# Megawatt-Scale Low Temperature Electrolyzer Research Expansion

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## OVERVIEW

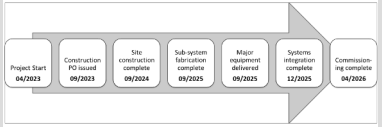
- Support industry partners participating in the $1B DOE Clean Hydrogen Electrolysis Program
- Expand ARIES capability at NREL's Flatirons Campus to flexibly operate multi-MW scale low-temperature electrolyzers
  - **PEM stacks from 0.5-6 MW scale, liquid alkaline stacks from 0.5-2 MW scale**
    - **Liquid alkaline stacks with "core" balance of plant provided at 0.5-6 MW scale**
  - Flexible for simultaneous operation of stacks to 6 MW aggregate
  - **PEM or liquid alkaline full system integration up to 10 MW**
  - Grid integration with ARIES assets including renewables
  - **Commissioning 3 years from start**

## POTENTIAL IMPACT

- Development and installation of a flexible low-temperature electrolyzer research capability at the multi-MW scale with integrated renewables de-risks field deployments on the 10+ MW scale
- This NREL capability:
  - Helps lower the cost barrier to entry for electrolyzer manufacturers needing system and stack evaluation
  - Enables more electrolyzer manufacturers to accelerate to commercialization with building block scale demonstration and validation
  - DOE HFTO investment to support the $1B DOE Clean Hydrogen Electrolysis Program working to achieve the Hydrogen Shot goal of $1 for 1 kg hydrogen in 1 decade, lower greenhouse gas emissions and criteria pollutants, build clean energy infrastructure, and provide pathways to private sector uptake

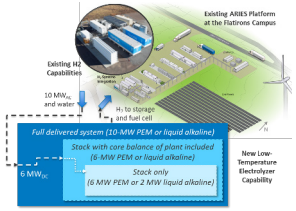
## SUMMARY

- New project to develop a flexible multi-MW low-temperature electrolysis experimental platform on the 0.5 – 10 MW scale
- Flexibly designed balance of plant and balance of system to meet most PEM and liquid alkaline stack designs
- Connection to current and future hydrogen infrastructure at NREL's Flatirons Campus, as well as the renewable production assets (research grids)
- This capability will fill a critical industry need for multi-MW scale electrolyzer stack and system performance validation, including renewables coupling



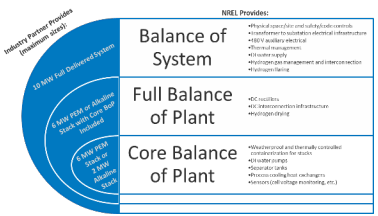

## APPROACH

### Integration with Existing ARIES Platform



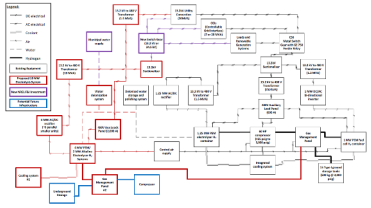

**This new low-temperature electrolyzer capability will be integrated with exiting hydrogen, electrical, and renewable production assets at NREL's Flatirons Campus**

### System Sizing Boundaries



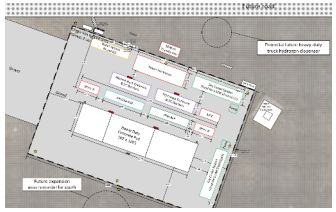

**This NREL capability will have all the balance of system or plant needed to support the equipment delivered by the stack manufactures for evaluation. The delivered equipment could range from a single stack to a full system.**

### One-Line Drawing



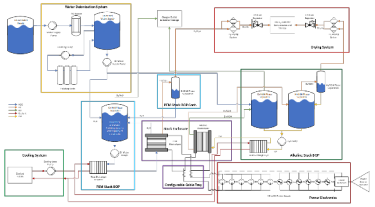
**The one-line drawing highlights the new hardware components which are needed for the planned multi-MW electrolyzer research capability and how the new hardware is planned to integrate into the exiting hydrogen system at NREL's Flatirons Campus.**

