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

Clean Hydrogen Electrolysis Program
Hydrogen and Fuel Cell Technologies Office

NATIONAL LABORATORY CALL FOR PROPOSALS

National Lab Funding Call for Proposals - Fiscal Year 2023

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

Modifications

Modifications to the Lab Call are HIGHLIGHTED in the body of the FOA.

Mod. No.	Date	Description of Modification
0001	03/30/2023	1. Directs applicants to EERE Exchange to access a summary slide template. Further defines the information that is required in the summary slides. 2. The Topic Area Description related to PEM electrolyzers has been modified. See highlighted section below. 3. Clarification on the timeline for announcing encourage/discourage decisions.

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I. Lab Call Description

A. Background and Context

i. Overview and Purpose

The Office of Energy Efficiency and Renewable Energy (EERE) National Laboratory Guiding Principles require all offices to pursue a merit review of direct-funded National Laboratory work. In line with these principles, EERE's Hydrogen and Fuel Cell Technologies Office (HFTO) is issuing this Lab Call in fiscal year 2023 (FY 2023). HFTO conducts comprehensive efforts to overcome the technological, economic, and institutional challenges facing the widespread adoption and use of clean hydrogen (H_2) and fuel cell technologies. To this end, HFTO, in collaboration with other Department of Energy (DOE) offices, supports a broad portfolio of projects for the production, processing, delivery, storage, and use of clean hydrogen, along with cross-cutting topics in system development and integration, safety, codes and standards, and systems analysis. This Lab Call[1] will only pertain to the new topic areas below and is part of an ***'all-hands-on-deck' expanded initiative to reduce electrolyzer cost.***

Building a clean and equitable energy economy and addressing the climate crisis is a top priority of the Biden Administration. This Lab Call will advance the Biden Administration's goals to achieve carbon pollution-free electricity by 2035 and to "deliver an equitable, clean energy future, and put the United States on a path to achieve net-zero emissions, economy-wide, by no later than 2050"[2] to the benefit of all Americans. The Department of Energy is committed to pushing the frontiers of science and engineering, catalyzing clean energy jobs through research, development, demonstration, and deployment (RDD&D), and ensuring environmental justice and inclusion of underserved communities.[3]

The research and development (R&D) activities to be funded under this Lab Call will support the government-wide approach to the climate crisis by driving the innovation that can lead to the deployment of clean energy technologies, which are critical for climate protection. Specifically, this Lab Call will target cost reduction of electrolytic production of clean hydrogen through development of electrolyzer materials and

[1] Note: Some labs have continuing multi-year projects that have already gone through the merit review process (e.g., through consortia) and/or are engaged in FOA-selected projects as sub-recipients. These will continue to be reviewed through the annual peer review process.

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

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

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

The Hydrogen Shot, announced June 7, 2021, by Energy Secretary Granholm as DOE's first *Energy Earthshot Initiative*, sets an ambitious goal for hydrogen cost reduction. Producing clean hydrogen from electrolyzers utilizing clean electricity and water, costs $4-6 per kilogram (kg) today based on specific scenarios for electrolyzer costs, efficiencies, capacity factors, and electricity costs.[4] The Hydrogen Shot established a target of $**1** per **1** kilogram of clean hydrogen produced in **1** decade ("1 – 1 – 1"), to help unlock a significant increase in markets for clean hydrogen, including steel manufacturing, clean ammonia, energy storage, and heavy-duty transportation. This would create more clean energy jobs, reduce greenhouse gas and criteria pollutant emissions, increase energy security and resiliency, and position America to compete in the clean energy market on a global scale. The Clean Hydrogen Electrolysis Program, with an interim goal of $2 per kilogram of clean hydrogen produced by 2026,[5] will directly support the Hydrogen Shot through RDD&D of advanced water electrolyzer technologies and their associated manufacturing processes and equipment.

Supporting the goals of the Clean Hydrogen Electrolysis Program and the Hydrogen Shot, HFTO has established several consortia to help address clean hydrogen production costs. The HydroGEN Consortium[6] and ElectroCat Consortium[7] are collectively developing novel high-performing materials for low-temperature and high-temperature electrolyzers. The Hydrogen from Next-generation Electrolyzers of Water (H2NEW) Consortium[8] is focused on cell integration processes to improve electrolyzer durability while also pushing the limits of performance. This Lab Call will leverage the expertise of these existing efforts, build on the successes achieved through previous funding opportunities to develop advanced materials and components, and will complement efforts to be solicited via an upcoming Funding Opportunity Announcement.[9]

This Lab Call also includes an opportunity to increase coordination of Office of Science (SC)-funded activities with the applied R&D efforts of HFTO through a pilot initiative called **"H2-LinkSc",** which aims to "**link**" basic **Sc**ience research with applied office

[4] DOE Hydrogen and Fuel Cells Program Record 20004: Cost of Electrolytic Hydrogen Production with Existing Technology (energy.gov)
[5] 42 U.S.C. § 16161(d).
[6] "HydroGEN." https://h2awsm.org/
[7] "ElectroCat." https://www.electrocat.org/
[8] "Hydrogen from Next-generation Electrolyzers of Water (H2NEW)." https://h2new.energy.gov/
[9] https://eere-exchange.energy.gov/FileContent.aspx?FileID=5be9deb8-aa9e-4250-b4b0-c980cfd6fec6

activities. Basic science work, such as through the Energy Frontier Research Centers (EFRCs) and Energy Earthshot Research Centers (EERCs) is funded through the Office of Science and can provide significant progress in innovations and fundamental understanding that can help accelerate applied efforts, including HFTO-funded activities which are highly tailored towards developing and demonstrating innovations and progress towards meeting cost and performance targets. Specifically, this Lab Call is focused on approaches that can meet the $2/kg target for electrolytic hydrogen production by 2026 and enable the Hydrogen Shot goal of $1/kg by 2031.

DOE encourages applicants to review the Basic Energy Sciences (BES) Roundtable report[10] published in 2022 and to engage with SC-funded researchers and potential applicants to the EERC Lab Call[11] to identify specific areas of work that could be more strongly coordinated between SC and HFTO. HFTO intends to provide funds[12] specifically for activities that strengthen this coordination, which could include engagement with consortia, joint workshops, disseminating applied R&D targets, validating theoretical models, and other approaches to accelerate the transition of innovations and fundamental understanding to meet Hydrogen Shot and other DOE Hydrogen Program goals.

ii. Timeline and Process Logistics

Timeline

KEY DATES	
Lab Call Release Date:	February 15, 2023
PROPOSAL DEADLINE AND DECISION DATES	
Concept Paper Submission Deadline:	March 22, 2023 5 pm ET
Full Application Submission Deadline(s):	May 25, 2023 5 pm ET
Decision Date(s):	Q4 2023

[10] Basic Energy Sciences Roundtable on Foundational Science for Carbon-Neutral Hydrogen Technologies (2021), https://science.osti.gov/-/media/bes/pdf/brochures/2021/Hydrogen_Roundtable_Report.pdf

[11] https://science.osti.gov/bes/-/media/grants/pdf/lab-announcements/2023/LAB_23-2954.pdf

[12] Funding of approximately $100K to $200K per award is anticipated specifically for the linkage activities between HFTO and basic science work.

Process Logistics

All communication to HFTO regarding this Lab Call must use hftolabcall@ee.doe.gov.

- **PROPOSAL SUBMISSIONS:** To apply to this Lab Call, lab personnel must register (and sign in) with their lab email address and submit application materials through EERE eXCHANGE. Application materials must be submitted through EERE eXCHANGE at https://eere-eXCHANGE.energy.gov, EERE's online application portal. Frequently asked questions for this Lab Call and the EERE Application process can be found at https://eere-eXCHANGE.energy.gov/FAQ.aspx.

  Applicants are responsible for meeting the submission deadlines. DOE strongly encourages all applicants to submit the required information at least 24 hours in advance of the submission deadline. Applicants should not wait until the last minute—internet and data server traffic can be heavy in the last hours before the submission deadline, which may affect the applicants' ability to successfully submit the required information before the deadline.

