NATIONAL RENEWABLE ENERGY LABORATORY

U.S. Department of Energy (DOE)
Hydrogen and Fuel Cell Technologies Office (HFTO)

2021 H2@Scale CRADA Call Supporting
Advanced Research on Integrated Energy Systems (ARIES)

Timeline:

- **6/7/2021**: HFTO Laboratory CRADA call release date
- **7/19/2021**: Deadline for proposal submission by 5 p.m. MDT
- **September 2021**: Selection and announcement of awards (anticipated)
- CRADAs must be fully negotiated (including the Joint Statement of Work) and ready for submission to DOE for approval within 120 days of selection or the selected project may be cancelled

Contact/Questions: The full proposal and all communications and questions should be directed by email to H2atScaleCRADAcall@nrel.gov. Please be aware that all questions that are submitted and the respective answers will be posted here: https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html (barring those questions deemed unresponsive to the call). To ensure fairness for all applicants, please do not ask individual HFTO or NREL staff questions directly.

Proposal Submissions: Only DOE national laboratories are eligible to submit a proposal to this Lab CRADA call (see Eligibility section). To apply to this CRADA call, lab personnel should submit their proposals using their lab email to H2atScaleCRADAcall@nrel.gov by 5 p.m. MDT on July 19, 2021. Once a proposal is received, a confirmation email will be sent within 2-3 days stating the date and time of receipt. Note: e-mail restricted to 20 MB for entire email with all attachments. See additional details under the Proposal Preparation section below.

Notification of Selection: Once selections are finalized, lab applicants will receive an email from the DOE Hydrogen and Fuel Cell Technologies Office.

2021 H2@Scale CRADA Call Supporting Advanced Research on Integrated Energy Systems (ARIES)

Collaboration with H2@Scale National Laboratories

DOE seeks National Laboratories and qualified partners to participate in collaborative projects in one of the topics areas described below. Each selected collaborative project will be conducted under a Cooperative Research and Development Agreement (CRADA) between the laboratories and qualified partners working on the project, also referred to as a CRADA project. To be eligible for selection, a proposed CRADA project must include at least one national laboratory as the project lead and at least one qualified partner (see Eligibility and Lab Contact Information section below).

Objective

Through this CRADA call being issued by the National Renewable Energy Laboratory (NREL), the U.S. Department of Energy's (DOE's) Hydrogen and Fuel Cell Technologies Office (HFTO) seeks proposals to support the H2@Scale vision and NREL's Advanced Research on Integrated Energy Systems (ARIES)[1] research goals. Joint partnerships between national laboratories and qualified partners selected under the three topic areas below will enable the integration of hydrogen technologies in future energy systems:

Topic Area 1: H2@ARIES—Integrated Hydrogen Energy System Testing/Validation seeks to advance integrated hydrogen systems testing and validation using the ARIES capabilities.

Topic Area 2: Applied Risk Assessment and Modeling for H2@Scale Applications focuses on applied risk assessment and modeling efforts pertaining to large-scale hydrogen deployment applications, such as those that accompany large-scale projects like the ARIES-based energy systems.

Topic Area 3: Next-Generation Sensor Technologies is aimed at developing advanced hydrogen wide area monitoring systems, in conjunction with existing capabilities, to address key safety challenges with large-scale infrastructure deployments.

[1] https://www.nrel.gov/aries/

Funding Summary by Topic Area

Topic Area	Total Funding Level (over 3 years)	Anticipated Number of Awards	Federal Funding per Award	Max Project Duration (years)	Min Required Non-Federal Cost Share %
Topic Area 1: H2@ARIES - Integrated Hydrogen Energy System Testing/Validation	**$4–6M**	**4 to 6**	**$500K–2M**	**3**	**30% (including at least 10% cash in)[2]**
Topic Area 2: Applied Risk Assessment and Modeling for H2@Scale Applications	**$3–4M**	**4 to 6**	**$500K–1M**	**3**	**30% (including at least 10% cash in)[2]**
Topic Area 3: Next-Generation Sensor Technologies	**$1–2M**	**1 to 2**	**$500K–1M**	**3**	**30% (including at least 10% cash in)[2]**
Total:	**Up to $12M***	**9 to 14**			

* Total funding includes approximately $4M each year in FY21, FY22, and FY23, subject to appropriations.

