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The #H2IQ Hour

Today's Topic:

Advanced Research on Integrated Energy Systems (ARIES) Platform

This presentation is part of the monthly H2IQ hour to highlight hydrogen and fuel cell research, development, and demonstration (RD&D) activities including projects funded by U.S. Department of Energy's Hydrogen and Fuel Cell Technologies Office (HFTO) within the Office of Energy Efficiency and Renewable Energy (EERE).

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HOUSEKEEPING

This webinar is being recorded.

This webinar is being recorded and will be available on the H2IQ webinar archives.

Technical Issues:

- If you experience technical issues, please check your audio settings under the “Audio” tab.
- If you continue experiencing issues, direct message the host, Kyle Hlavacek

Questions?

- There will be a Q&A session at the end of the presentation
- To submit a question, please type it into the Q&A box; **do not** add questions to the Chat

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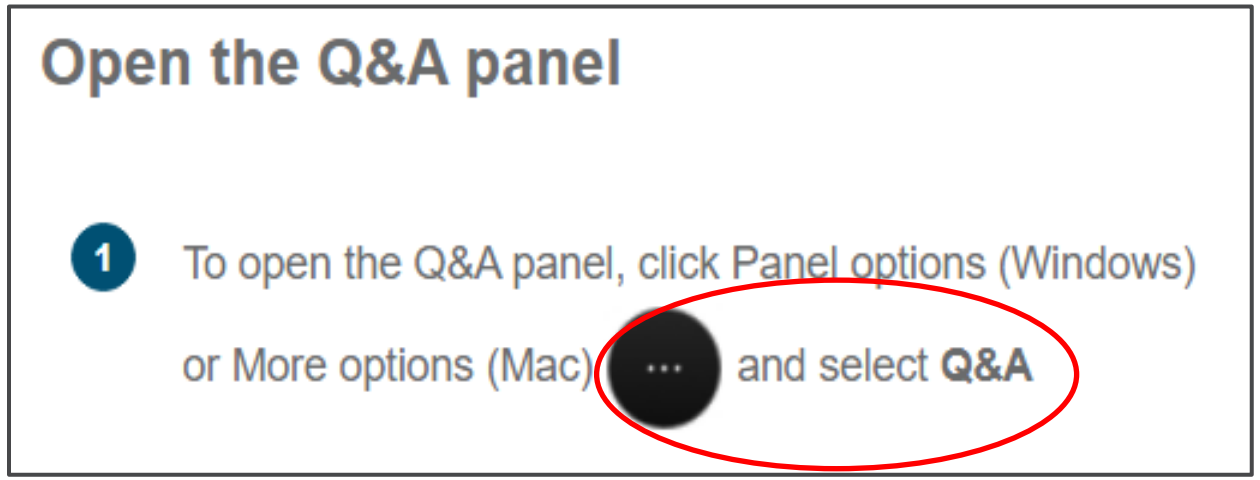
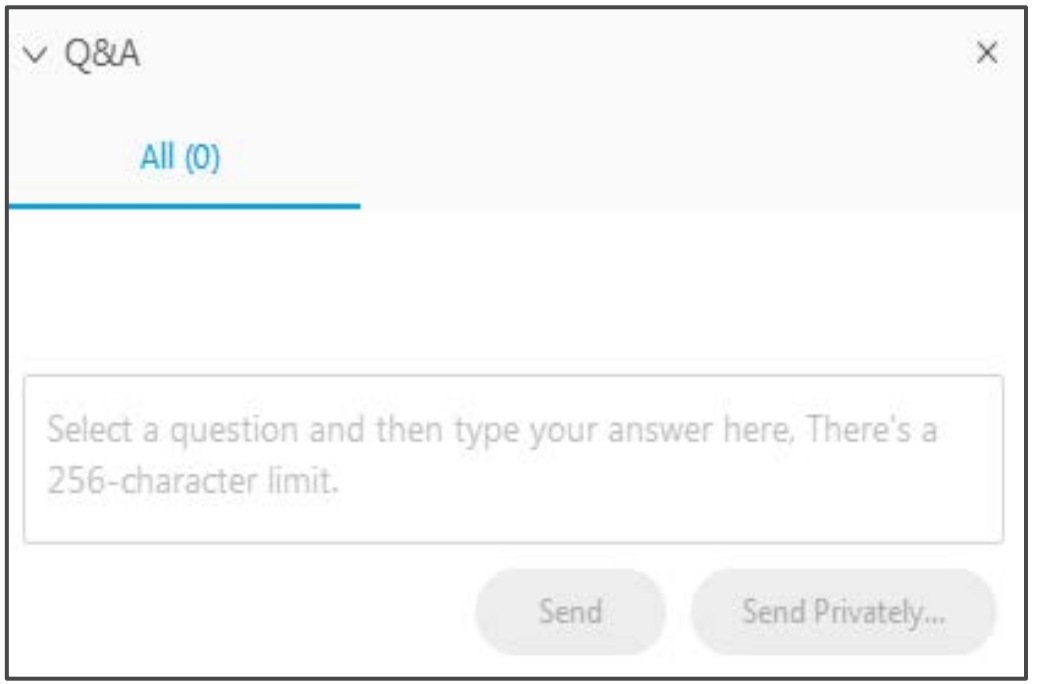
The #H2IQ Hour Q&A

Please type your questions in the Q&A Box





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ARIES H2@Scale Partnership Opportunity

HFTO Webinar

October 9, 2024

Thank you EERE: Project Funding & Program Guidance

ARIES by NREL

This CRADA Call and the ARIES platform would not be possible without significant investment and vision from EERE and its Hydrogen & Fuel Cell Technologies Office (HFTO)

EERE's mission is to accelerate the research, development, demonstration, and deployment of technologies and solutions to equitably transition America to net-zero greenhouse gas emissions economy-wide by no later than 2050, and ensure the clean energy economy benefits all Americans, creating good paying jobs for the American people—especially workers and communities impacted by the energy transition and those historically underserved by the energy system and overburdened by pollution.

EERE: https://www.energy.gov/eere/office-energy-efficiency-renewable-energy
HFTO: https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office

ARIES H2@Scale Webinar Objectives & Agenda

ARIES by NREL

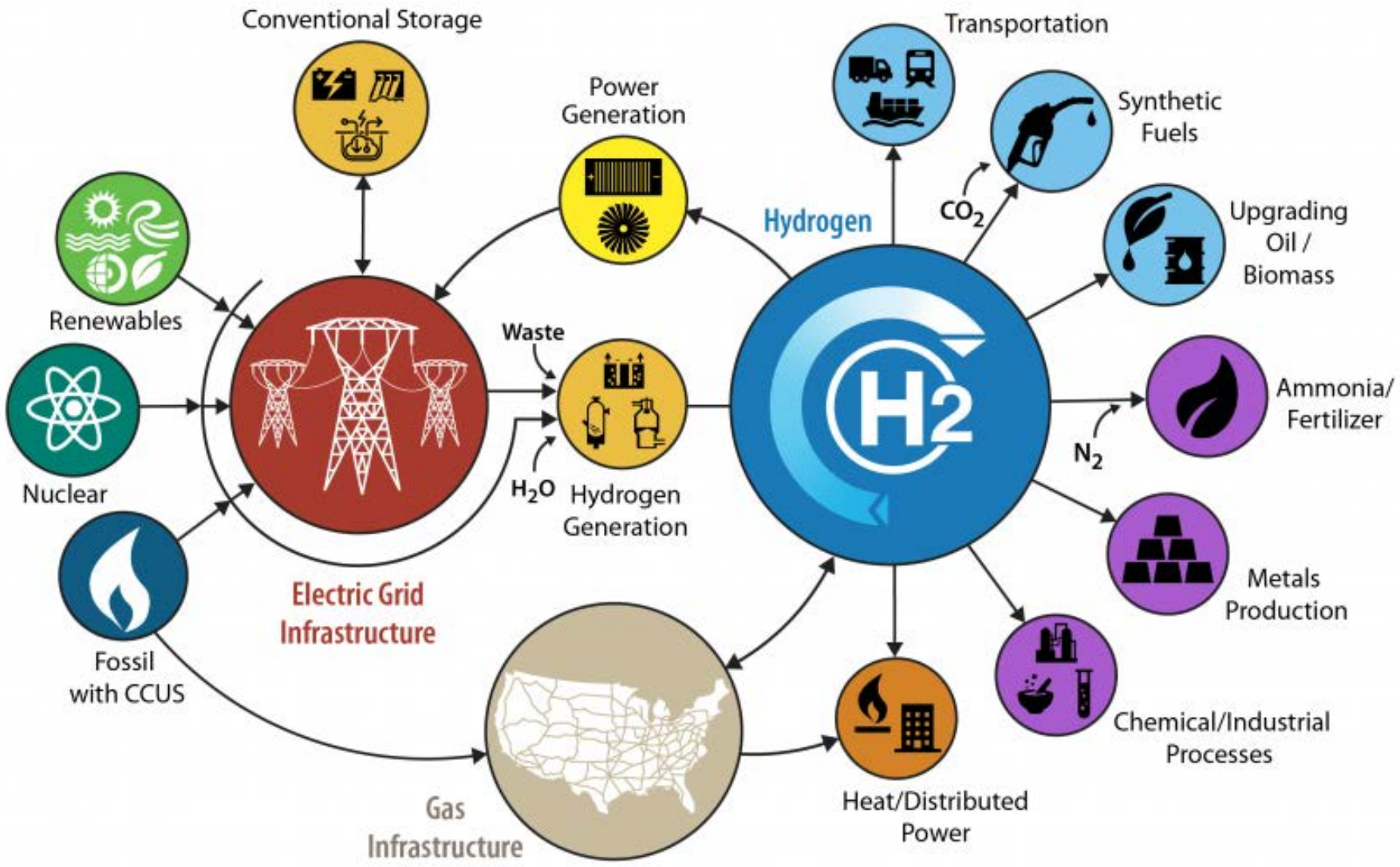
Today's Objectives

- Launch an open partnership call to utilize the ARIES research platform for H2@Scale system integration, industrial applications, and electrolyzer stacks
- Present the ARIES capabilities
- Describe the process and next steps

Agenda

1. ARIES Introduction & Opportunity Overview
2. Topic 1 – Validating Hydrogen System Integration (Dan Leighton)
3. Topic 2 – Hydrogen Systems for Industrial Applications (Jen King)
4. Topic 3 – PEM & Alkaline Electrolyzer Validation (Kevin Harrison)
5. CRADA Opportunity Details
6. Q&A

H2@Scale



Source: https://www.energy.gov/eere/fuelcells/h2scale

Advanced Research on Integrated Energy Systems (ARIES)

ARIES by NREL

Need

Addressing Urgent National Need

RD&D backed by real-time validation are needed for innovative solutions for large-scale energy systems integration and deployment in a rapidly changing environment.

What

Developing at-Scale RD&D Platform

ARIES is DOE's advanced research platform for energy system integration research, validation, and demonstration at a size and scale that matters.

Why

De-risking Energy Systems

ARIES will de-risk deployment by providing a research platform that can replicate real-world energy system scenarios and demonstrate the best pathways to reach local and national decarbonization goals.

Uniqueness

Integrating Energy Technologies

ARIES crosses multiple energy sectors, scales, and technologies. It integrates physical and virtual energy technology assets together and enables national labs to combine their expertise and capabilities to address complex energy systems integration challenges.

