LWR Integrated Energy Systems Interface Technology Development & Demonstration

Flexible Plant Operation and Generation (FPOG)

Pathway Stakeholder Engagement Meeting

Principle Investigator: Dylan Sylvester
Project Manager: Brian Greenhoe

March 18, 2025

Core Research Objectives

Demonstration of safe nuclear plant thermal energy extraction for non-electric energy application

- Collect data and monitor performance
- Assess interactions with the nuclear plant and electricity distribution systems
- Understand operation in different seasonal climate conditions present during the time of testing

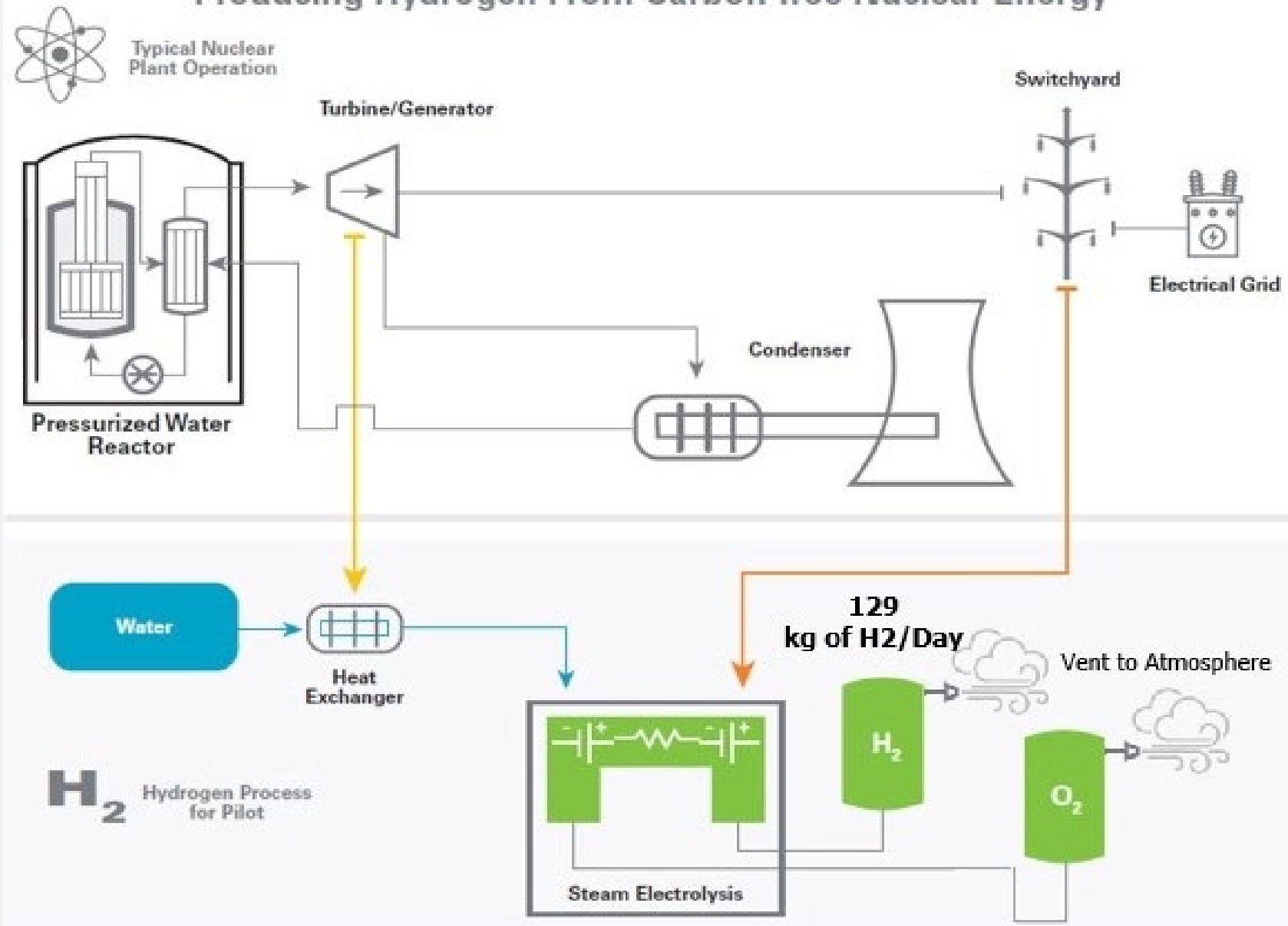
Demonstration of carbon-free hydrogen production by nuclear energy and HTSE

- Utilize High-Temperature Steam Electrolysis cells (HTSEs) and plant steam to generate hydrogen

Enable supply chain of U.S. based manufacturing and technology for non-electric applications

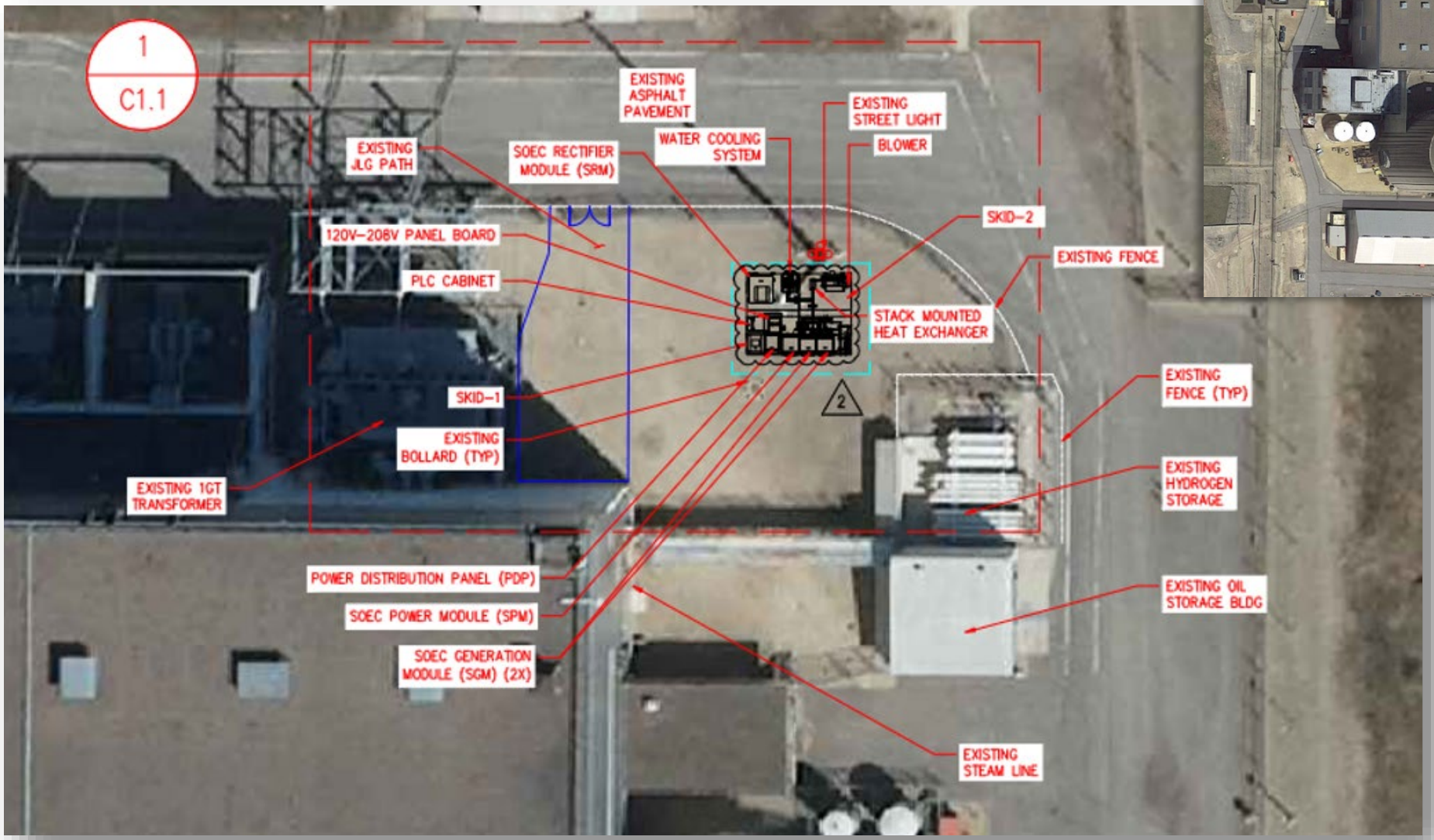
Parts and materials procured from U.S. domestic suppliers

