# LWR Integrated Energy Systems Interface Technology Development and Demonstration

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This presentation does not contain any proprietary, confidential or otherwise restricted information

# Project Goal

Carry out planning, design, testing, demonstration, and evaluation of a scalable hydrogen generation pilot plant connected to a light-water reactor (LWR) power plant.

- Provide alternative revenue streams to nuclear power plants to mitigate the impact of low electricity prices
- Improve the availability of hydrogen generated by carbon-free nuclear power
- Create an infrastructure that can support long-term scalability of hydrogen generation

# Overview

## Timeline

- Awarded: September 2021
- Project Estimated End Date: December 2024

## Budget

- Total Project Budget: $14,702,588
- Total DOE Share: $11,384,229
- Total Recipient Share: $3,318,359
- Total DOE Funds Spent*$9,032,891
- Total Recipient Funds Spent*$3,118,027

* As of 03-31-2024 as it relates to track 2

## Barriers

- Risk elimination/mitigation
- Refueling outage constraints
- Hydrogen project proficiency
- Hydrogen skid fabrication

## Partners

- Idaho National Laboratory (INL)
- Xcel Energy Inc. (XE)
- Arizona Public Service Co. (APS)

# Overview

## Track 1

Perform a Technical Economic Assessment for Arizona Public Service Company (APS) and Xcel Energy Inc.

## Track 2

Establish plant infrastructure to install an electrolysis skid to demonstrate the technical and economic feasibility of operating a Hydrogen generation plant in-situ with a nuclear power facility.

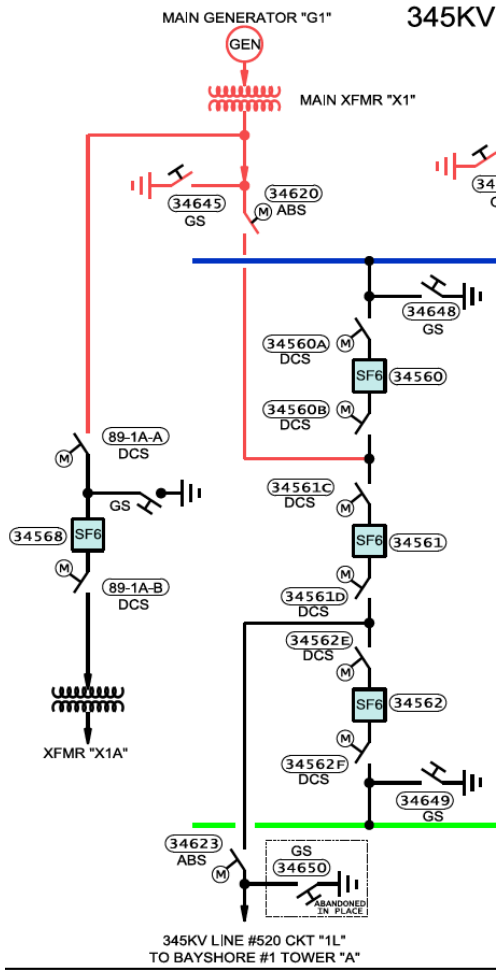
## Location

Davis-Besse Nuclear Power Plant located in Oak Harbor, OH which is approximately 25 miles east of Toledo, OH