- **QUESTIONS DURING OPEN LAB CALL PERIOD:** Specific questions about this Lab Call should be submitted via e-mail to hftolabcall@ee.doe.gov HFTO will provide answers related to this Lab Call on EERE eXCHANGE at: https://eere-eXCHANGE.energy.gov. Please note that you must first select the specific opportunity number for this Lab Call in order to view the questions and answers specific to this Lab Call. EERE will attempt to respond to a question within 3 business days, unless a similar question and answer have already been posted on the website. To ensure fairness for all lab participants, please do not ask individual HFTO staff questions directly.

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

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

B. Key Considerations and Area of Interest

i. Key Considerations

- **AVAILABLE FUNDING:** There is approximately **$30,000,000** available to fund **all** projects solicited in this Lab Call pending appropriations, program direction, and go/no-go decision points.

- **NON-LAB PARTNERS:** Labs partnering with industry, academia, or other non-lab entities to perform work under this Lab Call must enter into Cooperative Research and Development Agreements (CRADAs) with those partners within

time parameters set forth by the funding program. HFTO intends for national labs to be recipients of the funds available through this Lab Call. If non-lab partners are included through CRADAs, the private sector would be responsible for funding non-lab work scope.

- **ELIGIBILITY:** All DOE/National Nuclear Security Agency (NNSA) Federally Funded Research and Development Centers (FFRDCs), and all National Laboratories, are eligible to submit proposals as prime awardees, unless specified otherwise. Proposals that involve more than one laboratory are also allowed. Applicants are eligible for multiple awards under this solicitation. Applicants must submit an eligible Concept Paper in order to submit a Full Application.
- **COMMUNITY BENEFITS PLAN:** DOE is committed to investing in R&D innovations that deliver benefits to the American public and leads to commercialization of technologies and products that foster sustainable, resilient, and equitable access to clean energy. Further, DOE is committed to supporting the development of more diverse, equitable, inclusive, and accessible workplaces to help maintain the nation's leadership in science and technology. To support the goal of building a clean and equitable energy economy, projects funded under this BIL Lab Call are expected to (1) advance diversity, equity, inclusion and accessibility (DEIA); (2) contribute to energy equity; and (3) invest in America's workforce. To ensure these objectives are met, applications must include a Research and Development Community Benefits Plan (R&D Community Benefits Plan) that addresses the three objectives stated above. See Section II.A.iii and II.B.ii for the more information on the R&D Community Benefits Plan content requirements and review criteria.
- **TEAMING:** The applied materials- and component-level R&D relevant to electrolysis included in this topic complements the ongoing work being performed with three of HFTO's national laboratory consortia: H2NEW, HydroGEN, and ElectroCat. Projects will be expected to interact with one of these consortia to foster innovation and accelerate progress. Applicants are invited to visit the H2NEW,[13] HydroGEN,[14] and ElectroCat[15] websites and Annual Merit Review presentations[16] to learn more about their work and capabilities. Applicants or teams that include multiple labs, especially those with PIs that are not a part of existing HFTO-funded consortia, are highly

[13] https://h2new.energy.gov/research.html#lte
[14] https://h2awsm.org/capabilities
[15] https://www.electrocat.org/category/capabilities/
[16] https://www.hydrogen.energy.gov/amr-presentation-database.html

encouraged. To the extent practical and appropriate, HFTO encourages lab projects that involve industry engagement.

ii. Topic Area Description

The focus areas for this Lab Call were developed based on input from industry, national labs, academic experts, and other stakeholders on areas of most interest and most applicable for national lab activities and aligned with the goals of both Hydrogen Shot and achieving $2/kg for electrolytic hydrogen production. Innovative concepts that have significant potential but not covered in these focus areas may also be proposed with strong justification.

Area of Interest: Advanced Materials, Components, and Interfaces for Electrolyzers

- Eligibility: No Restrictions
- Estimated DOE Funding Available: $30,000,000
- Estimated Number of Projects Expected: 9-20
- Estimated Project Award: Up to $3,200,000[17]
- Estimated Project Duration: 2-3 years

This area of interest is specifically aimed at higher-risk R&D with high impact potential for diverse electrolyzer options. Work should focus on materials and components to help achieve long-term cost, performance, efficiency, and lifetime goals in next generation electrolyzer technologies, including advanced proton exchange membrane (PEM), liquid alkaline (LA), and oxide ion-conducting solid oxide electrolysis cell (O-SOEC), as well as emerging alkaline exchange membrane (AEM) and proton-conducting solid oxide electrolysis cell (P-SOEC) electrolyzers. Each of these electrolyzer technologies have specific needs to improve the performance, efficiency, durability, cost, and/or operating conditions to enable meeting the Clean Hydrogen Electrolyzer Program goal of $2/kg H_2; and all offer the potential to meet the Hydrogen Shot target of $1/kg H_2 with further advancements. Aligned with the goals of the Clean Hydrogen Electrolysis Program, the novel materials and components developed under this topic for next generation electrolyzer systems can help protect against certain market risks (e.g., supply chain limitations) while providing multiple viable options for affordable clean hydrogen.

As an example of the potential benefits, development of new non-PFSA (perfluorosulfonic acid) proton-conducting membrane materials or advancement of AEM technologies could address possible future limitations on PFSA materials in PEM electrolyzers. As another example, development of proton-conducting solid oxide materials for novel P-SOEC designs would enable lower-temperature operation compared to today's O-SOEC electrolyzers, offering opportunities for extended lifetimes and associated cost reductions from use of lower cost metals for balance

[17] Up to $3,000,000 for project proposed, and up to $200,000 for work proposed under the H2-LinkSc Activities.

of plant components. Key R&D needs of interest for the different electrolyzer technologies are discussed below. Submissions of concepts for materials and/or components that are not encompassed in the specific needs discussed are allowed but must include a strong justification, including in the Concept Paper, as to how the proposed advancement will enable a hydrogen production cost of $2/kg H_2, and ultimately $1/kg H_2.

All projects will be expected to interact with one of the HFTO-funded consortia (H2NEW, HydroGEN, or ElectroCat). The applicant must select the consortium that has the best capabilities and most relevant expertise and value to the proposed work with consideration of the technologies the consortium is focused on. The nature and level of involvement should be defined by the applicant and included in the proposal. It can range from attending consortium meetings to requesting use of consortium capabilities such as testing of the materials and/or components to be developed. Applicants that have interest in utilizing consortium resources do not need to include the cost of consortium capabilities in their proposed budget. The use of those capabilities and expertise will be provided, within reason (e.g., work scope that would be up to ~10% of the proposal budget), via existing funding allocated to the consortia. Applications that propose work that duplicate efforts covered in existing consortia are not of interest.

All applicants have the opportunity to propose activities that strengthen coordination with SC-funded researchers or a potential Hydrogen Shot EERC. These activities may include, but are not limited to, engagement with SC-funded centers or projects, joint workshops, disseminating applied R&D targets, validating theoretical models, and other approaches to accelerating the transition of innovations and fundamental understanding to meet Hydrogen Shot and other goals. Applicants are highly encouraged to leverage work funded through SC through this coordination. Proposal of these activities is optional and will be reviewed separately from the full application. Please see Section II.B.iii. for the review criteria.

The following sections identify specific materials and components of interest for this Lab Call and are based on feedback through multiple workshops, requests for information, and various stakeholder engagement activities.

Advanced Catalysts, Membranes and Ionomers for PEM Electrolyzers

This area seeks applications to support development of novel materials and components for next-generation PEM electrolyzers, particularly in the areas of oxygen evolution reaction (OER) catalysts and non-PFSA membranes and ionomers. Previous analysis indicates that the membrane and OER catalysts are significant contributor to stack cost and major sources of performance limitations for PEM electrolyzers.[18] In addition to needing overall cost reductions and performance improvements, commercial PEM technology is typically based on PFSAs, but these ionomer materials are expensive, particularly at low production volumes. Recently, there has been growing concern that the use of PFSA may face increased regulatory barriers due to potentially detrimental environmental impacts of the chemicals used to manufacture PFSA

[18] Advanced Materials for PEM Electrolyzers Workshop Report: https://www.energy.gov/eere/fuelcells/h2-amp-hydrogen-shot-workshop-advanced-materials-pem-electrolyzers

membranes. Therefore, non-PFSA PEMs, including those based on hydrocarbon membranes, could represent a lower-cost, more environmentally friendly alternative; however, these membranes require significant advancements in performance and durability for electrolyzer applications.