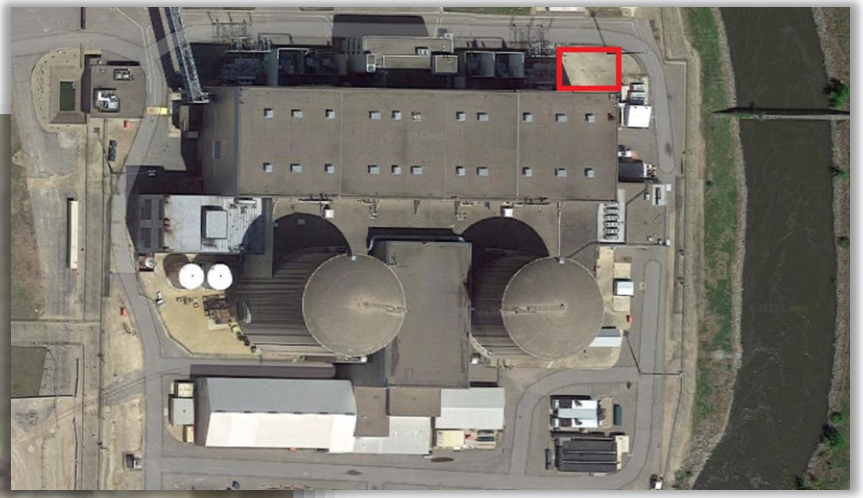
Producing Hydrogen From Carbon-free Nuclear Energy



Installation Location:

Prairie Island Nuclear Generating Plant (PINGP)





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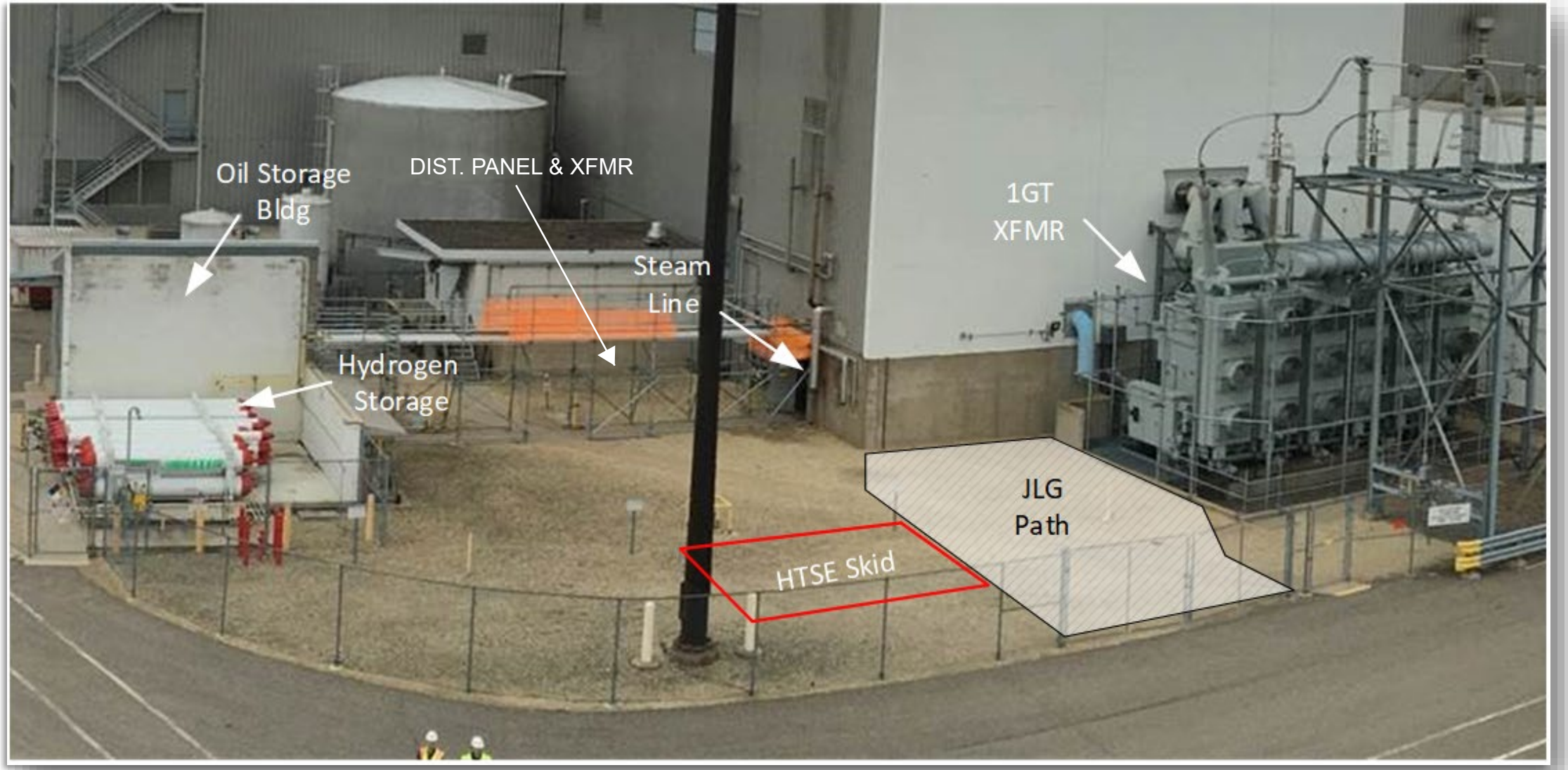
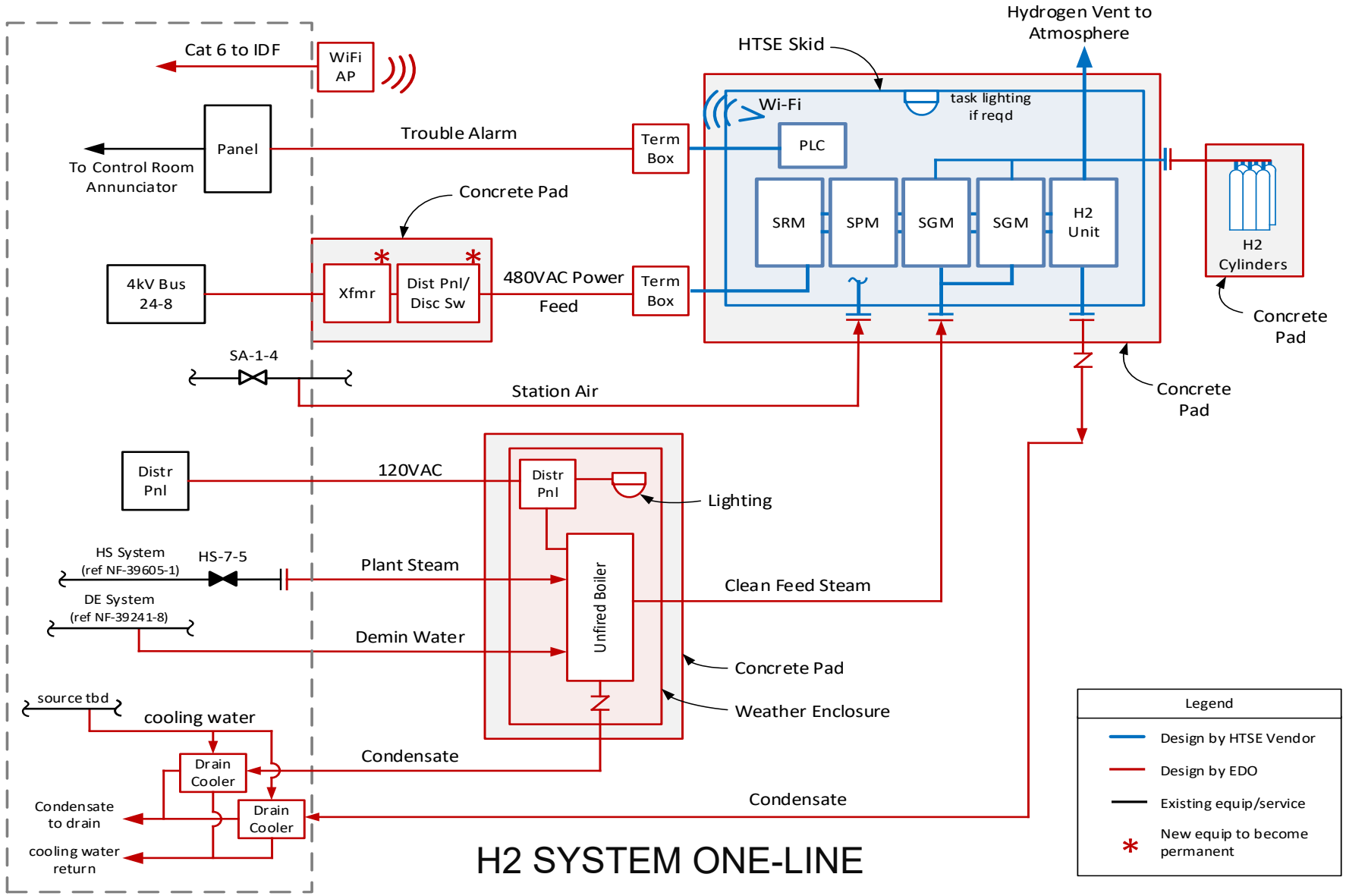