Example: H2@Scale Hydrogen Fueling Infrastructure Capability*

Collaboration with HFTO, Labs, and Industry

- Unique capability for fast flow fueling component and fueling protocol evaluations and station reliability
- Support for specific safety, codes, and standards groups
- Expanding for medium- and heavy-duty fueling research and integration into the ARIES platform
- Advanced modeling for system simulation, component performance, and fueling protocol validation
- Interest in cryogenic systems and components

**Example only, not included in this CRADA call. Please contact NREL for more information on these hydrogen fueling capabilities if interested.*

ARIES H2@Scale Partnerships Announcement

FY25 Cooperative Research and Development Agreement (CRADA) Call utilizing the Advanced Research on Integrated Energy Systems (ARIES) research platform

OCTOBER 9, 2024 -- DOE's Hydrogen and Fuel Cell Technologies Office (HFTO) and the NREL ARIES team announce an opportunity for qualified partners to participate in CRADA projects in support of DOE's H2@Scale initiative utilizing the ARIES research platform.

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 new energy technologies and how to integrate them with the energy grid.

The FY25 CRADA Call seeks partners that will leverage NREL's ARIES research platform's assets and modeling tools to validate the integration of hydrogen technologies in three topic areas.

https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office
https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html
https://www.nrel.gov/aries/

ARIES H2@Scale CRADA Call Topics

ARIES by NREL

Topic 1

Validate Hydrogen Systems Integration with Renewables and the Grid

Proposals to advance integrated hydrogen systems to derisk technology and system deployments through validation and testing with a goal of generating impactful results that reveal how electrolyzers and fuel cells interact when on or off grid and with intermittent sources

Leads: Daniel Leighton and Monterey Gardiner

Topic 2

Analyze/Model/Validate Hydrogen Systems for Industrial Applications

By leveraging GreenHEART modeling tools, the NREL team will work closely with partners to site and optimize possible location-specific integrated energy systems, purpose-built for clean hydrogen production through to industrial end use

Leads: Jen King and Steve Hammond

Topic 3

Validate PEM and Alkaline Electrolyzers with Dynamic Profiles

NREL will provide 3rd party validation of PEM and alkaline electrolyzers operating on clean energy sources with variable power supply profiles. Partners can validate their PEM or alkaline electrolyzers under a range partner specified operational profiles and multiple standard renewable operational profiles (wind, solar, grid services, etc.)

Leads: Kevin Harrison and Meital Shviro

Funding Summary by Topic Area

ARIES by NREL

Topic Area	Total Federal Funding per CRADA	Anticipated Number of CRADAs	Project Duration (years)	Min Required Non-Federal Cost Share %
Topic 1: Validate Hydrogen System Integration with Renewables and the Grid	$500K-$3M	1 to 3	1-3	30% (including in-kind labor, funding, or equipment)
Topic 2: Analyze/Model/Validate Hydrogen Systems for Industrial Applications	$100K-$500K	1 to 3	1-2	30% (including in-kind labor, funding, or equipment)
Topic 3: Validate PEM and Alkaline Electrolyzer with Dynamic Profiles	$100K-$500K	1 to 3	1	30% (including in-kind labor, funding, or equipment)
Total:	Up to $5M*	3 to 9		

*The total DOE funding includes up to $5M in FY25 funding to NREL, subject to appropriations. Funding provided by Hydrogen and Fuel Cell Technologies Office, EERE, DOE

https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html

Validating Hydrogen System Integration

Description of Capabilities and Topic Objective

Leads: Daniel Leighton and Monterey Gardiner

ARIES by NREL

Agenda

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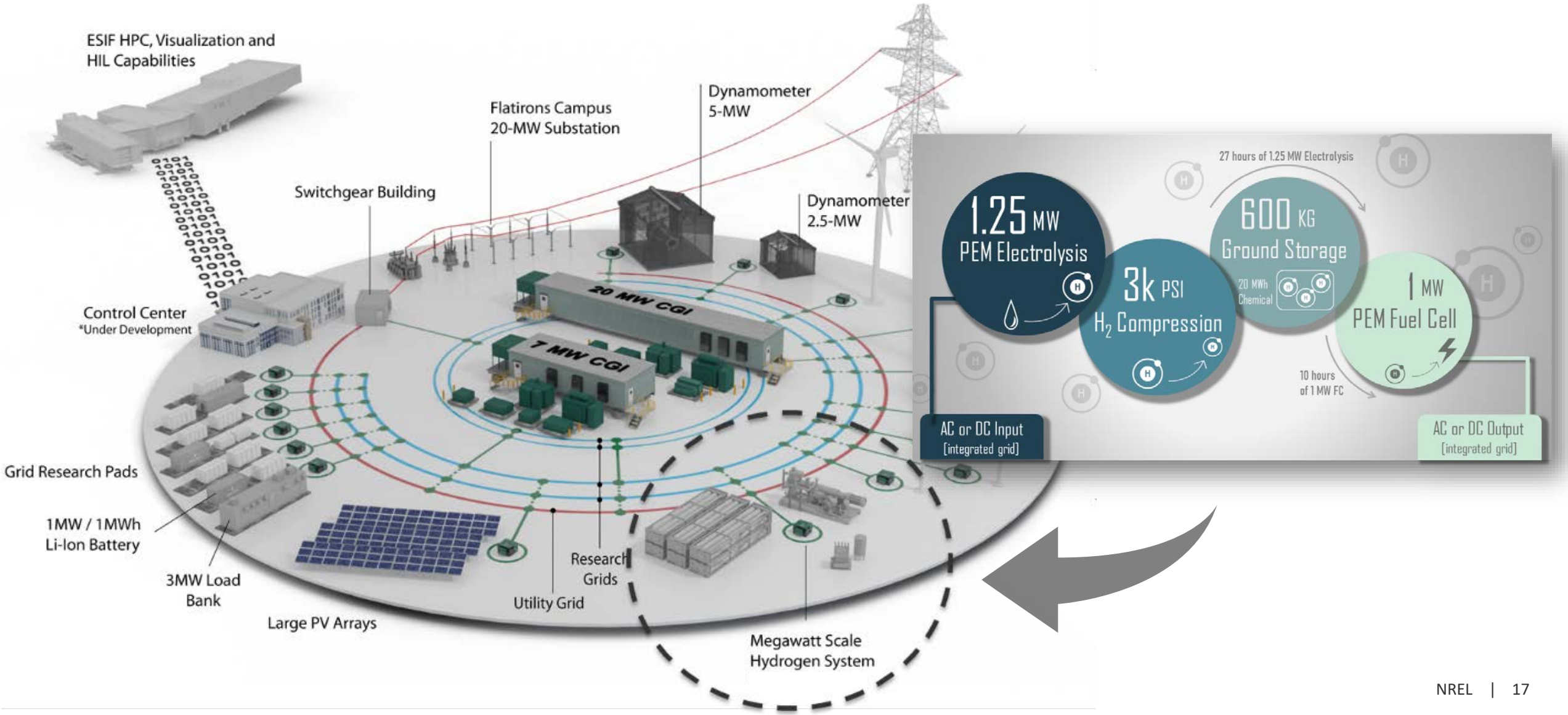
Topic 1: Validate Hydrogen System Integration with Renewables and the Grid

Under this topic, DOE seeks proposals to advance integrated hydrogen systems utilizing current ARIES hydrogen research capabilities to **derisk technology and system deployments through validation and testing**, with an emphasis on generating **impactful experimental and modeling results** that reveal electrolyzers and fuel cells performance when on or off the grid and with intermittent sources.

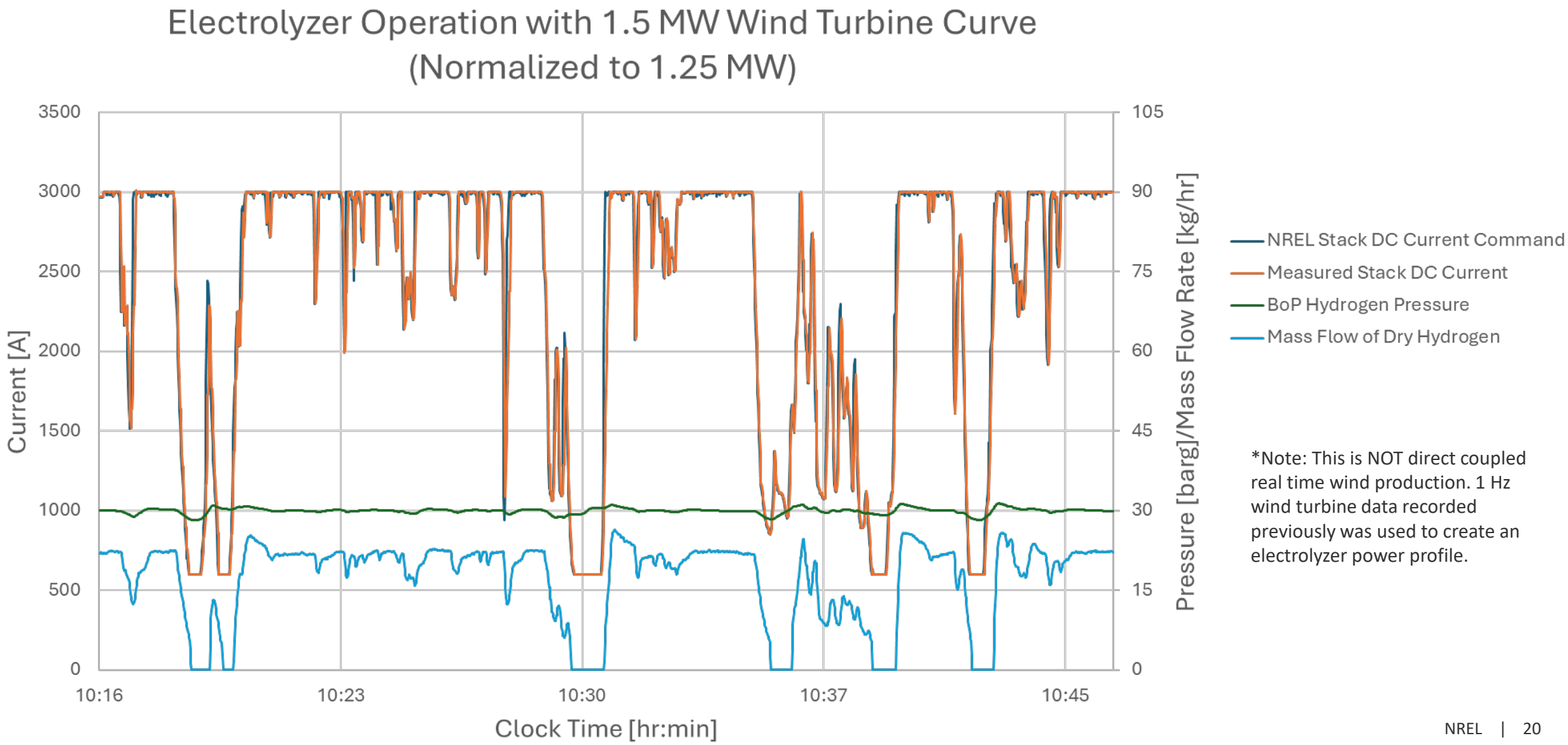
- NREL's ARIES capabilities will be used to evaluate the integration of hydrogen energy systems with renewables and the grid. Areas of particular interest include, but are not limited to:
  - Systems Integration/Hybridization (including electrolyzer testing/integration)
  - Renewable Hydrogen Production (e.g., wind to hydrogen)
  - Grid Services (including peak and resource adequacy services)
  - Long Duration Energy Storage with Hydrogen
  - Control Systems (e.g., economic dispatch models for hydrogen resources)
  - Power Electronics
  - Innovative and Expanded Hydrogen End-use Applications

