MRO 2023 Reliability Conference

Wednesday, May 17, 2023 | 8:30 a.m. to 4:00 p.m. Central

King Conference Center

St. Paul, MN & Webex

MIDWEST RELIABILITY ORGANIZATION

380 St. Peter St, Suite 800
Saint Paul, MN 55102
651-855-1760
www.MRO.net

HOSPITALITY ITEMS

Breakfast
A hot breakfast will be available from 7:30 a.m. to 8:30 a.m. in the conference center lounge. If you have any dietary restrictions, please see the registration desk or the server in the lounge.

Beverages
Hot and cold beverages will be available in the conference center lounge, please help yourself.

Lunch
A lunch buffet will be provided. If you have any dietary restrictions, please see the registration desk or the server in the lounge. Please follow the emcee's instructions for dismissal to lunch.

Restrooms
Restrooms are located outside of the conference center, as well as on floor seven. If you choose to use a restroom on another floor, please take the elevators. The staircases only provide exit access on the first floor of the building.

First Aid
There is a first aid kit at the front desk in the reception area should you need medical or first aid supplies.

Conference Etiquette
As a courtesy to presenters and conference participants, please:

- Silence all of your electronic devices prior to sessions.
- Please defer to speakers' preferences for questions and wait for a microphone so those attending online can hear.
- Be seated prior to the beginning of each session.

Name Badges
Please wear your name badge at all times.

Conference Evaluation
Your feedback is appreciated. Please complete the feedback survey using the QR code included in this packet.

Luggage
Storage for any size travel luggage is available in MRO's lobby by the registration desk. Please ask MRO staff for assistance.

Lost and Found
An MRO representative will always be in the meeting room; however, personal belongings are left at your own risk. If you find or lose an item, please visit the registration desk. After the conference, please contact Lauren Mcclary at: Lauren.Mcclary@mro.net

Power and Wi-Fi
Power will be supplied at the tables. Please refrain from plugging into floor outlets to minimize the hazard from tripping. MRO's guest Wi-Fi password can be found on the table.

Photographs
MRO may take videos or photos at its events for use on the MRO website or in MRO publications or other media produced by MRO. MRO reserves the right to use any image taken at any event sponsored by MRO, without the express written permission of those individuals included within the photograph and/or video.

To ensure the privacy of conference attendees, images will not be identified using names or personal identifying information without the express written approval from the individual shown. If you do not wish to have your image taken for future publication, please notify MRO event staff. By participating in this MRO event or by failing to notify MRO of your desire to not have your image taken by MRO, you are agreeing to allow MRO to use your image as described.

EMERGENCY PROCEDURES

SEVERE WEATHER

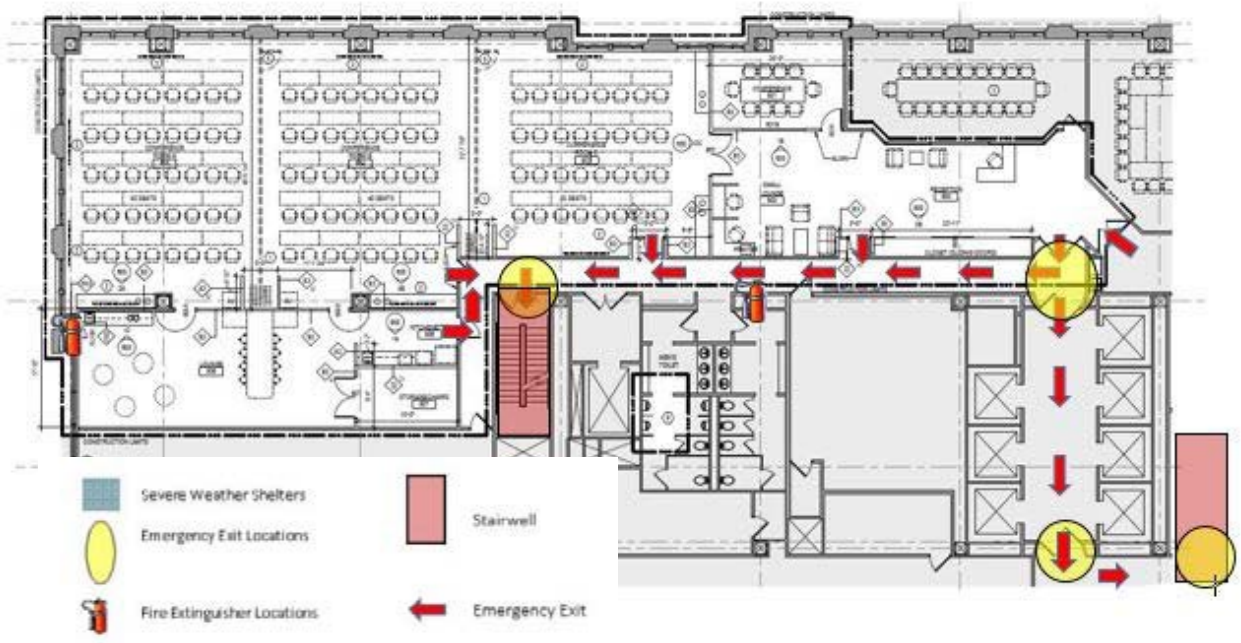
If the city of Saint Paul and/or Ramsey County sound the emergency sirens, Infor Commons building management will instruct employees to seek shelter immediately in an interior room of the building with no windows. **The building's interior corridors, stairwells, and restrooms have been designated as severe weather shelters**. Infor Commons building management will use the building's paging system to warn occupants of the need to take shelter, and will also notify occupants when it's safe to return to their offices by stating "all clear."

FIRE

The Infor Commons Building is equipped with fire/strobe alarms and an automatic fire suppression and sprinkler system. Pursuant to local fire code, fire extinguishers are available for employee use in the event of an emergency. Infor Commons building management will provide instruction to building occupants in the event of a fire emergency. Fire emergencies usually do not require full evacuation.

EVACUATION

In the event the building needs to be evacuated, Infor Commons building management will notify building occupants of the need to evacuate. Use the nearest stairwell and exit the building on the ground floor (please see the evacuation map below). MRO employees and guests are asked to gather at the open Impark Lot across the street from our building on the corner of Sixth and Wabasha streets.



LOGISTICS

WebEx Login
If any help is needed logging into WebEx please reach out to Rebecca Schneider at rebecca.schneider@mro.net.

Audio
Participants will be muted upon entry and will not be able to unmute themselves to speak.