- Novel OER Catalysts: Applications in this area should describe the materials that they plan to develop and how those materials have the potential to drive down the overall catalyst cost while maintaining high performance and durability. Novel catalyst approaches could include, but are not limited to, Ir and non-Ir alloys as well as high surface area or extended surface catalysts. Electronically-conductive OER catalyst supports to enable increased catalyst utilization, increased durability, and decreased loading is an area of interest. Proposals must develop catalysts that are platinum group metal (PGM)-free or aim to meet the DOE goal of <0.125 mg Ir/cm^2. Catalysts and electrodes must be tested under dynamic operating conditions including on/off operation.
- Novel Membranes and Ionomers: Applications in this area should be based on proton-conducting, and preferably non-PFSA, ionomers and membranes for water electrolyzers. Eliminating or minimizing fluorine content is strongly encouraged. Any non-PFSA material approaches that still contain fluorine should include a plan to mitigate the impacts of any fluorinated species used during synthesis and explain how it addresses potential regulatory barriers associated with this species. While the focus should be on novel polymer chemistry for the membrane, proposed innovations may also include reinforcements and other additives to improve the membrane properties. The membrane materials that will be developed and how those materials have the potential to meet properties and characteristics required for application in PEM electrolyzers must be described. Properties/characteristics that need to be considered and should be quantified include proton conductivity, resistance, permeability (hydrogen crossover), selectivity, chemical-mechanical durability and robustness, ability to withstand high pressure differentials, and thickness, with information gained on the tradeoffs among these properties. Current status and targets for these properties/characteristics should be included in the proposal as appropriate.

Proposed innovations need to demonstrate a pathway to meeting the DOE targets of 1.8 V at ≥3 A/cm^2 with a degradation rate of <2.3 mV/khr. Following catalyst and membrane material development, proposed technologies must be tested in at least a 25 cm^2 membrane electrode assembly (MEA); larger cell testing is encouraged. This may be accomplished in collaboration with the H2NEW or ElectroCat Consortia.

Advanced Components for Next-Generation LA Electrolyzers

This area seeks applications on advanced separators, electrodes, and interface designs that can help achieve DOE performance targets, while maintaining high durability, in next-generation LA electrolyzers.

Conventional LA electrolyzers were designed to operate continuously at a low current density to optimize operating and capital costs; as a result, they have a large system footprint. These electrolyzers typically operate between 0.2-0.6 A/cm^2 and are not amenable to start/stop operation.[19] Applications should clearly describe how the proposed innovations will enable cell performance targets of ≥2.0 A/cm^2 @ 1.7 V/cell with ≤1.6 mV/khr degradation rate in concentrated, heated (80-85 °C) potassium hydroxide (5-10 M). Advances of interest could include: enabling of dynamic operation; reduction/elimination of shunt or reverse currents; interface optimization; bubble management; higher temperature operation; and/or enabling of pressure differentials. Novel cell designs which help enable these advances can be part of a proposal. Mitigating degradation and minimizing voltage losses at interfaces (e.g., catalyst/substrate, catalyst/electrolyte, and separator/electrolyte), including the impact from intermittent operation, is needed.

- Novel Separators: Applicants developing novel separator materials could focus on optimized structures (e.g., porosity, thickness) and composite membranes. A better understanding of the impact of separator properties on performance and how to control these properties is needed to inform their design. These efforts could include fundamental R&D that informs the design of compositions and structures for optimized chemical, mechanical, and thermal properties. Separators that can enable higher operating temperatures are of interest.
- Electrode development: Applicants should use PGM-free catalysts to develop advanced electrodes and support structures with high surface areas, high catalytic activity, and high conductivity that can be incorporated into advanced cell designs (e.g., zero-gap electrodes). Tolerance for reversal currents and the impact of intermittent operation needs to be investigated. Novel catalyst material development should not be a focus of this topic area; the emphasis is on electrode development.

Applicants must plan to integrate their innovation in an advanced (for example, zero-gap) single cell electrolyzer configuration (≥25 cm^2) for testing by the end of the project. This may be accomplished in collaboration with the H2NEW consortium.

Advanced Membranes and Electrodes for AEM Electrolyzers

This area seeks applications on advanced membranes and electrodes that can help achieve DOE performance targets in AEM electrolyzers.

AEM water electrolyzers aim to combine the advantages of both PEM and LA electrolyzers: the alkaline environment enables the use of non-precious metal catalysts[20] and less expensive metal interconnects while the dense membrane enables differential pressure operation and operation at higher current densities than traditional LA electrolyzers.[21] Due to the local alkalinity in the membrane, pure water can be fed to the electrolyzer instead of liquid alkaline

[19] IRENA 2020, Fraunhofer ISE 2022

[20] Current AEM technologies still use catalysts with trace PGM materials to improve efficiency and durability.

[21] Ayers, K., Danilovic, N., Ouimet, R., Carmo, M., Pivovar, B., and Bornstein, M. (2019). Perspectives on Low-Temperature Electrolysis and Potential for Renewable Hydrogen at Scale. Annu. Rev. Chem. Biomol. Eng. 10, 219–239. doi:10.1146/annurev-chembioeng-060718-030241

electrolyte to reduce balance of plant costs; although, current technology has better performance and durability with a low concentration supporting electrolyte feed (e.g., ≤ 0.5 M).

Critical limitations in the development of high-performance, long-lifetime AEM electrolyzers are the need for stable membranes, ionomers, and electrodes that can endure long-term operation. Interfaces between these components, especially the catalyst-ionomer interactions, can have a significant impact on performance and durability. Applications of specific interest include:

- AEM Membranes/Ionomers: Development of novel AEM membranes and ionomers to enable high electrolyzer efficiency with enhanced durability. Durability is seen as the key challenge, especially at expected stack operating temperature above 60°C and in pure water feeds where electrochemical oxidation of the membrane and ionomer can occur.[22] Chemical stability can be improved by avoiding hydroxide attacks on membrane functional groups. Mechanical stability is also a pressing issue with edge failures and swelling from water uptake causing delamination of the catalyst layer and rapid performance losses.[23, 24]
- AEM Electrodes: Development and optimization of electrode interfaces, structure, and catalyst-ionomer interactions are highly encouraged as the electrode structure and electrode/membrane interface are significant sources of degradation. For example, non-PGM anode catalyst conductivity and Fe impurities in the anode water feed have been shown to cause ionomer degradation in the electrodes.[25] Novel approaches for eliminating the significant performance and durability gap between pure water and supporting electrolyte operation could be part of a proposed project. Applications focused on development of novel catalyst materials are not of interest.

Applicants should clearly describe how the proposed innovations will enable cell performance targets of ≥2.0 A/cm^2 @ 1.8 V/cell and a ≤3 mV/khr degradation rate. Following material development, proposed technologies must be tested in at least a 25 cm^2 cell in both water and supporting electrolyte feed (~0.5 M); however, materials may be optimized for the feedstock of choice. Cell testing may be accomplished in collaboration with one of the national lab consortia. Larger cell testing is encouraged.

Engineered Materials and Interfaces for O-SOEC

This area aims to develop innovative materials and components for oxide ion-conducting solid oxide electrolysis cell (O-SOECs) that can make demonstrable progress towards the DOE ultimate durability target (80,000 hours). O-SOECs benefit from high efficiencies (34 kWh/kg)

[22] C. Santoro, A. Lavacchi, P. Mustarelli, V. Di Noto, L. Elbaz, D. R. Dekel, F. Jaouen, ChemSusChem 2022, 15, e202200027.