ARIES Flatirons Campus Grid Equipment



Flatirons Campus Hydrogen System Today

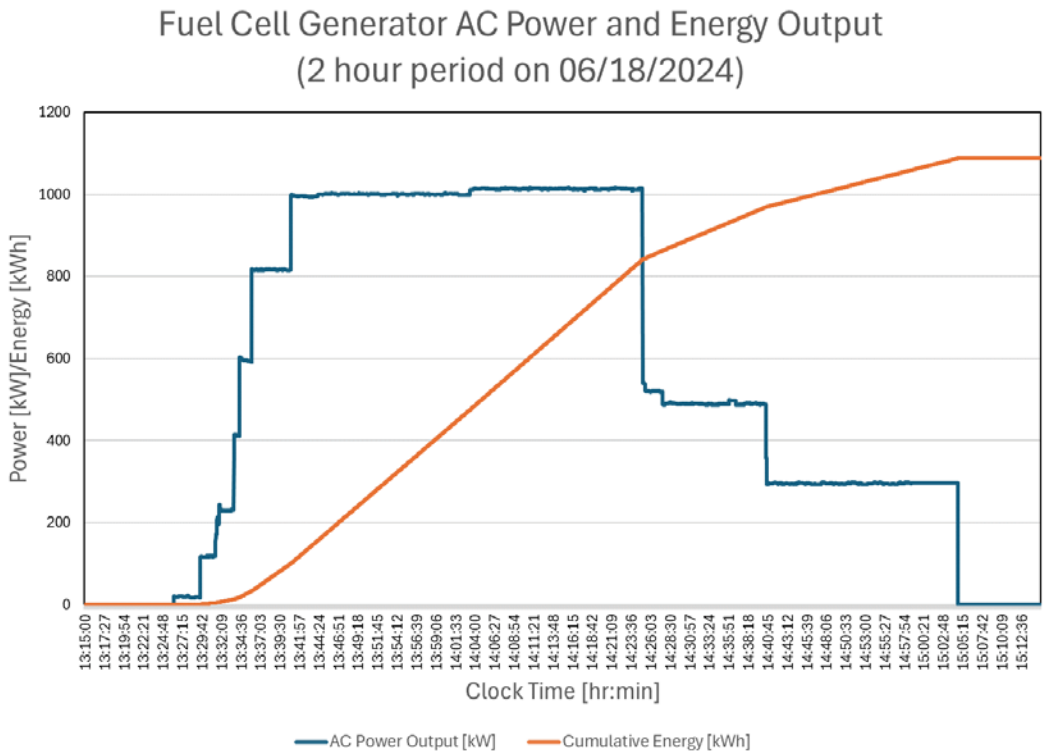
Electrolyzer Operated with Wind Turbine Profile

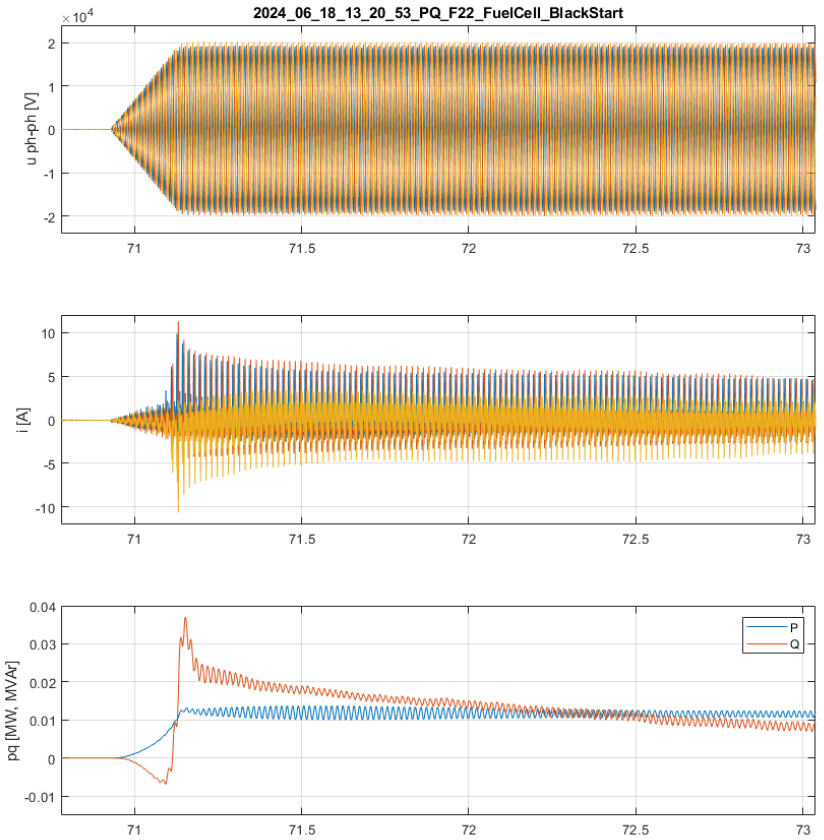


*Note: This is NOT direct coupled real time wind production. 1 Hz wind turbine data recorded previously was used to create an electrolyzer power profile.

Fuel Cell Generator Black Start/Grid Forming

- 11 MVA of transformers black started on 13.2kV grid in 200 ms with maximum inrush current of 12 A
- Peak output power of 1.016 MWe-AC, with 1.088 MWhe-AC of energy produced
- 64.4 kg of hydrogen consumed, which is 50.7% AC-LHV efficiency





MV Grid 50 kHz data of black start voltage, current, real and reactive power (from top to bottom) versus time in seconds – Courtesy of: Przemyslaw Koralewicz

Key Hydrogen Capabilities* Available

- Electrolyzer and fuel cell generator systems
  - Can be directly AC-coupled with any permutation of wind turbines, solar PV, lithium battery, load bank, controllable grid interface, utility grid, or Virtual Emulation Environment (digital real time simulation and cyber range)
  - Hybrid grid controller controls all power assets on campus including closed loop power point control of the electrolyzer and fuel cell generator and can be customized per project
  - 1.25 MW PEM electrolyzer and 1 MW PEM fuel cell generator
  - Electrolyzer power gain (up) rate of ~6%/sec and slew (down) rate of ~15%/sec
  - Fuel cell can grid follow as well as black start/grid form (near instantaneous 100% power response)
  - Fuel cell turns down to 0%, electrolyzer turns down to 20% (including balance of plant)
  - 1 Hz standard data acquisition and control rate with 50 kHz data acquisition possible for AC grid
- 600 kg of hydrogen storage available (including compression)
  - Enables nearly 27 hours of full power electrolyzer operation or 10 hours of fuel cell generator operation
  - Hydrogen storage system maximum operating pressure of 3,000 psig
  - Hydrogen purity of 99.9995% (meets or exceeds SAE 2719 specifications)
  - 500 kg of additional metal hydride storage soon to be online (currently undergoing commissioning)

*Additional information on NREL's existing infrastructure is provided in the July 25, 2024, H2IQ Hour presentation at: https://www.energy.gov/eere/fuelcells/2024-h2iq-hour-webinar-archives#07252024

Topic 1 - R&D Ideas*

Optimization of controls and hardware configuration to load follow renewable generation, provide grid energy storage, produce "behind-the-meter" renewable hydrogen, and/or provide grid services

- **Capabilities used:** 1.25 MW electrolyzer, hydrogen compression and storage, 1 MW fuel cell generator, 1MW/1MWh lithium-ion battery, 1.5 MW wind turbine, solar PV field(s)/emulator, controllable grid interface
- **Impacts and Outputs:** De-risk large scale deployments of both grid-connected and "behind-the-meter" hydrogen systems by quantifying performance, validating models, optimizing control schemes, and identifying appropriate system configurations and sizing to reduce the levelized cost of hydrogen

Quantify performance of hydrogen technologies for specific end-uses cases such as backup power

- **Capabilities used:** 50 kHz data acquisition rate, 1 MW fuel cell generator, hydrogen storage, controllable grid interface, digital real time simulation, 3 MVA load bank
- **Impacts and Outputs:** De-risk large scale deployments of hydrogen-fueled backup power generation systems for different applications such as data center backup power, building or village backup power, or grid resiliency and energy storage. Develop a confidence interval for reliability required by different applications.

Demonstrate emerging, innovative, and early-stage hydrogen technologies such as novel storage solutions, molecule building, industrial end uses, hydrogen generation, and hydrogen power production

- **Capabilities used:** electrical grid connection(s), hydrogen production and storage, thermal management system, auxiliary air/water/controls/electrical systems
- **Impacts and Outputs:** Leverage existing equipment to reduce time / cost to demonstrate prototype technologies interactions with other MW-scale hydrogen, renewable, and grid technologies. Identify obstacles to deployment.

*Note: These examples are for illustrative purposes. Previously awarded FY21 H2@Scale projects can be found here: https://www.energy.gov/eere/articles/doe-announces-nearly-8-million-national-laboratory-h2scale-projects-help-reach

Hydrogen Systems for Industrial Applications

Description of Capabilities and Topic Objective

Leads: Jen King and Steve Hammond

ARIES by NREL

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Topic 2: Analyze/Model/Validate Hydrogen Systems for Industrial Applications

Using the GreenHEART modeling tools and analysis expertise, NREL will work with industry partners to **site and optimize location-specific integrated energy systems**.

- These integrated energy systems will be closely coupled from electricity generation through end-use for clean hydrogen production using renewable electricity (behind the meter or grid connected), to supply industrial end uses like green steel or green ammonia.
- Deliverables will include analysis and **reporting to DOE and industry partners** on **siting specific parameters** (e.g. water availability, land restrictions, wind resource, solar resource, and underground hydrogen storage options); reference designs and use cases with site-specific optimized mixes of equipment, renewable energy mix, battery storage, and electrolyzer capacity; as well as site specific levelized cost of hydrogen, levelized cost of green steel, or levelized cost of green ammonia.

