

Delivering the Nuclear Promise Top Innovative Practice



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Demonstration of Clean Hydrogen Production at Nine Mile Point 2023 Top Innovative Practice Winner¹

Summary

With the goal of zero carbon emissions becoming increasingly vital to the United States and the world, nuclear energy has distinguished itself as a clear path forward. The benefits of nuclear energy are vast, and not limited to electricity production, as demonstrated by Constellation’s innovative research with clean hydrogen production at Nine Mile Point (NMP). Illuminating the possibilities of a Nuclear-Hydrogen partnership, Constellation has installed a Proton Exchange Membrane (PEM) electrolyzer² for in-house hydrogen supply and consumption, opening the door to larger scale electrolyzer development and installation to be used in power markets. This innovation represents a game-changing step forward in linking multiple energy sectors towards the shared goal of decarbonization, with nuclear at the forefront.

Innovation

In-house production of clean hydrogen using a PEM electrolyzer is an innovative project and the first of its kind at a US nuclear plant. The project received \$5.8M in US Department of Energy funding³ for the purpose of performing a pilot project to demonstrate hydrogen production, storage, and distribution through its H2@Scale program.⁴ This innovative project also illustrates the importance of clean hydrogen produced by carbon-free nuclear power – to create jobs, grow the economy and take on the climate crisis with the urgency required. The next stage of innovative hydrogen technology development at NMP is to demonstrate a clean hydrogen fuel cell for long-duration energy storage for the grid.

Background

Globally, nations are in search of solutions to drive down carbon emissions. Already, nuclear energy comprises almost 50 percent of the carbon-free energy in the United States and is viewed as a key part of any viable climate solution. A Nuclear-Hydrogen partnership is a natural fit to further reduce carbon emissions, protecting our climate while fueling the future transportation and industrial sectors and revolutionizing other industries through applications such as fuel cell vehicles, metals refining, and synthetic

¹ Winning entries of from NEI’s Top Innovative Practices (TIP) awards are republished as DNP Efficiency Opportunities to ensure the broadest possible dissemination of these operating plant innovations.

² Described at <https://nelhydrogen.com/product/m-series-containerized/>

³ Per Constellation press release, March 7, 2023, at <https://www.constellationenergy.com/newsroom/2023/Constellation-Starts-Production-at-Nations-First-One-Megawatt-Demonstration-Scale-Nuclear-Powered-Clean-Hydrogen-Facility.html>.

⁴ Information available at <https://www.energy.gov/eere/fuelcells/h2scale>.

fuels. Using all available carbon-free sources, including nuclear, for hydrogen production will be game-changing.

At NMP, Constellation is demonstrating electrolyzer operation at a nuclear power plant to allow for dynamic participation in an organized electricity market and in-house hydrogen supply. This is a first-of-its-kind project in the United States. A 1 MW PEM electrolyzer and supporting infrastructure have been installed at NMP. The electrolyzer will provide an economic supply of in-house hydrogen for plant needs and simulate a scale-up operation of a larger electrolyzer for participation in power markets. The project demonstrates a nuclear hydrogen pathway described in the DOE vision for H2@Scale. The H2@Scale initiative brings together stakeholders to advance affordable hydrogen production, transport, storage, and utilization to enable decarbonization and revenue opportunities across multiple sectors.

Safety

Constellation evaluated the hydrogen electrolyzer demonstration project for its potential impact on plant safety and the plant licensing basis. The company concluded that this plant modification could be completed under the terms of 10 CFR 50.59⁵, meaning it did not present a new or different hazard or a substantial increase in an existing hazard. The installation does not in and of itself improve plant safety. However, the hydrogen that it produces for in-house use will replace offsite sources of hydrogen that in generation and transportation contribute to global carbon emissions.⁶ By averting the need for such carbon emissions to meet the plant's hydrogen needs, this project benefits public health and safety in the long term.

The plant uses hydrogen primarily for cooling of the main electric generator and for injection into the reactor coolant system to protect against intergranular stress corrosion cracking (IGSCC) of austenitic stainless-steel piping.

Cost Savings

The installed system will save approximately \$1 million per year on hydrogen deliveries by outside suppliers. The current supply of hydrogen is derived from natural gas and is trucked into the plant in storage tube trailers. The main uses of the hydrogen at NMP are for the Hydrogen Water Chemistry (HWC) system and generator cooling.

Productivity/Efficiency

Implementation of clean hydrogen production in-house improves productivity and efficiency. NMP will no longer have to rely on outside sources to fill its hydrogen needs. The learnings from installation and operation of this demonstration project (see Figure 1) will improve productivity and efficiency for future projects and larger scale launches of hydrogen production from clean nuclear energy. (Additional graphics are provided in Figures 2 and 3.) An inherent advantage over technologies that produce intermittent electricity (like wind and photovoltaic solar) is nuclear's baseload capacity to produce electricity and heat. This gives nuclear the advantage of high reliability and availability to support all hydrogen production technology options.

Transferability

This innovation is transferable to other nuclear stations for implementation of on-site hydrogen production on a small or large scale based on this demonstration project. Today's hydrogen market already exceeds \$100 billion and is expected to grow significantly. This market represents an opportunity for current and new nuclear plants alike.

⁵ Code of Federal Regulations, Title 10, Part 50.59, Changes, Tests and Experiments.

⁶ The Department of Energy notes that more than 95 percent of hydrogen is currently generated using carbon-intensive steam methane reforming of natural gas. Per <https://www.energy.gov/eere/fuelcells/hydrogen-resources>.

Team Members

- Ugi Otgonbataar, Director of Corporate Strategy
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- Rebecca Schneider, Lead Responsible Engineer
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- Jonathon Shaver, Lead Electrical Engineer

References

- EPRI, Considerations for Producing Hydrogen with an Existing Nuclear Power Plant, 3002025730, November 2022
- EPRI, Conceptual Design Guide for Developing a Nuclear-Integrated Hydrogen Facility, 3002026514, September 2023

Additional Information

Figure 1: Installation-Rigging Electrolyzer into Place



Graphic 1 - Installation - Rigging Electrolyzer into Place

Figure 2: Alice Caponiti, Deputy Assistant Secretary for Reactor Fleet and Advanced Deployment at the US DOE, speaking at Nine Mile Point's "Hydrogen is Happening Here" Celebration



Graphic 2 - Alice Caponiti, Deputy Assistant Secretary for Reactor Fleet and Advanced Deployment at the US DOE, speaking at Nine Mile Point's "Hydrogen is Happening Here" Celebration

Figure 3: Constellation CEO Joe Dominguez joins Federal, State and Local Officials to celebrate the "Hydrogen is Happening Here" event at Nine Mile Point Nuclear Station video.

[Event Highlights Video](#)



<https://twitter.com/CEGCleanEnergy/status/1575840514590515200>

Graphic 3 - Constellation CEO Joe Dominguez joins Federal, State and Local Officials to celebrate the "Hydrogen is Happening Here" event at Nine Mile Point Nuclear Station video.