Questions
If you have questions for a speaker, please utilize WebEx's chat feature. Please submit all questions to "All Panelists". If we are unable to get all questions asked/answered during the conference, a response will be provided after the conference either directly to the requestor or through another form of outreach.

Presentations
The presentations and recordings from today's conference that can be provided will be made available in the near future.

Feedback
Your feedback is very important to us. Please utilize the survey link, also at the end of this packet, to provide your feedback.

Certificate of Attendance
If you would like to request a certificate of attendance for today's conference, please send your request to Rebecca Schneider at rebecca.schneider@mro.net.

AGENDA

Wednesday, May 17, 2023 | 8:30 a.m. to 4:00 p.m. Central

7:30 a.m. – 8:30 a.m.	**Registration and Continental Breakfast**
8:30 a.m. – 8:50 a.m.	**Welcome and Introduction** *Bryan Clark, Director of Reliability Analysis, Midwest Reliability Organization* *Emcee: Dallas Rowley, Director System Operations, Oklahoma Gas & Electric*
8:50 a.m. – 9:10 a.m.	**Assessing Risk to Reliability of the Regional Bulk Power System** *Richard Burt, Sr. Vice President and COO, Midwest Reliability Organization*
9:10 a.m. – 10:00 a.m.	**Multi-day Energy Storage Technology and Pilot Project** *Andrew Rapin, Staff Project Engineer, Form Energy*
10:00 a.m. – 10:20 a.m.	**Morning Break**
10:20 a.m. – 11:10 p.m.	**Operational Resiliency in Response to Emerging Security Risks** *Bob Taylor, ICS and Emergency Preparedness Manager, Oklahoma Gas & Electric*
11:10 a.m. – 12:00 p.m.	**The Evolution of Human Performance at MidAmerican Energy** *Gary Riibe Jr., Manager Substation Operations-West, MidAmerican Energy Company*
12:00 p.m. – 1:00 p.m.	**Lunch**
1:00 p.m. – 2:15 p.m.	**Facility Ratings Best Practices Panel** *Moderator: Andy Witmeier, Director of Resource Utilization, MISO* *Dan Custer, General Manager, System Control & Grid Technology, MidAmerican Energy Company* *Evan Wilcox, Director – Advanced Transmission Studies & Modeling, American Electric Power* *Jon Radloff, Manager, Asset Data and Ratings, American Transmission Company* *Valerie Agnew, General Counsel, North American Transmission Forum*
2:15 p.m. – 2:35 p.m.	**Afternoon Break**
2:35 p.m. – 3:25 p.m.	**Overview of NuScale and Grid Reliability Features** *Steven Breeding, Director of Sales, NuScale Power*
3:25 p.m. – 3:40 p.m.	**Wrap Up/Questions/Feedback/Adjourn** *Emcee: Dallas Rowley, Oklahoma Gas & Electric*

SPEAKER BIOGRAPHIES

Wednesday, May 17, 2023 | 8:30 a.m. to 4:00 p.m.

Bryan Clark

Director of Reliability Analysis, Midwest Reliability Organization

Bryan Clark is the Director of Reliability Analysis. This group is responsible for regional Reliability Assessments, Event Analysis, and Performance Analysis (Data Collection).

Prior to joining MRO in 2018, Bryan spent 8 years with Southwest Power Pool, as a transmission planning engineer, a market operations engineer and a Supervisor of the Day Ahead Operations department. Bryan also worked for Entergy as a Nuclear Operator where he was responsible for monitoring and operating various primary and secondary plant systems at Arkansas Nuclear One (Unit 2).

Bryan has a Bachelor of Science in Engineering from Arkansas State University, is a registered Professional Engineer in Arkansas and Minnesota, and is a member of the National Society of Professional Engineers.

Contact Bryan: bryan.clark@mro.net

Dallas Rowley

Director System Operations, Oklahoma Gas and Electric

Dallas Rowley is the Director System Operations for Oklahoma Gas and Electric (OG&E). Areas of responsibility include the T&D Control Centers, Substation Operations and Engineering Support, T&D Operations Engineering Support, and T&D ICS and Emergency Preparedness. Previously he worked as Manager System Operations, Area Substation Operations Supervisor, and Protection and Control Technician. Dallas has 17 years of utility operations experience.

In addition, Dallas is member of the MRO RAC.

Contact Dallas: rowleydk@oge.com

Richard Burt

Senior Vice President and Chief Operating Officer, Midwest Reliability Organization

As chief operating officer, Richard Burt leads the organization's industry-facing efforts with regard to reliability and security initiatives that strengthen the bulk power system in MRO's regional footprint. As an engineer with experience in telecommunications, transmission planning studies, control systems, power quality, and management roles in both Energy Management Systems and NERC compliance, Burt acts as liaison to the board's Organizational Group Oversight Committee (OGOC). The OGOC is tasked with implementing the board's vision of a stakeholder structure that effectively and efficiently supports MRO's mission to "identify, prioritize and assure effective and efficient mitigation of risks to the reliability and security of the North American bulk power system by promoting Highly Effective Reliability Organizations (HEROs).

Burt's industry experience has been invaluable to MRO as the industry grapples with challenges associated with energy assurance and a significant transformation of energy resources.

Burt joined MRO in February 2012 as principal risk assessment and mitigation engineer and was soon after promoted to vice president risk assessment and mitigation and standards in April 2015. In August 2018, he was named senior vice president and chief operating officer.

He brings a diverse technical power systems background to MRO's leadership team obtained through 14 years of industry experience. Burt earned his Bachelor of Science degree in Electrical Engineering from the University of North Dakota, and has also completed the University of Idaho Utility Executive Course. He is a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) and the IEEE Power and Energy Society, and has been inducted into both the Eta Kappa Nu and Tau Beta Pi engineering honor societies.

Contact Richard: richard.burt@mro.net

Andrew Rapin

Staff Project Engineer, Form Energy

Andrew Rapin is a Staff Project Engineer at Form Energy, where he is the technical lead for executing projects from customer contract through commercial operation. Prior to joining Form, he developed, deployed, and operated energy storage and micro grid projects for federal customers. Prior to his work in energy storage, Andrew deployed megawatt-scale wind energy projects for large commercial and industrial customers in the Midwest.

Andrew holds a Professional Engineering license in Mechanical Engineering and a MS in Mechanical Engineering from the University of Michigan.