[23] Park, E. J., Arges, C. G., Xu, H., and Kim, Y.S. (2022). Membrane Strategies for Water Electrolysis. ACS Energy Lett. 2022, 7, 3447−3457. doi.org/10.1021/acsenergylett.2c01609

[24] Santoro, C., et al. What is Next in Anion-Exchange Membrane Water Electrolyzers? Bottlenecks, Benefits, and Future. ChemSusChem, 2022. doi.org/10.1002/cssc.202200027

[25] Krivina, R., et al. Anode Catalysts in Anion-Exchange-Membrane Electrolysis without Supporting Electrolyte: Conductivity, Dynamics, and Ionomer Degradation. *Adv. Mater.* 2022. DOI: 10.1002/adma.202203033

but experience more rapid degradation rates than DOE targets, resulting in shortened stack lifetimes (~20,000 hours) and more frequent stack replacements.[26, 27]

In order to improve the lifetime and durability of O-SOECs, applicants are encouraged to focus efforts on interface and material engineering, mitigating degradation, and enabling lower operating temperatures (≤700 °C); without sacrificing current density. Degradation mechanisms are varied, can be dependent on operating conditions, and are often influenced by factors including local electrical overpotentials, oxygen chemical potential distributions, and steam utilization. Investigation of novel operating strategies as a way to mitigate degradation is of interest. Known degradation issues include Ni coarsening and Cr poisoning, which can be mitigated through materials, interface engineering, and/or operations improvements. The oxygen electrode, commonly based on a perovskite material, is another source of degradation and its performance becomes limiting as the temperature decreases. Approaches to eliminate the barrier layer between the oxygen electrode and the electrolyte are also of interest. Innovations in the following areas are of specific interest:

- Electrode/barrier layer/electrolyte interface development to mitigate degradation.
- Material development to enable lower temperature operation (≤700 °C).
- Investigations into novel electrode designs (nanostructured electrodes) that enhance electrode catalytic activity and minimize performance losses and degradation.

Applicants should clearly describe how the proposed innovations will achieve cell performance targets of ≥1.2 A/cm^2 @ 1.3 V/cell with ≤3.2 mV/khr degradation rate at an operation temperature ≤750°C. Testing of cells under dynamic operating conditions is encouraged. Cell testing size and format need to be relevant to what is being investigated. Small cell testing (e.g., button cells) with active area > 1 cm^2 can be part of the proposed R&D; however, larger format cell testing (at least 10 cm^2) is expected by the end of the project and preferably sooner. This may be accomplished in collaboration with the H2NEW Consortium.

Advanced Materials for P-SOEC

This area aims to develop P-SOEC materials for next-generation electrolyzers with a potential to meet DOE cost targets. P-SOECs are a promising electrolyzer technology because they have potential electrical efficiencies on par with O-SOECs at a lower operating temperature (≤ 600°C). Operation at or below 600°C enables the use of lower cost steel alloys for stack and balance of plant construction, reduces the rate and impact of contaminant diffusion, simplifies sealing, promotes rapid dynamic system response, and shortens startup/shutdown duration without dramatic impacts on overall system performance or efficiency.

However, P-SOECs still suffer from low faradaic efficiencies, poor durability, and processing challenges. Recent advancements in P-SOEC efficiency and durability have been encouraging, but additional effort is required to translate and build upon these advancements to promote

[26] Shen, F., Wang, R., Tucker, M.C., "Long term durability test and postmortem for metal support solid oxide electrolysis cells, J. of Power Sources, Vol, 474, 31 October, 2020, 228618

[27] Hauch et al., Science 370, 186 (2020)

the commercial production of P-SOEC systems.[28] Proposed research activities are expected to focus on materials development, thermal processing improvements, interface engineering, and characterization/optimization of faradaic efficiency with an emphasis on cell-level performance and durability improvements over a wide range of operating conditions. Specific areas of interest include:

- Material development and/or interface engineering to enhance performance and efficiency and mitigate degradation.
- Material development to enable lower temperature operation.
- Material development to enable better manufacturability and mechanical properties.

Applicants should clearly describe how the proposed innovations will achieve cell performance targets of ≥0.8 A/cm^2 @ 1.3 V/cell with ≤5 mV/khr degradation rate and a faradaic efficiency of ≥85%. A discussion on how faradaic efficiency will be measured should be included. Cell testing size and format need to be relevant to what is being investigated. Small cell testing (e.g., button cells) with active area > 1 cm^2 can be part of the proposed R&D; however, larger format cell testing (at least 10 cm^2) is expected by the end of the project. Cell testing for meeting the above performance targets should be done at: operating temperature ≤600^{o}C; and steam concentration ≥50%. Cell testing may be done in collaboration with the HydroGEN consortium.

II. Application Submission and Review Information

A. Application and Submission Details

i. Application Process

The application process includes two phases: a Concept Paper phase and a Full Application phase. **Only applicants who have submitted an eligible Concept Paper will be eligible to submit a Full Application.**

To apply to this Lab Call, applicants must register with their lab email address and submit application materials through EERE eXCHANGE at https://eere-eXCHANGE.energy.gov, EERE's online application portal. Beginning on July 8, 2022*, eXCHANGE will be updated to integrate with Login.gov. As of August 5, 2022*, potential applicants will be required to have a Login.gov account to access EERE eXCHANGE. As part of the eXCHANGE registration process, users will be directed to create an account in https://login.gov/. Please note that the email address associated with Login.gov must match the email address associated with the eXCHANGE account. For more information, refer to the Exchange Multi-Factor Authentication (MFA) Quick Guide in the Manuals section of eXCHANGE.

[28] Hanchen Tian, Zheyu Luo, Yufei Song, Yucun Zhou, Mingyang Gong, Wenyuan Li, Zongping Shao, Meilin Liu & Xingbo Liu (2022) Protonic ceramic materials for clean and sustainable energy: advantages and challenges, International Materials Reviews, DOI: 10.1080/09506608.2022.2068399

* Please note that these dates are tentative and subject to change.

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

ii. General Proposal Requirements

Proposals should be formatted for 8.5 x 11 paper, single spaced, and have 1-inch margins on each side. Typeface size should be 12-point font, except tables and figures, which may be in 10-point font**.**

iii. Proposal Content

Proposal content aligns with content required in the EERE Annual Operating Plan (AOP) project forms, with additional information to assist reviewers in evaluating technical details. **Applicants must include all content they wish to have reviewed in the proposal.** References do not count toward the Technical Volume's 12 page limit.

Concept Papers

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

DOE will make an independent assessment of each Concept Paper based on the criteria in Section II.B.ii. DOE will encourage a subset of applicants to submit Full Applications. Other applicants will be discouraged from submitting a Full Application. The Encourage/Discourage notification will be posted to EERE Exchange within at least 30 days of the full application submission date.

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

The Concept Paper must conform to the following content requirements:

SECTION	PAGE LIMIT	DESCRIPTION
Cover Page Section	1	The cover page should include the project title, the electrolyzer technology being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Technology Description and Team	4	Applicants are required to describe succinctly: • The proposed technology, including its basic operating principles and how it is unique and innovative; • The proposed technology's target level of performance (applicants should provide technical data or other support to show how the proposed target(s) could be met); • The current state-of-the-art in the relevant field and application, including key shortcomings, limitations, and challenges; • How the proposed technology will overcome the shortcomings, limitations, and challenges in the relevant field and application; • The potential impact that the proposed project would have on the relevant field and application; • The key technical risks/issues associated with the proposed technology development plan and mitigation strategies; and • The impact that EERE funding would have on the proposed project. Applicants are required to describe succinctly the qualifications, experience, and capabilities of the proposed Project Team, including: • Whether the Principal Investigator (PI) and Project Team have the skill and expertise needed to successfully execute the project plan; • Whether the applicant has prior experience which demonstrates an ability to perform tasks of similar risk and complexity; • Whether the applicant has worked together with its teaming partners on prior projects or programs; and • Whether the applicant has adequate access to equipment and facilities necessary to accomplish the effort and/or clearly explain how it intends to obtain access to the necessary equipment and facilities.

Full Applications

- EERE will not review or consider ineligible Full Applications.
- Each Full Application shall be limited to a single concept or technology. Unrelated concepts and technologies shall not be consolidated in a single Full Application.