Current Progress:

Transformer / Distribution Panel

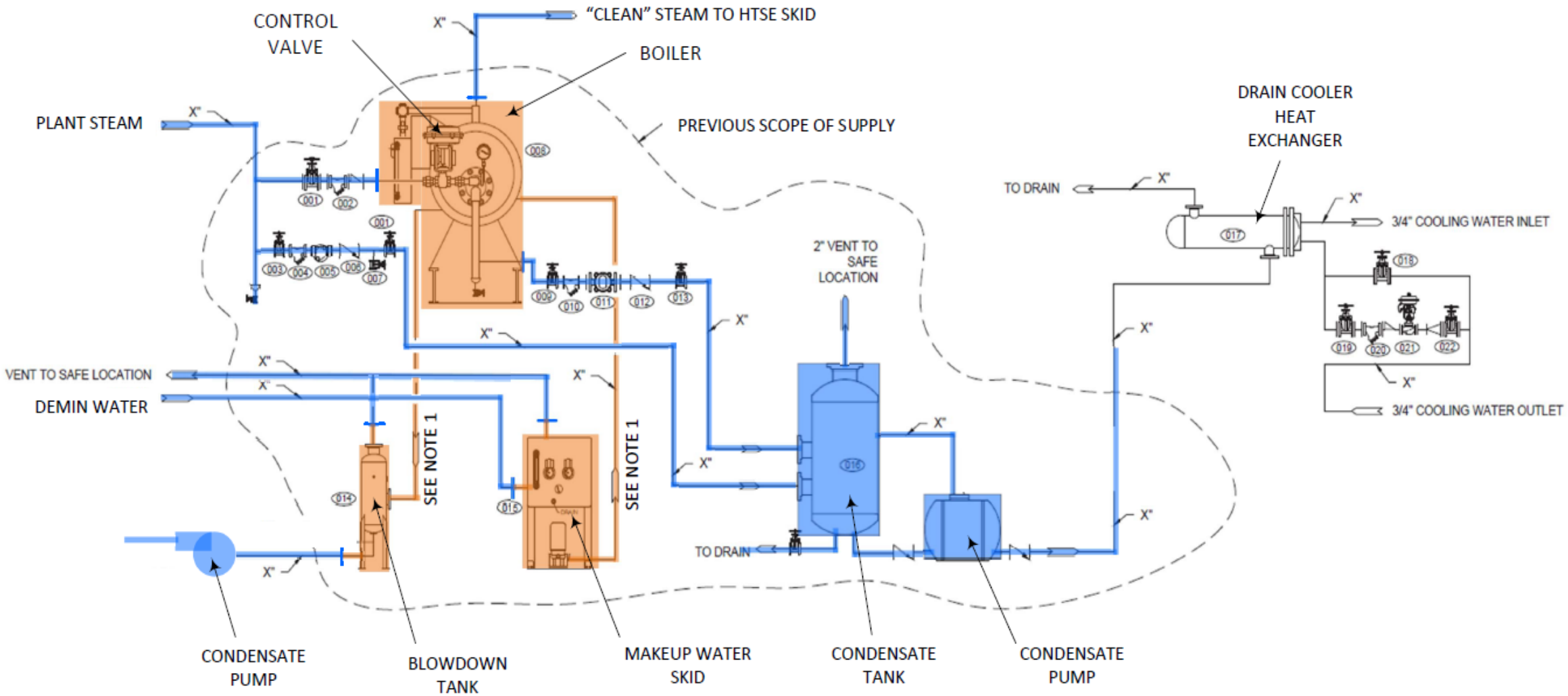
HTSE Skid

System Overview



H2 SYSTEM ONE-LINE

Unfired Boiler Equipment



Project Details

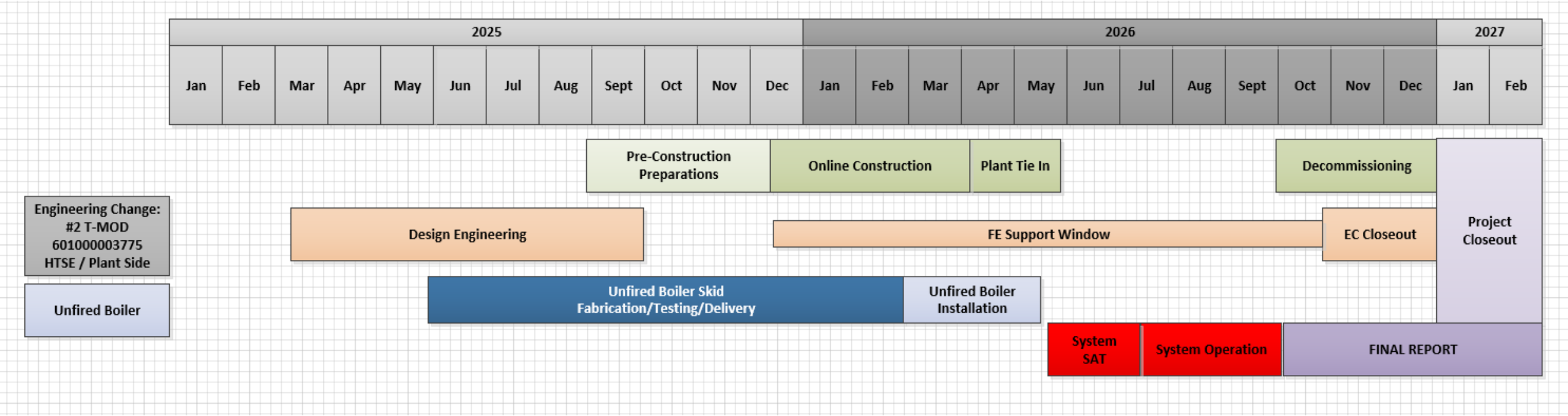
H2 Production Rate:	5.4 kg/hr | 129 kg/day
H2 Purity:	92% (after cooling)
H2 Outlet Pressure/Temperature:	0.04 bar | 212°F-360°F
Steam Consumption:	34 kg/hr
Steam Input Pressure/Temperature:	60psig-75psig | 300°F-400°F

Project Status

Electrical Interface	Mechanical Interface	Construction Complete	Hydrogen Production Demonstration

• Initial electrical infrastructure construction
  • Plant Bus Tie
  • External Transformer
  • Distribution Panel
  [COMPLETE]
• Final electrical/ communication tie-in post HTSE skid installation on foundation
  [Est. Q2 2026]
	• High-Temperature Steam Electrolysis (HTSE) Skid delivered to site
	• Design Work-in-Progress: Mechanical Tie-in
	  • Steam
	  • Demin Water
	  • Station Air
	  • Condensate
	• Unfired Boiler Skid from INL [Est. 6 months]
		[Est. Q2 2026]	3 months

Project High-Level Schedule



Required Acknowledgements & Disclaimers

This material is based upon work supported by the Department of Energy under Award Number DE-NE00009038.


