

Awardees are expected to develop representative proof of concept prototypes at sufficient scale that demonstrate installation details and airtightness and watertightness of the proposed technology. Simulation results that indicate long-term predicted performance of the retrofit solution are highly encouraged.

Parameters	Minimum Performance	Preferred Performance
Thermal performance	R5 CI	R10 CI
Max combined thickness of insulation and cladding (in)	2 (ideally ≤ 1.5)	3 (ideally ≤ 2.5)
Detailing	Uses readily available materials or components that can be easily manufactured to meet quick demand	
Cladding types	Fiber cement, vinyl, wood, engineered wood	

Key Challenges in the Technology Area:

- Current residing practices offer little to no energy efficiency benefits, which poses a missed opportunity to add additional insulation and/or air-sealing, for this commonly executed remodel activity.
- During current practices of adding continuous insulation while residing, an additional rigid foam layer is added between the existing sheathing and new siding. This extra layer requires proper and time-consuming detailing and taping, particularly at interfaces with windows, roofs, and foundations, which requires new skills for the contractor to learn and can increase contractor time on the job. Therefore, proposed solutions to this topic must be able to fold seamlessly with existing workforce skills and practices.

9. **Affordable TES Systems**

Summary of Technology Area #9:

Thermally driven loads make up over 53% of primary energy used in buildings, and are among the primary drivers of peak loads in the building sector. Thermal Energy Storage (TES) can play a significant role in shifting building loads while facilitating space and water heating electrification. BTO seeks the development, validation, and commercialization of next generation TES technologies for residential heat pump systems, residential heat pump water heaters, commercial rooftop units, and refrigeration systems. Key drivers in making TES systems economically viable are the costs to integrate thermal storage with equipment. These costs include the integration of thermal storage materials, heat exchangers, valving, packaging, controls, and installation. This TES topic focuses on developing TES systems with low integration costs, improved performance, and ease of installation to accelerate adoption of TES systems in buildings.

Key Challenges in the Technology Area:

To better facilitate the increased use of thermal storage in residential and commercial space conditioning, water heating, and refrigeration applications, and to lower the installation costs of these equipment-integrated thermal storage systems, work must be done in the following areas:

- Develop TES-heat pump systems with enhanced cold climate and defrost performance, comfort, peak shifting ability, and energy efficiency.
- Develop systems that simplify integration, installation, control, maintenance, and reduce first costs.
- Develop systems for space- or weight-constrained applications.
- Support market adoption of these thermal storage systems with OEM partnerships as needed.
- Other opportunities for improvement, not identified here.

AOI 4.08: Geothermal Technologies Office (GTO)

Overview of Major Mission Areas:

The Geothermal Technologies Office (GTO) works to reduce costs and risks associated with geothermal development by supporting innovative technologies that address key exploration and operational challenges. GTO seeks any proposal that fits the following technology areas:

Outline of Eligible Technology Areas:

1. **Well Cements**

Summary of Technology Area #1:

The development of Reservoir Thermal Energy Storage systems will require hardened well construction materials that can withstand multiple thermal cycling events. GTO are interested in cement blends that are thermal-shock resistant, have good thermal insulating properties, low embedded carbon emissions, and can lower the lifecycle costs of geothermal wells.

2. **Underground energy storage for occupied buildings or industrial heating and cooling loads**

Summary of Technology Area #2:

GTO is interested in methods and applications which leverage off-peak power, electrical/thermal energy conversion devices, and subsurface energy storage (as borehole- or reservoir-thermal energy storage) to provide scalable grid energy storage on a diurnal or seasonal basis.

AOI 4.09: Hydrogen and Fuel Cell Technologies Office (HFTO)

Overview of Major Mission Areas:

The Hydrogen and Fuel Cell Technologies Office (HFTO) in the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy leads federal research, development, and demonstration activities to enable the commercial viability of hydrogen and fuel cell technologies. HFTO's mission is to enable affordable clean hydrogen and fuel cell technologies for a sustainable and resilient economy. HFTO is guided by the U.S. National Clean Hydrogen Strategy and Roadmap[35], which follows three overarching strategies:

- Target strategic, high-impact end uses: The use of clean hydrogen will be focused strategically to provide maximum benefits, particularly in sectors that are hard to decarbonize.
- Reduce the cost of clean hydrogen: The United States can dramatically lower the delivered cost of clean hydrogen by developing sustainable and supply-resilient pathways including water electrolysis; thermal conversion with carbon capture utilization and storage (CCUS); and advanced or hybrid production pathways.
- Focus on regional networks: Scale can be achieved strategically by focusing on regional networks—ramping up hydrogen production and end-use in close proximity to drive down transport and infrastructure costs and create holistic ecosystems that provide local benefits.

Only proposals addressing the technology area descriptions below will be considered.

1. **Commercialization and Enhanced Safety of Hydrogen Infrastructure**

Summary of Technology Area #1:

[35] U.S. National Clean Hydrogen Strategy and Roadmap (energy.gov)

HFTO conducts RD&D to lower the cost and improve the reliability and safety of hydrogen technologies and infrastructure; including infrastructure for storage, transport, distribution, and dispensing that can help enable commercialization of hydrogen in diverse applications, including medium and heavy-duty (MD/HD) transportation. Cost-reductions are an important part of this RD&D in support of commercialization. For example, the target cost for delivery and dispensing of hydrogen in MD/HD vehicle applications is ≤ $5/kg H_2 by 2025, including the cost of any necessary on-site storage. This technology area seeks applications for collaborative efforts that involve industrial partners working with National Laboratories to further develop and commercialize hydrogen infrastructure technologies that address the needs for hydrogen delivery, storage, and dispensing.

This technology area seeks proposals focused on commercialization of infrastructure components including, but not limited to: liquid cryopumps; meters; nozzles/receptacles; hoses; high-throughput compressors; cascade storage systems; and fast response, high-capacity mass flow meters. All proposed hydrogen infrastructure hardware and components need to be rated for operating temperatures between -40 °C to +85 °C, except for liquid hydrogen components which must also be suitable for the applicable liquid hydrogen service. Refueling hardware must be capable of average hydrogen flows of at least 10 kg H_2/min, and 20 kg H_2/min peak. Components for high-pressure refueling must be rated for service pressures of at least the 875 bar fueling pressure, but typically at least 1000 bar. Applications must describe the technology and components to be developed and commercialized, and provide cost and performance targets.

This technology area also seeks proposals focused on the commercialization hydrogen carriers, which are hydrogen-rich materials that have a high hydrogen density and from which hydrogen can be released under relatively mild conditions. These materials, which offer potential benefits for bulk hydrogen storage and transport applications, need to be stable at near-ambient temperatures and pressures, but can rapidly and controllably release hydrogen under other conditions, such as when the temperature is elevated or when passed through a catalytic reactor. Mission areas include development of novel hydrogen carrier materials, development of catalysts for hydrogen uptake or release, and reactor development and demonstration. Applications must describe the materials and components to be developed and commercialized, and provide cost and performance targets relevant to specific end-use application.

Safety and reliability need to be a primary consideration in the design, selection and use of any materials and components used in hydrogen technologies and infrastructure, including those associated with hydrogen storage, transport, and distribution. As such, **this technology area also seeks proposals** addressing risk identification and mitigation in hydrogen storage vessels, pipelines, pumps, etc.; such as, risks associated with leakage, venting, purging, boil-off, etc. This includes development and/or improvement of risk assessment and mitigation tools specifically relevant to hydrogen infrastructure.

2. **Innovative Concepts in non-PFSA High Temperature Proton Exchange Membrane Fuel Cells for Heavy-Duty Applications in Transportation**

Summary of Technology Area #2:

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

When developing fuel cell systems, it is critical to target a total cost of ownership that is competitive with incumbent and advanced alternative powertrains, considering capital, fuel costs, and lifetime. High fuel cell system durability is essential to amortize capital costs over a longer lifetime. For example, long haul trucks require a lifetime of over one million miles, which is roughly equivalent to 25,000 operating hours. Significantly longer vehicle lifetimes and range requirements also mean that hydrogen fuel costs comprise a greater proportion of vehicle lifecycle cost. As such, increased fuel cell efficiency is a key parameter for economic viability. Cost-competitiveness with incumbent and advanced alternative powertrains requires continued R&D to simultaneously reduce capital costs of fuel cell components and systems while maintaining high efficiency and durability.

Recent fuel cell R&D efforts supported by HFTO have centered around enhanced performance and durability for PEMFC systems, typically operating at a temperature near 80°C (up to 120°C), which for conventional PEMFC systems tends to optimize system performance and lifetime. These commercial PEMFC membrane technologies are typically based on perfluorosulfonic acid (PFSA) ionomers, but PFSA-based membranes are facing increased regulatory barriers domestically and abroad due to potentially detrimental environmental impacts of the chemicals used during manufacturing. Eliminating PFSA-based membrane and ionomer materials from use may simplify manufacturing, reduce environmental impacts and potential regulatory challenges, and facilitate end-of-life recycling/recovery efforts. Additionally, operation of fuel cell systems at higher temperatures offers the potential to realize improved heat rejection, compact thermal management balance of plant, and potential fuel flexibility.

This technology area seeks proposals focused on the development of non-perfluorosulfonic acid high-temperature membranes and ionomers, and their integration into fuel cells for heavy-duty transportation end uses. Applications must describe the materials and components to be developed and commercialized, and provide cost and performance targets.

AOI 4.10: Industrial Efficiency and Decarbonization Office (IEDO)

Overview of Major Mission Areas:
The Industrial Efficiency and Decarbonization Office (IEDO) accelerates the research and development of innovative, cost-effective technologies that position American industry to lead on the competitive stage in evolving domestic and global markets. IEDO supports the development of innovative industrial technologies that can equip the industrial sector to embrace the growth from America's economy and secure national supply chains.

Outline of Eligible Technology Areas:

1. **Energy- Intensive Industries (EII)**

Summary of Technology Area #1:

Industries such as iron and steel, cement, and chemicals underpin modern life and assure American competitiveness and security on a global stage.

Many of these industries utilize energy-intensive industrial processes. The U.S. industrial sector accounts for almost a third (27%) of the nation's primary energy consumption. Developing innovative technologies that increase efficiencies in industrial energy use and productivity can help to strengthen the U.S. industrial sector and ensure national energy abundance.