Contact Andrew: arapin@formenergy.com

Bob Taylor

ICS and Emergency Preparedness Manager, Oklahoma Gas and Electric

Bob Taylor has been employed with OG&E for 10 years. In 2015, Bob got involved in storm restoration activities in a volunteer capacity and worked his way up to a Branch Manager position in OG&E's Incident Command organization. Today, he is the ICS and Emergency Preparedness Manager.

Prior to OG&E, Bob worked for several manufacturing companies in the Oklahoma City area, including Terex, Southwest Electric, and Tinker Air Force Base. These companies provided skills and a passion for continuous improvement that Bob applies to his current role at OG&E, always striving to get better at storm response and restoration.

Bob holds an Industrial Engineering degree from Oklahoma State University.

Contact Bob: taylorrc@oge.com

Gary Riibe, Jr.

Manager Substation Operations-West, MidAmerican Energy Company

Mr. Riibe graduated from the University of Nebraska – Lincoln with a Bachelor of Science Degree in Electrical Engineering. Upon graduation from UNL, he spent four years working in Substation Engineering in Davenport, Iowa for MidAmerican Energy designing substation projects. In 2006, Gary became the Substation Operations Supervisor in Council Bluffs, Iowa where he had responsibility over substations in Southwest Iowa. In 2011, Gary transferred to Sioux City where he was the Operations Supervisor over Northwest Iowa, and later, the Substation Operations Manager of Western Iowa.

Mr. Riibe has been involved in the design, construction, and commissioning of a number of substation projects in his 20-year career with MidAmerican Energy. In 2019, Gary completed a HPI Champions Program within MidAmerican; the inaugural year of a program that aims to add champions across all departments of MidAmerican each half of the year.

Gary is a licensed Professional Engineer in the State of Iowa.

Contact Gary: Gary.Riibejr@midamerican.com

Andy Witmeier

Director of Resource Utilization, Midcontinent System Operator, Inc. (MISO)

Andy Witmeier is currently the Director of Resource Utilization at the Midcontinent Independent System Operator, Inc. (MISO). The Resource Utilization team manages MISO's Generator Interconnection Queue as well as assessing generator requests for surplus, replacement, or retirement. Andy started at MISO after graduating from Purdue University with a Bachelor's degree in Electrical Engineering. He spent the first seventeen years of his career in various positions in Operations. He was a NERC certified System Operator for 14 years working various positions in scheduling, engineering, and as a reliability coordinator. He then led several groups within MISO Operations as a manager in engineering, reliability coordination, and seams administration. At the beginning of 2020, he moved into his current role in MISO's Planning department.

Contact Andy: awitmeier@misoenergy.org

Daniel Custer

General Manager, System Control & Grid Technology, MidAmerican Energy Company

Dan Custer is general manager of system control and grid technology at MidAmerican Energy Company in Des Moines, Iowa. Dan's operations include electric distribution control serving roughly 800,000 customers, transmission control of 4,900 transmission miles, and staff responsible for outage coordination, transmission accounting, and compliance support. Dan has worked at MidAmerican Energy for 21 years in electric system planning and in the control room.

Contact Dan: Daniel.Custer@midamerican.com

Evan Wilcox

Director – Advanced Transmission Studies & Modeling, American Electric Power

Evan Wilcox is the Director of Advanced Transmission Studies & Modeling for American Electric Power (AEP). He oversees all transmission model management functions, and special studies including dynamic stability, power quality, and emerging technology assessments.

In his 20 years at AEP, Evan has held various leadership positions in Transmission Planning, FERC & RTO Policy, and Engineering Services. He holds a BS in Electrical and Computer Engineering from The Ohio State University, an MBA from Capital University and is a registered professional engineer in the State of Ohio.

Contact Evan: erwilcox@aep.com

Jon Radloff

Manager – Asset Data and Ratings, American Transmission Company

Jon Radloff is manager of asset data and ratings at ATC in the asset management department, responsible for maintaining multiple asset data applications and overseeing the facility ratings program.

Radloff joined ATC in 2012 as a transmission line engineer before moving into project management within the construction department. He then spent several years as a team leader of ratings in the asset management department before being promoted to his current position in 2021.

Prior to ATC, Radloff worked in the consulting engineering industry specializing in land development and water resources in Colorado and Wisconsin.

Radloff has earned a bachelor's degree in civil engineering and a technical leadership certificate from the University of Wisconsin-Madison.

Contact Jon: jradloff@atcllc.com

Valerie Agnew

General Counsel, North American Transmission Forum

Valerie (Val) Agnew serves as NATF's general counsel, manages the NATF Supply Chain activities and supports the risk, controls and compliance (RCC) practice group. Val focuses on overall reliability practices through the incorporation of risk assessments and controls into members' compliance and supply chain programs. In her supply chain role, Val also works to align NATF activities with external stakeholders and facilitates the Industry Organizations Team.

Val has held several positions within industry and the ERO Enterprise. Most recently, Val served as the vice president of enforcement at the Midwest Reliability Organization (MRO). Prior to MRO, she was at the North American Electric Reliability Corporation (NERC) in the positions of the senior director of standards and the senior director of reliability assurance, overseeing the compliance, registration and reliability assurance teams. While at NERC, Val was instrumental in the Paragraph 81 project, the Independent Experts Review Project and efforts to implement risk-based compliance monitoring. Prior to the ERO, Val was with Honeywell International and UniSource Energy in Arizona, where she led the key account management team for key gas and electric customers. Val is a licensed attorney in Arizona and holds an MBA from Colorado State University.

Contact Val: vagnew@natf.net

Steven Breeding

Director of Sales, NuScale Power LLC

NuScale is the provider of a proprietary and innovative advanced nuclear power solution, the NuScale Power Module™ (“NPM”), which is the only viable, near-term deployable SMR technology. NuScale’s NPM can serve as a reliable, carbon-free source of power that complements renewable sources such as wind, solar and hydropower generation.

Steven Breeding has more than 39 years of domestic and international commercial nuclear power industry experience. Steven graduated from Drexel University with a Bachelor of Science degree in Mechanical Engineering and has held an NRC Senior Reactor Operator License. Currently, Steven is Director of Sales for NuScale Power LLC.

Contact Steven: SBreeding@nuscalepower.com

MRO DISCLAIMER

Midwest Reliability Organization (MRO) is committed to providing outreach, training, and non-binding guidance to industry stakeholders on important industry topics. Subject Matter Experts (SMEs) from MRO's organizational groups and the industry may develop materials, including presentations, provided as a part of the event. The views expressed in the event materials are those of the SMEs and do not necessarily express the opinions and views of MRO.