Xcel Energy®

Dominion Energy Nuclear Overview

LWRS Flexible Power operations and Generation

Dominion Energy At a Glance

~7M
Total Customers

States of Operation predominately Mid-Atlantic Region

58,510
Electric Distribution Miles
6,800 Electric Transmission Miles

Thousands of Gas Distribution Miles

31GW
Total Generation
11GW Zero-carbon

85%+
of our energy comes from clean energy sources or natural gas

Our Path to Net Zero by 2050

Rapidly deploy the clean energy ***technologies of today…***

- Wind
- Solar
- Energy Storage
- Zero-Carbon Nuclear
- Renewable Natural Gas
- Methane Emissions Reduction

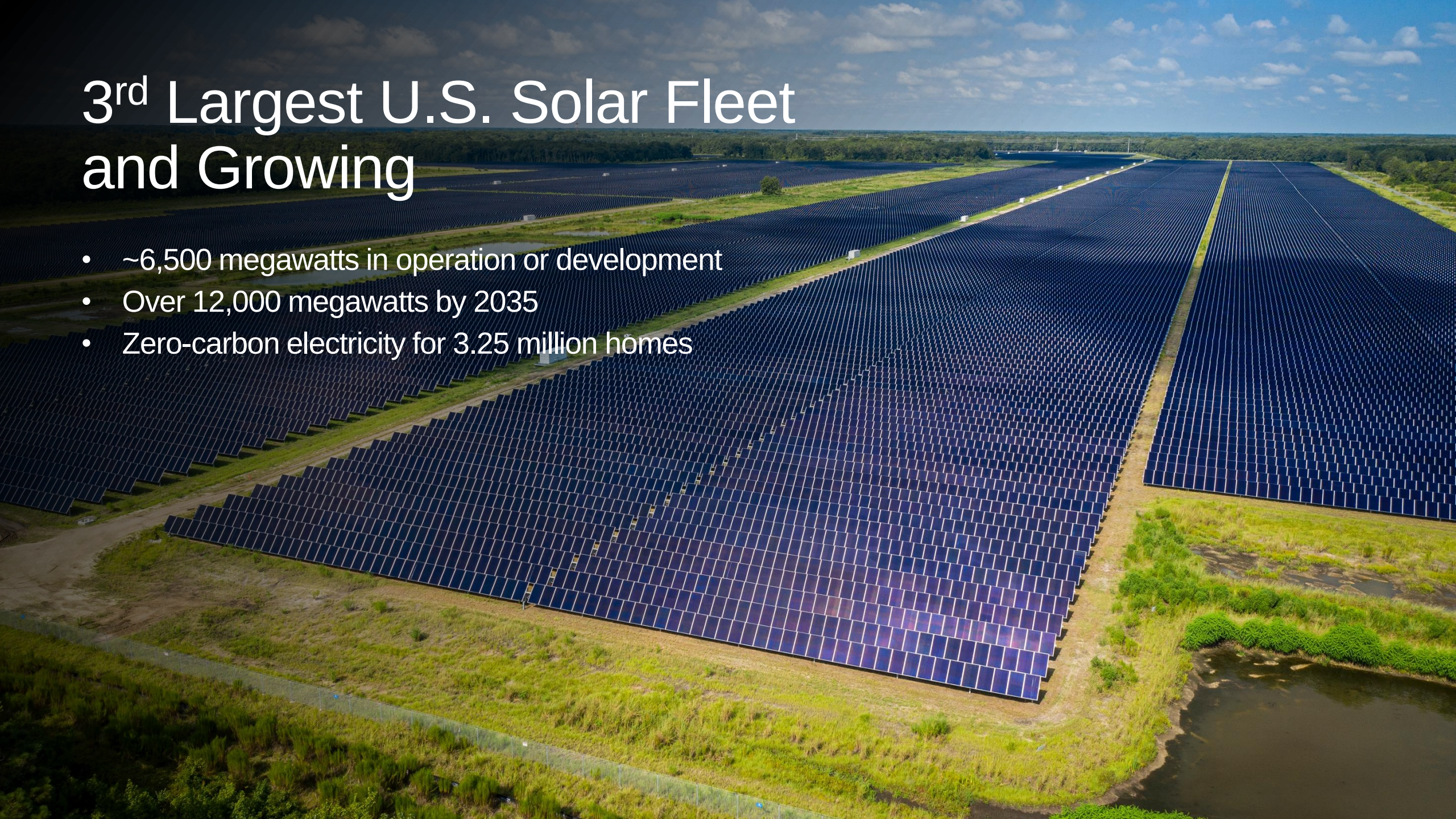
While investing in the emerging ***technologies of tomorrow…***

- Hydrogen
- Advanced Nuclear
- Carbon Capture

Largest Offshore Wind Project in North America

- Virginia Coastal Offshore Wind (CVOW)
- 12-megawatt pilot completed in 2020
- 2,600 megawatts by 2026
- Zero-carbon electricity for 650,000 homes

3rd Largest U.S. Solar Fleet and Growing



- ~6,500 megawatts in operation or development
- Over 12,000 megawatts by 2035
- Zero-carbon electricity for 3.25 million homes

Dominion's Nuclear Power Plants

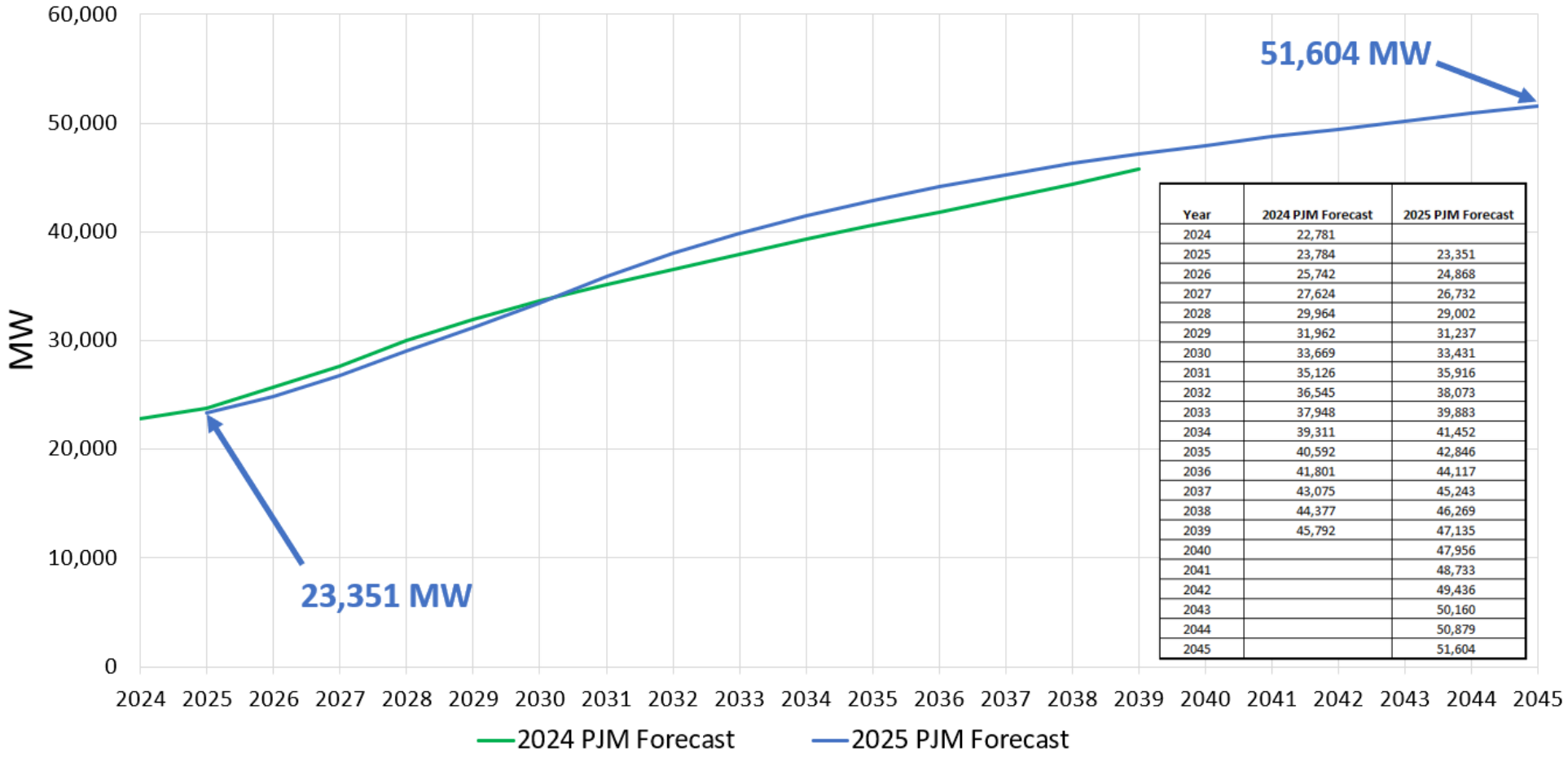
- Millstone Power Station – Merchant
- North Anna Power Station - DEV
- Surry Power Station - DEV
- V.C. Summer Power Station - DESC