Full Applications must conform to the following requirements:

SECTION	FILE FORMAT	PAGE LIMIT	FILE NAME
Technical Volume	PDF	12 (excluding references and Budget)	ControlNumber_LeadOrganization_TechnicalVolume
Resumes	PDF	6 pg total	ControlNumber_LeadOrganization_Resumes
Letters of Commitment, if applicable	PDF	1 pg each	ControlNumber_LeadOrganization_LOCs
Summary/Abstract for Public Release	PDF	1	ControlNumber_LeadOrganization_Summary
Summary Slide	MS PowerPoint	2	ControlNumber_LeadOrganization_Slide
DOE Work Proposal for FFRDC, if applicable (see DOE O 412.1A, Attachment 3)	PDF	N/A	ControlNumber_LeadOrganization_WP
Authorization from cognizant Contracting Officer for FFRDC	PDF	N/A	ControlNumber_LeadOrganization_FFRDCAuth
Community Benefits Plan	PDF	5	ControlNumber_LeadOrganization_CBP
H2-LinkSc Activities, optional	PDF	1	ControlNumber_LeadOrganization_H2LinkSc

Technical Volume

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

Applicants must provide sufficient citations and references to the primary research literature to justify the claims and approaches made in the Technical Volume. However, EERE and reviewers are under no obligation to review cited sources. References do not count toward the Technical Volume's page limit.

The Technical Volume to the Full Application may not be more than 12 pages, including the cover page, table of contents, and all charts, graphs, maps, photos, or other graphics, and must include all of the information in the table below. The applicant should consider the weighting of each of the evaluation criteria when preparing the Technical Volume.

The Technical Volume must conform to the following content requirements:

SECTION / PAGE LIMIT	DESCRIPTION
Cover Page 1 pg	The cover page should include the project title, the electrolyzer technology being addressed, both the technical and business points of contact, names of all team member organizations, and any statements regarding confidentiality.
Project Overview Approximately 10% of the total	The Project Overview should contain the following information: • Background: The applicant should discuss the background of their organization, including the history, successes, and current research and development status (i.e., the technical baseline) relevant to the technical topic being addressed in the Full Application. • Project Goal: The applicant should explicitly identify the targeted improvements to the baseline technology and the critical success factors in achieving that goal. • DOE Impact: The applicant should discuss the impact that DOE funding would have on the proposed project. Applicants should specifically explain how DOE funding, relative to prior, current, or anticipated funding from other public and private sources, is necessary to achieve the project objectives.
Technical Description, Innovation, and Impact Approximately 30% of the total	The Technical Description should contain the following information: • Relevance and Outcomes: The applicant should provide a detailed description of the technology, including the scientific and other principles and objectives that will be pursued during the project. This section should describe the relevance of the proposed project to the goals and objectives of the Lab Call, including the potential to meet specific DOE technical targets or other relevant performance targets. The applicant should clearly specify the expected outcomes of the project. • Feasibility: The applicant should demonstrate the technical feasibility of the proposed technology and capability of achieving the anticipated performance targets, including a description of previous work done and prior results. • Innovation and Impacts: The applicant should describe the current state-of-the-art in the applicable field, the specific innovation of the proposed technology, the advantages of proposed technology over current and emerging technologies, and the overall impact

	on advancing the state-of-the-art/technical baseline if the project is successful.
Workplan Approximately 40% of the total	The Workplan should include a summary of the Project Objectives, Technical Scope, Work Breakdown Structure (WBS), Milestones, Go/No-Go Decision Points, and Project Schedule. The Workplan should contain the following information: • Project Objectives: The applicant should provide a clear and concise (high-level) statement of the goals and objectives of the project as well as the expected outcomes. • Technical Scope Summary: The applicant should provide a summary description of the overall work scope and approach to achieve the objective(s). The overall work scope is to be divided by performance periods that are separated by discrete, approximately annual decision points (see below for more information on Go/No-Go decision points). The applicant should describe the specific expected end result of each performance period. • WBS and Task Description Summary: The Workplan should describe the work to be accomplished and how the applicant will achieve the milestones, will accomplish the final project goal(s), and will produce all deliverables. This includes the milestones indicated in the R&D community benefits plans. The Workplan is to be structured with a hierarchy of performance period (approximately annual), task and subtasks, which is typical of a standard WBS for any project. The Workplan shall contain a concise description of the specific activities to be conducted over the life of the project. The description shall be a full explanation and disclosure of the project being proposed (i.e., a statement such as "we will then complete a proprietary process" is unacceptable). It is the applicant's responsibility to prepare an

	adequately detailed task plan to describe the proposed project and the plan for addressing the objectives of this Lab Call.
	• Milestones: The applicant should provide appropriate milestones throughout the project to demonstrate success. A milestone may be either a progress measure (which can be activity based) or a SMART technical milestone. SMART milestones should be Specific, Measurable, Achievable, Relevant, and Timely, and must demonstrate a technical achievement rather than simply completing a task. The minimum requirement is that each project must have at least one milestone per quarter for the duration of the project with at least one SMART technical milestone per year (depending on the project, more milestones may be necessary to comprehensively demonstrate progress). The applicant should also provide the means by which the milestone will be verified.
	• Go/No-Go Decision Points: The applicant should provide the project-wide Go/No-Go decision points at appropriate points in the Workplan. A Go/No-Go decision point is a risk management tool and a project management best practice to ensure that, for the current phase or period of performance, technical success is definitively achieved and potential for success in future phases or periods of performance is evaluated, prior to actually beginning the execution of future phases. At a minimum, each project must have at least one project-wide Go/No-Go decision point for each budget period (12 to 18-month period) of the project. The applicant should also provide the specific technical criteria to be used to evaluate the project at the Go/No-Go decision point. Go/No-Go decision points are considered "SMART" and can fulfill the requirement for an annual SMART milestone.
	• End of Project Goal: The applicant should provide end of project goal(s). At a minimum, each project must have one SMART end of project goal. The end-of-project goal should be clearly defined, quantitative, and support targets included in the topic description.
	• Project Schedule (Gantt Chart or similar): The applicant should provide a schedule for the entire project, including task and subtask durations, milestones, and Go/No-Go decision points.
	• Project Management: The applicant should discuss the team's proposed management plan, including the following:
	  ○ The overall approach to and organization for managing the work
	  ○ The roles of each project team member
	  ○ Any critical handoffs/interdependencies among project team members
	  ○ The technical and management aspects of the management plan, including systems and practices, such as financial and project management practices

	○ The approach to project risk management, including identification of possible risks and mitigation strategies ○ A description of how project changes will be handled ○ If applicable, the approach to Quality Assurance/Control ○ How communications will be maintained among project team members
Technical Qualifications and Resources Approximately 20% of the total	The Technical Qualifications and Resources should contain the following information: • Describe the project team's unique qualifications and expertise, including those of key subrecipients. • Describe the project team's existing equipment and facilities that will facilitate the successful completion of the proposed project; include a justification of any new equipment or facilities requested as part of the project. • This section should also include relevant, previous work efforts, demonstrated innovations, and how these enable the applicant to achieve the project objectives. • Describe the time commitment of the key team members to support the project. • Describe the technical services being requested of H2NEW, HydroGEN, or ElectroCat, if applicable. • For multi-organizational or multi-investigator projects, describe succinctly: ○ The roles and the work to be performed by each PI and Key Participant; ○ Business agreements between the applicant and each PI and Key Participant; ○ How the various efforts will be integrated and managed; ○ Process for making decisions on scientific/technical direction; ○ Publication arrangements; ○ Intellectual Property issues; and ○ Communication plans
Budget 1 page (not included in the 12 page limit)	Applicants will be required complete the table given in Appendix A and submit as part of the Technical Volume. The budget for the work defined in the Technical Volume should not exceed $3,000,000. If applicable, the budget should also include costs associated with the H2-LinkSc Activities, up to $200,000 in additional funds (i.e., up to $3,200,000).

Resumes

Applicants are required to submit 6-pages of resumes for key participating team members. Save the resumes in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_Resumes".

Letters of Commitment

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

Summary/Abstract for Public Release

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

Summary Slide

Applicants are required to provide 2 MS Powerpoint slides summarizing the proposed project. This slide is used during the evaluation process.

The Summary Slide template requires the following information:

- A technology summary;
- A description of the technology's impact;
- Proposed project goals;
- List of Go/No-go and other key milestones;
- Any key graphics (illustrations, charts and/or tables);
- The project's key idea/takeaway;
- Topline diversity, equity, workforce, and community benefits;

- Project title, prime recipient, Principal Investigator, and Key Participant information; and
- Project length and requested EERE funds (including amounts going to each subcontractor).