PRESENTATIONS

All presentations for today's conference are included in order of presentation.

MIDWEST RELIABILITY ORGANIZATION

Welcome to the 2023 Hybrid Reliability Conference

Cris Zimmerman Manager, Outreach & Stakeholder Engagement

MRO Logistics, Safety & E-Plan

- Safety – First Aid, CPR and AED
- Food and beverages
- Restrooms
- Emergency plan – severe weather/evacuation

MIDWEST RELIABILITY ORGANIZATION

Evacuation route & accountability location 6th St & Wabasha St

Classification: Public

2023 Reliability Conference Survey

https://www.surveymonkey.com/r/X676PFY

HERO

HIGHLY EFFECTIVE RELIABILITY ORGANIZATION

FIVE BASIC PRINCIPLES:

1. **Preoccupation with failure**
   Attention on close calls and near misses (“being lucky vs. being good”); focus more on failures rather than successes.

2. **Reluctance to simplify interpretations**
   Solid “root cause” analysis practices.

3. **Sensitivity to operations**
   Situational awareness and carefully designed change management processes.

4. **Commitment to Resilience**
   Resources are continually devoted to corrective action plans and training.

5. **Deference to Expertise**
   Listen to your experts on the front lines (ex. authority follows expertise).

Annual HERO Award

Nominate Someone Today!

MIDWEST RELIABILITY ORGANIZATION

www.mro.net/about/hero/

HERO
HIGHLY EFFECTIVE RELIABILITY ORGANIZATION

Upcoming Event Dates

- MRO SAC Network Exposure Analysis Webinar – June 8, 2023 10 a.m. – 11 a.m. Central CDT
- MRO CMEPAC Good Catch Program Webinar – June 12, 2023 10 a.m. – 11 a.m. CDT
- MRO 2023 Regional Summer Assessment (RSA) Webinar – June 29, 2023 10 a.m. – 11 a.m. CDT
- MRO CMEP Conference – July 26, 2023

Disclaimer for organizational group hosted events or materials

Midwest Reliability Organization (MRO) is committed to providing outreach, training, and non-binding guidance to industry stakeholders on important industry topics. Subject Matter Experts (SMEs) from MRO's organizational groups and the industry may develop materials, including presentations, provided as a part of the event. The views expressed in the materials are those of the SMEs and do not necessarily express the opinions and views of MRO.