Key Challenges in the Technology Area:

- **Advance material properties of components in alternative reactors for chemicals production:**
  - Recent development in alternative reactor systems such as electrochemical systems, plasmonic reactors, and photocatalytic systems open possibilities for new synthetic capabilities and sustainability gains for manufacturing of chemicals. These offer potential for multiple important advantages over incumbent systems such as: improved energy efficiency through use of milder conditions or lower energy pathways; use of clean energy sources and green electrons; improved control and efficiency in heat and mass transfer; higher selectivity; and process intensification. While there are many types of next generation reactor systems, a common need is found for material development to advance them to commercialization. This solicitation seeks material development that will enable such advanced reactor systems, with a focus on improved component performance, stability and lifetime. Examples of advanced reactor systems include, but are not limited to, the following: plasma reactors, photocatalytic systems, plasmonics, electrochemical reactors, microwave heating, etc. Components to consider include, but are not limited to, catalysts, membranes, electrodes, heat receptors, etc.
  - Proposals should quantify the expected improvements with metrics and relevant benchmarks such as: reduced greenhouse gas intensity measured in % CO_2e/kg product, increased component lifetime measured in number of cycles or time, and/or improved performance in the appropriate user-defined metric.
  - Proposed work should focus on chemical production, including commodity and specialty chemicals. Degradation of contaminants from municipal waste or from drinking water is <u>not</u> of interest, though degradation of pollutants from chemical process effluents will be considered.
- **Building Materials:** Materials such as concrete, asphalt, and steel are critically important to the built environment, but are also associated with high energy use and environmental emissions from production, which can lower competitiveness of American products in domestic and global markets. Durability of these materials, used in buildings, roadways, bridges, and other applications is also important and can contribute to the need for premature replacement of these materials/structures which can lead to additional emissions as well as high cost. This technology area is

focused on technology proposals that lead to significant reduction in energy and emissions associated with building materials including cement, concrete, steel reinforcement, and asphalt pavements. Areas of interest include alternative materials and production processes that yields materials with improved market competitiveness (particularly materials with emissions 25% or less than benchmark materials). Also of interest are solutions that significantly improve the durability/lifetime of these materials, thereby reducing costs that result from the need for replacement of roadways and structures (e.g., steel rebar corrosion in concrete, asphalt pavement degradation, etc.). Also of interest are tools and techniques that can be used for accelerating testing, *in situ* monitoring, or otherwise can predict or monitor the long-term performance of materials in the laboratory or field environment.

- **Alternative Glass Feedstocks:** Glass is a versatile material playing an important role in the U.S. economy in application such as automotive, architecture, consumer products, energy conversion, pharmaceuticals, and communication. Consuming 272 TBtu of primary energy or 1% of primary energy use from the industrial sector, the glass sector is expected to grow ~3.5%/year[36]. Due to its technical complexity, the glass making process is facing consequent challenges and one solution cannot fit all. As the industry works towards improved market competitiveness, various levers have been identified (electrification, alternative fuels, process monitoring, glass chemistry and circularity) but high risks are frequently encountered, and innovative ideas remain at low TRLs. IEDO is seeking applications focused on using alternative feedstocks and glass chemistries to reduce energy demand and/or improve competitiveness and product quality, and also potentially enable increased use of cullet, especially for flat glass. Specifically of interest are (1) feedstocks that greatly reduce or eliminate carbonates and their related process emissions and (2) process and/or chemistry changes that enable significant use of pre and/or post-consumer cullet in flat glass. Applicants will be required to provide analysis for each potential feedstock identified centered around an LCA and a TEA. Proposals should provide quantitative pathways improved market competitiveness.

2. **Cross-Sector Technologies (CST)**

Summary of Technology Area #2:

IEDO also pursues energy reduction challenges that are common across all industrial subsectors. For example, all industrial subsectors involve heating processes that have conventionally required fossil fuel combustion, leading to significant direct emissions, as well as wasted heat lost to the environment.

[36] International Finance Corporation report-2021- final-ifc-glass-7-26-21.pdf

Similarly, nearly all industrial operations consume water and produce wastewater. Innovations in energy and water use represent significant opportunities to lower energy and emissions and reduce manufacturing costs across the industrial sector.

Key Challenges in the Technology Area:

- **Scale-up for membrane production for low thermal budget separations:** Membrane-based separations can require less energy compared to conventional separation methods. Membrane technologies are versatile with a broad range of industrial applications and allow for selective separation of components based on size, charge or chemical affinity. These technologies reduce the need for thermal energy in separation and are generally compact with an ability to scale easily. A frequent roadblock for commercialization of a new membrane technology is the lack of available membrane production lines for scaling up fabrication. Specifically, lines that can produce enough quantities of membranes at sizes that are required for modules that allow testing in realistic or industrial slip streams without the need to reduce flow rate to accommodate for reduced membrane surface area. Production throughput of these membranes is also important as longer timelines to make a quantity required for production of modules entails membrane degradation, introducing variability in membrane performance. Applications should be focused on production scale-up activities for more than one membrane technology, rather than being highly specific to one membrane composition. Applications should specify the lab-scale/bench scale membrane technologies that will be targeted for production scale-up and include plans to produce membranes sufficient to enable production of an appropriate module, such as a spiral-wound module or hollow fiber module and testing in an industrial or commercially relevant set-up. Applications should include targets for improvements in energy intensity, emissions intensity, and other relevant metrics (e.g., performance increases, cost savings, etc.) relative to the current industrial process for the targeted separation.
- **Thermal Energy Storage:** Thermal energy storage (TES) will be necessary to support advanced efficiency and emissions reduction of manufacturing or industrial facilities, while reducing additional burden on the electricity grid as additional facilities consider electrification technologies. Additionally, to support the efficient integration of low-cost intermittent power sources, TES can provide a method of ensuring high quality and reliant thermal energy. Examples of technologies of interest for this lab include, but are not limited to, industrial process heating integrated with TES, which may avoid inefficient conversion between thermal and electrical sources of energy; materials that enable greater thermal energy storage for manufacturing or industrial processes; thermochemical reactors for thermal energy outputs; and TES systems that can enable the utilization of low-cost,

intermittent electricity by converting it into thermal energy (e.g., through resistive heating), store, and deploy as thermal energy (e.g., building heat) when needed, without requiring significant disruption of process operation. Applicants should make clear if the proposed technology will be applicable for low-temperature (< 100°C), medium-temperature (100 to 400°C), or high-temperature (> 400°C) grade systems. Applications should include targets for improvements in energy intensity, emissions intensity, and other relevant metrics (e.g., performance increases, cost savings, etc.).

- **Waste Heat Recovery Technologies:** Technologies focused on recovering, storing, and utilizing heat that is otherwise wasted in buildings or manufacturing operations. Example application areas include 1) Pod design and manufacturing for integrated heat pumps; 2) Materials and designs for recovering waste heat from high-temperature industrial processes; 3) Advanced technologies for more efficient electric generation from waste heat (low, medium, and high temperature); and 4) Waste heat recovery to thermal energy storage in the building and/or integrate with HVAC and/or used for process heating.

AOI 4.11: Solar Energy Technologies Office (SETO)

Overview of Major Mission Areas:

The Solar Energy Technologies Office (SETO) supports research & development to harness America's abundant solar energy resources for secure, affordable, and reliable electricity. SETO drives innovation to make American-made solar technology affordable and accessible. SETO also enables solar energy with storage to support the reliability, resilience, and security of the electricity grid. In addition, SETO provides relevant and objective technical information to streamline processes and support consumer choice.

Outline of Eligible Technology Areas:

1. **Acceleration of Photovoltaics (PV) Production**

Summary of Technology Area #1:

SETO supports the movement of solar technologies to market by strengthening innovative concepts and increasing their readiness for greater private sector investment and scale-up to commercialization.

Key Challenges in the Technology Area:

SETO is seeking to support activities by National Lab staff aiming to transfer lab-developed PV-related technologies to industrial partners or the broader marketplace. The following topic areas are of particular interest:

- Qualification testing, quality assessment, or monitoring methods and technologies for manufacturing or field performance of PV cells, modules, systems, or balance of systems (BOS) components.
- Innovations that improve PV manufacturing processes (including in-line metrology and supply chains).
- Innovations that enable dual-use, application-, and climate-specific applications (e.g., agrivoltaics, building-integrated solar PV, floating solar PV, vehicle-integrated solar PV, photovoltaic thermal systems).
- Innovations in advanced power electronics for PV systems, including converter/inverter technologies, multi-port systems (which combine PV with energy storage and electric vehicle charging), and advanced inverter controls, including grid-forming and grid-services functionality. Emphasis will be given to the use of wide- or ultra-wide-bandgap semiconductor materials, such as SiC, GaN, or Ga_2O_3, and to technologies that leverage the performance advantages of such materials and the potential for automated manufacturability.
- Software tools to assess or predict PV system performance and reliability.
- Innovations developed in the DuraMAT Consortium, with a commercialization interest expressed by the industrial partners.

The below topic areas are not of interest to SETO as part of the FY25 CLIMR Lab Call:

- Space, unmanned aerial vehicle, high-altitude spaceship applications.
- Internet of things, wearables, consumer electronics.
- Applications with product lifetimes below 10 years.

2. **Systems Integration of Solar Technologies**

Summary of Technology Area #2:

SETO funds research to address the evolving challenges for affordable, reliable, resilient, and secure integration of solar energy, energy storage, and other inverter-based resources (IBR) onto the transmission and distribution electric grid.

Key Challenges in the Technology Area:

SETO is seeking technologies in the following topic areas:

- **Self-Healing Distribution Grids:** SETO seeks innovations that can accelerate the deployment of resilient and self-healing distribution grid concepts[37, 38, 39] through adaptive, automatic and coordinated operation of utility distribution systems with Distributed Energy Resources (DER) and microgrids technologies, [40]. The solutions are expected to 1) incorporate advanced technologies such as fault detection and location, adaptive protection coordination, dynamic and optimal network reconfigurations, steady-state and transient stability analysis, and/or IBR's grid services and black start capabilities into the emergency response and restoration process; and 2) be integrated into utilities' grid automation and distribution management system for advanced protection and outage management, and fault location, identification, and service restoration (FLISR) applications.