GreenHEART Overview

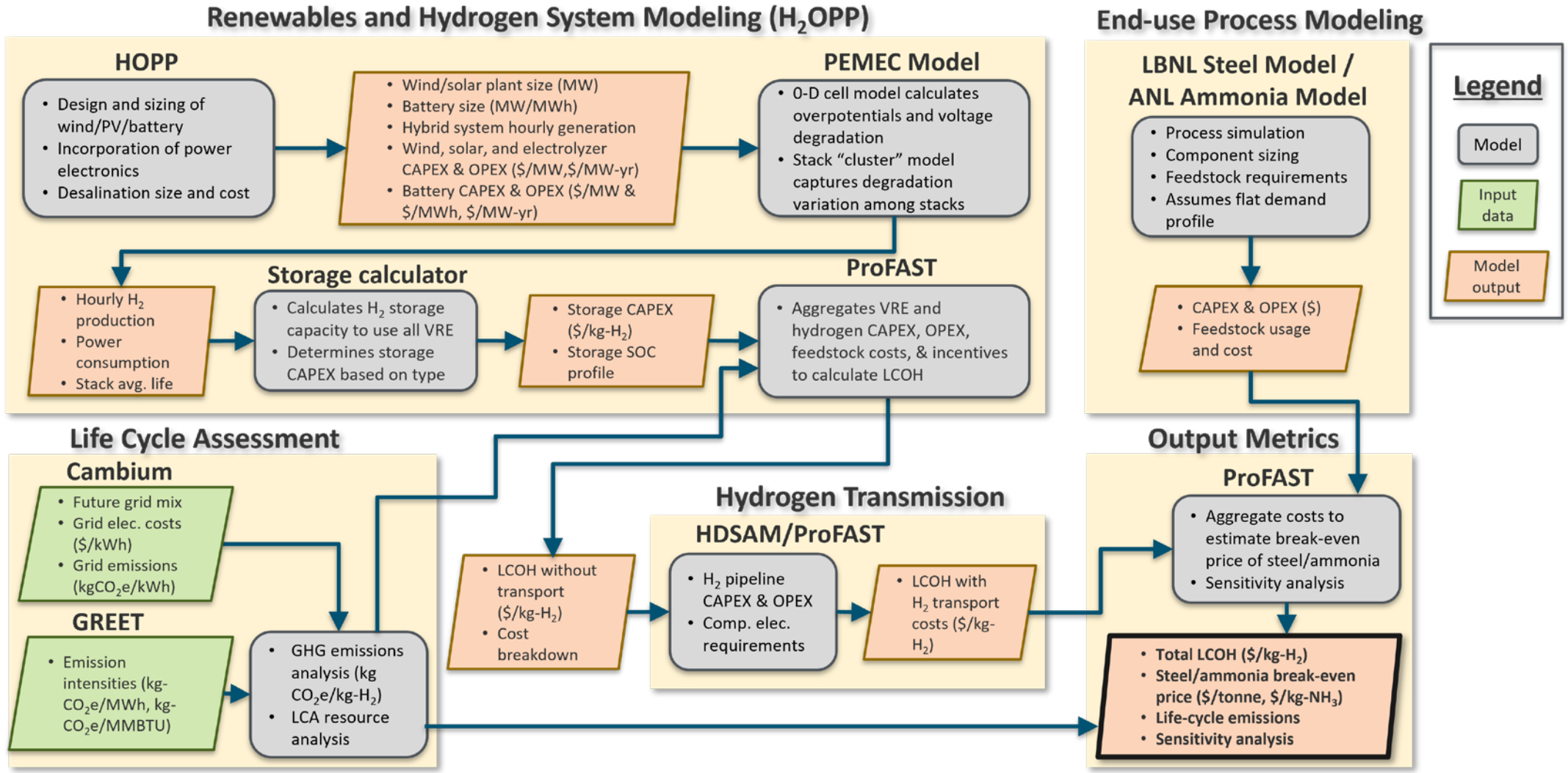
Comprehensive, detailed integrated TEA capability for purpose-built, **MW-** and **GW-scale** behind-the-meter hybrid energy systems, tightly-coupled w/ green H_2 production, co-located with industry end uses, that can accelerate the path to decarbonize hard to abate industries.

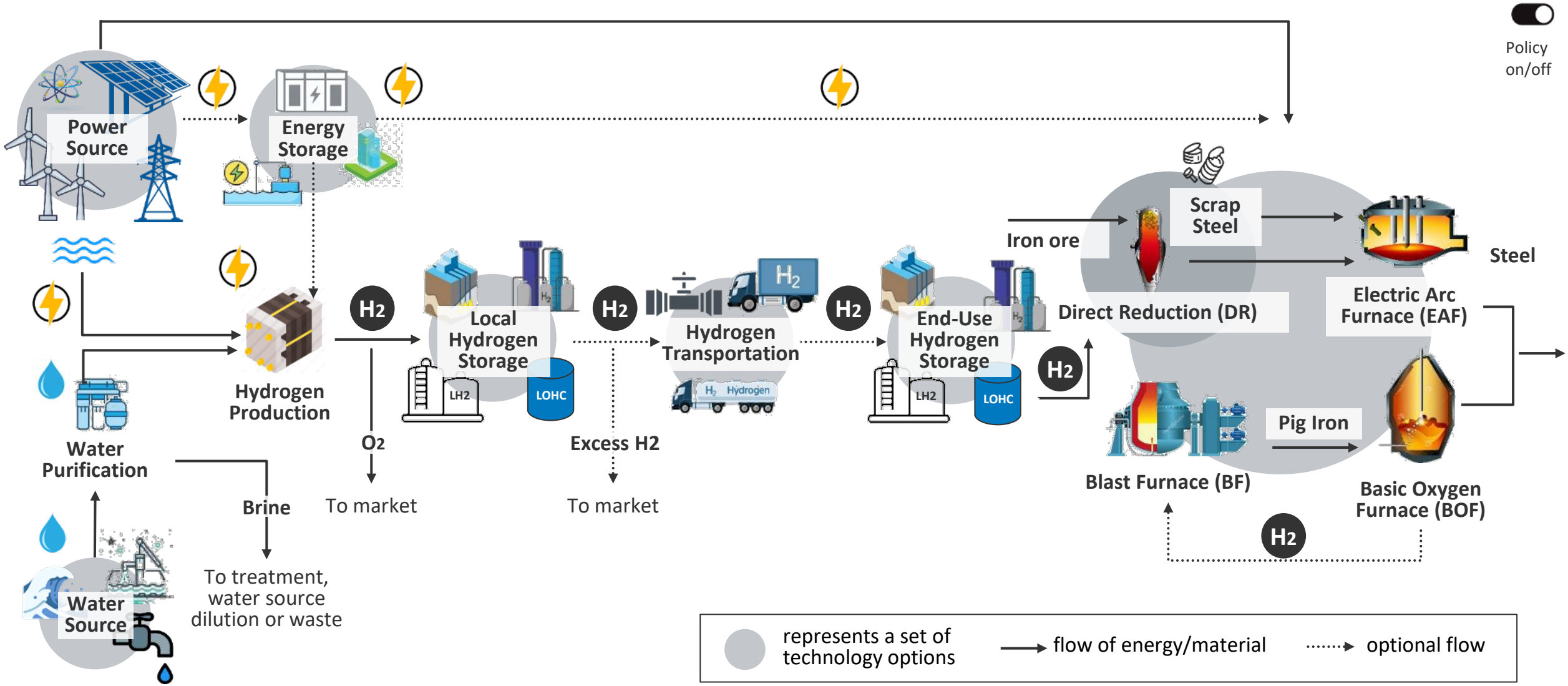
Novelty and Advantages:

- Optimized LCOH delivered for the specific end use
- Holistic approach, increased efficiency, & reduced capital costs
- Independence from natural gas price volatility, grid connection permits and new large-scale transmission build outs.

Funded by DOE HFTO & Wind Energy Technology Office
NREL (lead) + Argonne Natl Lab, Lawrence Berkley Natl Lab, Oak Ridge Natl Lab & Sandia Natl Lab

Overview of GreenHEART Structure





GreenHEART models full Integrated System

Renewables to **H2 to Storage to Steel**

END-USE:

- Ancillary equipment not depicted
- One icon on the diagram does not reflect the number of technologies which are required for the actual process flowsheet

GreenHEART Data Integration

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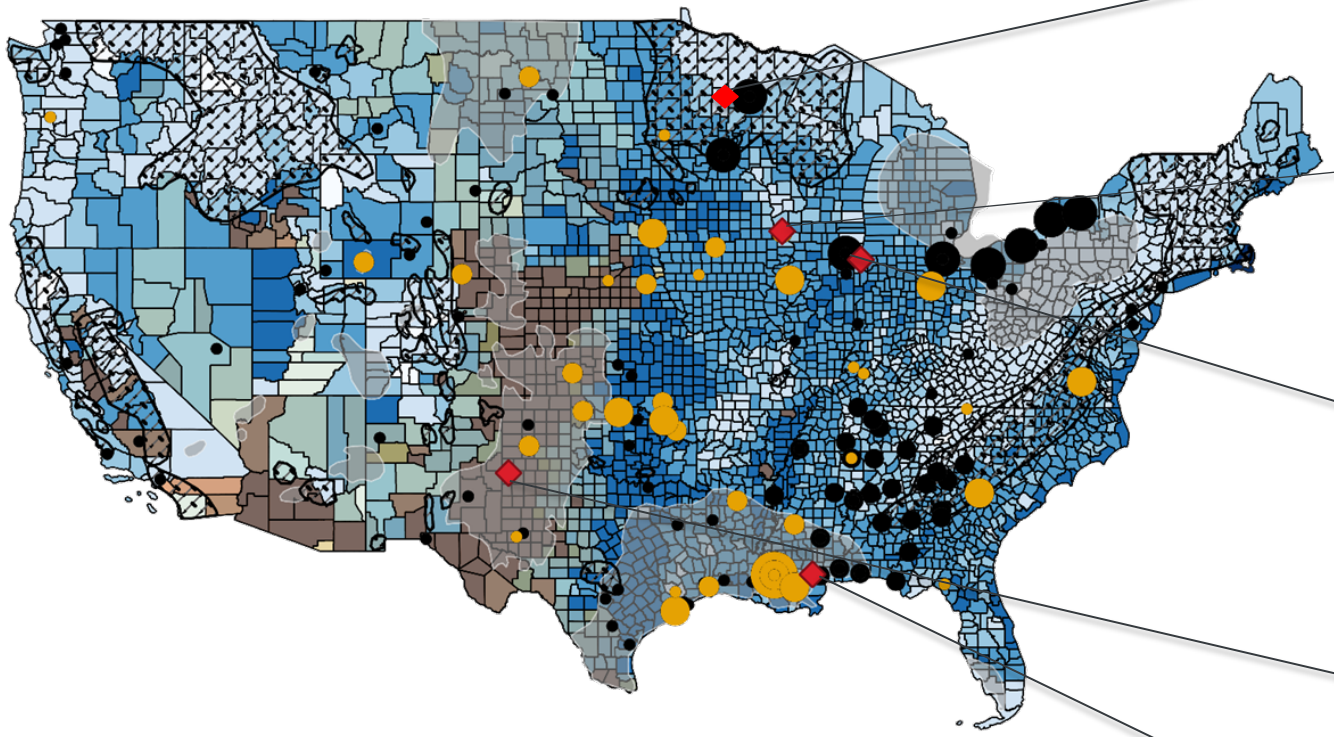


MINNESOTA
- Suitable renewables
- Lined rock caverns; raw materials

IOWA
- Existing ammonia pipeline
- Close to ammonia and steel demand centers
- No geologic storage

INDIANA
- Largest steel mill in the U.S. with 8.2 MMT steel/year capacity
- No geologic storage

TEXAS
- Salt caverns and water stress region
- Excellent wind resources

MISSISSIPPI
- Close to existing demand
- Salt caverns

Legend

- Selected Locations

Hydrogen Demand for Ammonia Production (MT)
- 0 - 35,000
- 35,000 - 110,000
- 110,000 - 250,000
- 600,000 - 810,000

Hydrogen Demand for Synfuels and Metals (MT)
- 0 - 1,000
- 1,000 - 50,000
- 150,000 - 700,000
- Hardrocks
- Salt Caverns

Water scarcity index (-)
- 0 - 5
- 5 - 10
- 10 - 30
- 30 - 50
- 50 - 70
- 70 - 100