MIDWEST RELIABILITY ORGANIZATION

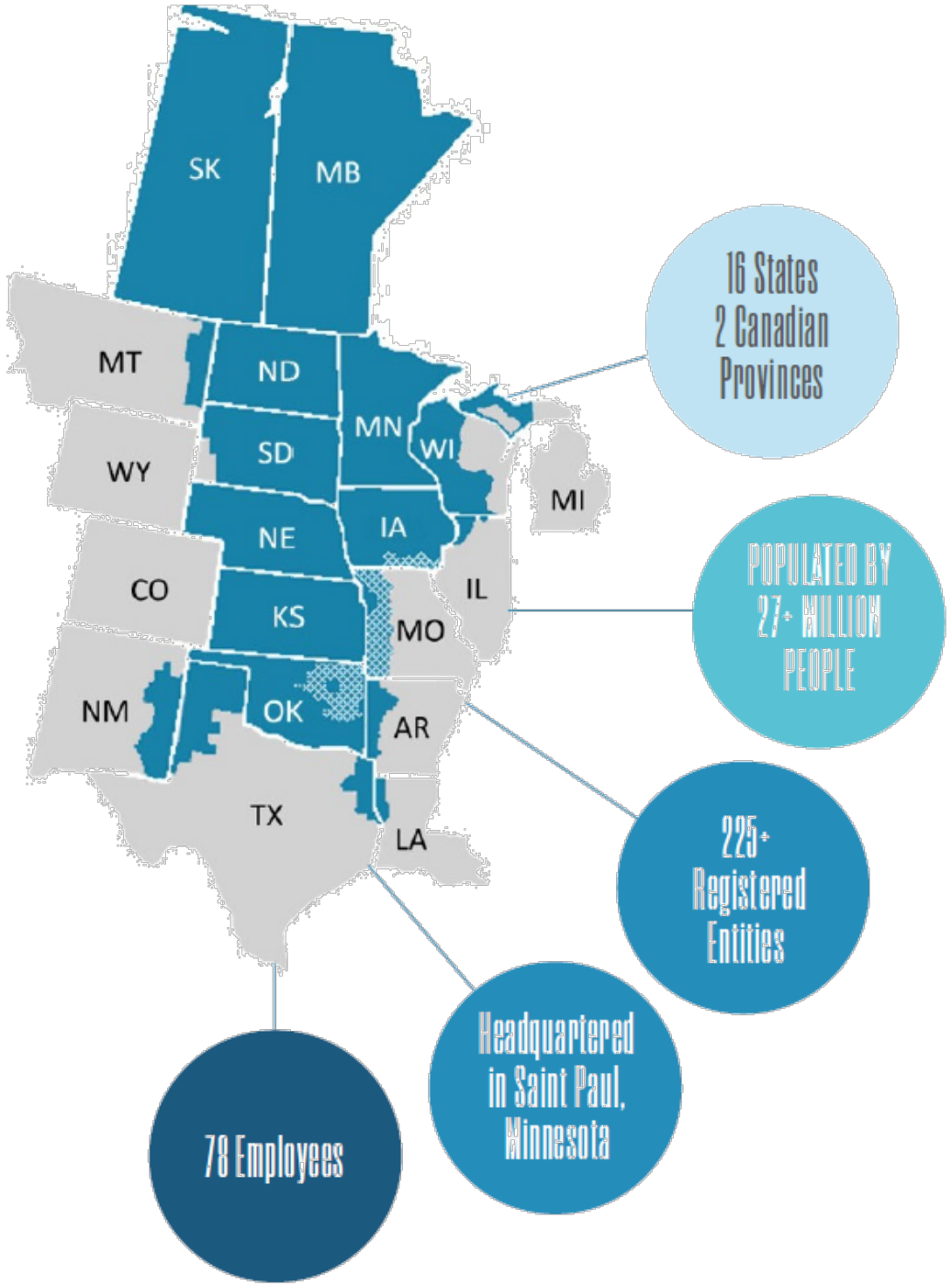
MRO 2023 Annual Reliability Conference

Bryan Clark

Director of Reliability Analysis

CLARITY | ASSURANCE | RESULTS

About the MRO Region



Electric Reliability Organization: Reliability Risk Mitigation Toolkit

Reliability Guideline

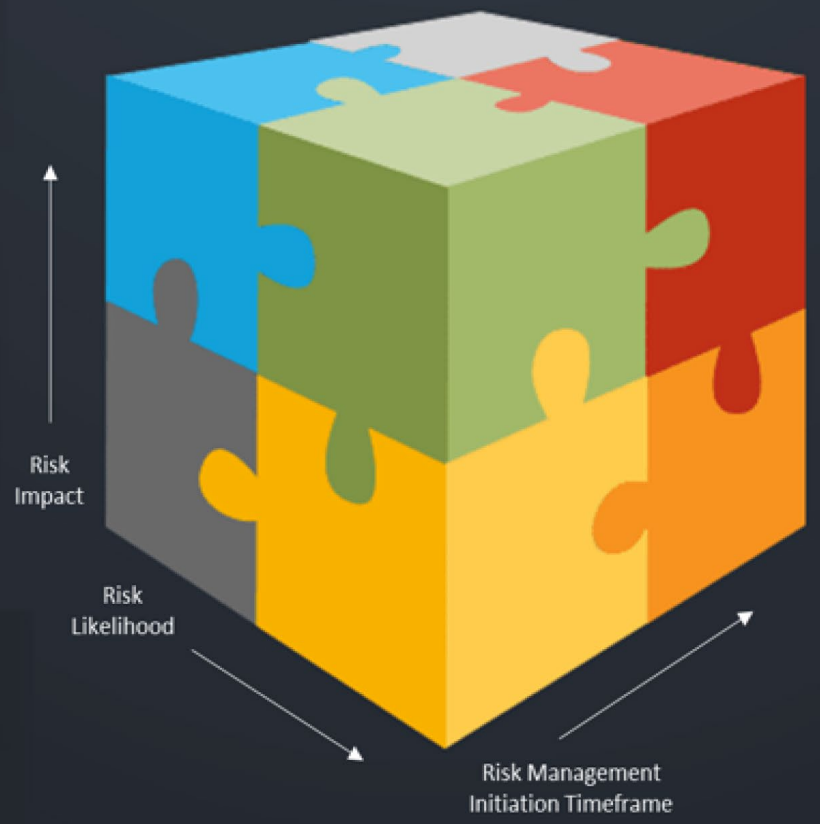
Suggested approaches or behavior in a given technical area for the purpose of improving reliability. Guidelines are not enforceable, but may be adopted by a responsible entity in accordance with its own policies, practices, and conditions.

NERC Alert: Level 2-3

NERC alerts are divided into three distinct levels, 1) Industry Advisory, 2) Recommendation to Industry, and 3) Essential Action, which identifies actions to be taken and require the industry to respond to the ERO.

Technical Engagement

Technical Engagement is a catch-all for a variety of technical activity that is conducted between the ERO and entities. This includes, technical committee activities, technical reference documents, workshops and conferences, assist visits, joint and special studies, etc.



Reliability Standards

NERC Reliability Standards define the mandatory reliability requirements for planning and operating the North American BPS and are developed using a results-based approach focusing on performance, risk management, and entity capabilities.

Reliability Assessment

NERC independently assesses and reports on the overall reliability, adequacy, and associated risks that could impact BPS reliability. Long-term assessments identify emerging reliability issues that support public policy input, improved planning and operations, and general public awareness.

NERC Alert: Level 1

NERC Alerts are divided into three distinct levels, 1) Industry Advisory, 2) Recommendation to Industry, and 3) Essential Action, which identifies actions to be taken and require the industry to respond to the ERO.

2023 RAC Work Plan

- Conduct outreach and awareness
- Provide support for Reliability Standards
- Support regional representation of NERC organizational groups
- Review the summary of misoperations across the MRO region

RAC Support

- MRO regional seasonal assessments
- Ranking of regional risks
- MRO Regional Risk Assessment
- Newsletter articles, conferences and webinars

MIDWEST RELIABILITY ORGANIZATION

Maintaining a Reliable and Secure Regional Bulk Power System

Richard Burt, Senior VP and COO

CLARITY | ASSURANCE | RESULTS

(No Model.) 2 Sheets—Sheet 1.

N. TESLA.

ELECTRICAL TRANSFORMER.

Patented Nov. 2, 1897.

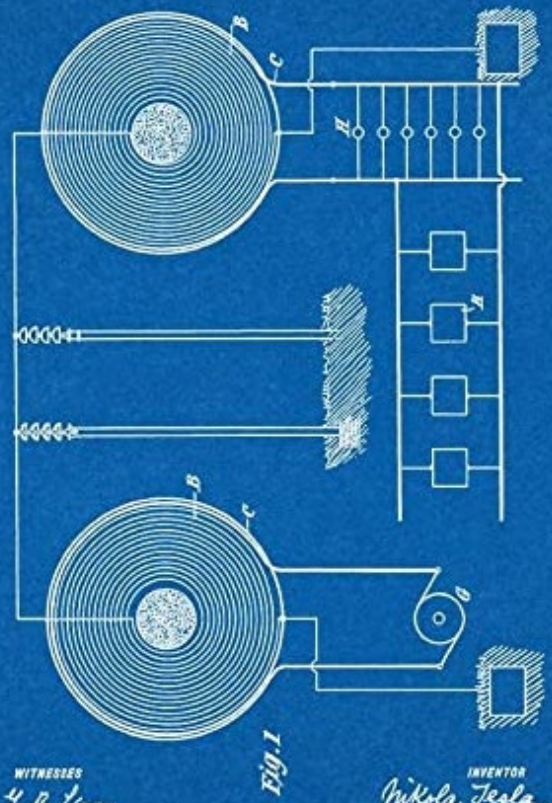


Fig. 1

WITNESSES

H. B. Lyon.

Edwin B. Hopkinson.

INVENTOR

Nikola Tesla

BY

Kerr, Curtis & Page.

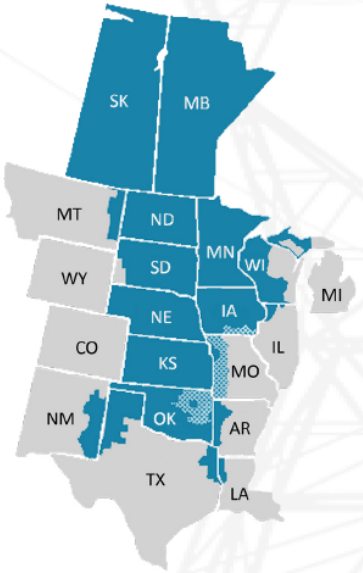
ATTORNEY

MIDWEST RELIABILITY ORGANIZATION

MRO 2023 Regional Risk Assessment

Top risks to the reliable and secure operation of the North American bulk power system in MRO's regional footprint.