- **Artificial Intelligence and Machine Learning-Based Solutions for Solar Integration:** SETO seeks innovations to advance the effectiveness, reliability and trustworthiness of AI/ML solutions[39, 41] for power system applications; and to accelerate their acceptance and adoption by utilities and industry to enhance solar integration[42, 43]. The solutions are expected to 1) address the real-world challenges that may hinder the wide-scale adoption of AI/ML solutions; 2) demonstrate the viability and values of AI/ML-based applications such as solar/netload forecasting, dynamic/transient modeling of IBRs and aggregate DERs, fault and abnormal events detection and identification, predictive maintenance, state estimation, and network topology identification; 3) conduct rigorous testing and validation under real-world operation scenarios and using realistic datasets with close collaboration among researchers, practitioners, and other stakeholders; and 4) demonstrate the AI/ML technologies can be integrated with grid management system.

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[37] *"Evaluation of Centralized Model-Based FLISR in a Lab Setup: Preprint"*. Golden, CO: National Renewable Energy Laboratory. NREL/CP-5D00-79745. https://www.nrel.gov/docs/fy21osti/79745.pdf.
[38] Solar Energy Technologies Office Lab Call FY2019-21 | Department of Energy.
[39] Funding Opportunity Announcement: Solar Energy Technologies Office Fiscal Year 2020 Funding Program | Department of Energy.
[40] "*Protection of Distribution Circuits with High Penetration of Solar PV -Distance, Learning, and Estimation-Based Methods"*, PNNL-32230, October 7, 2021.
[41] Solar Energy Technologies Office Lab Call FY2022-24 | Department of Energy
[42] Muhammad Sohail Ibrahim, Wei Dong, Qiang Yang, "*Machine learning driven smart electric power systems: Current trends and new perspectives*", Applied Energy, Volume 272, 15 August 2020, 115237.
[43] *"Artificial Intelligence/Machine Learning Technology in Power System Applications"*, Richland, WA: Pacific Northwest National Laboratory.

- **Advanced Communications for DER Control and Operation:** SETO seeks innovations to apply advanced communications network technologies[44, 45] for distributed solar integration and power grid control and operations[46, 47]. The solutions are expected to 1) incorporate advanced communication technologies into solar grid integration such as grid-edge solutions, autonomous DER optimization and control, automated fault location and isolation, distribution system real-time situation awareness, distributed controls, and/or network configuration; 2) establish common interfaces for data sharing and interoperability; 3) include cyber-security considerations for distribution system; and 4) demonstrate the viability of the solution with grid management system.

3. **Concentrating Solar-Thermal Power**

Summary of Technology Area #3:

SETO supports the development of novel concentrating solar power (CSP) and concentrating solar thermal (CST) technologies and systems that offer reliable low-cost electricity-generation or deliver cost-effective renewable heat for non-electricity generation purposes including industrial processing heat applications such as water desalination, food and beverage processing, as well as chemical and fuel production.

Key Challenges in the Technology Area:

SETO seeks to support activities to transfer lab-developed CSP and CST technologies to industrial partners or the marketplace. Technologies developed for CSP such as thermal energy storage, metrology tools, and advanced materials have potential value outside the currently modest CSP market. Applicants are encouraged to identify opportunities across multiple industries to accelerate commercialization, reduce costs, and mature the supply chain. Innovations within the following areas are of interest:

- **Gen3 CSP**: Generation 3 Concentrating Solar Power (Gen3 CSP) refers to an advanced CSP system incorporating flowing particles as the heat transfer

[44] "*5G Enabled Energy Innovation: Advanced Wireless Networks for Science (Workshop Report)*". United States: N. p., 2020. Web. doi:10.2172/1606538.
[45] "*5G Energy FRAME: The Design and Implementation of Data, Model, and Use Case (Year 2 Report)*". United States: N. p., 2023. Web. doi:10.2172/1995522.
[46] "*5G Securely Energized and Resilient: (5G-SER): Final Report*". Golden, CO: National Renewable Energy Laboratory. NREL/TP-5T00-88550. https://www.nrel.gov/docs/fy24osti/88550.pd
[47] Bringing 5G to power (ericsson.com)

medium and thermal energy storage. Heat is delivered to a supercritical CO_2 (sCO_2) Brayton power cycle at 700 °C. It is envisioned that a Gen3 CSP system can achieve SETO's cost goal of $0.05/kWh for a baseload configuration[48]. SETO seeks innovations to support commercialization of high-temperature components and integrated subsystem development of Gen 3 CSP.

- Improvements in reliability and performance of **Commercial CSP** systems: These systems include thermal oil based parabolic trough systems and molten salt-based power towers incorporating thermal storage at up to 565°C. Additionally, innovations which overcome barriers limiting the deployment of the commercial CSP systems are of interest. The topic areas include but is not limited to thermal energy storage tank improvements, siting and permitting, and workforce training.
- **CST systems for non-electricity** applications can support DOE's Industrial Heat Shot[49] goals by providing a clean heat source and long duration thermal energy storage for a variety of industrial processes. The varied nature of the industrial sector will likely require somewhat unique CST systems for specific industries. Innovations are sought which could support the commercialization of CST systems for applications such as food and beverage processing, water desalination, chemical and fuel production, and others thermal energy intensive uses.
- **Heliostat**-based CSP and CST systems can offer high temperature heat in systems that can scale from a few MW to a GW thermal. Heliostat performance, reliability, and cost largely dictate the technoeconomic viability of power tower systems[50]. SETO seeks innovation to support heliostat system commercialization. SETO is interested in applications that critical heliostat improvements generally in alignment with DOE's Heliostat Consortium roadmap.

4. **Interconnection**

Summary of Technology Area #4:

SETO and the Wind Energy Technologies Office (WETO) lead DOE's Interconnection Innovation e-Xchange (i2X) program, started in 2022, with the mission to enable a simpler, faster, and fairer interconnection of clean energy resources while enhancing the reliability, resilience, and security of our electric grid. The i2X program

[48] Generation 3 Concentrating Solar Power Systems (Gen3 CSP) | Department of Energy
[49] https://www.energy.gov/eere/industrial-heat-shot
[50] https://www.nrel.gov/docs/fy22osti/83041.pdf

seeks innovative solutions that can be integrated in software solutions used by distribution electric utilities to improve interconnection services. Improvements of interest include automated interconnection studies, advanced grid hosting capacity and flexible cost sharing of grid-network upgrades, especially for high volumes of commercial, industrial, and community-scale generators and resources (ranging from 100 kW to 5 MW).

Key Challenges in the Technology Area:

The i2X program seeks innovations to advance the quality of service and the customer experience of distribution electric utility grid interconnection portals and hosting capacity dashboards. The goal is to help interconnection customers make informed decisions, with a high degree of confidence, about service availability and associated grid network upgrade costs. Innovations in automated interconnection studies and dynamic hosting capacity dashboards that use integrated grid planning scenarios, locational interconnection costs, or flexible interconnection of variable energy generation resources (e.g., solar and wind) are areas of special interest.

The i2X program also seeks innovations for automated interconnection studies and harmonized hosting capacity dashboards for multiple utilities with neighboring service territories, especially in cases in which affected system studies are triggered and require coordination. Automated interconnection screenings or studies and unified hosting capacity dashboards are critical to bring consistency and simplicity to interconnection customers across larger geographical areas within the same regulatory conditions.

The i2X program is interested in testing the integration of these innovations with existing software solutions at domestic distribution electric utilities. The program prefers applications that include at least one domestic electric utility partner. Innovations that require utilities to completely replace their existing software solutions used for interconnection services are not of interest.

AOI 4.12: Vehicle Technologies Office (VTO)

Overview of Major Mission Areas:

Vehicles move our national economy. Annually, vehicles transport 12 billion tons of freight—more than $38 billion worth of goods each day —and move people more than 3 trillion vehicle-miles. Growing our economy requires transportation, and transportation requires energy. The transportation sector accounts for approximately 27% of total U.S. energy needs and the average U.S. household spends over 17% of its total family expenditures on transportation, making it, as a percentage of spending, the most costly personal expenditure after housing. Transportation is critical to the overall economy, from the movement of goods to providing access to jobs, education, and healthcare.

The Vehicle Technologies Office (VTO) funds research, development, demonstration, and deployment of new, efficient, and clean mobility options that are affordable for all Americans. VTO leverages the unique capabilities and world-class expertise of the National Laboratory system to develop new innovations in vehicle technologies, including: advanced battery technologies (including automated and connected vehicles as well as innovations in efficiency-enhancing connected infrastructure); innovative powertrains to increase efficiency and reduce criteria emissions from hard to electrify off-road, rail, maritime, and aviation sectors; and technology integration that helps demonstrate and deploy new technology at the local level. Across these technology areas and in partnership with industry, VTO has established aggressive technology targets to focus RDD&D efforts and ensure there are pathways for technology transfer of federally supported innovations into commercial applications. The U.S. Department of Energy's Vehicle Technologies Office provides low cost, secure, and sustainable energy technologies to move people and goods across America.

Outline of Eligible Technology Areas:

1. **Batteries**

Summary of Technology Area #1:

The Battery subprogram focuses on high-energy and high-power battery materials and battery systems that will lead to a significant reduction in the cost, weight, volume, and charge-time of electric vehicle (EV) batteries. These activities focus on generating knowledge and addressing technology barriers for batteries. Specific goals include reducing the cost of battery packs to less than $75/kWh while increasing vehicle range to 300 miles and decreasing charge time to less than 15 minutes by 2030.

Proposals are sought to advance towards commercialization any technology whose development as funded through the Battery Technologies program directly addresses critical needs in battery chemistry and production.

Key Challenges in the Technology Area:

To reduce the cost and improve the safety and performance of EV batteries, work must be done to address the following challenges:

- Increasing the calendar and cycle life of near-term chemistries to at least 10 years and 1000 cycles, respectively.
- Improving lithium-ion battery safety to prevent overheating, fire or explosion through innovations in battery materials, electrode, and other cell components.
- Understanding and improving processes for large scale synthesis of battery active materials and precursors from domestic feedstocks and resources.
- Reducing or eliminating critical material content in EV batteries.
- Reducing reliance on costly, energy-intensive, or environmentally harmful processes in battery material, electrode and cell production.