Background

Building a clean and equitable energy economy and addressing the climate crisis is a top priority of the Biden Administration. This CRADA 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"[3] 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.[4]

The activities to be funded under this CRADA 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 CRADA call will support the H2@Scale initiative, illustrated in Figure 1, by enabling wide-scale hydrogen production, storage, transport and utilization across multiple applications and sectors in the United States. In addition, this CRADA call will

[2] Required cost share percentages are calculated based on the total cost of the project. Cost share may include cash or in-kind contributions, but for this CRADA call at least 10% of the total project costs must be in the form of cash into the national laboratories. For example, if the total project cost is $1,000,000, 30% (or $300,000) must come from non-federal sources and at least $100,000 of that must be funds-in (i.e., cash contributions) that are costed at the national laboratories. Cost share from other DOE offices is not permitted.

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

[4] 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 in the definition of "equity." E.O. 13985. For purposes of this CRADA 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.

emphasize increasing diversity of research staff, increasing diversity of voices in research design, and/or increasing quantification and emphasis on supporting underserved communities.

The intent of H2@Scale is for hydrogen to enable—rather than compete with—energy pathways across applications and sectors. The H2@Scale effort supports collaborations between various industry stakeholders and national laboratories to accelerate research, development, and demonstration of applicable hydrogen technologies. For more information, visit the H2@Scale website.[5]

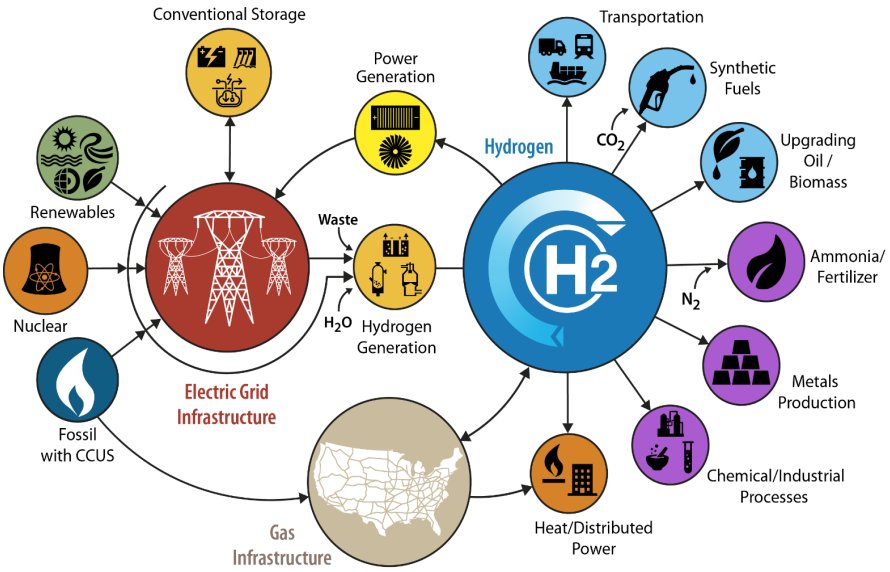

Figure 1. The H2@Scale vision: hydrogen can be produced from diverse domestic resources and is a central input to many important end uses in the industrial, chemical, and transportation sectors

The U.S. power grid is transitioning away from large, centralized power plants and is increasingly reliant on variable generation and distributed energy resources such as renewable energy sources like wind and solar. To realize future energy systems that are clean, secure, reliable, safe, and affordable, it is critical to address the challenges of how to scale up the physical size of these new energy technologies. Determining how to integrate multiple diverse technologies into the bulk power systems by seamlessly incorporating storage, load management, and dynamic controls is also vital and hydrogen can be a key part of the solution.

ARIES is a research platform that can match the complexity of the modern energy system and conduct integrated research to support the development of groundbreaking new energy technologies. ARIES is designed to de-risk and optimize current energy systems, and provide insight into the design and operation of future energy systems by addressing the fundamental challenges of:

- Variability in the physical size of new energy technologies being added to energy system
- Controlling large numbers (millions to tens of millions) of interconnected devices
- Integrating multiple diverse technologies that have not previously worked together.

[5] https:/www.energy.gov/eere/fuelcells/h2scale

The ARIES platform is intended to be highly flexible to study the impact of, and how to get the most value from, the millions of new grid-connected devices, such as electric vehicles, renewable generation, hydrogen systems, energy storage, and grid-interactive efficient buildings. ARIES addresses the risks and opportunities of widescale integration across five research areas:

1) **Energy storage** to balance variable renewable generation and demand
2) **Power electronics** to control and integrate rapidly increasing electronics-based technologies
3) **Hybrid energy systems** to achieve enhanced coordinated capabilities beyond isolated technologies
4) **Future energy infrastructure** to adapt existing energy infrastructure for safety, monitoring, and controls
5) **Cybersecurity** to secure operations to prevent disruption, damage, and loss of functionality.