A Summary Slide Template is provided for your convenience in the "Application Forms and Templates" section of EERE eXCHANGE at https://eere-eXCHANGE.energy.gov/. Save the Summary Slide in a 2-page MS Powerpoint file using the following convention for the title "ControlNumber_LeadOrganization_Slide".

Budget for DOE/NNSA FFRDC (if applicable)

If a DOE/NNSA FFRDC contractor is to perform a portion of the work, the applicant must provide a DOE Work Proposal (WP) in accordance with the requirements in DOE Order 412.1A, Work Authorization System, Attachment 3, available at https://www.directives.doe.gov/directives-documents/400-series/0412.1-BOrder-a-chg1-AdmChg Save the WP in a single PDF file using the following convention for the title "ControlNumber_LeadOrganization_WP".

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

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

R&D Community Benefits Plan

The R&D Community Benefits Plan must set forth the applicant's approach to ensuring the Federal investments advance the following three objectives: (1) advance diversity, equity, inclusion and accessibility (DEIA); (2) contribute to energy equity; and (3) invest in America's workforce. The below sections set forth the content requirements for the R&D Community Benefits Plan, which addresses each of the foregoing objectives. Applicants must address all three sections.

The applicant's R&D Community Benefits Plan must include at least one Specific, Measurable, Assignable, Relevant, and Timely (SMART) milestone per budget period to measure progress on the proposed actions. These milestones should also be included the Work Plan in the Technical Volume. The R&D Community Benefits Plan will be evaluated as part of the technical review process. If EERE selects a project, EERE will incorporate the R&D Community Benefits Plan into the award and the recipient must implement its R&D Community Benefits Plan as part of carrying out its project. During the life of the EERE award, EERE will evaluate the recipient's progress, including as part of the Go/No-Go review process.

The plan should be specific to the proposed project and not a restatement of organizational policies. Applicants should describe the future implications or a milestone-based plan for identifying future implications of their research on energy equity, including, but not limited to, benefits for the U.S. workforce. These impacts may be uncertain, occur over a long period of time, and/or have many factors within and outside the specific proposed research. Applicants are encouraged to describe the influencing factors and the most likely workforce and energy equity implications of the proposed research if the research is successful. While some guidance and example activities are provided in Appendix B, applicants are encouraged to leverage promising practices and develop a plan that is tailored for their project.

The R&D Community Benefits Plan must not exceed five (5) pages. It must be submitted in PDF format using the following convention name for the title: "Control Number_LeadOrganization_CBP." This Plan must address the technical review criterion titled, "R&D Community Benefits Plan." See Section V. of the Lab Call.

The applicant's R&D Community Benefits Plan must address the following three sections:

1) Diversity, Equity, Inclusion, and Accessibility:

To build a clean and equitable energy economy, it is important that there are opportunities for people of all racial, ethnic, socioeconomic and geographic backgrounds, sexual orientation, gender identity, persons with disabilities, and those re-entering the workforce from incarceration. This section of the plan must demonstrate how DEIA is incorporated in the technical project objectives. The plan must identify the specific action the applicant would undertake that is integrated into the research goals and project teams. Submitting an institutional DEIA plan without specific integration into the project will be deemed insufficient.

2) **Energy Equity:**

This section must articulate the applicant's consideration of long-term equity implications of the research. It must identify how the specific project integrates equity considerations into the project design to support equitable outcomes should the innovation be successful. Like cost reductions and commercialization plans, the R&D Community Benefits Plan requires description of the equity implications of the innovation if successful. Additionally, efforts must be included to contribute to the President's goal that 40% of the overall benefits of certain Federal investments flow to disadvantaged communities (DACs) as part of the Justice40 Initiative.

3) **Workforce Implications:**

This section must articulate the applicant's consideration of long-term workforce impacts and opportunities of the research. It must identify how the project is designed

and executed to include an understanding of the future workforce needs should the resulting innovation be successful.

See Appendix B for more guidance.

H2-LinkSc Activities (Optional)

This section must articulate the applicant's plans to strengthen coordination with SC-funded researchers (e.g., EFRCs or other projects) or a potential Hydrogen Shot EERC.[29] The budget for the proposed work should not exceed $200,000 and should be included in the overall budget as a separate task. The applicant should provide a clear and concise discussion of the goals and objectives of the work as well as the expected outcomes. Applicants should also discuss the SC-funded work leveraged in the execution of the project proposed.

The H2-LinkSc Activities must not exceed one (1) page. It must be submitted in PDF format using the following convention name for the title: "Control Number_LeadOrganization_H2LinkSc." This plan must address the review criterion titled, "H2-LinkSc Activities" and will be reviewed separately from the technical volume and R&D community benefits plan. HFTO may consider funding the H2-LinkSc portion of the application if there is a strong likelihood of success by linking with SC-funded work even if the full application is not selected for funding.

Treatment of Application Information

Proprietary Information

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

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

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

[29] Subject to the applicant being selected for EERC funding by the Office of Science

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

1. Notice of Restriction on Disclosure and Use of Data:

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

B. Application Review Details

i. Merit Review and Selection Process

Upon receipt and review for initial compliance with requirements, all proposals received in eXCHANGE by the deadline will undergo a thorough technical review. HFTO will use expert reviewers familiar with the HFTO portfolio, goals, and objectives. HFTO will collect and collate review scores and comments for use in making final project selections. The HFTO Selection Official will consider the merit review results and other selection factors to make the final project selections. For transparency, HFTO will provide summaries of the Full Application review results to assist labs in understanding how their submission reviewed and aid in improving future work.

ii. Technical Review Criteria

Concept Papers

Concept Papers will be evaluated based on consideration of the following factors:

Criterion 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 proposed technology, describes how the technology is unique and innovative, and how the technology will advance the current state-of-the-art;
- The applicant has identified risks and challenges, including possible mitigation strategies, and has shown the impact that EERE 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; and
- The proposed work, if successfully accomplished, would clearly meet the objectives, targets, and key R&D needs as stated in the Lab Call.

Final Applications

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

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

This criterion involves consideration of the following factors:

Technical Merit and Innovation

- Extent to which the proposed technology, process, or project is innovative;
- Degree to which the current state of the technology, challenges to be addressed, and the proposed advancement are clearly described and quantified with sufficient technical detail provided;
- Extent to which the application specifically and convincingly demonstrates how the applicant will move the state-of-the-art to the proposed advancement.

Impact of Technology Advancement

- Extent to which the project supports the technical objectives, required deliverables, and target specifications and metrics;
- Potential impact of the project on advancing the state-of-the-art.

Criterion 2: Quality of Workplan (20%)

This criterion involves consideration of the following factors:

- Degree to which the approach and critical path have been clearly described and thoughtfully considered;
- Degree to which the task descriptions are clear, detailed, timely, and reasonable, resulting in a high likelihood that the proposed Workplan will succeed in meeting the project goals.
- Discussion and demonstrated understanding of the key technical risk areas involved in the proposed work and the quality of the mitigation strategies to address them.

- Adequacy, reasonableness, and soundness of the project schedule, including periodic Go/No-Go decision points;
- The level of clarity in the definition of the baseline, metrics, and milestones including relative to a clearly defined experimental baseline; and the strength of the quantifiable metrics, milestones, and mid-point deliverables such that meaningful interim progress will be made.

Criterion 3: Team and Resources (15%)

This criterion involves consideration of the following factors:

- The capability of the Principal Investigator(s) and the proposed team to address all aspects of the proposed work with a high probability of success. The qualifications, relevant expertise, and time commitment of the individuals on the team;
- The sufficiency of the existing facilities to support the work;
- The level of participation by project participants and how well they are integrated into the Workplan; and
- The reasonableness of the budget for the proposed project and objectives.

Criterion 4: R&D Community Benefits Plan (15%)

The R&D Community Benefits Plan will be evaluated at 15% of the total merit review criteria. Each section of the plan will be evaluated at 5% of the merit criteria, such that full credit can only be given for plans with technically meritorious approaches in all three areas.