### Preliminary Layout Visualization



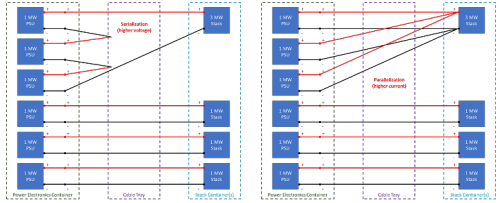
**This preliminary layout diagram shows the critical building blocks of the planned multi-MW electrolyzer research capability. The upcoming detailed design phase will further refine container access, system connection points, stack in/out flexibility, and optimize the design.**

### Process Flow Diagram



**This high-level process flow diagram outlines the subsystem needed in both a PEM and liquid alkaline electrolysis system.**

### DC Electrical Architecture




**Configurable cable tray design for independent, serialization, or parallelization of PSU "Building Blocks" to meet current and voltage needs of multiple multi-MW stacks. Actual configuration depends on stack technical specifications and PSU capabilities.**

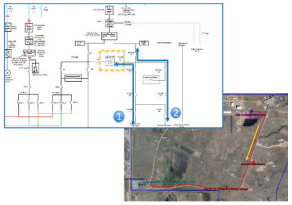
## ACCOMPLISHMENTS AND PROGRESS

- **This is a newly awarded project that has been in progress less than six months**
- **The focus of work so far has been scoping, design, budgeting, and identification of long lead components ("approach" section)**
- **Highlighted to the right is progress made on infrastructure upgrades needed to enable this research capability**

### Permanent Site Construction Contracting Underway

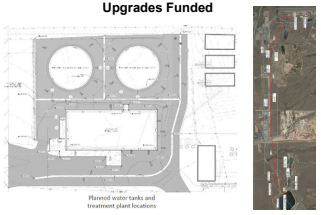
**Plans are moving forward to build a new pad that has the space and auxiliary requirements to support MW-scale electrolysis research. See presentation TA048_Leighton for more details on current site design**

### Campus Electrical Infrastructure Upgrades Funded



**Separate infrastructure investment will upgrade upstream electrical gear and conduit for 10 MW (everything but hydrogen system transformer and wiring)**

### Campus Water Supply Infrastructure Upgrades Funded




**Separate infrastructure investment will develop water main from reservoir, treatment facility, storage system, and supply lines to equipment (including hydrogen site)**

## FUTURE WORK

- Initiate detailed design phase
  - Identify, specify, and order long lead time items
  - Determine the optimal deployment configuration and subsystem sizing
  - Identify system capability boundaries and collaborate with industry to align with industry needs
- Develop timeline for purchase, installation, and commissioning of critical items to achieve successful deployment
- Work with NREL's site operations team to coordinate construction
- Begin assembly of custom balance of plant and balance of system for PEM and liquid alkaline electrolyzers

## CHALLENGES AND BARRIERS

- Timeline (supply chain issues, equipment availability, etc.)
  - Site construction is moving forward now
  - Planning to build containerized sub-systems in parallel with site construction and lift into place and integrate after construction completion
  - Order major, long-lead equipment as quickly as possible to progress critical path
  - Campus construction projects for upstream electrical infrastructure upgrades and water supply system are funded and are nearing completion of design phases
- Emerging stack technologies (different current/voltage combinations, footprints, etc.)
  - Flexible DC electrical infrastructure design using ~1 MW "building blocks" to maximize voltage/current combinations
  - Flexible balance of plant design to support different size stacks and system specifications
  - Design for stack footprints and weights larger than current state-of-the-art

## COLLABORATION AND COORDINATION

- This work is directly funded by HFTO with separate infrastructure investments for campus improvements (water treatment, upstream electrical, etc.)
- The project will be integrated into the ARIES platform at NREL's Flatirons Campus
- Gathering inputs from numerous PEM and Alkaline manufacturers for technical specifications (voltage, current, etc.) to maximize flexibility to accept a range of manufacturer's electrolyzers, both current and future
  - Additional inputs welcome!

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