ARIES brings together state-of-the-art research assets and capabilities at NREL's Energy Systems Integration Facility (ESIF)[6] and Flatirons Campus[7] to support integrated energy research, analysis, modeling, and hardware experiments. Unique research capabilities at multiple scales and across sectors create a platform for understanding the full impact of energy systems integration and represent a substantial scale-up in experimentation capability from existing research platforms, allowing for research at power levels from tens of kW up to 20 MW. The scale of the platform can be amplified by coupling physical (e.g., hardware-in-the loop) experiments with a virtual emulation environment powered by NREL's 8-petaflop high-performance supercomputer to study the integration and control of numerous (up to millions) of interconnected devices. Figure 2 below shows a representation of ARIES, including the different scales available at NREL's ESIF and Flatirons Campus.

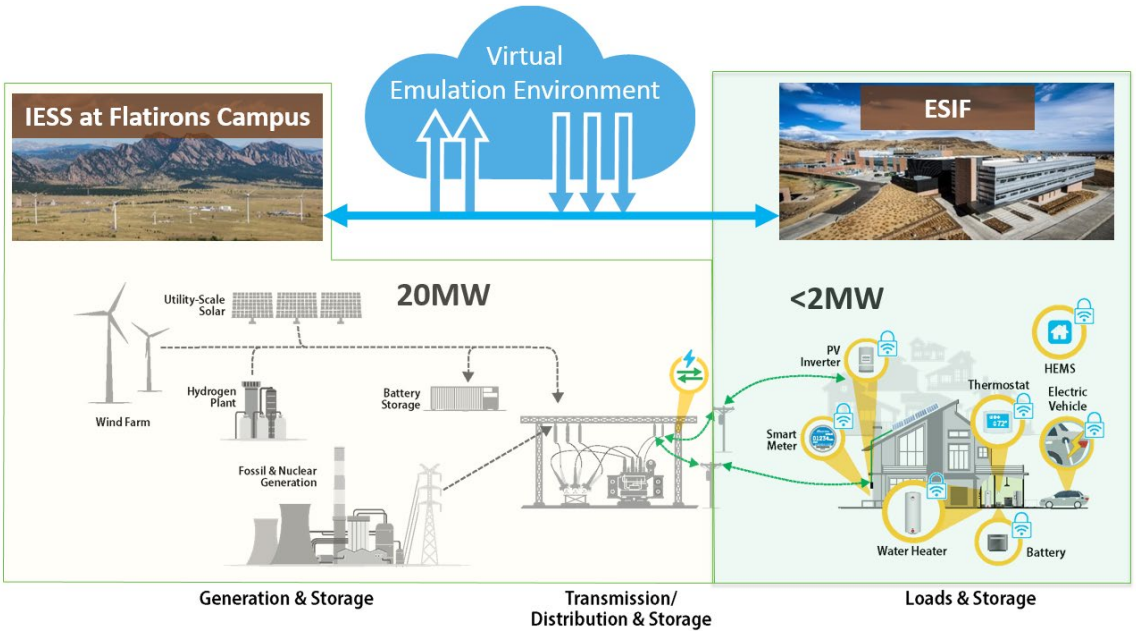

Figure 2. ARIES leverages the research capabilities at ESIF and IESS/Flatirons, as well virtual emulation, to study integrated energy systems at scale

[6] For a list of capabilities available at the NREL's ESIF facility, see https://www.nrel.gov/esif/capabilities.html
[7] For a list of capabilities available at the NREL's Flatirons campus, see https://www.nrel.gov/flatirons-campus/

Recent DOE investments are expanding the Integrated Energy Systems at Scale (IESS) capabilities at NREL's Flatirons Campus. Existing megawatt-scale research assets at the Flatirons Campus include multi-MW wind turbines, a 0.5 MW solar PV array, a 1 MW/1 MWh battery system, and a 6.3 MW Controllable Grid Interface (CGI). Additional capabilities currently under development include a 20 MW CGI, a MW-scale battery emulator, and a MW-scale hydrogen production and power system. These assets are designed to be integrated using NREL's controllable grid interface (6.3 MW existing + 20 MW in process).