This presentation will focus on Track 2

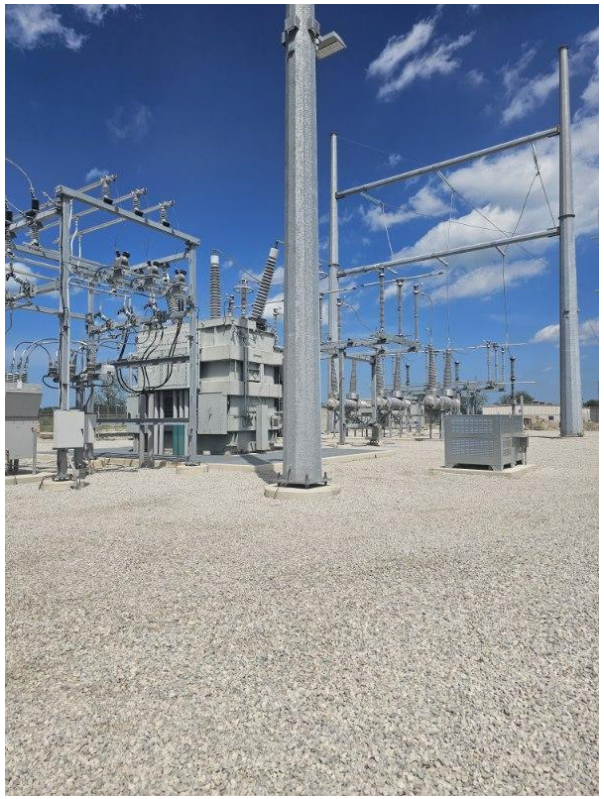
# Electrical Infrastructure

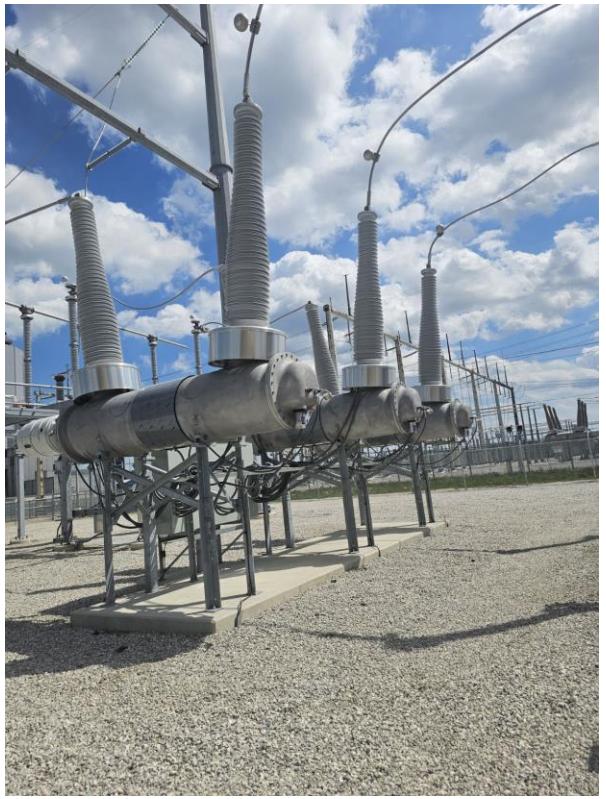
- Electrical tie-in was added between the main transformer and generator output breakers
- New differential relaying needed to be added to protect the assets
- Connection required load study by the utility



# Electrical Infrastructure

Installation/testing of electrical modifications is complete.





# Hydrogen Infrastructure

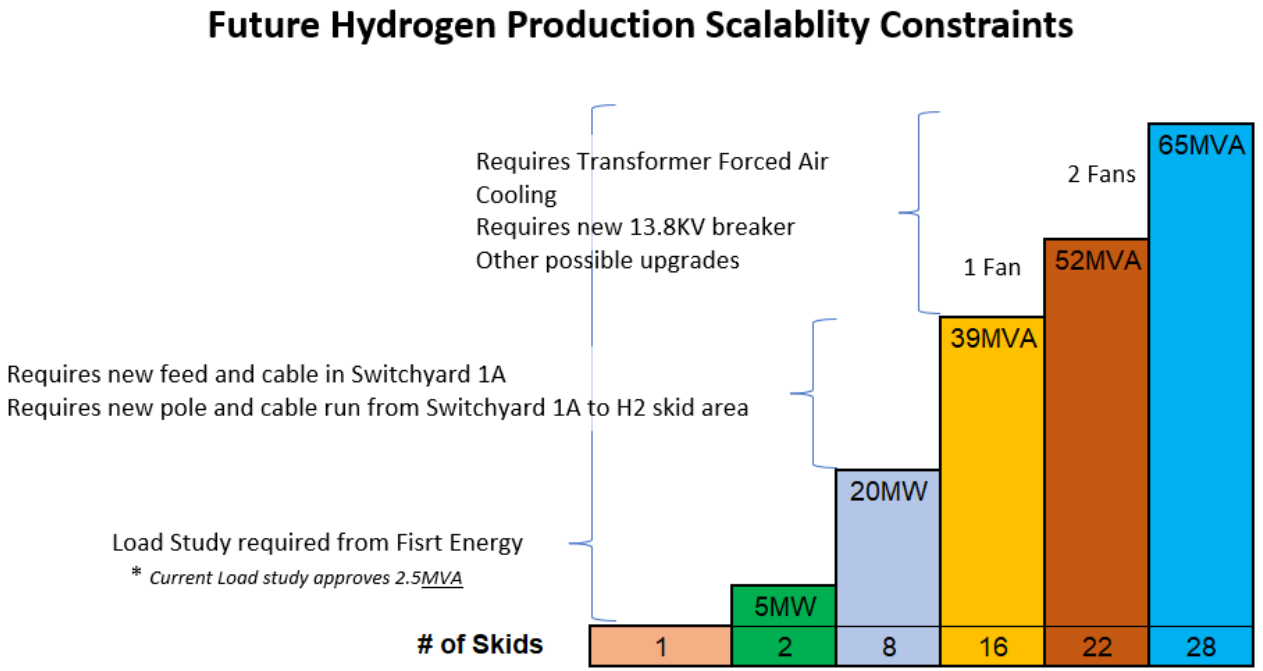
Hydrogen Infrastructure is in progress.