Dominion Energy Virginia

Highest Electric Demand Growth Forecasted in the Nation

2025 PJM Summer Peak Load Forecast (MW) - Dominion Zone

Summer Peak: 10-Yr Avg Growth: 6.3% 20-Yr Avg Growth: 4.0%



Year	2024 PJM Forecast	2025 PJM Forecast
2024	22,781	
2025	23,784	23,351
2026	25,742	24,868
2027	27,624	26,732
2028	29,964	29,002
2029	31,962	31,237
2030	33,669	33,431
2031	35,126	35,916
2032	36,545	38,073
2033	37,948	39,883
2034	39,311	41,452
2035	40,592	42,846
2036	41,801	44,117
2037	43,075	45,243
2038	44,377	46,269
2039	45,792	47,135
2040		47,956
2041		48,733
2042		49,436
2043		50,160
2044		50,879
2045		51,604

The IRP & The VCEA

Resource Planning

Driving the Clean Energy Transition

2024 Integrated Resource Plan (IRP)

Filed in October 2024

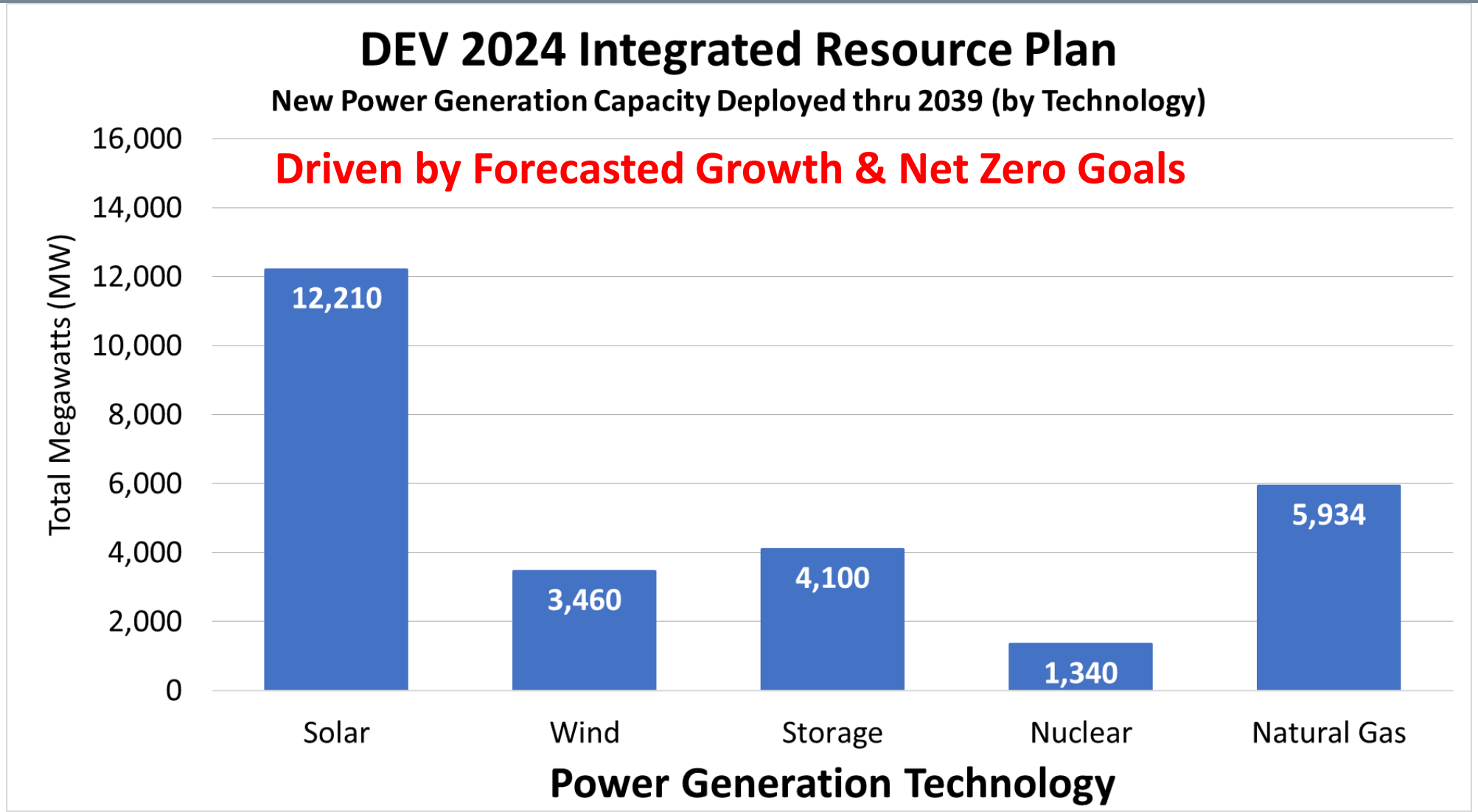
The Virginia Clean Economy Act (VCEA)

A multi-faceted approach to achieving a clean energy portfolio

- **100% zero-carbon** generation by the end of 2045 with critical protections for **reliability** and low-income customers
- Significant development of zero-carbon resources (**24 GW** by 2035)
  - **16.1 GW** solar/onshore wind
  - **5.2 GW** offshore wind (**3 GW** by 2027)
  - **2.7 GW** energy storage[2] (35% PPAs, 10% BTM)

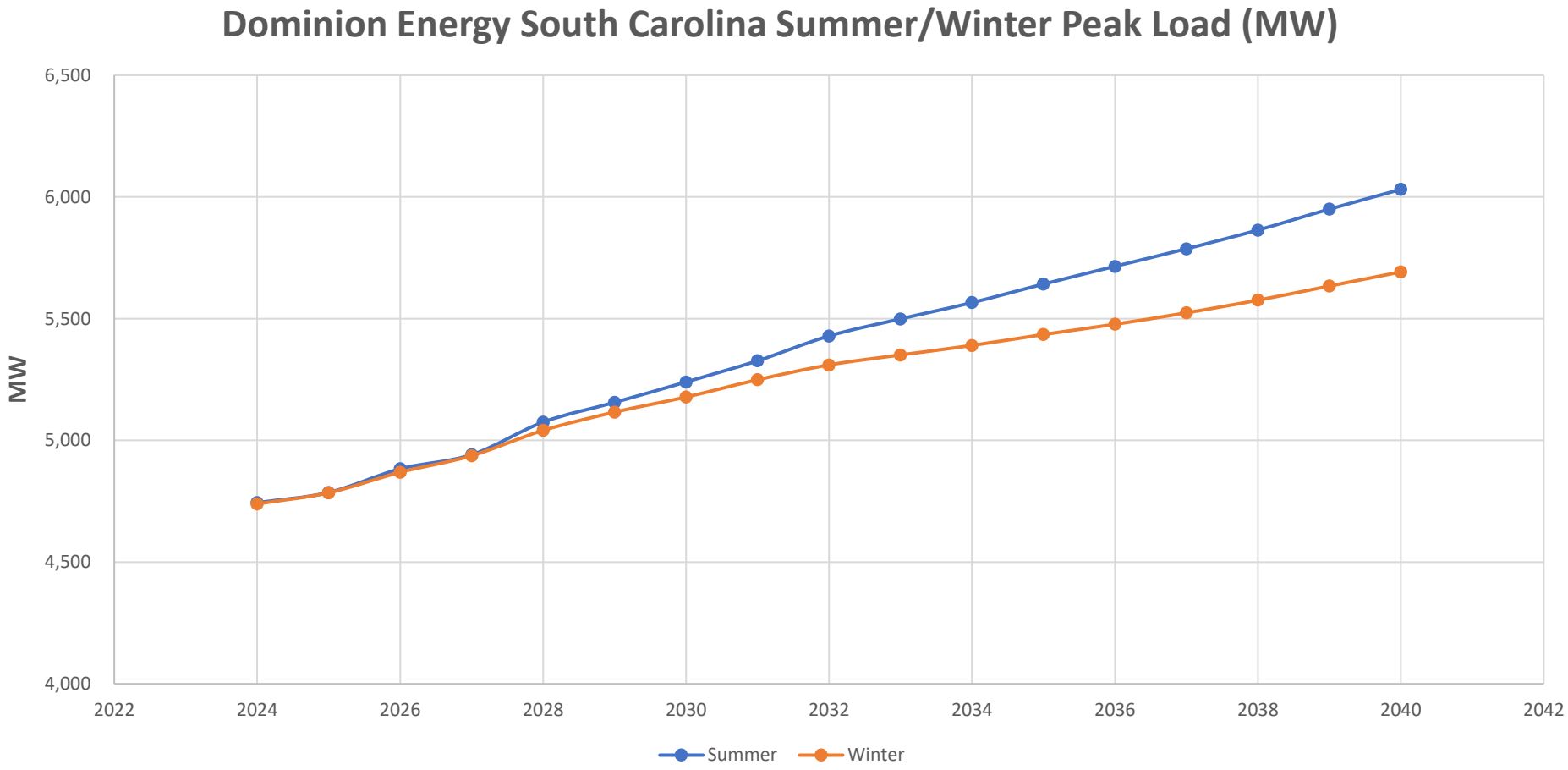
New Power Generation Capacity Planned for VA Customers