The hydrogen infrastructure, which includes a 1.25 MW PEM electrolyzer, compression, storage, and a 1 MW fuel cell system, is scheduled to be commissioned by the end of fiscal year 2021 (FY21) and will support H2@Scale goals by enabling integrated systems research, development, and demonstrations (RD&D) to study the science of scaling hydrogen energy systems. Figure 3 below shows the planned hydrogen system capabilities at NREL's Flatirons campus that will be available to support integrated energy system RD&D.

For more information about the ARIES platform, current and planned laboratory capabilities, and partnership opportunities, please see the recording of NREL's September 2, 2020 ARIES Industry Workshop.[8]

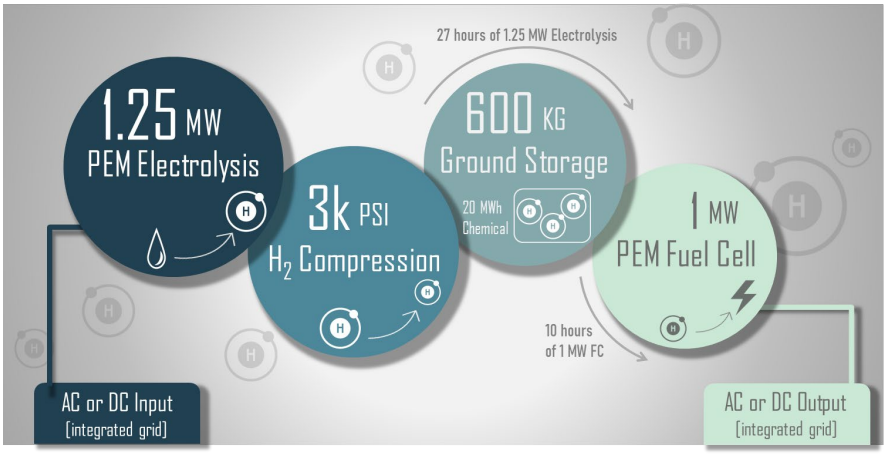

Figure 3. Planned hydrogen system capabilities at NREL's Flatirons campus

To address the safety requirements that accompany large-scale projects such as ARIES-based energy systems, H2@Scale also requires the development and implementation of regulations, codes, and standards (RCS) and next-generation safety technology such as detection systems to minimize hydrogen-related safety hazards.

RCS provide the technical basis to enable the safe and consistent deployment and commercialization of hydrogen and fuel cell technologies. Applied risk assessment and modeling are essential elements in the development of effective RCS and of best practices for safety, and can provide regulators, operators, and end users with the tools they need to ensure that emerging hydrogen and fuel cell technologies will be as safe as incumbent technologies. They will also play an important role in improving confidence in

[8] https://www.nrel.gov/esif/aries-industry-workshop.html

the safety of the technologies among all stakeholders, accelerating adoption and facilitating investments.

Previous efforts in applied risk assessment and modeling focused largely on hydrogen stored in a gaseous state and with gaseous hydrogen releases associated with light-duty vehicle (LDV) fueling stations and from LDVs in maintenance facilities. As efforts accelerate to leverage hydrogen to decarbonize energy sectors beyond light-duty transportation, further efforts in applied risk assessment and modeling are required to address the growing body of application spaces necessary to enable the H2@Scale vision.

In addition, current limitations of point sensors in large areas or difficult to access locations are driving the need for next-generation hydrogen detection systems, including hydrogen wide area monitoring (WAM) technology. WAM technologies have potential for deployment in large-scale production, storage, and end-use scenarios including indoor and underground facilities.[9]

No single approach is likely to provide comprehensive coverage in the design of a detection system for a large-scale (e.g., industrial applications) or congested (e.g., data centers or other indoor facilities) deployment. Integrating WAM technologies with point sensors or other detection technologies can provide the broad coverage needed for the successful deployment of hydrogen and fuel cell technologies at scale, such as those being investigated at ARIES.

Topic Areas of Interest

Topic Area 1: H2@ARIES—Integrated Hydrogen Energy System Testing/Validation

Estimated Number of Projects: 4–6 projects

Period of Performance: 24–36 months

Estimated DOE Funding Available (for use at National Laboratories): $4M to $6M total ($500K to $2M per project)

Cost Share: Federal funding must be cost shared at 30%, including at least 10% cash in.[2] All federal funds must be costed at the national laboratories.