Territory



About Us

As part of the ERO Enterprise, MRO is committed to a shared mission to identify, prioritize and assure effective and efficient mitigation of risks to the reliability and security of the North American bulk power system in its regional footprint.

Read more at www.MRO.net

MRO Reliability Risk Matrix: Risk Rankings

Consequence / Impact (C)		Likelihood (L) L1 Very Unlikely	L2 Unlikely	L3 Possible	L4 Likely	L5 Almost Certain
C5	Severe					
C4	Major				4,5,6,16	
C3	Moderate		2	9,12,13	1	
C2	Minor			3,7,8,10,14,17	15	
C1	Negligible			11		

LOW
MEDIUM
HIGH
EXTREME

Top risks are reflected in orange above and described below. A full list of risks assessed can be found in the final report.

Assessment Overview

- Extreme weather, consumer demand, and changes in technology and generation resources continue to present a rapidly increasing number of challenges to grid planners and operators. Physical and cyber security risks also continue to evolve at an unprecedented pace.
- MRO's annual *Regional Risk Assessment* considers continent-wide risks to reliability and security of the North American bulk power system and determines which are more likely to occur and would have a higher impact in MRO's region.
- This report is focused on risk identification, prioritization and mitigation and highlights for industry the priorities needed to collaboratively address these challenges. It also serves to inform key decision makers of challenges the industry faces and the policies and regulations that will help define a variety of proposed solutions.
- **READ MRO'S 2023 REGIONAL RISK ASSESSMENT**

Key Findings: Top Reliability and Security Risks in MRO's Territory

Model Assumptions

RISK 1. Assumptions used in bulk power models to plan and operate the grid have not accounted for the rapid increase in inverter-based and distributed energy resources, challenging industry's ability to accurately assess current and future system characteristics.

Planning Reserves

RISK 4. Traditional methods to calculate Planning Reserve Margin are inadequate to properly plan for the generation capacity needed to meet increasingly uncertain system operations, especially during extreme weather events.

Energy Reliability

RISK 5. Increased uncertainty from changing energy supply and customer demand challenge the grid's ability to meet load for all hours of the year. There is no comprehensive planning that assesses assurance of available energy and fuel sources over all time periods to maintain grid reliability.

Generation Unavailability

RISK 6. Generation availability assumed during cold weather, particularly in the southern U.S., has been shown to be unrealistically high due to a lack of generation winterization and natural gas curtailments.

Transmission Line Ratings

RISK 12. Use of constant overhead transmission line ratings year-round (non-seasonal) limits available transmission capacity and leads to inefficient real-time decisions when system conditions deviate from assumptions that drive rating calculations, such as cooler temperatures or during emergency operations.

Insider Threats

RISK 9. Employees or contractors using their knowledge and authorized access of critical systems to do harm to the bulk power system is a continued, substantial threat to organizations and the reliability of the grid.

Malware/ Ransomware

RISK 13. Phishing attacks can introduce malware or ransomware to corporate IT systems, which can impact critical systems necessary for reliable bulk power system operations through direct or in-direct connections those systems have to IT networks.

Supply Chain Compromise

RISK 16. A cyber security event carried out through the vendor supply chain can broadly impact bulk power system reliability, especially where the vendor is a market leader providing systems used for system operation.

Form Energy Multi-day Energy Storage and Pilot Project with GRE

Andrew Rapin

MRO Presentation

May 17, 2023

Form energy

Energy Storage
For A Better World

Rising to the challenge of climate change with a team that will deliver

LED BY ENERGY STORAGE VETERANS

Decades of cumulative experience in energy storage

- 100's of MW of storage deployed

OUR INVESTORS: LONG-TERM AND IMPACT-FOCUSED

$820M+ in venture capital from top investors including: Breakthrough Energy Ventures (BEV), TPG's Climate Rise Fund, Coatue Management, GIP, NGP Energy Technology Partners III, ArcelorMittal, Temasek, Energy Impact Partners, Prelude Ventures, MIT's The Engine, Capricorn Investment Group, Eni Next, Macquarie Capital, Canada Pension Plan Investment Board, and other long-term, impact oriented investors

The Challenge

The Challenge

The electrical grid needs to fundamentally transform to meet the challenges posed by climate change

Intermittency of renewable assets create periods of undersupply

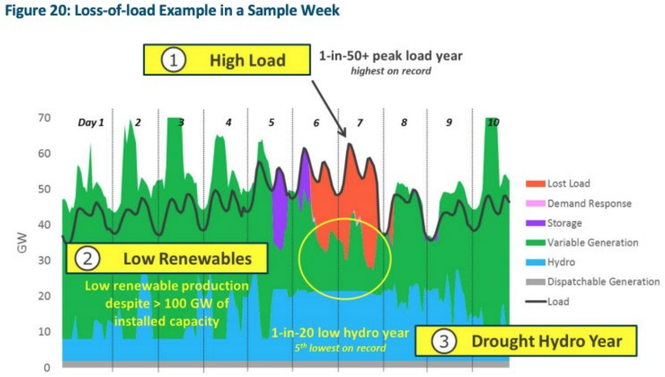
Carbon mandates require retirements and risk stranding fossil assets

Extreme weather events become more frequent and disruptive to customers

Increased transmission congestion and long interconnection queues

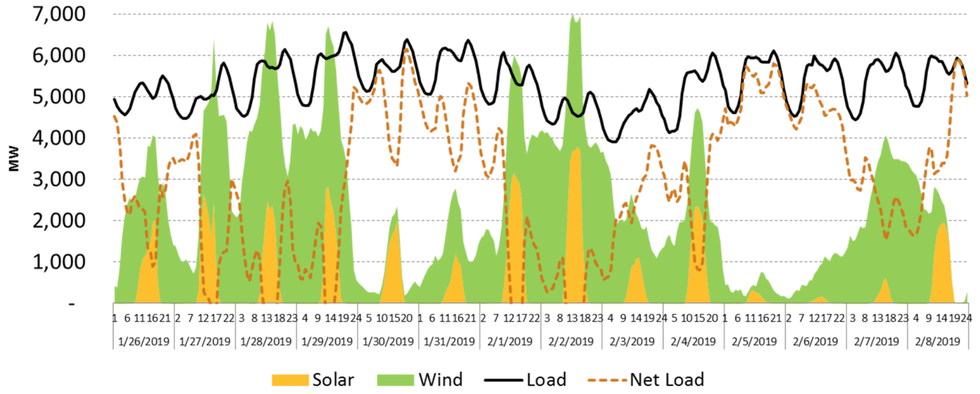
Weather-driven multi-day reliability challenges are universal