Location considerations:

- Hazard creation
- Proximity to the electrical source
- Proximity to a water source
- Traffic flow
- Scalability

# Scalability

Electrical Infrastructure and skid location allows the station to scale up.



# Risk Impact

Installation of a new electrical infrastructure that connects directly to the nuclear power plant presents risks. The following risks were addressed:

- Generation Risk – New protective relaying needed to be tied into a cabinet in the control room. Existing circuitry in the cabinet could have caused a plant trip if an error was made
- Personnel Safety Risk – Installation of new poles and cable requires proper standoff distances from high voltage lines
- Nuclear Safety Risk – System outages for electrical modifications have to be coordinated to achieve shutdown defense in depth
- Cyber Security Risk – New equipment must be adequately assessed and hardened to preclude cyber threats

# Refueling Outage

Some of the risks were eliminated by conducting installation during a refueling outage. This presented other challenges:

- Coordination – Alignments required for testing may not be compatible with the shutdown defense in depth philosophy.
- Resources – The amount of work during an outage can cause a competing demand for work location and personnel to perform the work.
- Duration – Refueling outages are set to a specific duration to meet business goals. Project activities need to fit within discrete windows to perform the work.

# Hydrogen Project Proficiency

- Our organization is proficient at running nuclear power plants and installing modifications that improve the nuclear power plant.

- Our lack of proficiency in designing and installing hydrogen generation requires us to get assistance from outside experts for the design and installation.

- We do not plan to operate the hydrogen generation equipment ourselves.
  - Testing – equipment manufacturer
  - If demonstration is successful and economics are favorable, we would seek potential relationships with leading gas suppliers.

# Hydrogen Skid Fabrication

- Failure of the equipment supplier to meet contractual commitments has led to delays in the Hydrogen Infrastructure
- Currently working with a different supplier that will minimize further delays
- Being open to electrolysis technologies (HTE vs LTE) creates more possibilities for resolution

# Positive Public Impact

Stakeholders that have visited our site to learn about the project have walked away with a positive perception of nuclear power and hydrogen generation.

- Local / State / Federal political figures
- Community organizations
- High school and college students
- Nuclear Regulatory officials
- Community day participants

# Accomplishments and Progress

- Design of new Switchyard – completed April 2022
- Design of plant interface – completed February 2023
- Design of Hydrogen skid installation – in progress
- Construction of new Switchyard – completed March 2024
- Installation of plant interface – completed March 2024
- Hydrogen production demonstration – TBD (expected December of 2024)

# Safety

- Safe operation at a nuclear power plant takes precedence over all other considerations including time, economic, and competitive pressures.

- Activities at a nuclear power plant must consider:
  - Nuclear Safety
  - Radiological Safety
  - Personnel Safety
  - Environmental Safety

# Summary

- Electrical infrastructure has been successfully installed and tested
- Hydrogen skid infrastructure is in progress
- Design and equipment selection allows scalability
- Results and lessons learned will be shared with others pursuing hydrogen generation capabilities

# Technical Backup and Additional Information

# Technology Transfer

**Track 1**

- Location specific Technical and Economic Assessments have been created by Xcel Energy Inc. and Arizona Power Service Co.

**Track 2**

- An economic analysis of the viability of hybrid operations at a LWR facility will be completed. This analysis will incorporate costing data from the design, installation, maintenance, and operation of the skid.
- This report will ultimately be used by other utilities that operate nuclear power facilities for large-scale commercialization.