2. **Charging and Electric Vehicles**

Summary of Technology Area #2:

The Electrification Technologies subprogram focuses on transportation electrification through two technology areas: (1) research for interoperable, fast, secure, and resilient Plug-in Electric Vehicle (PEV) charging that is effectively integrated with the electrical grid and other infrastructure through Electrification R&D activities, and (2) extreme high power density motor and power electronics for PEV traction drive systems under Electric Drive R&D. These activities focus on generating knowledge and addressing technology barriers for electric drive systems, and high-power charging systems that can enable transportation electrification, reduce the cost of transportation, and end reliance of foreign energy sources. Specific subprogram goals include: (1) decreasing charge time to less than 15 minutes by 2028, (2) enabling 1+ MW charging for medium- and heavy-duty PEVs, (3) technologies that enable ancillary energy services, effective vehicle-grid integration, and EV hardware interoperability, including bidirectional EVs (to enable charging and discharging to the grid), (4) decreasing the cost of 530 kW Electric Traction Drive Systems by 20% to $13.4/kWpeak, (5) enhancing volumetric power density by 20%* to 3.22 kWpeak/liter, (6) reliably achieving 1 million miles/25,000 hours of operation for electric drive systems in Class 8 trucks without failure by 2030 (7) reduce or eliminate the need for heavy rare-earth minerals in motors without sacrificing performance (8) reducing the cost of on-board chargers to less than $20/kW by 2030 for a 19.2-kW system.

Proposals are sought to advance the commercialization of energy-related technologies whose development was funded through the through the Electrification Technologies subprogram that directly addresses critical needs in charging technologies and vehicle electrification.

Key Challenges in the Technology Area:

- Smart Charge Management (SCM) systems capable of controlling wide-scale utilization of various EV charging level systems (AC Level 2, DCFC, megawatt charging systems).
- Cybersecurity methodologies for EV charging, including Smart Charge Management.
- Electric vehicle charging equipment that enables seamless interoperability with variations in electric vehicle architecture.
- Components that can enable DC-connected EV-charging that integrates with distributed energy resources, such as solar generation and battery storage.
- Components that can enable advanced charging concepts, including higher voltage charging installations with reduced component count and cost, bidirectional and wireless charging, and/or reduce supply chain constraints.
- Behind-the-Meter-Storage (BTMS) solutions that are safe, cost-effective, minimize the use of critical materials, and enable reduced operating costs for DC fast charging (DCFC) stations.
- Power electronics with reduced cost and voltage/power levels suitable for next generation electric vehicles, including heavy-duty and off-road commercial vehicles.
- Electric motors with reduced rare-earth content and elimination of heavy rare-earth elements.
- Advanced cooling/thermal management strategies that reduce size, cost, weight, and reliability of key components.

3. **Energy Efficient Mobility Systems**

Summary of Technology Area #3:

The Energy Efficient Mobility Systems (EEMS) program envisions an affordable, efficient, low-emission, and accessible mobility system future in which mobility is decoupled from energy consumption. Through EEMS, VTO works to realize a future that provides affordable, reliable, and convenient transportation choices that operate efficiently, acknowledging contributions from automation, connectivity, electrification, and sharing technologies.

EEMS conducts research, development, and demonstration at the vehicle, traveler, and mobility system levels, creating new knowledge, insights, tools, and technology solutions that increase mobility energy productivity and decrease greenhouse gas and pollutant emissions for individuals and businesses. This multi-level approach is critical to understanding the opportunities that exist for optimizing the overall transportation system. This approach informs the development of tools and capabilities to evaluate the energy impacts of new mobility solutions and will lead to the creation of technologies that provide economic benefits to all Americans through enhanced mobility.

Proposals are sought to advance the commercialization of energy-related technologies that has relevance to the EEMS program. This may include technology previously developed through EEMS, through internal lab projects, or other programs.

Key Challenges in the Technology Area:

- Reducing barriers for the adoption of new mobility solutions.
- Providing high fidelity tools that are accessible to a broad stakeholder community.
- Increasing the convenience and efficiency of the transportation system. Topics include: improving mode choice for travelers and goods movement; decarbonizing and/or improving energy efficiency of intermodal hubs; and planning and routing tools for zero/low emission vehicles.

Additional information:

- Partnerships with organizations such as MPOs, transit agencies, fleet operators, and the like are encouraged.

4. **Off-Road, Rail, Marine and Aviation R&D Program**

Summary of Technology Area #4:

The Off-Road, Rail, Marine, and Aviation Technologies R&D program supports research, development, and demonstration of new propulsion and vehicle technologies in these difficult-to-electrify transportation applications. These technologies include optimization of high-efficiency engines and emission control systems for alternative fuels such as advanced biofuels, ammonia, methanol, hydrogen, and e-fuels (electro-fuels, i.e., fuels synthesized from CO2 and hydrogen, typically facilitated with renewable electricity), and the integration of electrified and hybrid-electric powertrains into vehicles to further increase efficiency and reduce criteria emissions.

The program utilizes unique capabilities and expertise at the national laboratories and collaborates closely with academia and industry to strengthen the knowledge base for the next generation of higher-efficiency, ultra-low-emissions combustion engines for non-road vehicles. In addition, a science-based understanding of how alternative fuels affect engine efficiency and emissions and how engines can be modified to take advantage of desirable fuel properties could enable further efficiency improvements.

The program supports industry needs to develop predictive, high-fidelity sub-models and simulation tools that are scalable and can leverage future exascale computing capabilities. The activity funds research of alternative fuel properties and utilization, in coordination with the Bioenergy Technologies Office, using chemical kinetics modeling of different molecules to determine their impact on combustion efficiency and emissions.

Proposals are sought to advance the commercialization of energy-related technologies whose development was funded through the Off-road, Rail, Marine and Aviation R&D Program.

Key Challenges in the Technology Area:

- Increase efficient use of alternative fuels (H2, biodiesel, ammonia, methanol, etc.) in combustion engines for off-road, rail, and maritime emissions and improve catalysts to reduce criteria emissions.
- Increase electrification of non-road vehicles through hybrid/plug-in architectures.
- Improve understanding of contrails formation from sustainable aviation fuels.
- Improve computer models of alternative fuel combustion and emission control.

5. **Materials Technology**

Summary of Technology Area #5:

The Materials Technology subprogram supports R&D of advanced materials to enable increased vehicle efficiency. Materials play an important role in increasing the efficiency of electric vehicles through weight reduction as well as enabling additional functionalities such as faster charging and new sensing technologies. Lighter weight vehicle structures and electric drivetrains will require fewer batteries to achieve the same driving range, which in turn reduces battery cost, material needs, and reduces the greenhouse gas emissions from battery production. Functional materials with improved properties such as electrical conductivity, thermal conductivity, and unique sensing capabilities will enable innovations in charging and autonomous vehicles. The materials and manufacturing methods used to make vehicles also contribute to energy demand and vehicle cost. The Materials Technology subprogram supports research, development, and deployment to increase recyclability and reduce the overall embodied energy of vehicles. To enable the use of materials such as advanced high-strength steel, magnesium, aluminum, plastics, and polymer composites, the Materials Technology subprogram focuses on reducing cost, improving prediction of properties, and enabling high volume manufacturing of components and multi-material assemblies. The Materials Program goal is to reduce the weight of a vehicle's glider by 25% at a cost of less than five dollars per kilogram saved.

Proposals are sought to advance the commercialization of energy-related technologies whose development was funded through the Powertrain Materials Core Program, Light Metals Core Program, Joining Core Program, or Composites Core Program.

Key Challenges in the Technology Area:

- Cost effective sustainable materials (Alloys or Composites) with>25% post-consumer recycled material for vehicle applications.
- Reducing the energy content of sustainable materials (alloys and composites) for vehicle applications.
- Cost effective materials for vehicle lightweighting that can meet the cost threshold of $5/kilogram without significantly increasing vehicle energy intensity.

AOI 4.13: Water Power Technology Office (WPTO)

Overview of Major Mission Areas:

The Water Power Technologies Office (WPTO) enables research, development, and testing of emerging technologies to advance marine energy as well as next-generation hydropower and pumped storage systems for a flexible, reliable grid. WPTO seeks proposals related to the commercialization of both marine energy and hydropower technologies, including energy generation systems like wave energy converters and turbines, as well as enabling technologies like cables, environmentally friendly coatings, etc. These are only examples and WPTO intends to support a wide range of related technologies.

To advance the state of marine energy and hydropower technologies and reduce costs of electricity and energy served by marine energy and hydropower, commercialization of technologies developed by the national laboratories is critical. Technologies and products developed by the national laboratories may seek to advance the industry at large and include applications that could be used by several developers. Additionally, research and IP developed by the labs could help developers de-risk investments that could result in commercially relevant technologies. WPTO encourages lab researchers to pursue open-source commercialization pathways, including making technology development and validation data publicly available, through this funding opportunity. Lab researchers are strongly encouraged to work with external partners from industry, end users, communities where these technologies may be deployed, and other relevant groups towards commercialization.

AOI 4.14: Wind Energy Technology Office (WETO)

Overview of Major Mission Areas:

The Wind Energy Technologies Office (WETO) invests in a diversified portfolio of wind energy research, development, demonstration, and deployment activities that enable and accelerate the innovations necessary to advance offshore, land-based, and distributed wind systems, reduce the cost of wind energy, drive deployment, and facilitate the integration of high-levels of wind energy with the electric grid. With continued innovation, wind energy has the potential to cost-competitively contribute between 35 and 45 percent of U.S. electricity in less than two decades, up from about 10 percent of all U.S. electric power in 2023. Wind energy can also contribute to grid reliability and resiliency, as well as the generation of fuels and supporting growth in good-paying jobs and domestic manufacturing across all regions of the country. Progress on these fronts, arising from continued innovation in technology, grid systems integration, and unique solutions to deployment challenges, can position the U.S. as a global leader in wind energy development at home and abroad.

Across all its wind energy development objectives, WETO emphasizes three common and overarching themes:

- Reduce the cost of wind energy for all wind applications (offshore, land-based utility-scale, and distributed)
- Accelerate the deployment of wind energy through siting and environmental solutions to reduce environmental impacts, minimizing timetables for wind energy project development, and facilitating responsible development and delivery of wind energy resources
- Enable and facilitate the interconnection and integration of substantial amounts of wind energy into the dynamic and rapidly evolving energy system that is cost-effective, cybersecure, reliable, and resilient, and includes systems integrated with other energy technologies and energy storage.