Pacific Northwest Multi-Day Weather Event, 2050



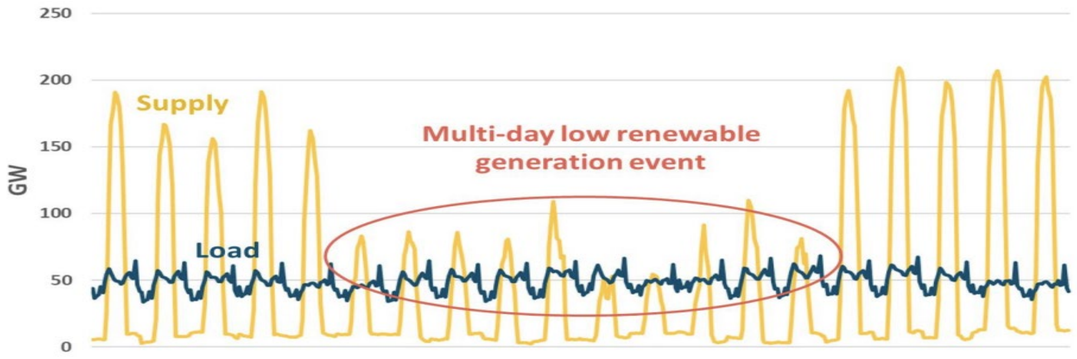
Source: E3, Resource Adequacy in the Pacific Northwest

Upper Midwest Multi-Day Weather Event in Winter, 2019



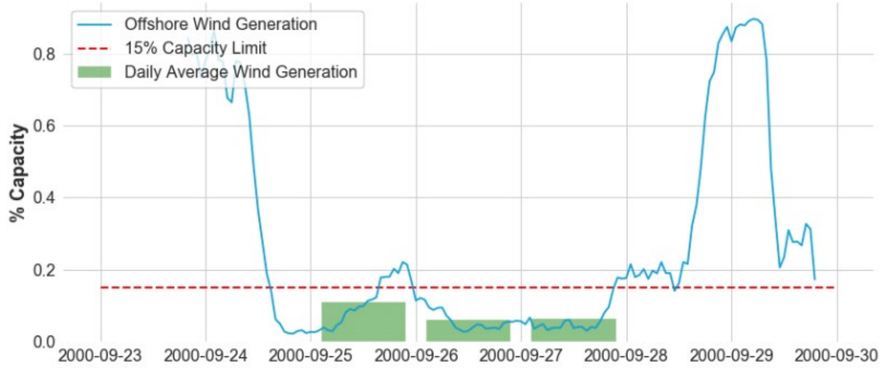
Source: Xcel Energy 2020 - 2034 Upper Midwest Resource Plan, May 20, 2019 Workshop

California Multi-Day Weather Event in Winter, 2050



Source: E3: Long-Run Resource Adequacy Under Deep Decarbonization

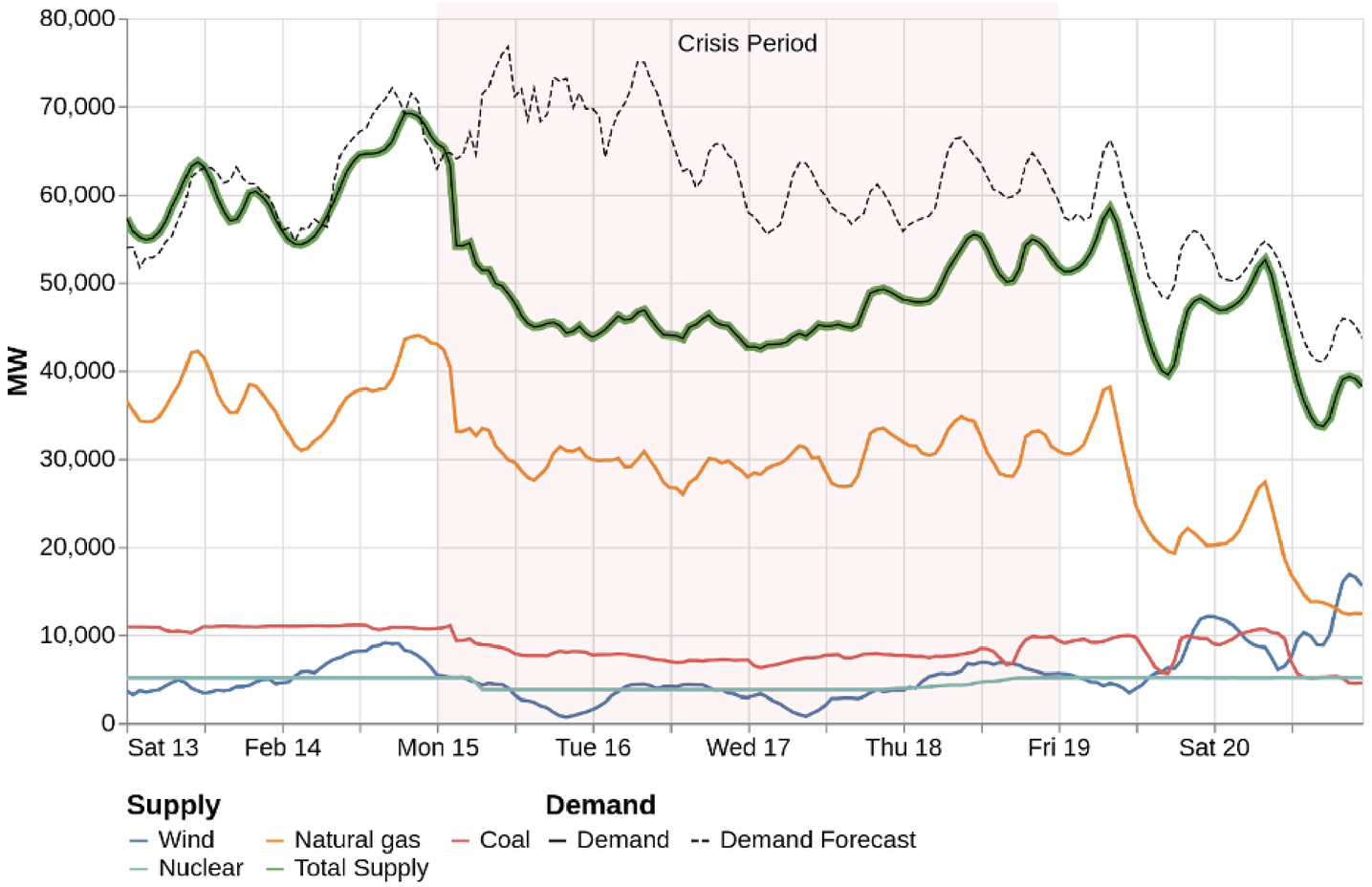
New England Multi-day offshore wind lull, 2000