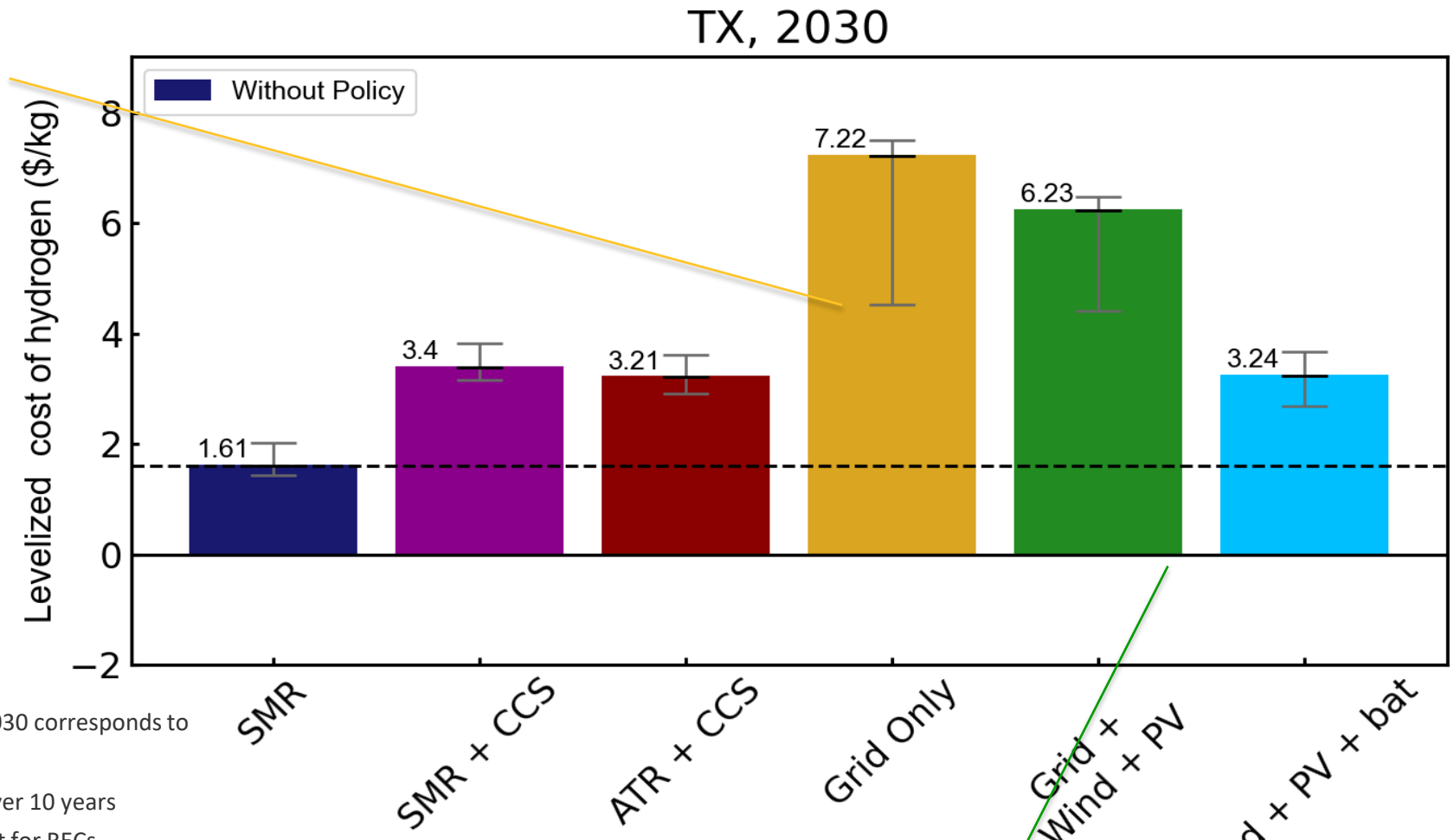
H2 Potential from Solar and Wind (MT/km2)
- 0 - 10
- 10 - 250
- 250 - 500
- 500 - 1,000
- 1,000 - 5,000
- 5,000 - 95,000

GreenHEART Capabilities

- Holistic treatment of purpose-built hybrid energy system microgrids, tightly-coupled w/ green H_2 production, to supply industrial end use needs.
- Utilizes hourly wind and solar resource data, for a full reference year of operation.
- Site-specific optimized mixes of equipment, including renewable energy mix, battery storage, electrolyzer capacity, and storage capabilities.
- Can compare and contrast with steam methane reforming (SMR), and utility grid driven approaches.
- Can quantify LCOH benefits of flexibility in industry end use versus steady state operation.
- Can account for applicable incentives and credits.
- Can do nationwide sweep to identify favorable locations.
- Incorporates latest costing and technology data for present/future consideration.
- Projected levelized cost of delivered hydrogen.
- Can include dynamic end-use profiles.

Example Analysis: Texas

Dependent on electricity price. This plot includes retail rates at 8.6 cents/kWh



Off-grid costs less than on-grid:

- Reduced electricity costs (retail vs. dedicated PPA results in decrease)
- Dynamic operation of H2 allowed (and accounted for in increased replacement costs)
- Low-cost hydrogen storage (salt caverns)

Notes:

- Technology year (TY) 2030 corresponds to operational year 2035
- H2/wind PTC applied over 10 years
- Model does not account for RECs
- **LCOE for TX 2030**
  - Off-grid: 1.3 cents/kWh with PTC
  - On-grid: 8.6 cents/kWh (retail rates), 4.1 cents/kWh (wholesale rates)

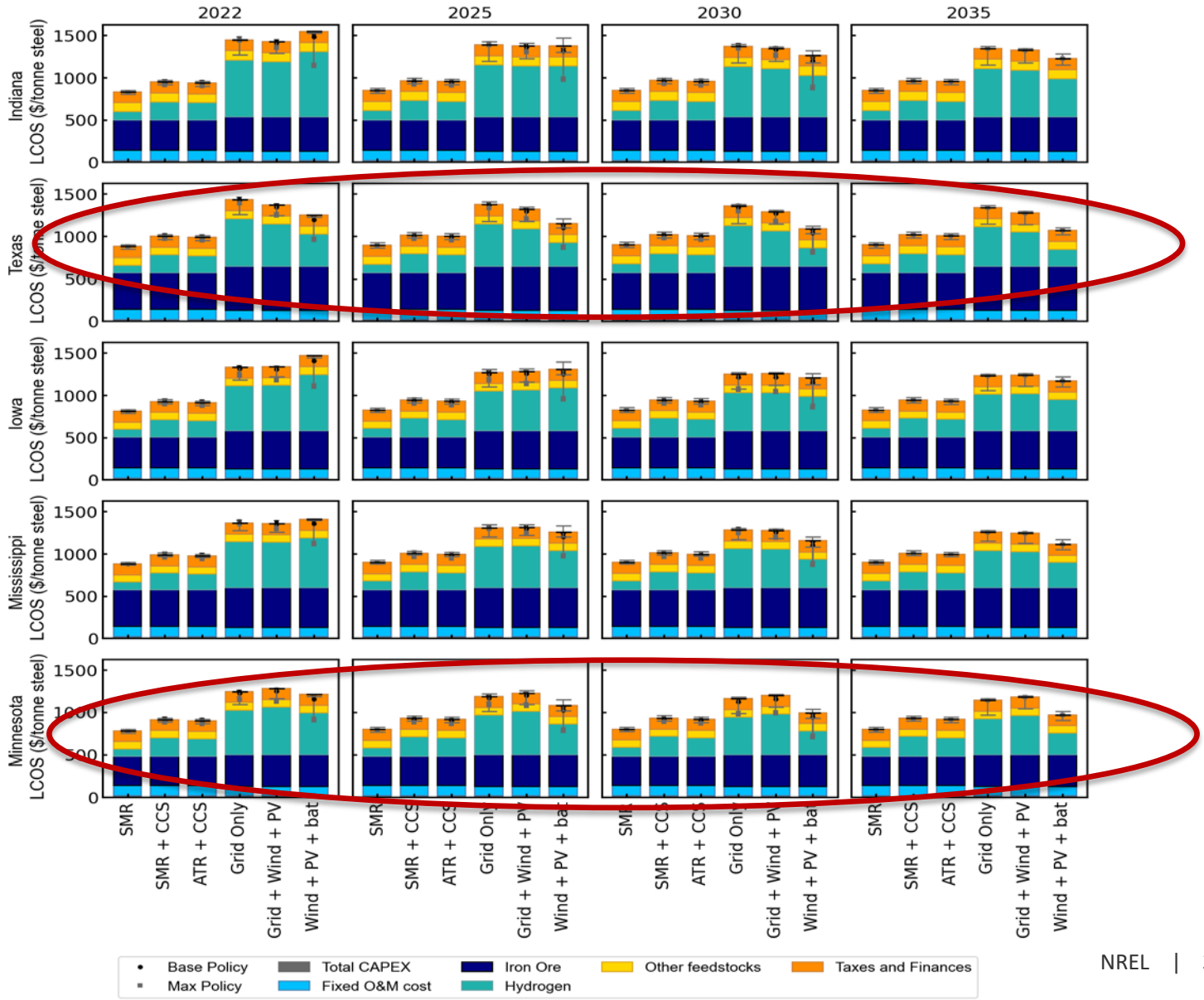
This analysis does not provide policy guidance. However, proposed 45V tax credits could provide benefit to LCOH.

Co-located renewables + electrolyzer backfilled with grid electricity

In addition to low-cost hydrogen, green steel production also benefits from proximity to existing infrastructure and feedstocks (iron ore)

- Iron ore is a significant contributor to levelized cost of steel
- MN, IN, and IA have lower iron ore cost than TX and MS due to lower transportation costs
- Off-grid wind+PV+bat in TX and MN competitive with SMR/ATR w/CCS with ***current costs & incentives*** or ***2035 costs without incentives***

Analysis also does not provide policy guidance, but represents policy using preliminary assumptions made prior to the release of proposed regulations for the 45V tax credit."



Topic 2 - R&D Ideas*

Green Steel Plant: Design and optimize a Midwest green steel facility using local wind and solar for hydrogen production.

- **Capabilities:** On-/off-grid modeling, hydrogen production, renewable siting
- **Impacts and Outputs:** Reduce CO_2 emissions, create a replicable green steel model, publish siting report, reference designs, LCOH and LCOS analysis

Green Hydrogen Production- U.S. Gulf of Mexico Region: Validate the cost and efficiency advantages of co-located, off-grid renewables and salt cavern storage for hydrogen-based industry end use.

- **Capabilities:** Co-locate industry end use with large-scale green H2 supply and real-time on-demand reliability
- **Impacts and Outputs:** Sustainable H2 production and storage to unlock new industry/employment potential, publish siting report, reference designs, LCOH delivered analysis

Multi-Use Industrial Park: Create a park using local renewables (wind, solar, hydro, etc.) for multi-use industrial applications (ammonia, fuels, steel, etc.).

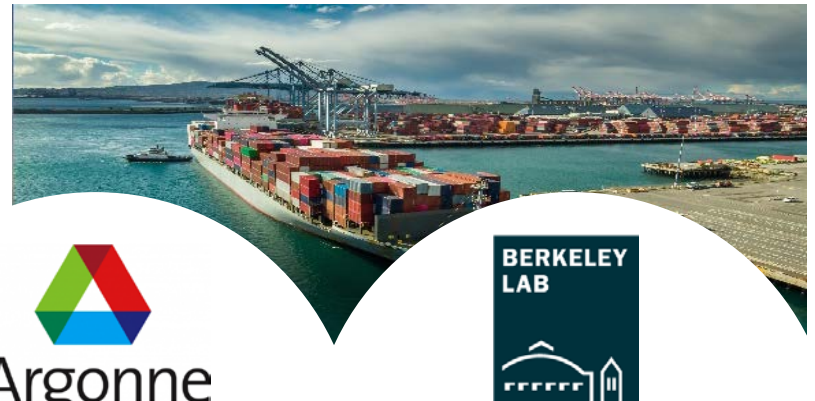
- **Capabilities:** Multi-resource integration, hybrid system design
- **Impacts and Outputs:** Cross-sector decarbonization, grid stability, hydrogen hubs, publish site-specific recommendations, reference designs, LCOH analysis

*Note: These examples are for illustrative purposes.