Outline of Eligible Technology Areas:

1. **Technology Area #1: Open Topic**

Summary of Technology Area #1:

WETO is soliciting an "Open Topic," for Technology Specific Partnerships. WETO seeks proposals from Labs to advance the commercialization of individual energy-related technologies. Projects funded under this topic will need to incorporate lab-created IP and be at a stage that will generate private sector interest. Applications must demonstrate ***clear evidence of commercial potential*** that combines technology progress with market pull or interest.

Examples of evidence of technology progress include:

- Demonstrated analytical and experimental proof of concept in a laboratory environment.
- Experiments or modeling and simulation validating the functional performance of the technology.

Examples of evidence of market pull or interest include:

- Market analysis demonstrating the technology's current or expected future cost and/or performance advantages vis-a-vis incumbent or competing technologies.
- Demonstrated interest from private industry partners or investors.

Ideal applications will include technologies with identified utility and potential impact to industry, market viability, and a clear commercialization path forward. Key milestones for applications under this topic must be commercialization focused, not technology focused, and demonstrate a clear understanding of barriers to commercial adoption (e.g., market entry barriers, regulatory barriers, supply chain barriers) and how they can be overcome. The application must address what the project intends to accomplish in terms of advancing the technology's readiness for commercialization. Applications must clearly demonstrate the market need the technology will meet, differences that make the technology more competitive than similar technologies, and the feasibility of moving the technology to market. The pathway for the technology beyond TCF funding should also be clearly identified for proposals in this topic. Applications should identify any risks associated with commercializing the technology and the ways the proposed project will mitigate the risks involved.

Applications including team members who have completed Energy I-Corps or similar programs are strongly encouraged.

AOI 4.15: EERE Grid Integration (EGI)

Overview of Major Mission Areas:

As our country pursues all sources of energy, power system planning and operations must evolve to accommodate variable resources that use power electronics rather than resources physically synchronized with the grid, while ensuring the long-term reliability and resilience of the system. The EERE Grid Integration (EGI) program takes a holistic approach to integration challenges across many technologies and systems. These challenges include:

- Accommodating the increase of variable generation, addressing changes in system dynamic behavior, and addressing bidirectional flows of electricity from distributed energy resources and the seams between transmission and distribution.
- Ensuring resource adequacy with an increased amount of variable generation on the power system; supporting the electrification of transportation, industrial, and other loads; and mitigating threats related to natural hazards (e.g., severe weather events) and physical and cyber security.
- Addressing infrastructure needs and interdependencies: This includes improving energy project siting and permitting processes and better understanding how to deploy additional system capacity. We must also increase existing transmission capacity use and account for the interdependencies between electricity, fuels, communication, and other infrastructures.

- Accommodating diverse state preferences, markets, and business models. This includes assistance to grid operators in developing market products and tools for facilitating the mutual matching of generation and load, allowing for the optimization of energy storage, and ensuring power system flexibility and resource adequacy. This also includes meeting state and local decision-makers where they are to support choice-based energy buildout.

Addressing these challenges requires new technologies; improved data, tools, and models; and new analysis that directly supports decision-makers responsible for the planning, operation, and regulation, of the grid as a whole. To support system-wide decisions, it is critical that EERE's efforts mirror the integration of the grid and themselves be developed and implemented in a way that integrates across technologies and offices.

For that reason, the EGI program supports projects coordinated across the energy sector, leveraging staff and expertise within the wind, solar, geothermal, and water program offices. The EGI program also provides the connective tissue for grid-focused collaborations with EERE's Buildings and Industry pillar and Transportation and Fuels pillar, as well as the Office of Electricity and the Grid Deployment Office. EGI supports coordination on and contribution to the Grid Modernization Initiative, focused specifically on tools and technologies that directly facilitate the integration of variable resources and capitalize on the value of dispatchable renewable resources like hydropower and geothermal.

Outline of Eligible Technology Areas:

1. **Technology Area #1: Open Topic**

Summary of Technology Area #1:

EGI is soliciting an "Open Topic," for Technology Specific Partnership Projects that tie into EGI's mission. Applications **must** be cross-cutting and apply to at least one other AOI in topic 4 of this lab call.

VI. Application Submission Information

The application process will include two required phases: a concept paper phase and a full application phase. At each phase, DOE performs an initial eligibility review of the applicant submissions to determine whether they meet the eligibility requirements of the lab call. DOE will not review or consider submissions that do not meet the eligibility requirements.

DOE will not extend deadlines for applicants who fail to submit required information and documents due to server/connection congestion.

i. General Information

ELIGIBILITY

Only DOE National Laboratories, plants, and sites are eligible to receive funding from this lab call. All concept papers and full applications must either be 1) submitted to DOE from each lab's respective Office of Research and Technology Application (ORTA)[51] TTOs or 2) must include a letter of support from the TTO if submitted by someone outside of the TTO. A TTO letter of support may either be included in the concept paper and full application addendums or emailed to TCF@hq.doe.gov prior to both the concept paper and full application deadlines. If the TTO is emailing a letter of support, it is allowable to include multiple proposals in a single letter; when doing so, please identify the proposals by Exchange ID. A letter of support from the TTO is only required if the TTO is not the person submitting the concept paper or full application. Replies to reviewer comments may be submitted by someone other than a Lab TTO.

Only applicants who have submitted an eligible concept paper and received an 'encourage' determination from DOE will be eligible to submit a full application.

There are no limits on the number of concept papers each National Laboratory can submit.

For Topics 1, 2, 3, 5, and 6, National Laboratories are expected to coordinate internally and with other labs (when applicable) on the concept paper and full application submissions. If there is at least one lab partner on the project, the prime lab applicant can submit an unlimited number of full project applications. Only the prime lab applicant needs to submit a concept paper and full application on behalf of the proposal team. **When an application does not have any lab partners, the prime lab applicant may submit no more than two full applications that do not contain lab partners.** Any submitted applications that exceed this limit will not be considered. Applications will be counted in the order in which they are received. Labs can apply to multiple topics with the same application for Topics 1, 2, 3, 5, and 6.

For Topic 4, there are no limits on the number of full applications each National Laboratory can submit.

The concept paper, full application, and reply to reviewer comments must conform to the form and content requirements described in Sections VI.ii and VI.iii. If applicants exceed the maximum page lengths stated in Sections VI.ii or VI.iii, DOE will review only the authorized number of pages and will disregard any additional pages.

[51] 15 USC 3710.

SUBMISSION PROCESS

To apply to this lab call, lab personnel must register and sign in with their lab email address and submit application materials through Exchange. The EERE Exchange system has fields which must be completed as part of the submission process; however, many of the fields are not required by DOE as they are either not applicable or are captured elsewhere in the application process. Please see Appendix E for instructions on how to complete a concept paper or full application submission on the EERE Exchange System for this lab call.

Applicants are strongly encouraged to submit their concept papers, full applications, and replies to reviewer comments at least 48 hours in advance of the submission deadline.

The concept paper, full application, and reply to reviewer comments must conform to the following requirements:

- Must be submitted via Exchange.
- Must be submitted by the applicable deadline.
- Must be written in English.
- Must be submitted in Adobe PDF format unless stated otherwise.
- A control number will be issued when an applicant begins the Exchange application process. The control number must be prominently displayed on the top right corner of the header on every page.
- Page numbers must be included in the footer of every page.
- All pages must be formatted to fit on 8.5 x 11-inch paper with margins not less than one inch on every side. Use Calibri, Times New Roman, or Aptos typeface, black font color, and a font size of 11 point or larger (except in figures or tables, which may be 10-point font). A symbol font may be used to insert Greek letters or special characters, but the font size requirements still apply.
- Must not exceed the specified maximum page limit when printed using the formatting requirements.
- All proprietary information must be marked following the guidance below.

PROPRIETARY INFORMATION

Applicants should not include trade secrets or commercial or financial information that is privileged or confidential in their proposals, unless such information is necessary to convey an understanding of the proposed project or to comply with a requirement in this solicitation. Proposals that contain trade secrets or commercial or financial information that is privileged or confidential and that the applicant does not want disclosed to the public or used by the government for any purpose other than proposal evaluation must be marked as described below.

A cover sheet (preceding the title page), which does not count against the page limits, must be marked as follows and must identify the specific pages that contain trade secrets or commercial or financial information that is privileged or confidential:

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

The header and footer of every page that contains trade secrets or privileged commercial or financial information must be marked as follows:

"May contain trade secrets or commercial or financial information that is privileged or confidential and exempt from public disclosure."

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

The above-referenced markings enable DOE to follow the provisions of 10 C.F.R. §1004.11(d) in the event a Freedom of Information Act (FOIA) request is received for information submitted with a proposal. Failure to comply with these marking requirements may result in the disclosure of the unmarked information under a FOIA request or otherwise. The U.S. government is not liable for the disclosure or use of unmarked information and may use or disclose such information for any purpose.

Subject to the specific FOIA exemptions identified in 5 U.S.C. §552(b), all information submitted to DOE by an applicant is subject to public release under the Freedom of Information Act, 5 U.S.C. §552, as amended by the OPEN Government Act of 2007, Pub. L. No. 110-175. It is the proposer's responsibility to review FOIA and its exemptions to understand:

1. What information may be subject to public disclosure.
2. What information applicants submit to the government that is protected by law.

In some cases, DOE may be unable to make an independent determination regarding which information submitted is releasable and which is protected by an exemption. In such cases, DOE will consult with the applicant in accordance with 10 C.F.R. §1004.11 to solicit the proposer's views on how the information should be treated.

ii. Concept Papers

Applicants are required to submit the concept paper in Exchange no later than December 12, 2024, at 3 PM ET.

DOE will review the concept paper, and applicants will receive an official determination, 'encourage' or 'discourage'. The intent is to help the National Labs focus their efforts on the concepts with the highest potential under this lab call. **Only labs that receive an 'encourage' determination on the concept paper phase will be eligible submit a full application.**

The concept paper must conform to the following content and length requirements:

Title Page (1 page maximum)

- The Title Page is required to include the template table(s) provided in Appendix D.