Additional 27,000 MW of Largely Zero-Carbon Generation Needed by 2039



Dominion Energy South Carolina

Increasing Load Growth Driven By Data Centers and Manufacturing

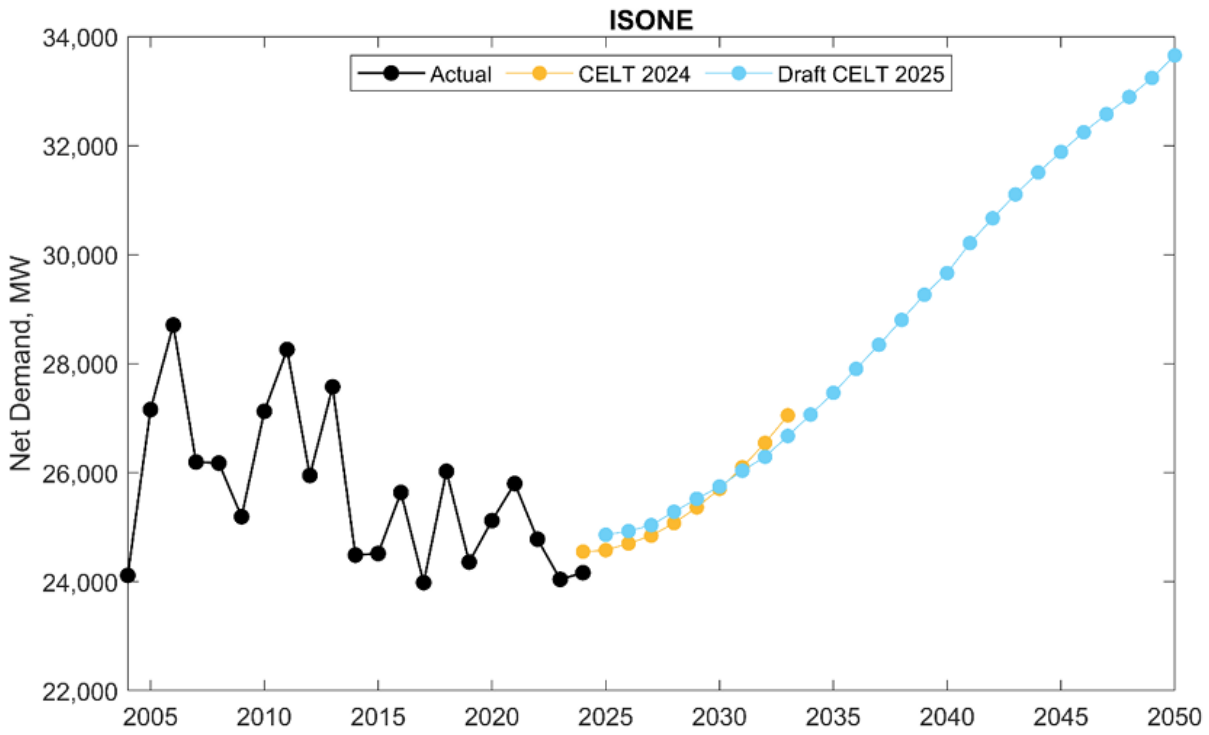


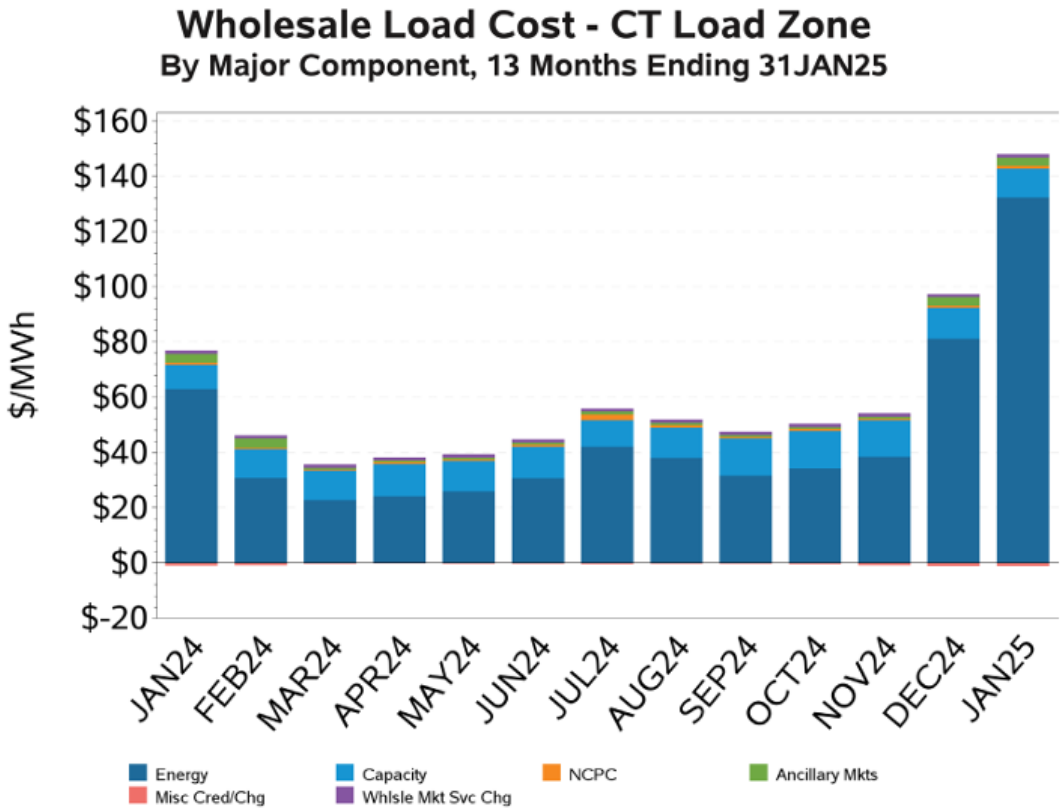
NE-ISO Summer Peak Demand Forecast

(2025 Draft)

Summer Net 50/50 Peak Forecast

New England – Draft CELT 2025 Vs. CELT 2024





Millstone Power Station Serves ~33% of CT's baseload

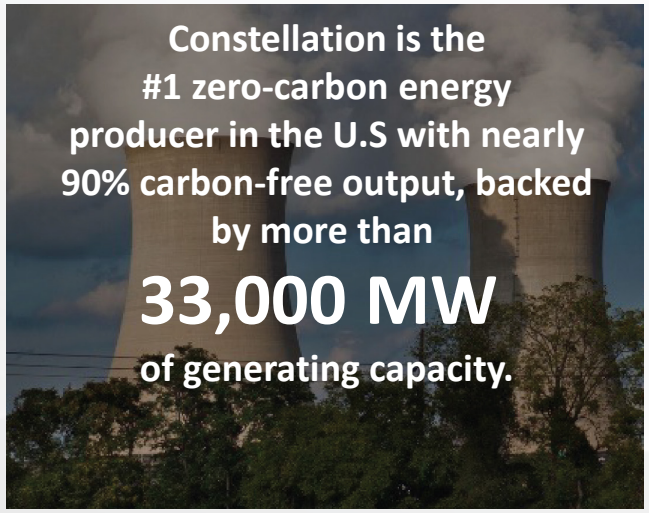
Questions?

Constellation

Constellation Hydrogen activities

Flexible Plant Operation and Generation Pathway Stakeholder Engagement Meeting

Constellation: By the Numbers



Constellation is the #1 zero-carbon energy producer in the U.S with nearly 90% carbon-free output, backed by more than

33,000 MW

of generating capacity.