Topic Area Description:

Under this topic, DOE seeks proposals to advance integrated hydrogen systems testing and validation through partnerships between industry and national laboratories, using the ARIES capabilities described above. DOE encourages proposals that leverage existing capabilities at the national laboratories and avoid duplication of capabilities across the national lab system. In addition to hardware testing at NREL's ESIF and/or Flatirons facilities, proposed projects may leverage a virtual emulation environment and ESnet[10] connection with other national laboratories and/or universities.

NREL's ARIES platform/capabilities will be used to evaluate the integration of hydrogen energy systems with renewables and the grid. Areas of particular interest include, but are not limited to:

- Systems Integration/Hybridization (including electrolyzer testing/integration)

[9] B. Zalosh and N. Barilo. "Wide Area and Distributed Hydrogen Sensors." International Conference on Hydrogen Safety. 2009. http://conference.ing.unipi.it/ichs2009/images/stories/papers/186.pdf

[10] About ESnet: https://www.es.net/about/

- Renewable Hydrogen Production (e.g., wind to hydrogen)
- Grid Services
- Energy Storage
- Control Systems (e.g., economic dispatch models for hydrogen resources)
- Power Electronics
- Innovative and Expanded Hydrogen End-use Applications (e.g., heavy-duty transportation, hydrogen blending with natural gas, industrial uses, etc.)[11]
- Other integrated demonstrations showcasing the H2@Scale concept.

Proposals should describe the current-state-of-the-art for the focus technology, the intended application, systems integration challenges, and quantitative metrics targeted by the proposed work. Applicants are encouraged to include letters of support from industry stakeholders (e.g., equipment manufacturers, system integrators, and utilities). Integration with ARIES is **required** for Topic 1 proposals.

Topic Area 2: Applied Risk Assessment and Modeling for H2@Scale Applications

Estimated Number of Projects: 4–6

Period of Performance: 24–36 months

Estimated DOE Funding Available (for use at National Laboratories): $3M to $4M total ($500K to $1M per project)

Cost Share: Federal funding must be cost shared at 30%, including at least 10% cash in.[2] All federal funds must be costed at the national laboratories.

Topic Area Description:

DOE seeks proposals focused on applied risk assessment and modeling efforts pertaining to large-scale hydrogen deployment applications. Proposals of interest include, but are not limited to:

- Integrated clean energy systems including hybrid approaches (e.g., nuclear or renewable power integration) including energy storage
- Transportation and hydrogen fueling demonstrations, including but not limited to, high-flow fueling applications for marine (both port- and ship-side), rail, and heavy-duty vehicles
- Chemical and industrial processes integrating hydrogen technologies focusing on decarbonization (e.g., ammonia production, cement, steelmaking/iron reduction)
- Large scale hydrogen production, storage, and transport necessary to enable the H2@Scale end uses noted in the bullets above.

Proposals should describe the hydrogen application space(s) the effort intends to address, the applied risk assessment and modeling efforts the project will undertake, and the risk assessment methodologies and modeling platforms the project will employ. Proposals should also describe planned efforts to engage with the RCS and hydrogen safety communities to support the dissemination of the proposed effort's outcomes and enable the global harmonization of codes and standards. To support the utility of

[11] Only proposals that complement scope within existing DOE-funded R&D on hydrogen blending will be considered for funding. Collaboration and coordination with existing projects are highly encouraged, and duplication of scope or capabilities across national laboratories will not be funded.

the applied risk assessment and modeling efforts, proposals should include gap analyses relative to current applicable RCS and assessments of the applicable approval and permitting processes for each application space. Proposals should also address the generation and dissemination of deployment guidance for each application space. Integration with ARIES is **optional** for Topic 2 proposals.

Topic Area 3: Next-Generation Sensor Technologies

Estimated Number of Projects: 1–2

Period of Performance: 24–36 months

Estimated DOE Funding Available (for use at National Laboratories): $1M to $2M total ($500K to $1M per project)

Cost Share: Federal funding must be cost shared at 30%, including at least 10% cash in.[2] All federal funds must be costed at the national laboratories.

Topic Area Description:

DOE seeks proposals that model and develop an integrated hydrogen detection system incorporating multiple detection technologies. Where possible, field demonstration is also of interest. This topic is aimed at developing advanced hydrogen WAM technologies, in conjunction with existing capabilities, to address key safety challenges with large scale infrastructure deployments. The proposed system should address the limitations of networked point sensors in large industrial settings as well as in congested spaces.