This criterion involves the consideration of the following factors:

Diversity, Equity, Inclusion and Accessibility (DEIA)

- Clear articulation of the project's goals related to diversity, equity, inclusion, and accessibility. These are four different, but related, concepts that should not be conflated. That is, you can achieve diversity without equity; all four are necessary for top scores.
- Quality of the project's DEIA goals, as measured by the goals' depth, breadth, likelihood of success, inclusion of appropriate and relevant SMART milestones, and overall project integration;

- Degree of applicant's commitment and ability to track progress towards meeting each of the diversity, equity, inclusion, and accessibility goals; and
- Extent of engagement of organizations that represent disadvantaged communities as a core element of their mission, including minority serving institutions (MSIs), Minority Business Entities, and nonprofit or community-based organizations.

Energy Equity

- Clear workplan tasks, staffing, research, and timeline for engaging energy equity stakeholders and/or evaluating the possible near and long-term implications of the project for the benefit of the American public, including, but not limited to the public health and public prosperity benefits;
- Approach, methodology, and expertise articulated in the plan for addressing energy equity and justice issues associated with the technology innovation;
- Likelihood that the plan will result in improved understanding of distributional public benefits and costs related to the innovation if successful;
- Extent to which the Community Benefits Plan identifies: specific, measurable benefits for DACs, how the benefits will flow to DACs, and how negative environmental impacts affecting DACs would be mitigated; and
- Extent to which the project would contribute to meeting the objective that 40% of the benefits of climate and clean energy investments will flow to DACs.

Workforce Implications

- Clear and comprehensive workplan tasks, staffing, research, and timeline for engaging workforce stakeholders and/or evaluating the possible near and long-term implications of the project for the U.S. workforce;
- Approach to document the knowledge, skills, and abilities of the workforce required for successful commercial deployment of innovations resulting from this research; and
- Likelihood that the plan will result in improved understanding of the workforce implications related to the innovation if successful.

iii. H2-LinkSc Review Criteria

H2-LinkSc Activities

H2-LinkSc Activities will be evaluated based on consideration of the following factors:
H2-LinkSc Activities Criterion: Overall Impact on Project Outcomes (Weight: 100%)

- Likelihood that the plan, if executed, will increase coordination between basic energy SC-funded research and HFTO's applied research and development;
- Degree to which proposed activities will improve overall project outcomes;
- Quality of the proposed activities;
- Likelihood that the proposed activities will be accomplished; and
- Reasonableness of the proposed budget for these activities.

iv. Other Review Criteria

In addition to the previous criteria, the selection official may consider the following program policy factors in determining which full applications to select for award negotiations:

- The degree to which the proposed project exhibits technological diversity when compared to HFTO's project portfolio and other projects selected from the subject Lab Call;
- The degree to which the proposed project will accelerate transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty; and,
- The degree to which the team includes national lab researchers, including the principal investigator, from outside HFTO's existing consortia, H2NEW, ElectroCat, and HydroGEN

v. Selection for Award Negotiation

HFTO carefully considers all of the information obtained through the proposal process and makes an independent assessment of each compliant and responsive proposal based on the selection criteria set forth in this Lab Call. HFTO may select or not select a proposal for negotiations. HFTO may also postpone a final selection determination on one or more proposals until a later date, subject to availability of funds and other factors. HFTO will notify applicants if they are, or are not, selected for award negotiation.

vi. Selection Notification

HFTO anticipates completing the project selection process and notifying labs of selections during Q4 2023 **(subject to change)**.

HFTO will notify lab leads of selection results from hftolabcall@ee.doe.gov and will provide lab leads with summaries of anonymized review comments for each Full Application submitted.

vii. Reporting

Additional reporting requirements apply to projects funded by BIL. As part of tracking progress toward key departmental goals – ensuring justice and equity, investing in the American workforce, boosting domestic manufacturing, reducing greenhouse gas emissions, and advancing a pathway to private sector deployment – DOE may require specific data collection. Examples of data that may be collected include:

- New manufacturing production, or recycling capacity
- Jobs data including:
    - Number and types of jobs provided, wages and benefits paid
    - Demographics of workforce including local hires
    - Efforts to minimize risks of labor disputes and disruptions
    - Contributions to training; certificates and training credentials received by employees; ratio of apprentice-to-journey level workers employed
- Justice and Equity data, including:
    - Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses and Veteran Owned Businesses acting as vendors and sub-contractors for bids on supplies, services and equipment.
    - Value, number, and type of partnerships with MSIs
    - Stakeholder engagement events, consent-based siting activities
    - Other relevant indicators from the Community Benefits Plan
- Number and type of energy efficient and clean energy equipment installed
- Funding leveraged, follow-on-funding, Intellectual Property (IP) Generation and IP Utilization

viii. Questions and Agency Contacts

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

Appendix A: Full Application Timeline/Budget

Cost Category	Project Year 1	Project Year 2	Project Year 3	Total
Labor – Principal Investigator				
FTE:				
Labor – Additional Staff				
Materials & Supplies				
Travel				
Subcontracting				
Overhead				
Other				
H2-LinkSc (Optional)				
Total DOE Funding				
Total Non-DOE Funding				
Total				

Appendix B: R&D Community Benefits Plan Guidance

The DOE is committed to pushing the frontiers of science and engineering; catalyzing high-quality domestic clean energy jobs through research, development, demonstration, and deployment; and ensuring energy equity and energy justice[30] for disadvantaged communities. Therefore, and in accordance with the Administration's priority to empower workers and harness opportunities to create good union jobs as stated in EO 14008 (Executive Order on Tackling the Climate Crisis at Home and Abroad),[31] it is important to consider the impacts of the successful commercial deployment of any innovations resulting from this Lab Call on current and future workforce.

The goal of the three-section R&D Community Benefits Plan is to allow the application to illustrate engagement in critical thought about implications of how the proposed work will benefit the broadest swaths of American people and lead to broadly shared prosperity, including for workers and disadvantaged communities.[32] The sections of the R&D Community Benefits Plans are considered together because there may be significant overlap between audiences considered in workforce and disadvantaged communities.

Example DEIA, Energy Equity, and Workforce Plan Elements

Outlined below are examples of activities that applicants might consider when developing their R&D Community Benefits Plan. Applicants are not required to implement any of these specific examples and should propose the Plan that best fits their research goals, institutional environment, team composition, and other factors. Creativity is encouraged.

DEIA

DOE strongly encourages applicants to involve individuals and entities from disadvantaged communities. Tapping all of the available talent requires intentional approaches and yields broad benefits.

[30] At DOE, we define energy justice as "the goal of achieving equity in both the social and economic participation in the energy system, while also remediating social, economic, and health burdens on those disproportionately harmed by the energy system" (Initiative for Energy Justice, 2019). Aligned with that document, the remainder of this document refers to this as, 'energy equity,' and is meant to encompass energy justice as well as DOE's efforts related to Justice40. https://www.energy.gov/diversity/articles/how-energy-justice-presidential-initiatives-and-executive-orders-shape-equity

[31] https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad

[32] Pursuant to E.O. 14008 and the Office of Management and Budget's Interim Justice40 Implementation Guidance M-21-28, DOE has developed a definition and tools to locate and identify DACs. These resources can be located at https://energyjustice.egs.anl.gov/. DOE will also recognize DACs as defined and identified by the White House Council of Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), which can be located at https://screeningtool.geoplatform.gov/. DOE's Justice40 Implementation Guidance is located at https://www.energy.gov/sites/default/files/2022-07/Final%20DOE%20Justice40%20General%20Guidance%20072522.pdf .

Equity extends beyond diversity to equitable treatment. Equitable access to opportunity for members of the project team is paramount. This includes ensuring that all members of the team, including students, are paid a living wage, provided appropriate working conditions, and provided appropriate benefits. In the execution of their project plan, applicants are asked to describe efforts in diversity, equity, inclusion, and accessibility. In this context, efforts toward DEIA are defined as:[33]

> 1) the practice of including the many communities, identities, races, ethnicities, backgrounds, abilities, cultures, and beliefs of the American people,
>
> 2) the consistent and systematic fair, just, and impartial treatment of all individuals, including protecting workers rights and adhering to Equal Employment Opportunity laws,
>
> 3) the recognition, appreciation, and use of the talents and skills of employees of all backgrounds, and
>
> 4) the provision of accommodations so that all people, including people with disabilities, can fully and independently access facilities, information and communication technology, programs, and services.