Project Description (3 pages maximum)

- Describe the project in enough detail that it may be evaluated for its innovation, impact, and relevance to the topic objectives.
- Describe relevant background information that helps demonstrate the need for this project, including the problem statement or major challenges and barriers being overcome through the project and the approach to solving the problem.
- Develop a commercialization plan that outlines the approach towards maximizing impact of DOE funding on the relevant field and application.
- Describe how the proposed project, if successfully accomplished, would clearly meet the objectives stated in the lab call.
- Applicants may provide graphs, charts, or other data to supplement their project description.
- For any proposals applying to topic 4, provide an explanation of the starting and ending TRL and ARL. Please take note of the TRL requirements in each of the program office AOI descriptions, when listed.

Team and Required Resources (2 pages maximum)

- Describe the qualifications, skill, expertise, capabilities, and/or experience that the project team has to successfully execute the project plan. Describe any additional skills that may be needed.
- Explain whether the applicant has worked together with their teaming partners on prior projects or programs.

- Explain whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how they intend to obtain access to the necessary equipment and facilities.

Addendum (No page limit)

- References.
- Letters of Commitment. If applicable, provide letter(s) of commitment from all third-party cost-share provider(s),1-page maximum per letter.
    - For any proposals applying to subtopic 4.b, provide evidence for eligibility of applying in this category.
    - For LEEP topic 4 applications, include evidence of participating in LEEP (e.g., a copy of the selection memo, a letter of support from the LEEP node).

Please note, a separate file titled "Concept_Paper_Template" can be found on Exchange under this lab call, containing the full concept paper requirements in a template format.

iii. Full Applications

If labs receive an 'encourage' determination from DOE at the concept paper stage, they are eligible to further expand their encouraged concept into a full application. **Only labs that receive an 'encourage' determination on the concept paper phase will be eligible to submit a full application**. Full applications are required to be eligible for selection under this solicitation. Applicants are required to submit the full application materials in Exchange no later than March 27, 2025, at 3 PM ET.

Each full application shall be limited to a single concept. Unrelated concepts shall not be consolidated in a single full application.

Full applications must conform to the requirements below and contain a Technical Volume, Budget Spreadsheet, and Summary Slide.

TECHNICAL VOLUME

Please note, a separate file titled "Technical_Volume_Template" can be found on Exchange under this lab call, containing the full Technical Volume requirements in a template format.

Technical Volumes should be no more than 15 single-spaced pages total. The Title Page and the Addendum of the Technical Volume do not contribute toward the 15-page limit. It is preferred that applicants use the headings corresponding to the bullet titles and content below. The Technical Volume must include the following sections:

Title Page (1 page maximum)

- The Title Page is required to include the template table(s) provided in Appendix D.

Glossary

- Spell out acronyms the first time they are used and add them to the glossary. Remove any acronyms and definitions from the glossary that are not used.

Acronym/Term	Definition

Executive Summary

- A short explanation of the proposed project.
- Clearly defined, easily communicated, end-of-project goal(s).
- A discussion on the impact that DOE funding would have on the proposed project, specifically explaining how DOE funding—relative to prior, current, or anticipated funding from other public and private sources—is necessary to achieve the project objectives.

Project Description

- Describe the project in enough detail that it may be evaluated for its innovation, impact, and relevance to the topic/AOI objectives.
- Describe the specific innovation of the proposed project, the advantages over current and emerging programs and/or processes, and the overall impact on advancing the baseline if the project is successful.
- Describe relevant background information that helps demonstrate the need for this project, including the problem statement.
- Include a brief explanation of why DOE TCF Base funding is necessary to achieve the objectives of the proposal.
- If applicable, indicate whether the project is related to other current or recently completed DOE-funded, lab-funded, or externally funded projects, and how they differ.
- Provide justification for the optimal budget proposed. Please provide justification for the cost-share amount (e.g., if 0%, why?).
- Long-Term Viability
    - Please include the project plan for impact without long-term, continued, direct funding from DOE. If the project is successful, include how it could ensure the project would continue or be maintained after receiving DOE funding.

    - If applicable, please address if the project is scalable to other labs, and how it can be adapted to meet the unique needs of each partner lab.

Potential Commercialization Advances

- For Topics 1, 2, 3, 5, and 6, identify root causes (inside and outside of the labs) of the existing lab commercialization challenges and barriers that, if addressed, will result in significant advances for commercializing technologies.
- For Topic 4, describe the expected path for the proposed project toward commercialization successes, including the anticipated timeline for market entry or increased market adoption for technologies involved in the proposal.
    - Provide justification on the starting and ending TRL and ARL.
- Identify and address key risks to achieving stated goals and the steps to be taken to minimize or mitigate those risks.
- Identify and discuss key barriers to commercial adoption (e.g., barriers that relate to the technology, market entry, supply chain, etc.) and how they can be overcome.

Project Metrics

- Describe how the proposed project would measure success during and after the period of performance, all projects must incorporate clear impact-tracking strategies.
- The metrics table is for metrics that measure impact and progress for the life of the project and the reporting period (5-year reporting period starting at the time of the award and/or for 3-years after the period of performance ends, whichever date is later). Consider short-, medium-, and long-term goals. Applicants should strive to include at least 5 metrics. The metrics table follows the below definitions:
    - <u>Type:</u> Activity, output, or outcome
    - <u>Reporting Location:</u> Quarterly reports, continuation applications, final reports, etc.
    - <u>Unit:</u> Count, $, ratio, etc.
    - <u>Minimum Frequency:</u> What is the minimum frequency to measure or evaluate this metric? e.g., quarterly, 4 times over life of project, etc. Can indicate if only measured during specific tasks and/or subtasks.
    - <u>Expected Frequency:</u> What is the typical/expected frequency to measure or evaluate this metric? e.g., monthly, 6 times over life of project, etc. Can indicate if only measured during specific tasks and/or subtasks.
    - <u>Project Target (Total):</u> What is the target achievement for the metric? e.g., targeting 5 end users, 3 interns hired, etc. If something is additive, list the total for the end of the project.

- Acceptable outcome-focused metrics could include but are not limited to: 1) number of commercialized technologies, 2) number of CRADAs or other partnering arrangements that come out of the labs, 3) increase in number of licensed lab technologies, 4) number of tangible improvements to lab-related activities based on customer discovery, 5) qualitative data before and after activity measuring understanding or perspective shift, 6) number of lab technology transfer professionals trained in areas outside of normal activities, 7) private funds invested in solutions, 8) number and value of established industry and incubator partnerships, 9) number of inquiries for new partnerships, 10) innovation and IP generation, 11) annual revenue from commercialized technologies, etc.
- Unacceptable metrics include but are not limited to 1) general reports describing activities, 2) exploratory experiments that lack a goal, 3) unverifiable data, 4) time spent on project, and 5) other subjective, vague, and/or ambiguous metrics.
- Define each metric passing and failing criteria.
- *Two examples for a project with a 3-year period of performance are included below.*

Metric	Type	Reporting Location	Unit	Min. Frequency	Expected Frequency	Project Target (Total)
Example #1: Technical Presentations	Activity	Quarterly Report	Count	Once	Annually	3
Example #2: Patent Licenses	Outcome	Annual Report	Count	3 years after project end date	Three times (end of years 4, 5, and 6)	1

Metrics will follow the below definitions:

- *Example #1: Technical presentations: passing = delivery of presentation at one or more conferences; failing = no presentation.*

- *Example #2: Patent licenses: passing = patent is licensed by at least one industrial partner within three years after end of project; failing = no patent licensing.*

Work Plan

- List the key project tasks and provide brief descriptions for each task below along with approximate time to completion. When possible, tasks and subtasks should be SMART. Some applicants may find it helpful to include a Gantt chart.

Team and Required Resources

- Describe the proposed project team, including industry partners, and explain how the team is qualified and capable of successfully completing the project.
- Describe the expected resources (from each: prime lab, partner labs, cost-share partners, non-cost-share partners), including proposed work areas, and any facility/equipment needs. Include specific locations and laboratories to be used.
- Identify any areas where additional resources may be needed and the plan to address the gap(s).
- Include a description of each performer's role and responsibility, and their full-time equivalent (FTE) listed in the table below. This table should include individuals from all involved parties.

Name	Organization Name	Roles/Responsibilities	FTE
e.g., John Smith	Lab X	Principal Investigator	e.g., 1.0 (40 hours/week)

Industry Partners:

- List industry partners and add the total project cost-share amounts (in-kind and cash) for each partner if applicable.

Subcontracting Entities:

- List name of subcontracting companies and entities or services provided.

Addendum (No page limit)

- References.
- Team Resumes. Resumes of key project participants must be included and should not exceed one page per participant.

- Letters of Commitment. If applicable, provide letter(s) of commitment from all third-party cost-share provider(s) and project partner(s); 1-page maximum per letter.
    - For any proposals applying to subtopic 4.b, provide evidence for applying in this category.
    - For LEEP topic 4 applications, include evidence of participating in LEEP (e.g., a copy of the selection memo, a letter of support from the LEEP node).

BUDGET SPREADSHEET

For FY25, DOE is requiring that all applicants provide a low, optimal, and high budget level request with the associated tasks and scope outlined at each proposed budget level in order to expedite project awardee negotiations and allow program offices to select the funding level that best suits their available budget and technology goals. **The low budget should be at least 20% less than the optimal funding, and the high budget should be at least 20% more than the optimal funding requested.**

The Budget Spreadsheet is a separate file which should be included in the application. There is a template that should be used for the budget spreadsheet, and it can be found on Exchange under this lab call, "FY25_Budget_Template." All sections should be filled out according to the instructions in the spreadsheet.

During the review and selection process, DOE reserves the right to negotiate an award with a modified project scope and budget. See Appendix A for additional cost-share information and requirements.

SUMMARY SLIDE

The summary slide is a separate file which should be included in the application. Format the slide to be in Widescreen slide size (e.g., 16:9 ratio, not Standard 4:3 ratio), and submit the file as a PowerPoint file. It must not exceed one PowerPoint slide, and it must be suitable for dissemination to the public. This slide must not include any proprietary or business-sensitive information because DOE may make it available to the public if the project is selected for award. The summary slide requires the following information:

- Proposal title, prime lab, partner lab(s), Principal Investigator (PI) name(s), topic(s), subtopic(s), and AOI(s) if applicable.
- A proposal summary.
- A description of the proposal's impact and goals.
- A brief explanation of why DOE TCF Base funding is necessary to achieve the objectives of the proposal.