Acknowledgements







NREL Transforming ENERGY

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Additional information about GreenHEART can be found in the 2024 DOE HFTO project presentation at:
https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/review24/sdi001_king_2024_o.pdf?sfvrsn=a800ca84_3

Proton Exchange Membrane (PEM) & Alkaline Electrolyzer Validation

Description of Capabilities and Topic Objective

Leads: Kevin Harrison and Meital Shviro

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Topic 3: Validate PEM and Alkaline Electrolyzer with Dynamic Profiles

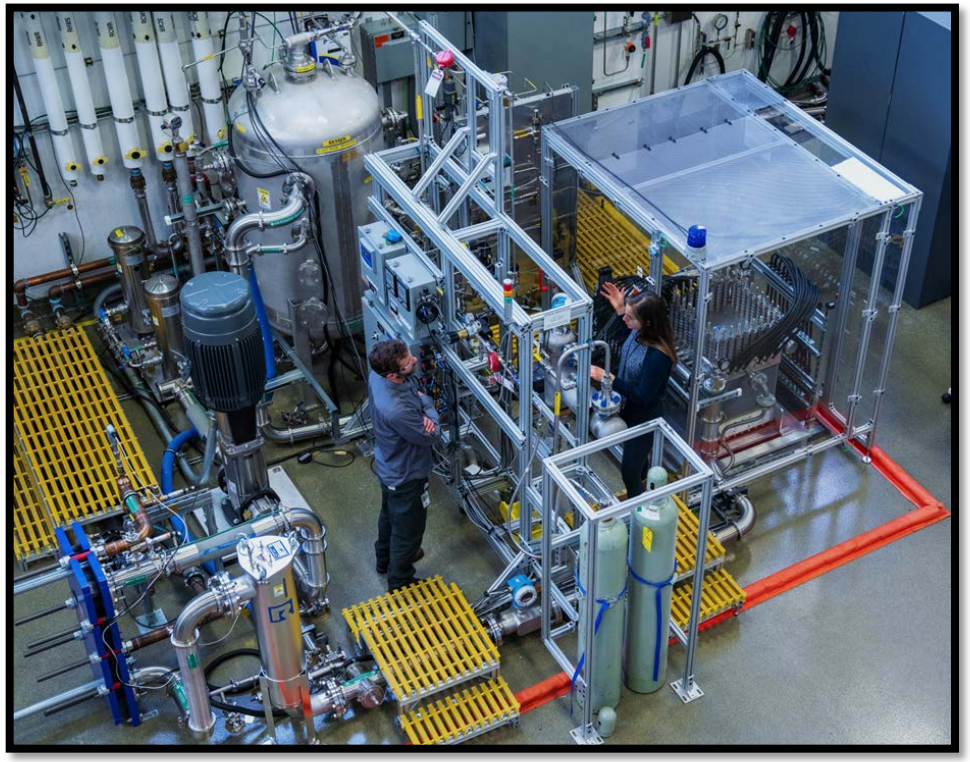
This topic will support R&D and provide **independent performance validation of PEM and alkaline electrolyzer stacks on advanced balance of plants at NREL.**

- Successful applicants will provide NREL their PEM or alkaline electrolyzer stacks to be operated on a variety of advanced balance of plants and power levels (25kW – 1MW)*.
- Applicants will work closely with NREL staff to specify temperature, KOH concentration, pressure, flows, current, and break-in, durability, and conditioning sequencing.
- Electrolyzer stack operational data will be monitored and provided to the applicant and to inform HFTO models and to validate electrolyzer performance and durability.

** Please note in your Letter of Interest the minimum kW power level for the alkaline electrolyzer and if it is pressurized or non pressurized. Considerations will be made for both stacks or systems as long as they are operational and ready.*

Electrolyzer Stack Capabilities

- **PEM – 1MW – NREL Designed Balance of Plants (BoP)**
  - User-defined slew rate (i.e., not limited to 200A/sec)
  - 132 channel cell voltage monitoring
  - Online and offline water quality monitoring & analysis
  - 250Vdc, 4000A
  - Split DI water anode feed to process and cooling (option)
- **PEM – 250kW**
  - DC Power: 300Vdc, 1500A
  - Offline water analysis
- **2x PEM – 25kW**
  - **System A:** 25Vdc, 1000A and **System B:** 50Vdc, 500A
  - 36 channel cell voltage monitoring
  - 3.5kW solar PV direct coupling capability
  - 12kWh of Lithium Iron Phosphate battery buffer
- **Alkaline – 50kW**
  - 200Vdc, 250A