Operates in

48 States & DC

Provided

100%

of business customers with custom GHG data by end of 2022

Scalable national platform of over

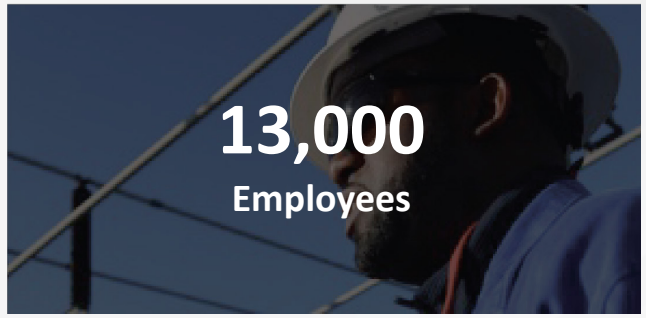
2 million

residential, public sector and business customers served, offering a diversity of innovative products and services, including ¾ of Fortune 100 companies

202 TWh

1.4 Tcf

Customer Load Served



13,000

Employees

Power Supply Mix	TWh
Nuclear	173
Conventional	22
Owned Renewable	4

C&I Market Share Ranking

#1

Constellation®

Generating Assets

Constellation produces around 10% of the nation's carbon-free energy

Constellation Owned Assets

- Nuclear
- Wind
- Gas/Other
- Solar
- Hydro
- Other Renewables

Constellation

Hydrogen Demonstration at Nine Mile Point

Research Objective

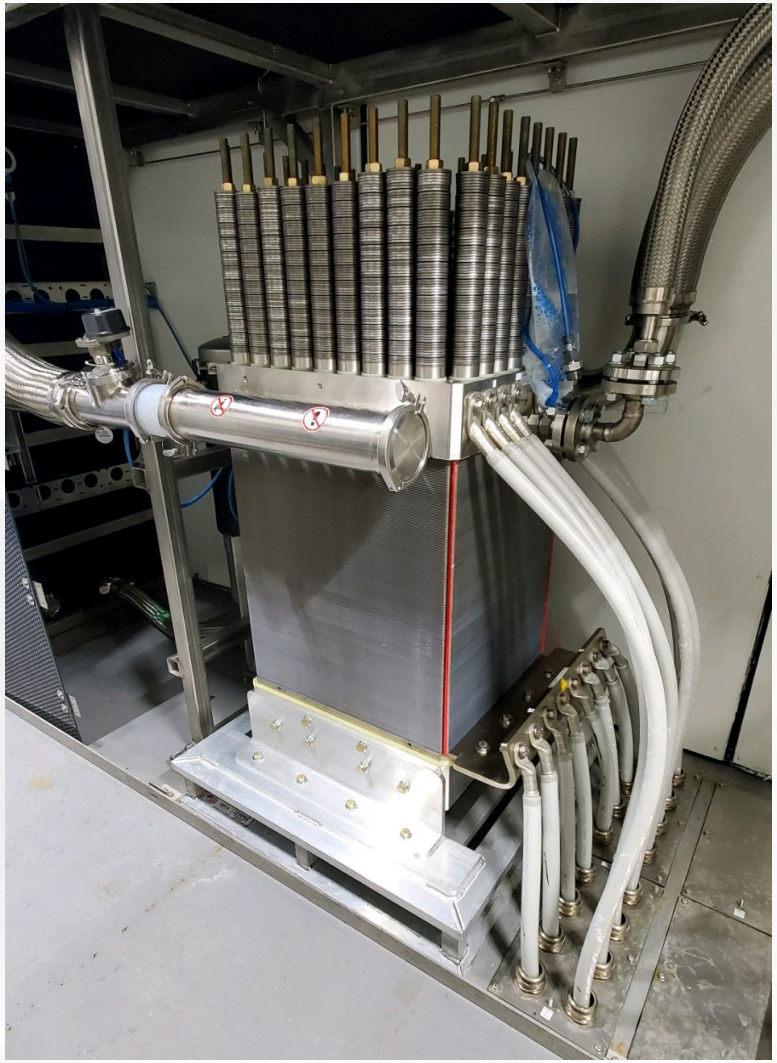
- Demonstrate early-stage Proton Exchange Membrane (PEM) electrolyzer technology at a Constellation generation facility (Nine Mile Point) to showcase carbon free generation of hydrogen behind the meter

Project Details

- March 7 2023 hydrogen production started at Constellation's Nine Mile Point Nuclear Plant in Oswego, NY.
- The project leverages DOE Grant of $5.8M to demonstrate hydrogen production and end use for the plant's own consumption of hydrogen
- The PEM electrolyze uses 1.25 MW of power behind the meter to produce 560kg/Day of clean hydrogen, more than enough to meet the plant's hydrogen use
- Additional hydrogen is being explored as a long-duration energy storage system in a separate grant project supported by NYSERDA

Constellation®

Hydrogen Demonstration Project



Electrolyzer Area to left: backup generator, power supply, and electrolyzer

Cell stack installed to right.