- State the requested optimum-level of federal funding, proposed cost-share amount, total project budget, and period of performance (months).
- Key graphics (illustrations, charts, and/or tables).

VII. Merit Review and Selection

i. Concept Paper Merit Review

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

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

This criterion involves consideration of the following factors:

- The applicant clearly describes the project in enough detail that it may be evaluated for its innovation, impact, commercialization potential, and relevance to meeting the lab call objectives.
- The applicant clearly describes relevant background information that helps demonstrate the need for this project, including the problem statement or major challenges and barriers being overcome through the project, and the approach to solving the problem.
- The applicant clearly identifies the topic(s), subtopic(s), AOI(s) (if applicable), and Technical Area(s) (if applicable) for which they are applying and how they meet the required elements of the topic(s), subtopic(s), AOI(s) when applicable, and Technical Area(s) when applicable.
- The applicant has shown the impact that DOE TCF funding and the proposed project would have on the relevant field and application.
- The applicant has the qualifications, experience, capabilities, and other resources necessary to complete the proposed project.

ii. Full Application Merit Review

Full applications are evaluated based on the following criteria (please note the weighting).

Criterion 1: Innovation and Impact (45%)

> How innovative and impactful is the project, assuming the stated outcomes can be achieved as written?

This criterion involves consideration of the following factors:

- Innovative—Extent to which the proposed project or solution is innovative. Degree to which the proposed project integrates market pull into its thinking and program design, forming a conduit of market insight and awareness.
- Impactful—Extent to which the proposed project or solution, if successful, impacts the core goals outlined in the lab call and/or the root causes (inside and outside of the labs) of the existing commercialization challenges and barriers. Proposals including multiple stakeholders (e.g., multi-lab and industry-leveraged effort) will be scored as inherently more impactful than single-lab projects. Note: single-lab solutions will be scored based on the applicability of having lab partner(s). For Topic 4, proposals that are applicable to multiple DOE program offices are inherently more impactful.
- Accelerates Speed of Commercialization—Degree to which the proposal has the potential to accelerate the speed of commercialization. Degree to which the proposal supports achieving the statutory requirement of the TCF to "promote promising energy technologies for commercial purposes."
- Long-Term Viability—Degree to which the proposal has the potential to continue to be impactful without long-term, continued, direct funding from DOE. Extent to which multi-year strategic partnerships are proposed or will be developed to continue the program beyond initial funding. Level of proposed cost-share for the project will be taken into consideration.
- Differentiated—Extent of differentiation with respect to existing commercialization programs or efforts. Potential to enhance commercialization activities at the National Laboratories.
- Scalable—Likelihood that the proposed solution, if successful, could be scaled to have a broader impact. Likelihood that the project could be scaled beyond the proposed multi-lab collaboration and to all labs, even those not directly participating in the proposed project.
- Commercialization Outcomes—Likelihood of the proposed solution achieving the proposed commercialization outcome metrics. Likelihood of the proposed team tracking and reporting on the commercialization outcome metrics.
- Cost-Share Commitment—Extent to which partners' interest and level of involvement is reflected in appropriate levels of proposed cost-share for the project will be taken into consideration.
- Evidence of Commercial Potential—Degree to which Topic 4 proposal demonstrates both technology progress and market pull or interest. Extent to which the proposed technology will result in a commercially successful product and/or company. Extent to which the proposed technology can be successfully

commercialized in a reasonable timeframe. Project starting and ending ARL will be considered.

Criterion 2: Quality and Likelihood of Completion of Stated Goals (35%)

Are the stated goals of the project SMART, and are they likely to be accomplished within the scope of this project? Is there a likelihood of success for the proposed project?

This criterion involves consideration of the following factors:

- Measurable—Degree to which the proposal is structured to produce a measurable result and impact. Extent to which the applicant shows a clear understanding of the importance of SMART, verifiable tasks.
- Risks mitigated—Extent to which the applicant understands and discusses the risks, core barriers, and challenges the proposed work will face, and the soundness of the strategies and methods that will be used to mitigate risks. Degree to which the proposal adequately describes how the team will manage and mitigate risks.
- Validated—Degree to which the proposed project fits within and builds on the National Laboratory ecosystem. For Topic 4 proposals, degree to which the project applies to one or multiple AOIs. Level of validation (letters of support/interest, partners, customer trials, data from prior work, report references, etc.).
- Reasonable assumptions—Reasonableness of the assumptions used to form the execution strategy (e.g., lab staff participation, costs, throughput at full scale, speed of proposed scale-up or adoption, and mode of long-term funding).
- Reasonable budget—The reasonableness of the overall funding requested to achieve the proposed project and objectives. The reasonableness and clarity of the budget and scope options (low, optimal, high). Level of proposed cost-share for the project will be taken into consideration.

Criterion 3: Collaboration and Capability of the Applicant and Project Team (20%)

Is the team well-qualified and positioned to successfully complete this project?

This criterion involves consideration of the following factors:

- Collaboration—Extent to which there are multiple labs engaged on the proposed project (this is particularly important for Topic 1, 2, 3, 5, and 6 applications). Degree to which the proposed project branches out, connects, and builds on the innovation ecosystem across the country. Extent to which connections and alliances are forged to harness the power of regional economies; state/local organizations; and other federal, state, or local agencies. Note: single-lab solutions will be scored based on the applicability of having lab partner(s).

- Capable—Extent to which the training, capabilities, experience, and level of participation of the assembled team will result in the successful completion of the proposed project. Extent to which this team (including proposed subrecipients) will be able to achieve the proposed results on time and to specification.
- Participation—The level of participation by project participants, as evidenced by letter(s) of commitment demonstrating cost-share and how well they are integrated into the work plan. Degree to which multi-lab, internal National Lab, and external collaboration is proposed.
- Team Quality—Extent to which the final team required to complete this project is fully assembled and committed to the project (e.g., are there any key members that are "to be hired" in the future?). Level of proposed cost-share for the project will be taken into consideration.
- Past Performance—Extent to which the assembled team has shown success in the past. Note: new performers will not be penalized. DOE encourages new entrants and new ideas, but past successes and/or failures will be noted.
- Access—Extent to which the team has access to facilities, equipment, people, expertise, data, knowledge, and other resources required to complete the proposed project.

iii. Selection for Negotiation

Selection of winning proposals will be determined based on available funding and input from DOE and external reviewers. In general, DOE will use data and other information contained in proposals for evaluation purposes only, unless such information is generally available to the public or is already the property of the government.

DOE carefully considers all information obtained through the selection process. DOE may select or not select a proposal for negotiations. DOE may also postpone a final selection determination on one or more proposals until a later date, subject to availability of funds and other factors. DOE anticipates completing the selection *and* negotiation processes by Q4 FY25 (subject to change). DOE will notify the prime National Lab TTO and PI electronically of selection results. All of DOE's decisions are final when communicated to applicants.

Type of Award Instrument: TCF awards will be documented and funded through OTT's work authorization and funds management processes within the Program Information Collection System (PICS). In contrast to the TCF funding process in prior years, appropriations will be transferred to a new Fund Value established for TCF and managed by OTT. The Budget and Reporting (B&R) structure of these transferred funds will identify the original funding source. DOE facilities will be required to track federal funds in accordance with normal departmental processes. DOE facilities will also be required to track cost-share funds in accordance with established DOE facility accounting processes.

DOE will direct transfer funding to the prime and partner labs; lab-to-lab transfers should not be needed. All partnerships between the Labs and outside partners must comply with individual lab requirements under their M&O contracts.

VIII. Project Administration and Reporting

DOE has an obligation to report on TCF implementation and impact. As such, all projects must incorporate clear impact-tracking strategies. Projects selected for award are managed by the DOE facilities in accordance with their requisite policies and procedures. OTT and participating DOE program offices will provide all required project oversight and engagement with TCF project recipients.

TCF project recipients will be required to report to PICS quarterly, at a minimum. DOE reserves the right to require more frequent reporting if necessary, depending on the project. Recipients will be required to submit a quarterly progress report and update project spend (federal and cost-share) in PICS. If multiple labs are participating in a project, then the prime lab will be responsible for all PICS reporting.

TCF project recipients will be required to meet quarterly with OTT and supporting DOE program offices to discuss project progress, provide quarterly progress reports, and a final report at the end of the project. Annual metrics reporting is required for a 5-year period starting at the time of award and/or for 3-years after the period of performance ends, whichever date is later. TCF Base project metrics will continue to be included in the Annual Data Call.

Appendix A: TCF Cost-Share and Nonfederal Cost-Share Information

This lab call is subject to Section 988 of the Energy Policy Act of 2005 regarding cost-share. DOE prefers all funded projects to meet this 50% of the total project cost-share fund requirement; however, DOE acknowledges that some potentially high-impact proposed projects may not be able to meet this requirement. In this case and following the requirements by topic below, labs may still apply with less than 50% nonfederal cost-share so that DOE can see the full universe of high-quality proposals. The scoring criteria reflect that higher levels of cost-share mitigate the risk of commercializing earlier stage technologies.

DOE has approved a Cost-Share Waiver for topics 1.b, 2.b, 3.b, 4.b, 5.b, and 6.b of this lab call (full topic descriptions above), to ensure all project ideas can apply and the most impactful mix of projects can be selected.

Each proposal that applies to a subtopic (a) commits to meet the minimum 50% of total project cost-share funds requirement.

Each proposal that applies to subtopics (b) may propose to meet less than the 50% of total project cost-share funds requirement. Further details on the eligibility criteria for topic 4.b are listed in the cost-share section of the lab call (see Section III.iv).

Cost-share funds are subject to audit by the Department or other authorized government entities (e.g., General Accounting Office). A written agreement may be advisable—either between the DOE Facility and the third party or between the CRADA partner and the third party—that requires the third party to provide the cost-share funds. Consult your DOE lab legal staff for advice about how to obligate the third party to provide the cost-share funds, and to ensure the cost-share funds meet the requirements for in-kind contributions, if applicable.