NREL's 1MW Electrolyzer (PEM) System at the ESIF

250Vdc, 4000A

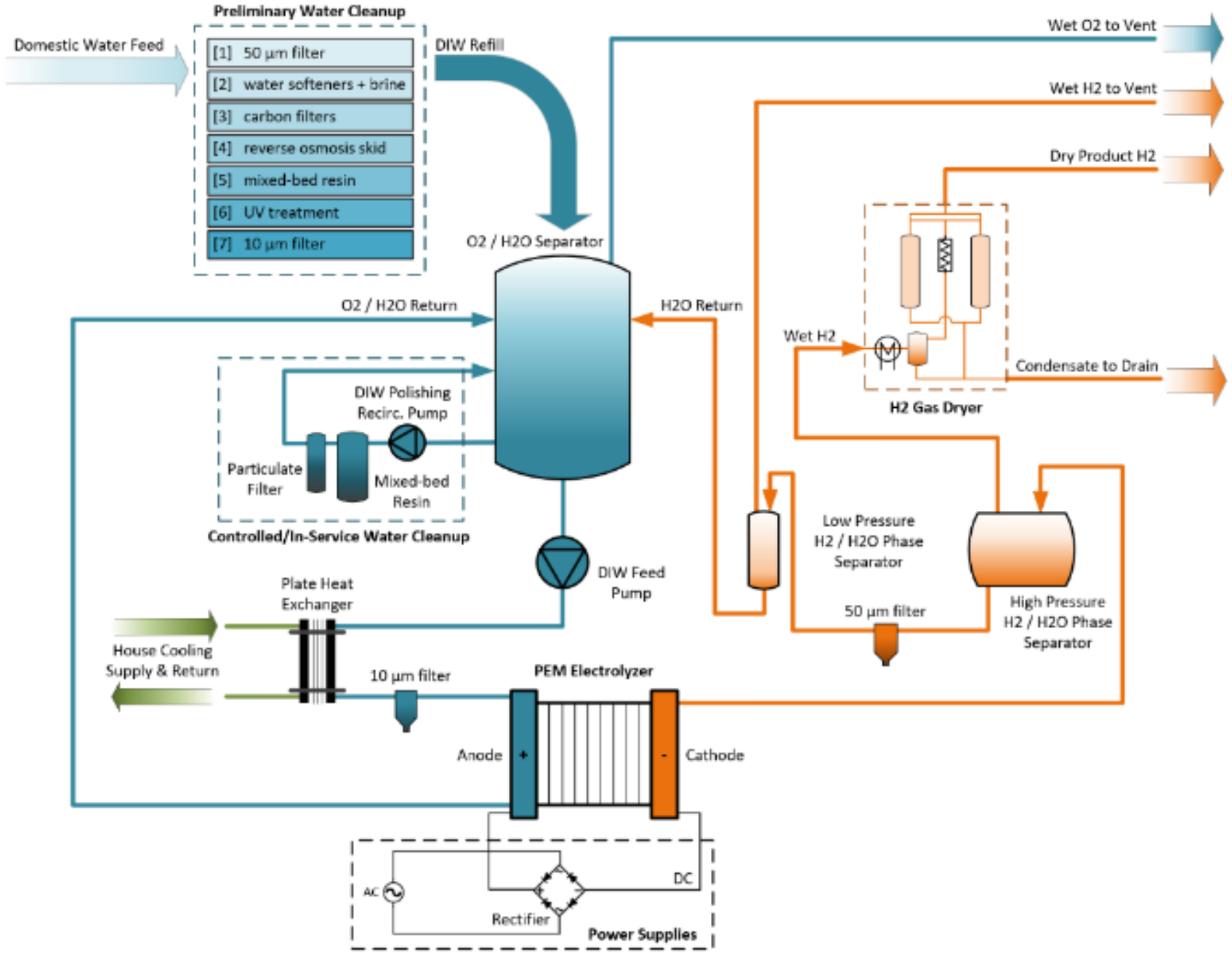
70°C, H_2 35 bar

Anode/Cooling Split Feed

Cell Voltage Monitoring

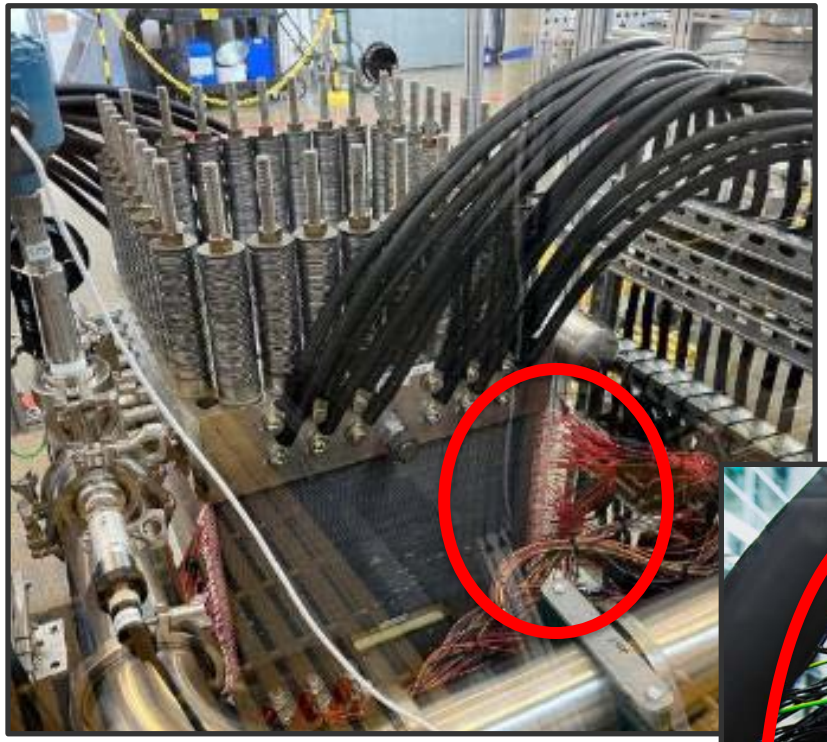
H_2-in-O_2 Monitoring

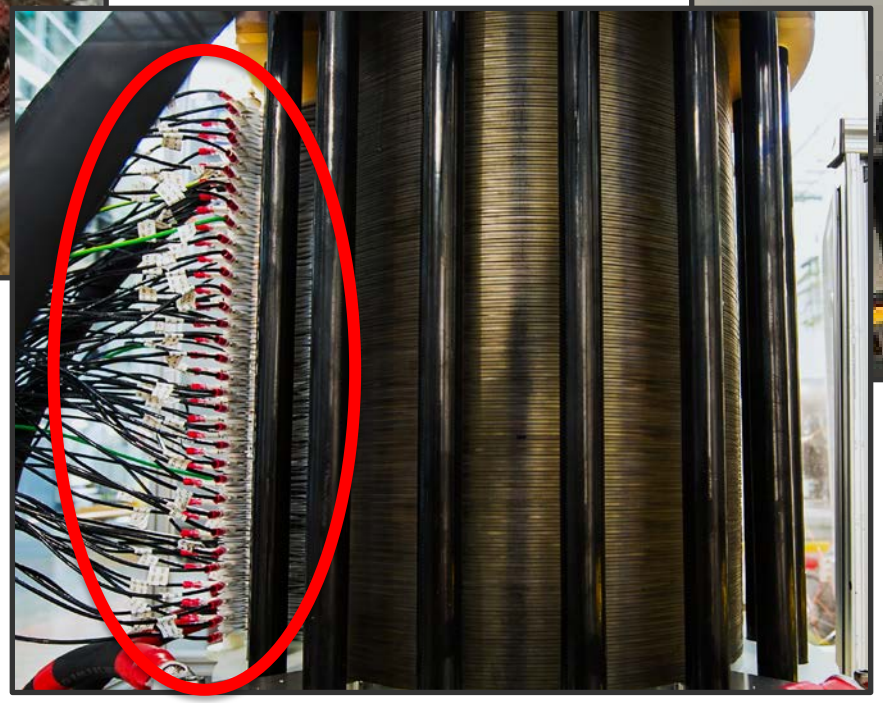
< 5ppm H_2O_v



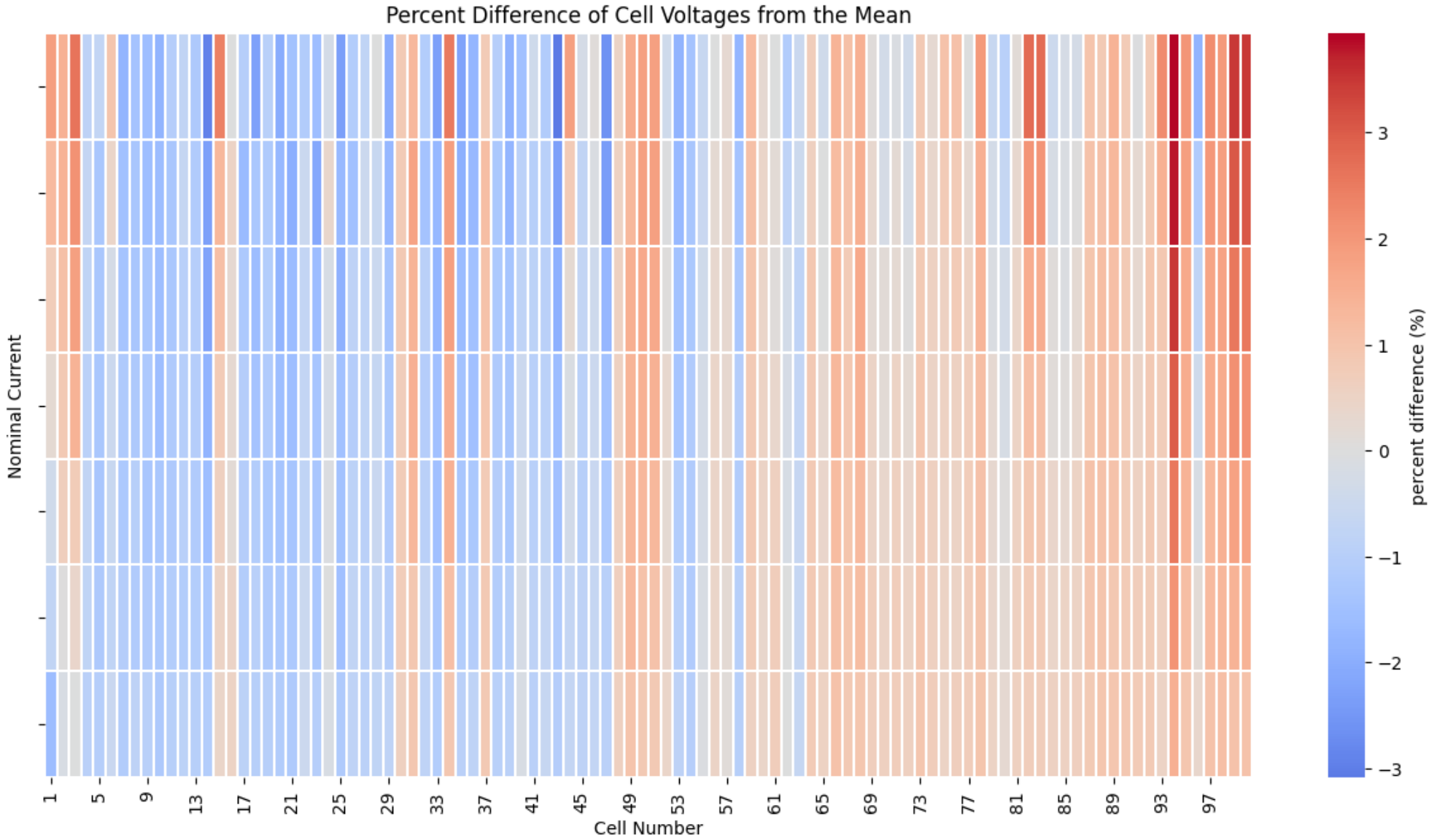
Individual Cell Voltages Monitoring
Up to 132-cell Stacks

ARIES by NREL



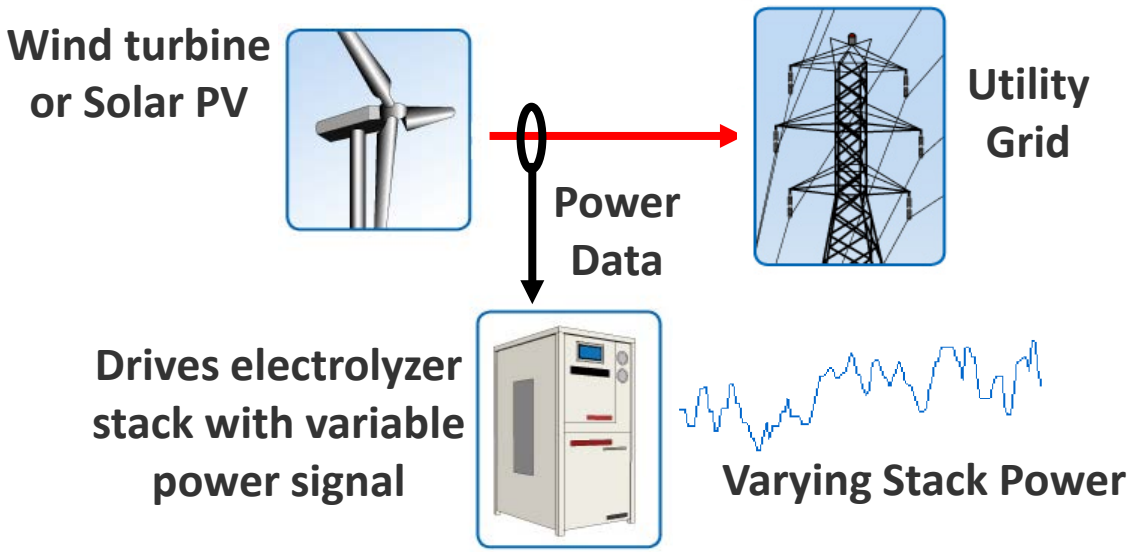


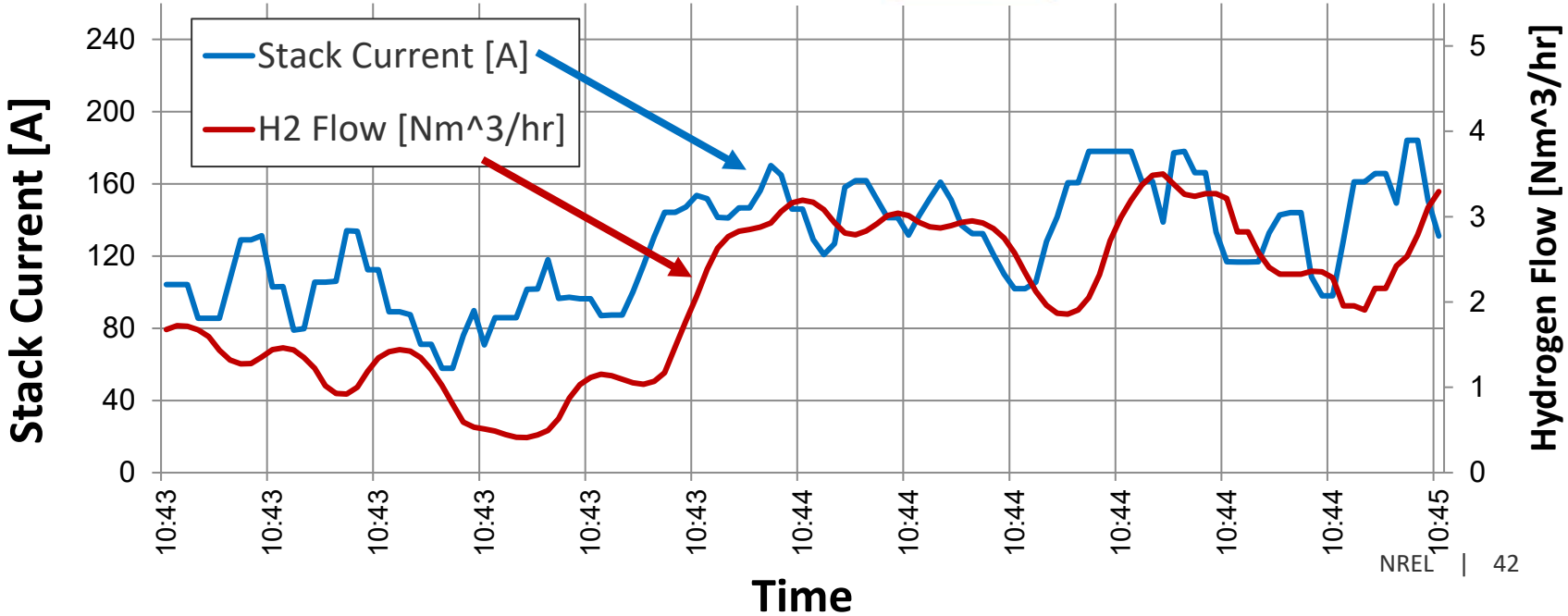
Individual Cell Voltages
Percent Difference from the Mean Voltage



“Classical” Wind or Solar to Hydrogen Configuration

- ESIF – Does not limit stack slew rate
- System controllers can limit slew rate
  - Manufacturer’s limit current steps to predetermined levels (e.g., 200A/sec)
- User defined break-in period, IV, water sampling, degradation, durability, and conditioning sequences
  - User defined cathode pressure, water quality, DIW flowrate, and IV curve polarization scans
  - User defined data sampling rate for temperature, pressure, current, and cell voltage.