Constellation

Hydrogen Demonstration Project

Electrolyzer and cooling unit to left
Compressor below

Constellation®

Wolf Creek – Market Pricing Impacts

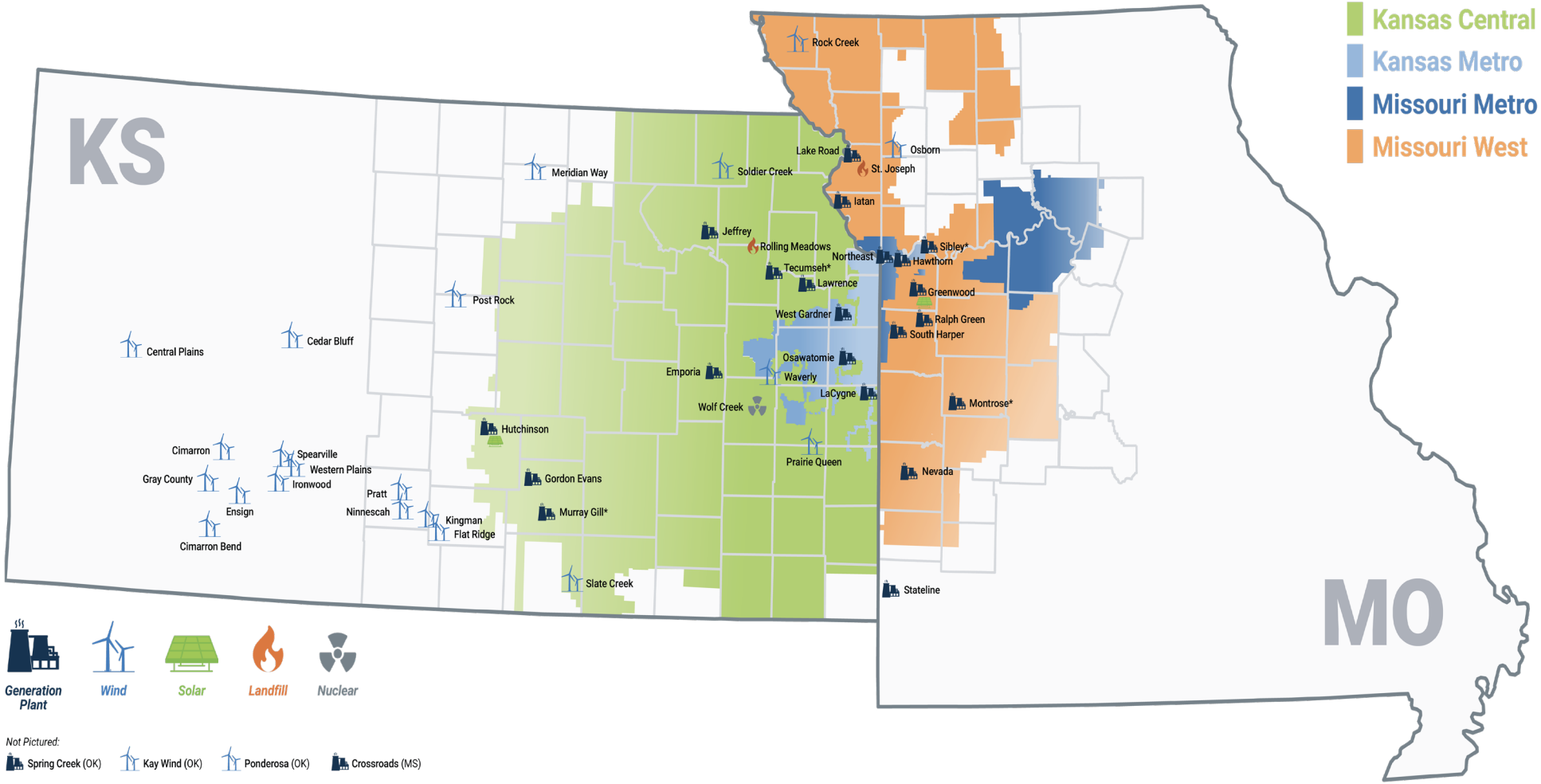
Frank Galati

Sr Manager Nuclear Engineering

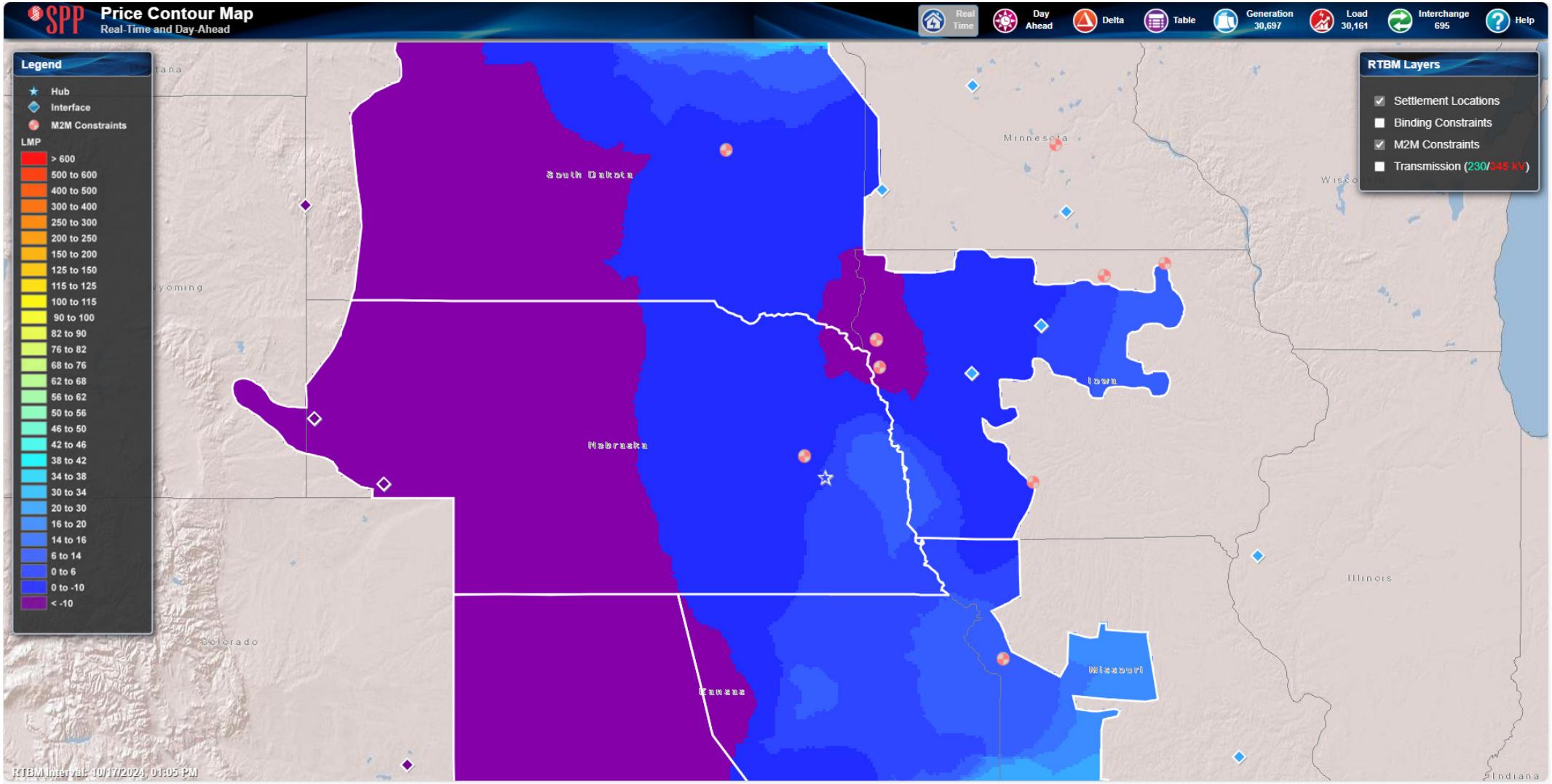
3/19/2025

evergy

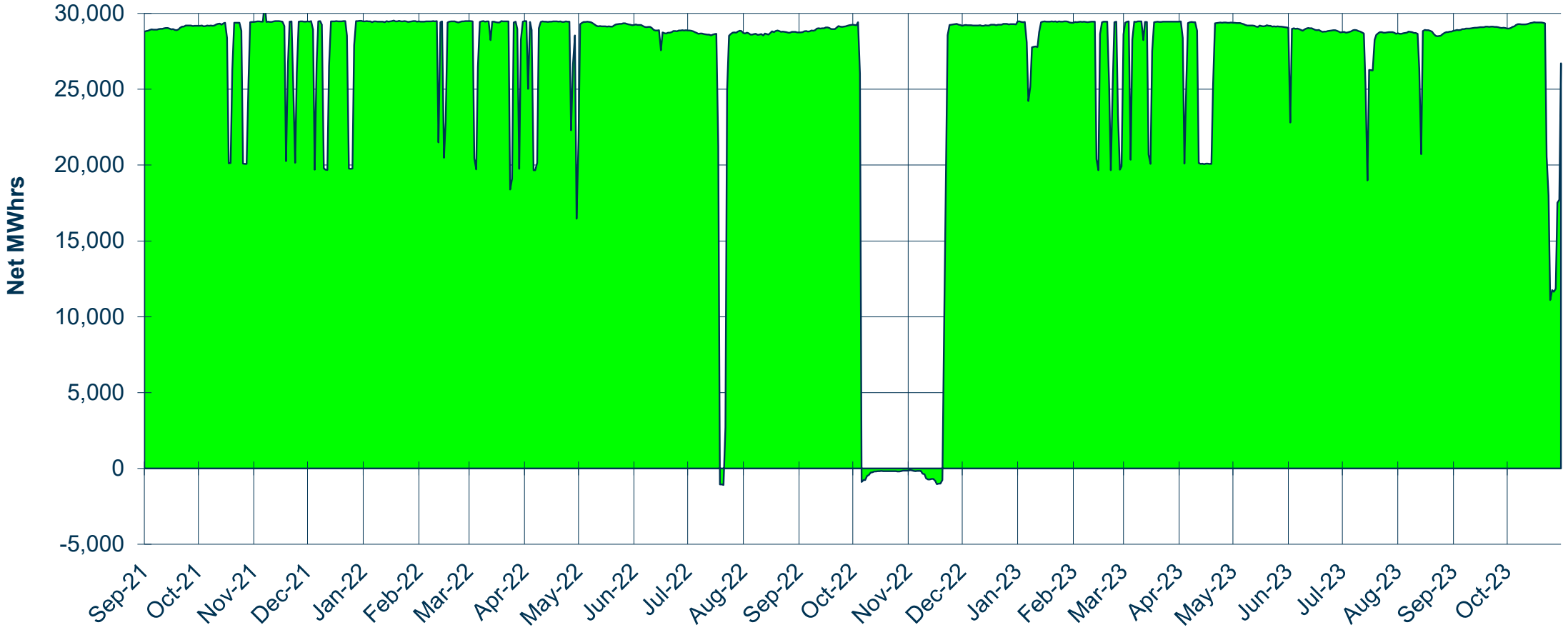
Evergy - Combined Service Territory



Grid / Pricing – 10/17/2024 @ 1300 Hours



Power History Curve



Advantages of Flex Ops Through Hydrogen Generation

- Traditional Flexible Operations Through Reactor Down Powers:
  - Minimum duration of down power is 36 hours, maximum is 14 days
  - 30% decrease in reactor output
  - Will not move plant once RCS reaches 300ppm boron concentration
  - Risk to generation during plant maneuvers
  - Core design safety analysis limits flex ops to a combined duration of 30 days

- Benefits of Flexible Operations through Hydrogen Generation
  - Agility to respond to narrower windows of negative pricing
  - Deeper output reduction possible beyond 30%
  - Eliminates RCS boron concentration and water management restrictions
  - Reduces plant risk during reactor power maneuvers
  - Eliminates core design restrictions on the combined duration of flex ops

Uranium / Fuel