Proposals should include a WAM system which incorporates at least two safety sensor/detector technologies, at least one of which is not a point-based sensor. Advanced technologies of interest to DOE include, but are not limited to:

- Raman scattering and LiDAR
- Schlieren imaging
- Ultrasonic/acoustic sensors
- Fiber optic sensors
- Complementary detection systems such as aspirating gas detectors or flame detection may also be considered.

Proposals should provide the rationale for selection as well as technical specifications for the selected technologies. In addition to sensitivity to hydrogen concentration levels,[12] properties of interest for detection systems include selectivity of hydrogen among other flammable gases, effectiveness in varied environmental conditions, deployment and operating cost, maintenance requirements, and operating life.[13] Proposals should also address the ability of the technologies to meet the requirements of relevant industry standards and the DOE Targets for Hydrogen Safety Sensors, provided below in Table 1.[14]

[12] NFPA 2, Hydrogen Technologies Code, National Fire Protection Association. https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=2

[13] Summary and Findings from the NREL/DOE Hydrogen Sensor Workshop (June 8, 2011) W. Buttner, R. Burgess, M. Post, and C. Rivkin. National Renewable Energy Laboratory, https://www.nrel.gov/docs/fy12osti/55645.pdf

[14] DOE Targets for Hydrogen Safety Sensors (Table 3.7.6). Multi-Year Research, Development, and Demonstration Plan (Revised 2015). https://www.energy.gov/sites/prod/files/2015/06/f23/fcto_myrdd_safety_codes.pdf

Table 1. DOE Targets for Hydrogen Safety Sensors

Targets for Hydrogen Safety Sensors	
Measurement Range	0.1%–10%
Operating Temperature	-30° to 80°C
Response Time	<1 second
Accuracy	5% of full scale
Gas Environment	Ambient Air, 10%–98% relative humidity range
Lifetime	10 Years
Interference Resistant	Yes (e.g., hydrocarbons)

In addition to addressing the capabilities of the selected sensors, proposals should include detailed plans for the integration of the proposed technologies and consider the operational needs of the industry partner. Applicants are encouraged to both model the performance of the integrated system in a real-world scenario to optimize deployment and include a field demonstration of the integrated system at a relevant large-scale site (e.g., hydrogen production facility, industrial facility, indoor installation). Integration with ARIES is **optional** for Topic 3 proposals.

Eligibility

Only DOE national laboratories are eligible to submit a proposal to this Lab CRADA call. Each application must include at least one non-national laboratory participant that will collaborate with one or more DOE national laboratories to perform the proposed work. Participant eligibility is limited to: (1) for-profit entities, educational institutions, and non-profits that are incorporated (or otherwise formed) under the laws of a particular state or territory of the United States and have a physical location for business operations in the United States and (2) U.S. state, local, and tribal government entities. Participation by foreign entities may be allowed if approved by DOE. The approval process may extend the award selection and approval timeframes for projects with foreign involvement. The applicant must identify how the non-lab partner meets the eligibility requirements of the CRADA call in its proposal.

For Topic Area 1, the CRADA project must include NREL as an integral partner but may include additional national laboratories.

Lab Contact Information

The points of contact at each national laboratory eligible to participate in this CRADA call are listed below; these individuals can support interested partners to better understand lab capabilities or conceptualizing collaborative R&D:

- National Renewable Energy Laboratory: Cory Kreutzer, cory.kreutzer@nrel.gov
- Sandia National Laboratories: Chris San Marchi, cwsanma@sandia.gov
- Idaho National Laboratory: Richard Boardman, richard.boardman@inl.gov
- Pacific Northwest National Laboratory: Jamie Holladay, jamie.holladay@pnnl.gov
- Argonne National Laboratory: Ted Krause, krauset@anl.gov
- Oak Ridge National Laboratory: Rich Davies, daviesrw@ornl.gov
- Los Alamos National Laboratory: Rod Borup, borup@lanl.gov

- Savannah River National Laboratory: Scott McWhorter, scott.mcwhorter@srnl.doe.gov
- Brookhaven National Laboratory: Alex Harris, alexh@bnl.gov
- Ames Laboratory: Vitalij Pecharsky, vitkp@ameslab.gov
- National Energy Technology Laboratory: Jared Ciferno, jared.ciferno@netl.doe.gov
- Lawrence Berkeley National Laboratory: Adam Weber, azweber@lbl.gov
- Lawrence Livermore National Laboratory: Brandon Wood, wood37@llnl.gov
- SLAC National Accelerator Laboratory: Steve Eglash, seglash@slac.stanford.edu