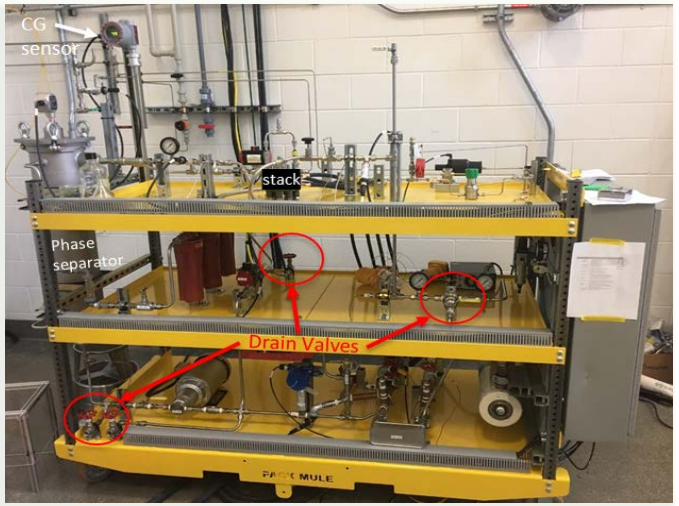




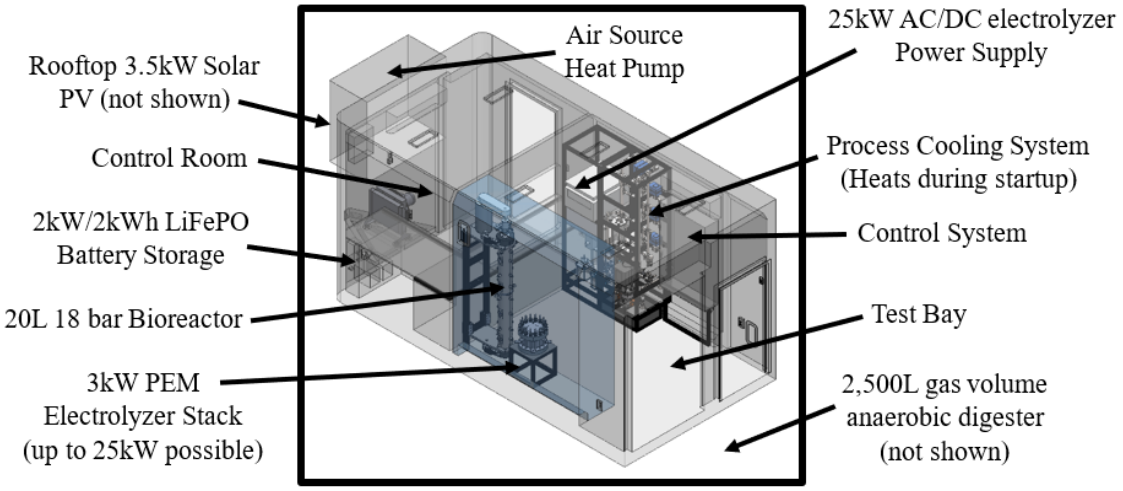
2x PEM 25kW NREL Designed Balance of plants

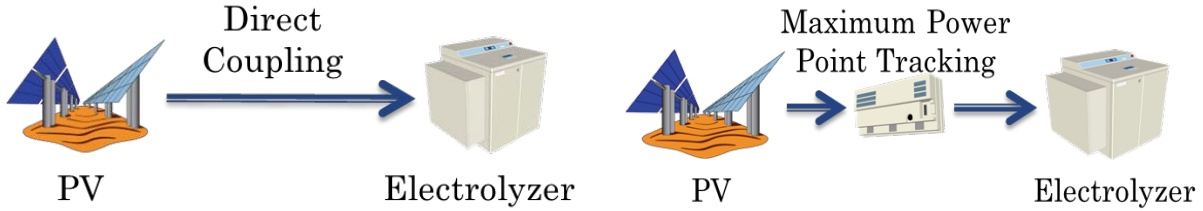
- **System A: 50Vdc, 500A (ACEES)**
  - Implement an active gas sampling mechanism to enable safe data collection at low current
  - Improved oxygen-water management system

Advanced Cell Electrolysis Evaluation System (ACEES)



- **System B: 25Vdc, 1000A AC/DC**
  - 3.5kW Solar PV direct or maximum power point tracking (MPPT) coupled
  - Offline water and polishing resin analysis





50kW Alkaline

- 50kW power supply (200Vdc, 250A)
  - Scalable to 200 slpm at 25 – 30 wt % KOH
  - 100 slpm up to 1 kg/hr H_2
- System operations intended for 24/7 unattended operation
- Balanced H_2/O_2 system operation up to pressure 10 Bar (147 PSIG)
- System configuration includes hydrogen generator system, mechanical components and plumbing necessary for sustaining the electrolysis process.
- Use of advanced diagnostics tools for in-depth analysis

Teledyne HMXT-100 (100 slpm) (up to 200 slpm with 2nd stack)

Topic 3 - R&D Ideas*

Stack Degradation Under Dynamic and Steady-State Power: Investigate the degradation behavior of electrolyzer stacks when subjected to dynamic/steady-state power profiles, simulating renewable energy sources like solar and wind.

- **Capabilities in both PEM and Alkaline:**
  - Electrochemical testing under variable load profiles, pressurized and non-pressurized
  - Durability testing, ramp up and down, on/off cycling protocols
  - *in-situ* diagnostics for real-time monitoring of temperature, pressure, current distribution, and gas crossovers to understand how different profiles affect stack and system behavior.
- **Impacts and Outputs:**
  - Development of better operating strategies for electrolyzers connected to renewable power grids.
  - Identification of failure mechanisms under dynamic conditions
  - Enabling the design of mitigation strategies that can significantly extend the operational lifetime of the stacks.
  - Publication of guidelines to optimize stack lifetime under dynamic loads
  - Improvements to the resilience and efficiency of electrolyzer systems, enabling more reliable hydrogen production from renewable sources
  - Reduction of maintenance and replacement costs
  - Innovation in electrolyzer design, materials, and operational protocols
  - Facilitation of improved integration with renewable energy grids, and support for the transition to a hydrogen-based energy economy

*Note: These examples are for illustrative purposes.

CRADA Opportunity Details

Additional Details

https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html

ARIES by NREL

Agenda

1. ARIES Introduction & Opportunity Overview
2. Topic 1 –Validate Hydrogen System Integration (Daniel Leighton)
3. Topic 2 – Hydrogen Systems for Industrial Applications (Jen King)
4. Topic 3 – PEM & LA Electrolyzer Validation (Kevin Harrison)
5. CRADA Opportunity Details
6. Q&A

FY25 Timeline for Interested Parties

ARIES by NREL

October 9 - November 1

- Submit Letters of Interest by **November 1, 2024**, via email attachment to: **ARIES@NREL.gov**
- Submission requirements, selection criteria, Letter of Interest template & CRADA template located at: https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html

November - December

- NREL will screen Letters of Interest
- Partners that that pass initial screening will be contacted by NREL Leads to develop scope, SOW, timeline, budget, etc.
- NREL panel will evaluate full proposals, rank & down select based on selection criteria

January – March

- Selected Partners notified
- Standard CRADA documentation execution required

Letter of Interest Screening

Letters of Interest screening will be done by NREL Topic Leads based on the following criteria:

- **Relevance**
  - Alignment with ARIES H2@Scale programmatic topics, goals, objectives and impacts
- **Timing**
  - Resources (e.g., equipment, data, staff, etc.) are available to start this fiscal year
  - Project's ability to deliver impactful progress and/or results in FY25
- **Feasibility**
  - Available resources (e.g., technical capabilities, space requirements, timeframe, etc.)
  - H2@Scale CRADA language is acceptable to partner, and a minimum of 30% cost share budget is available

Information & Template available at https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html

Evaluation Criteria

Complete Submissions will be evaluated and prioritized by the Review Panel based on the following criteria:

Technical (60%)

- Relevance of objectives, anticipated outcomes, impacts and alignment with the H2@Scale Topics and programmatic goals
- Overall technical merit and potential benefits achieved through the research opportunity
- Potential impact of collaboration on the technical challenge and on interested stakeholders through data sharing and publication
- Significance and impact of outcomes to marketplace and industry

Project Management/Execution (40%)

- Effective use of NREL and ARIES capabilities, resources, and expertise
- Project can meet the Period of Performance expectation for the Topic
- Partner cost-share portion and activities are clearly explained
- Outcomes are realistic considering asset utilization, timing, duration, configurations, and resources
- Commitment to publication and data sharing
- Extent the project encourages diversity, equity and inclusion
- Acceptance of existing H2@Scale CRADA template

Links to Important Information

- Department of Energy, Office Of Energy Efficiency & Renewable Energy, Hydrogen and Fuel Cell Technologies Office:
  https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office

- NREL ARIES H2@Scale CRADA call documentation, including CRADA Templates for review, Letter of Interest form, and updated FAQs: https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html

- NREL ARIES website: https://www.nrel.gov/aries/ and NREL Hydrogen & Fuel Cells website https://www.nrel.gov/hydrogen/

Please do not reach out to individual NREL or DOE staff with questions related to this Call

Submit all questions and Letters of Interest to: ARIES@NREL.gov

Thank You

ARIES by NREL

Eligibility

- 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 they meet the eligibility requirements in the Letter of Interest
- Selected Partners will enter into a CRADA with NREL based on the standard H2@Scale CRADA Template

How to Express Interest

Contact/Questions:

- Letters of Interest and questions related to the Call should be submitted by email to ARIES@NREL.gov. Please note *"ARIES H2@SCALE"* in the subject heading.
- Refer to https://www.nrel.gov/hydrogen/h2-at-scale-crada-call.html for the full set of documentation & instructions including:
  - Letter of Interest Template (Limited to 2 pages, 11 pt. font, single spaced)
  - Q&A submissions and responses
  - CRADA Call Overview including process, eligibility, requirements, goals, evaluation criteria, etc.
  - Applicable H2@Scale CRADA templates
  - This presentation, and a link to the recording of the H2IQ Webinar

Submission, Receipt and Notifications:

- Letters of Interest should be submitted by email attachment by **5 p.m. MST on November 1, 2024,** to be considered for the FY25 CRADA Call. Expect confirmation of receipt within 2 days.
- Once selections are announced, successful parties will receive an email from NREL indicating immediate next steps related to the execution of the H2@Scale CRADA documents and Joint Work Statement development.

Acronyms

ARIES	Advanced Research on Integrated Energy Systems
CGI	Controllable Grid Interface
CRADA	Cooperative Research and Development Agreement
DOE	Department of Energy
EERE	Energy Efficiency and Renewable Energy
ESIF	Energy Systems Integration Facitlity, NREL Table Mountain Campus, Golden, CO
FLATIRONS	NREL Campus for Mw scale research, Arvada, CO
GW	Giga Watt
H2	Hydrogen
HFTO	Hydrogen and Fuel Cell Technologies Office
HIL	Hardware in the Loop
HPC	High Power Computer
LA	Liquid Alkaline
LCOH	Levelized Cost of Hydrogen
LCOS	Levelized Cost of Steel
LI-ION	Lithium Ion
MPPT	Maximum Power Point Tracking
MVA	Mega Volt-Amperes relative to transformer size
MW	Mega Watt
NREL	National Renewable Energy Lab
PV	Photo Voltaic
PEM	Proton Exchange Membrane
RD&D	Research Development and Deployment
RTDS	Real Time Digital Simulation
SOW	Statement of Work

THANK YOU FOR ATTENDING TODAY'S WEBINAR

This project was supported by the Hydrogen and Fuel Cell Technologies Office

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ARIES: Advanced Research on Integrated Energy Systems
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NREL Facilities & Infrastructure Funding: $4.3M

Additional Federal Funding of $22.1M for 10MW Testing Facility

DOE Technology Manager – Brian Hunter

Principal Investigator – Daniel Leighton

Click for Annual Merit Review

For questions about this webinar, please contact us at HFTOInquiries@ee.doe.gov.