Successful plans will not only describe how the project team seeks to increase DEIA, but will describe the overall approaches to retention, engagement, professional development, and career advancement. Specifically, they will demonstrate clear approaches to ensure all team members' strengths are meaningfully leveraged and all members are provided opportunities and paths for career development, especially including paths for interns and trainees to secure permanent positions. Diversity should be considered at all levels of the project team, not just leveraging early career individuals to meet diversity goals.[34]

DOE strongly encourages applicants to consider partnerships as a means of promoting diversity, equity, inclusion, accessibility, justice, and workforce participation. Minority Serving Institutions, Minority Business Enterprises, Minority Owned Businesses, Disability Owned Business, Women Owned Businesses, Native American-owned Businesses, Veteran Owned Businesses, or entities located in an underserved community that meet the eligibility requirements are encouraged to lead these partnerships as the prime applicant or participate on an application as a proposed partner to the prime applicant.

When crafting the DEIA section of the Plan, applicants should describe the ways in which they will act to promote each of the four DEIA efforts above into their investigation. It is important to note that diversity, equity, inclusion, and accessibility are

[33] https://www.whitehouse.gov/wp-content/uploads/2021/11/Strategic-Plan-to-Advance-Diversity-Equity-Inclusion-and-Accessibility-in-the-Federal-Workforce-11.23.21.pdf

four different, but related, concepts that should not be conflated. That is, you can achieve diversity without equity; all four must be addressed. Applicants could discuss how the proposed investigation could contribute to training and developing a diverse scientific workforce. Applicants could describe the efforts they plan to take, or will continue to take, to create an inclusive workplace, free from retaliation, harassment, and discrimination. Applicants could outline any barriers to creating an equitable and inclusive workplace and address the ways in which the team will work to overcome these barriers within the bounds of the specific research project. The plan could detail specific efforts to inform project team members in any capacity of their labor rights and rights under Equal Employment Opportunity laws, and their free and fair chance to join a union. Note that this inclusion of informing project team members is also incorporated into awards through the National Policy Assurances.

Equal treatment of workers, including students, is necessary but overcoming institutional bias requires intentionally reducing sometimes hidden barriers to equal opportunity. Applicants could consider measures like childcare, flexible schedules, paid parental leave, pay transparency, and other supports to ensure that societal barriers are not hindering realization of DEIA intentions. Some of these considerations may result in common approaches in different sections of the plan, and that is acceptable, as long as the submission is not a singular approach to all sections.

EERE especially encourages applicants to form partnerships with diverse and often underrepresented institutions, such as Minority Serving Institutions, labor unions, and community colleges that otherwise meet the eligibility requirements. Underrepresented institutions that meet the eligibility requirements are encouraged to lead these partnerships as the prime applicant. The DEIA section of the Plan could include engagement with underrepresented institutions to broaden the participation of disadvantaged communities and/or with local stakeholders, such as residents and businesses, entities that carry out workforce development programs, labor unions, local government, and community-based organizations that represent, support, or work with disadvantaged communities. Applicants should ensure there is transparency, accountability, and follow-through when engaging with community members and stakeholders.

Specific examples include:

- Building collaborations and partnerships with researchers and staff at Minority Serving Institutions
- Addressing barriers identified in climate surveys to remove inequities
- Providing anti-bias training and education in the project design and implementation teams
- Offering training, mentorship, education, and other support to students and early/mid-career professionals from disadvantaged communities
- Providing efforts toward improving a workplace culture of inclusion

- Developing technology and technology integration innovations to meet the needs of disadvantaged communities
- Creating partnerships with local communities, especially under-resourced and disadvantaged communities
- Voluntary recognition of a union and informing employees of their rights, regardless of their classification
- Making research products and engagement materials accessible in a greater variety of formats to increase accessibility of research outputs
- Implementing training or distributing materials to reduce stigma towards individuals with disabilities
- Designing technologies that strategically fit within the existing workforce for installation and maintenance of the potential innovation

Energy Equity

The Energy Equity section should articulate how project proposals will drive equitable access to, participation in, and distribution of the benefits produced from successful technology innovations to disadvantaged communities and groups. Intentional inclusion of energy equity requires evaluating the anticipated long-term costs and benefits that will accrue to disadvantaged groups as a result of the project, and how research questions and project plans are designed for and support historically disadvantaged communities' engagement in clean energy decisions. Similar to potential cost reductions or groundbreaking research findings resulting from the research, energy equity and justice benefits may be uncertain, occur over a long period of time, and have many factors within and outside the specific proposed research influencing them.

Applicants should describe the influencing factors, and the most likely energy equity implications of the proposed research. Applicants should describe any long-term constraints the proposed technology may pose to communities' access to natural resources and Tribal Cultural resources. There may be existing equity research available to use and citation in this description or the applicant could describe milestone-based efforts toward developing that understanding through this innovation. These near and long term outcomes may include, but are not limited to: a decrease in the percent of income a household spends on energy costs (energy burden[35]); an increase in access to low-cost capital; a decrease in environmental exposure and burdens; increases in clean energy enterprise creation and contracting (e.g., women or minority-owned business enterprises); increased parity in clean energy technology access and adoption; increases in energy democracy, including community ownership; and an increase in energy resilience.

[35] Energy burden is defined as the percentage of gross household income spent on energy costs: https://www.energy.gov/eere/slsc/low-income-community-energy-solutions

Specific examples include:

- Describing how a successful innovation will support economic development in diverse geographic or demographic communities
- Creating a plan to engage equity and justice stakeholders in evaluating the broader impacts of the innovation or in the development of the research methodology
- Describe how the proposed research strategy and methodology was informed by input from a wide variety of stakeholders
- A literature review of the equity and justice implications of the outcomes of the specific research if the innovation is successful or a plan with dedicated budget and expertise (staffing or subawardee) to evaluate the potential equity implications of successful innovation outcomes.

Workforce

The Workforce section of the R&D Community Benefits Plan should articulate the future workforce implications of the innovation or a milestone-driven plan for understanding those implications. This includes documenting the skills, knowledge, and abilities that would be required of workers installing, maintaining, and operating the technology that may be derivative of the applicant's research, as well as the training pathways and their accessibility for workers to acquire the necessary skills. There may be field-specific or relevant existing research that could be cited in this section. In addition, applicants could detail the process they will use to evaluate long-term impacts on jobs, including job growth or job loss, a change in job quality, disruptions to existing industry and resulting changes to relationships between employers and employees and improvements or reductions in the ability of workers to organize for collective representation, and anything else that could result in changes to regional or national labor markets.

For additional support with developing the Workforce section of a R&D Community Benefits Plan, please refer to the DOE's Community Benefits Plan Frequently Asked Questions (FAQs) webpage (https://www.energy.gov/bil/community-benefits-plan-frequently-asked-questions-faqs). This new resource, though created primarily for demonstration and deployment projects funded by the Bipartisan Infrastructure Law (BIL), may be useful for R&D projects which is the main subject of this Lab Call template.

Applicants will find section 2 of the FAQ ("Investing in America's Workforce") particularly helpful for understanding key federal policies, terms and concepts, as well as workforce development strategies relevant to examination of the workforce implications of applicants' proposed research.

Specific examples include:

- Outlining the challenges and opportunities for commercializing the technology in the US
- Creating a literature review of the workforce implications of the outcomes of the specific research if the innovation is successful or a plan with dedicated budget and expertise (staffing or subawardee) to evaluate the potential equity implications of successful innovation outcomes
- Creating a plan and milestones for assessing how a successful innovation will have implications for job savings or loss, either at the macroeconomic level or within specific industries
- Describing how the project will support training of workforce to address needs of successful innovation
- Voluntary recognition of a union and informing employees of their rights, regardless of their classification or plans to develop policies that would ensure worker voice
- Creating a plan to evaluate how a successful innovation, will result in potential workforce shifts between industries or geographies.

Inclusion of SMART milestones

EERE requires that the applicant's R&D Community Benefits Plan include one Specific, Measurable, Achievable, Relevant and Timely (SMART) milestone for each budget period. An exemplar SMART milestone clearly answers the following questions:

- What needs to be accomplished?
- What measures and deliverables will be used to track progress toward accomplishment?
- What evidence suggests that the accomplishment is achievable?
- Why choose this milestone?
- When will the milestone be reached?