Diversity, Equity, and Inclusion

It is the policy of the Biden Administration that:

> [T]he Federal Government should pursue a comprehensive approach to advancing equity[15] for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality. Affirmatively advancing equity, civil rights, racial justice, and equal opportunity is the responsibility of the whole of our Government. Because advancing equity requires a systematic approach to embedding fairness in decision-making processes, executive departments and agencies (agencies) must recognize and work to redress inequities in their policies and programs that serve as barriers to equal opportunity.
>
> By advancing equity across the Federal Government, we can create opportunities for the improvement of communities that have been historically underserved, which benefits everyone.[16]

As part of this whole of government approach, this CRADA call seeks to encourage the participation of underserved communities and underrepresented groups. Applicants are highly encouraged to include individuals from groups historically underrepresented[17,18] in STEM on their project teams. As part of the application, applicants are required to describe how diversity, equity, and inclusion (DEI) objectives will

[15] The term "equity" means the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality. E.O. 13985.

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

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

[18] Note that Congress recognized in section 305 of the American Innovation and Competitiveness Act of 2017, Public Law 114-329: (1) [I]t is critical to our Nation's economic leadership and global competitiveness that the United States educate, train, and retain more scientists, engineers, and computer scientists; (2) there is currently a disconnect between the availability of and growing demand for STEM-skilled workers; (3) historically, underrepresented populations are the largest untapped STEM talent pools in the United States; and (4) given the shifting demographic landscape, the United States should encourage full participation of individuals from underrepresented populations in STEM fields.

be incorporated in the project. Specifically, applicants are required to reference, if available, existing laboratory and project partner Diversity, Equity, and Inclusion Plan(s) and describe within the proposal the actions the applicant will take to foster a welcoming and inclusive environment, support people from underrepresented groups in STEM, advance equity, and encourage the inclusion of individuals from these groups in the project; and the extent the project activities will be located in or benefit underserved communities (see Appendix A). Because a diverse set of voices at the table in research design and execution has an illustrated impact on innovation, this implementation strategy for the DEI plan will be evaluated as part of the technical review process.

Further, to the extent the proposed project will include external partners, the applicant is encouraged to include Minority Serving Institutions,[19] Minority Business Enterprises, Minority Owned Businesses, Woman Owned Businesses, Veteran Owned Businesses, or entities located in an underserved community.

Funding Requirements

DOE funds supporting each CRADA project are to be used for activities undertaken within the participating national laboratories for services, staff time, and facilities necessary to support each selected project. DOE funds provided to national labs for CRADA projects may not be costed outside of the national laboratories. The DOE funding will be provided directly to the national laboratory (or laboratories) in support of their work under the H2@Scale initiative. The CRADA project sizes may vary, but must include at least 30% cost share including at least 10% cash into the national laboratory. Cost share from other DOE offices or other federal sources is not permitted.

CRADA Requirements

For each CRADA project, the participant and each national laboratory conducting work for the project must enter into a CRADA based on the H2@Scale Template CRADA. Only changes to incorporate optional or alternate language approved in the DOE CRADA Order (DOE O 483.1B) and changes considered non-substantive can be made to the H2@Scale Template CRADA. No changes are allowed to the U.S. competitiveness provision. If the participant fails to agree to the terms of the CRADA with the national laboratories within thirty (30) days from selection, DOE may rescind the selection. Each applicant should review the H2@Scale Template CRADA carefully to understand the general terms, including intellectual property rights and requirements and the U.S. competitiveness provision, that will apply to its CRADA project.

Proprietary Data in Proposal

An applicant should not include proprietary information in the proposal unless such information is necessary to understand and evaluate the proposed project. If proprietary information is required to be included in the proposal, the proprietary information should be marked as such on the specific pages that contain this information. DOE, the national laboratories, and the external reviewers will treat properly marked proprietary information as confidential to the extent allowable under U.S. law.

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

Proposal Preparation

Proposals should be no more than 15 single spaced pages using 12-point font, should be in single pdf file format, and must include the following components under headings corresponding to the bullets below. Sections 7–10 must be included in the single pdf file but will not count toward the 15-page limit.