Labs are expected to put a process in place to assure cost-share commitments are met over the course of a project to avoid the situation where federal funds have been largely exhausted prior to the laboratory partner providing a significant portion of the cost-share. The lead DOE lab, in conjunction with other participating labs, as applicable, are responsible for assuring cost-share commitments documented in the proposal/SOW are met. Pursuant to cost-share requirements, any cost-share not otherwise waived shall be provided by a non-Federal source. It is acknowledged that Government-Owned Government-Operated (GOGO) labs do not have access to non-Federal funds other than from the non-Federal partner.

Subcontracting support services to a cost-share partner are allowed as long as the cost-share requirements are met, and they follow both DOE and the respective lab(s) policies and procedures. If a cost-share partner is also the subcontractor, then the work being subcontracted will be evaluated during the application review.

OTT has no policy regarding foreign expenditures. All relevant laws, DOE directives, and contractual obligations apply. Consult your DOE lab's legal staff for advice about foreign partners and agreements with the DOE lab.

Applicants must make sure their prospective partnership arrangements comply with individual lab requirements under their M&O contracts.

DOE will not allow pre-award costs (e.g., establishment of a CRADA between the cost-share partner and the prime lab).

WHAT QUALIFIES FOR NONFEDERAL COST-SHARE

Please consult the Federal Acquisition Regulations for the applicable cost-sharing requirements. In addition to the regulations referenced above, other factors may come into play, such as timing of in-kind contributions and length of the project period. For example, the value of 10 years of donated maintenance on a project that has a project period of 5 years would not be fully allowable. Only the value for the 5 years of donated maintenance that corresponds to the project period is allowable and may be counted.

As stated above, the rules about what is allowable are generally the same within like types of organizations. The following are the rules found to be common, but again, the specifics are contained in the regulations and cost principles specific to the type of entity:

A. **Acceptable contributions.** All contributions, including cash contributions and third-party in-kind contributions, must be accepted as part of the prime recipient's nonfederal cost-share if such contributions meet all of the following criteria:
    1) They are verifiable from the recipient's records.
    2) They are not included as contributions for any other federally assisted project or program.
    3) They are necessary and reasonable for the proper and efficient accomplishment of project or program objectives.
    4) They are allowable under the cost principles applicable to the type of entity incurring the cost.
    5) They are not paid by the federal government under another award unless authorized by federal statute.
    6) They are provided for in the approved budget.

B. Valuing and documenting contributions.

1) Valuing recipient's property or services of recipient's employees. Values are established in accordance with the applicable cost principles, which means amounts chargeable to the project are determined on the basis of costs incurred. For real property or equipment used on the project, the cost principles authorize depreciation or use charges. The full value of the item may be applied when the item will be consumed in the performance of the award or fully depreciated by the end of the award. In cases where the full value of a donated capital asset is to be applied as nonfederal cost-share funds, that full value must be the lesser of the following:
    a. The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation; or
    b. The current fair market value. If there is sufficient justification, the contracting officer may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project. The contracting officer may accept the use of any reasonable basis for determining the fair market value of the property.
2) Valuing services of others' employees. If an employer other than the recipient furnishes the services of an employee, those services are valued at the employee's regular rate of pay, provided the services are for the same skill level for which the employee is normally paid.
3) Valuing volunteer services. Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as nonfederal cost-share if the service is an integral and necessary part of an approved project or program. Rates for volunteer services must be consistent with those paid for similar work in the recipient's organization. In those markets in which the required skills are not found in the recipient organization, rates must be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, allowable, and allocable may be included in the valuation.
4) Valuing in-kind contributions by third parties.
    a. Donated supplies may include such items as office supplies or laboratory supplies. Value assessed to donated supplies included in the nonfederal cost-share must be reasonable and must not exceed the fair market value of the property at the time of the donation.
    b. Normally only depreciation or use charges for equipment and buildings may be applied. However, the fair rental charges for land

and the full value of equipment or other capital assets may be allowed, when they will be consumed in the performance of the award or fully depreciated by the end of the award, provided that the contracting officer has approved the charges. When use charges are applied, values must be determined in accordance with the usual accounting policies of the recipient, with the following qualifications:

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

5) Documentation. The following requirements pertain to the recipient's supporting records for in-kind contributions from third parties:
   a. Volunteer services must be documented and, to the extent feasible, supported by the same methods used by the recipient for its own employees.
   b. The basis for determining the valuation for personal services and property must be documented.

Appendix C: TCF Base Points of Contact at DOE National Lab TTOs

Facility	TCF Points of Contact
Ames National Laboratory	Julienne Krennrich jmkrenn@ameslab.gov 515-294-1202 Beth Pieper pieper@ameslab.gov 515-294-6486
Argonne National Laboratory	Hemant Bhimnathwala hbhimnathwala@anl.gov 630-252-2354 David McCallum dsm@anl.gov 630-252-4338 Benjamin Recchie brecchie@anl.gov Ilya Kats ikats@anl.gov Matthew Winter mwinter@anl.gov 630-252-4495
Brookhaven National Laboratory	Poornima Upadhya pupadhya@bnl.gov 631-344-4711 Vanessa Miller vmiller@bnl.gov 631-344-5981
Fermi National Accelerator Laboratory	William A Pellico pellico@fnal.gov 630-840-8368

Idaho National Laboratory	Danielle Ferreira danielle.ferreira@inl.gov 845-537-7602
Kansas City National Security Campus	Andrew Myers amyers@kcnsc.doe.gov 816-488-4432
Lawrence Berkeley National Laboratory	Shanshan Li shanshanli@lbl.gov 510-486-5366 Todd Pray tpray@lbl.gov 510-486-6053 Gail Chen gailchen@lbl.gov Jasbir (Jesse) Kindra jkindra@lbl.gov
Lawrence Livermore National Laboratory	Hannah Farquar farquar3@llnl.gov Chris Hartmann hartmann6@llnl.gov 925-422-2292
Los Alamos National Laboratory	MaryAnn D. Morgan mary_ann@lanl.gov 505-667-5324 Andrea Maestas andream@lanl.gov 505-667-1230 Jerome Garcia jgarcia@lanl.gov 505-665-9090

National Energy Technology Laboratory	Christy Pecyna christy.pecyna@netl.doe.gov proposal-coordination@netl.doe.gov
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Appendix D: Title Page Template

Control Number	
Project Title	
Prime Lab	
Partner Lab(s)	
Primary Topic (e.g., 1, 2, 3, 4, 5, or 6)	
Secondary Topic(s) (e.g., 1, 2, 3, 5, and/or 6)	
Sub-topic (a or b)	
Principal Investigator(s) Name(s)	
Principal Investigator(s) Email(s)	
Cost-Share Partner(s)	
Cost-Share Type (cash, in-kind, both, none)	
Cost Share Amount	
Requested DOE Funding Amount	
Total Project Budget	
Period of Performance (months)	
Nonproprietary Project Summary suitable for public release (150 words or less):	

Topic 4 Applications Only:

AOI Number(s) (e.g., 4.01, 4.02 etc.)	
Technology Area(s) (e.g., 1, 2, etc.)	
Collaboration with LEEP innovator? (yes or no)	
Past Participation in I-Corps? If yes, specify which Program/Topic (e.g., Energy I-Corps [EIC] Topic 1, 2, 3; National Science Foundation [NSF] I-Corps; I-Corps-like training or similar programs at your National Lab, Plant, or Site)? What year and/or Cohort #?	
ARL Start	
ARL End	
TRL Start	
TRL End	

Appendix E: Exchange Instructions

OTT is using the EERE Exchange system to formally announce the FY25 CLIMR Lab Call and receive submissions for both the concept paper and full applications. All required submission documents are listed within the lab call document and should be uploaded into EERE Exchange. However, the EERE Exchange system has additional fields that must be completed as part of the submission process. Many of the fields are NOT applicable to your submission. Please follow the instructions below for completing a concept paper or full application submission on the EERE Exchange System.

i. Concept Paper

General Tab

Control Number: This number is automatically generated by EERE Exchange System.

Submission Initiated By: Please search for name/email if not already populated.

Project Title: Please enter title of the project.

Topic: Please select the topic number that is most applicable.

Project Start Date: Please enter the anticipated start date of the project.

Project End Date: Please enter the anticipated end date of the project.

UEI Number: Please check N/A if it is not already populated with a number.

Partner Laboratories: Please add all partner laboratories.

Is this a continuation of an existing project?: Please select "No".

Project Overview (Multi-Year): Please include the nonproprietary project summary from the Title Page here.

Project Objectives (Multi-Year): Please enter N/A.

Contact Information Tab

Lab Lead Point of Contact: Please fill out all cells that have an asterisk. It is recommended to add colleagues via the 'Share Submission' function on the bottom so that more than just the applicant listed here can access the application.

Financials Tab

You are NOT required to enter detailed financial information into this section. Please enter any value into the required field to allow you to complete the submission. It populates with the FYs that cover the project period of performance; for example, you may put $1 for 'Planned Project Cost' for the year(s) that have an asterisk.

Performers Tab

You are NOT required to enter detailed performer information into this section. Please skip this section.

Modalities/TRL Tab

You are NOT required to enter detailed Modalities/TRL information into this section. Please skip this section.

Project Impacts Tab

You are NOT required to enter information into this section. Please skip this section.

Upload and Submit Tab

Please upload the concept paper file. Check both boxes. Select 'Yes' or 'No' for the last question on the bottom regarding if you would like to share application details with LPO.

ii. Full Applications

Applicants will not be able to create a full application until an encouraged concept paper decision is provided. Once a full application is created, the directions are the same as mentioned above, unless an update is noted below.

Project Plan Tab

You are NOT required to enter detailed project tasks into this section. Please skip this section.

Risks Tab

You are NOT required to enter detailed project risks into this section. Please skip this section.

Modalities/TRL Tab

TRL is required for the full application stage in Exchange, both Current TRL and TRL at end of project. Please enter a value between 1–9 and 2–9 for current and end boxes respectively.

Project Impacts Tab

Deliverable/Product or "Output" Description: Please enter N/A.

Audience/Customer: Please enter N/A.

Audience/Customer Use: Please enter N/A.

Communications/Outreach Strategy: Please enter N/A.

Does this project involve significant industry engagement?: Please select "No".

Associated CRADAs?: Please select "No".

Upload and Submit Tab

Please submit all full application files. Check both boxes. Select 'Yes' or 'No' for the last question at the bottom regarding if you would like to share application details with LPO. When you submit the application, a banner will appear at the top of the page which states that the application has been submitted.