- **Title Page:** proposal title, principal investigator(s), brief company description, and non-proprietary summary. Include name, address, phone number, and email addresses for both technical and business contacts of the lead applicant (organization).
- **1.0 Abstract:** Describe the specific product, component, analysis or process being developed, refined, or validated. Include how the national laboratory unique capability is essential to execute the work. State the Topic being applied to.
- **2.0 Project Description:** Describe the project in enough detail that it may be evaluated for its feasibility, impact, relevance to H2@Scale objectives and ARIES research areas, topic area, and appropriate use of national lab capability.
- **3.0 Potential Technology Advancement:** Identify technical challenges that, if addressed, will result in significant technological advancements.
- **4.0 Expected Benefits:** Projection of economic benefit and/or industrial energy savings and/or pollutant emission and petroleum use reductions that would come from successful implementation of the technology/project.
- **5.0 Required Resources:** Describe the expected DOE and national laboratory member resources, including proposed work areas, staff time, and any testing/characterization needs. Include a summary of any testing to be done and the goals this testing is expected to achieve, including specific locations and laboratories to be used.
- **6.0 Budget/Cost-Sharing:** Provide a detailed table describing the proposed budget (both federal and cost share), clearly articulating cash vs. in-kind.
- **7.0 References** (not counted in the 15-page limit).
- **8.0 Team:** Single page resumes of key project participants should be included (not counted in the 15-page limit).
- **9.0 Commitment Letters:** Letters from Third Parties Contributing Cost Share and Letters of Support from Industry (not counted in the 15-page limit).
- **10.0 Diversity, Equity, and Inclusion Plan:** Include equity impacts, benefits to underserved communities, and how DEI objectives will be incorporated into the project. See Appendix A for additional guidance and requirements (not counted in the 15-page limit).

Proposal Evaluation and Selection Process

DOE HFTO will conduct the proposal evaluation and will be solely responsible for the selection of winning proposals. While unlikely, HFTO may seek the input of qualified external reviewers during the evaluation process. By submitting its proposal, the applicant consents to the use of non-federal reviewers.

The primary categories and relative ranking criteria used to evaluate submissions will be as follows.

<u>Technical (60%)</u>

- Relevance of proposed work to the goals of H2@Scale and ARIES research areas
- Overall technical merit

- Potential impact of the collaboration on the technical challenge being addressed (e.g., national lab and industry leveraged effort)
- Impact of collaboration on other interested and impacted stakeholders (e.g., through publication of data or experimental results)
- Degree to which the current state of the technology and the proposed advancement are clearly described
- Extent to which the collaboration specifically and convincingly demonstrates how the applicant will move the state-of-the-art to the proposed advancement, validation, demonstration, etc.

Programmatic (40%)

- Adequacy and feasibility of proposed work plan to meet clearly articulated goals of the project
- Appropriate use of national lab capabilities, resources, and expertise
- Clear estimated level of support requested from team members and strong justification, including table of cash and in-kind cost share to be provided by the industrial partner
- Importance of technology development to general market acceptance
- Qualifications and expertise of the key technical personnel who are active participants in the proposed project
- Ability of the non-lab partner(s) to support proposed activities as well as the commitment of individuals, team members, available facilities, and equipment, etc. necessary to perform the scope
- The quality and manner in which the measures incorporate diversity, equity and inclusion goals in the project
- Extent to which the project benefits underserved communities

Proposals submitted after the due date may be considered as funding allows. However, proposals will be evaluated on a rolling basis and preference will be given to high-scoring proposals submitted by the submission deadline that also meet the objectives of the CRADA call.

Following selection and depending on the scope of work proposed, HFTO may request or require submission of a Safety Plan and/or involvement of DOE's Hydrogen Safety Panel to assist in safety planning. Participants in the CRADA projects will be encouraged to share best practices and lessons learned developed over the course of the project via DOE's H2Tools portal (https://h2tools.org/). H2Tools hosts an anonymous database of lessons learned from safety incidents (https://h2tools.org/lessons, with no attribution to parties involved) to educate and inform the hydrogen community.

Appendix A

Project Specific Implementation of Diversity, Equity, and Inclusion Plan

As part of the proposal, applicants are required to describe how diversity, equity, and inclusion objectives will be incorporated in the project. Specifically, applicants are required to submit a description of how the project will support or implement the Diversity, Equity, and Inclusion Plan and describe the actions the applicant will take to foster a welcoming and inclusive environment, support people from groups underrepresented in STEM, advance equity, and encourage the inclusion of individuals from these groups in the project; and the extent the project activities will be located in or benefit underserved communities. The plan should include SMART milestones supported by metrics to measure the success of the proposed actions.

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

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

The Diversity, Equity, and Inclusion Implementation Plan should be included with the proposal as described in the Proposal Preparation section.