Source: DNV-GL Analysis of Stochastic Dataset for ISO - NE

A Texas snapshot

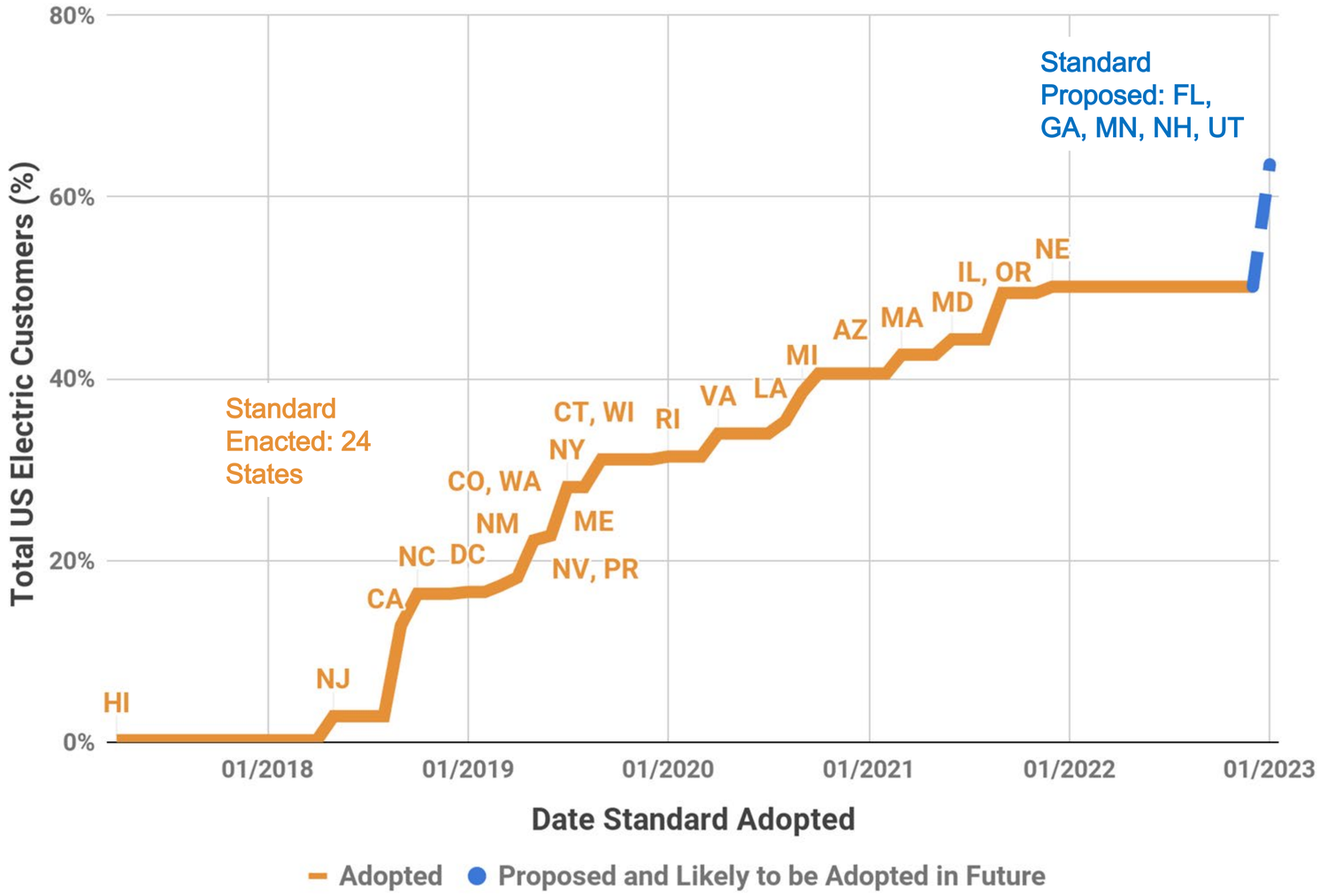
ERCOT Market Supply and Demand, February 2021



- **Supply shortage:** 30GW of expected generation disappeared.
- **Cost to system:** >$30B in extreme energy prices and >$50B in damages.
- **Solution:** At $10/kWh capex, multi-day storage could have provided all firming required to make Texas 100% renewable and reliable

U.S. state clean energy standards are changing quickly

US Electric Customers in States with 100% Clean Energy Standards



- 50% of Americans live in a state that requires 100% clean energy
- An additional 15% are likely to be covered in the near future.

Influential studies and early procurements signal the need/desire for long-duration storage solutions

LDES has gone from projected need in 2020…

gtm: Solar Grid Edge Storage Wind Trending Podcasts White Papers Webinars

ENERGY STORAGE

California Could Need 55GW of Long-Duration Storage to Meet Its 2045 Carbon-Free Grid Goal

A new study calculates a drastically higher need for long-duration storage than state officials had recognized.

JULIAN SPECTOR | DECEMBER 09, 2020

As solar comes to dominate California's electricity supply, long duration storage will become increasingly valuable, a new study contends.

…to deployable asset in 2022

UTILITY DIVE Deep Dive Opinion Podcasts Library Events

DIVE BRIEF

Long-duration energy storage has attracted more than $58B in global commitments since 2019: WoodMac

Published Dec. 12, 2022

Stephen Singer
Editor

The Solution

Form reinvented a decades-old Iron-Air chemistry for 100hr+ durations

1960s:
NASA/GTE
Earliest known work on Fe-air

2010s: Academic Interest in Fe-air revitalized in US and Europe
Projects motivated by 1-2 hour duration EV and daily cycling grid storage applications

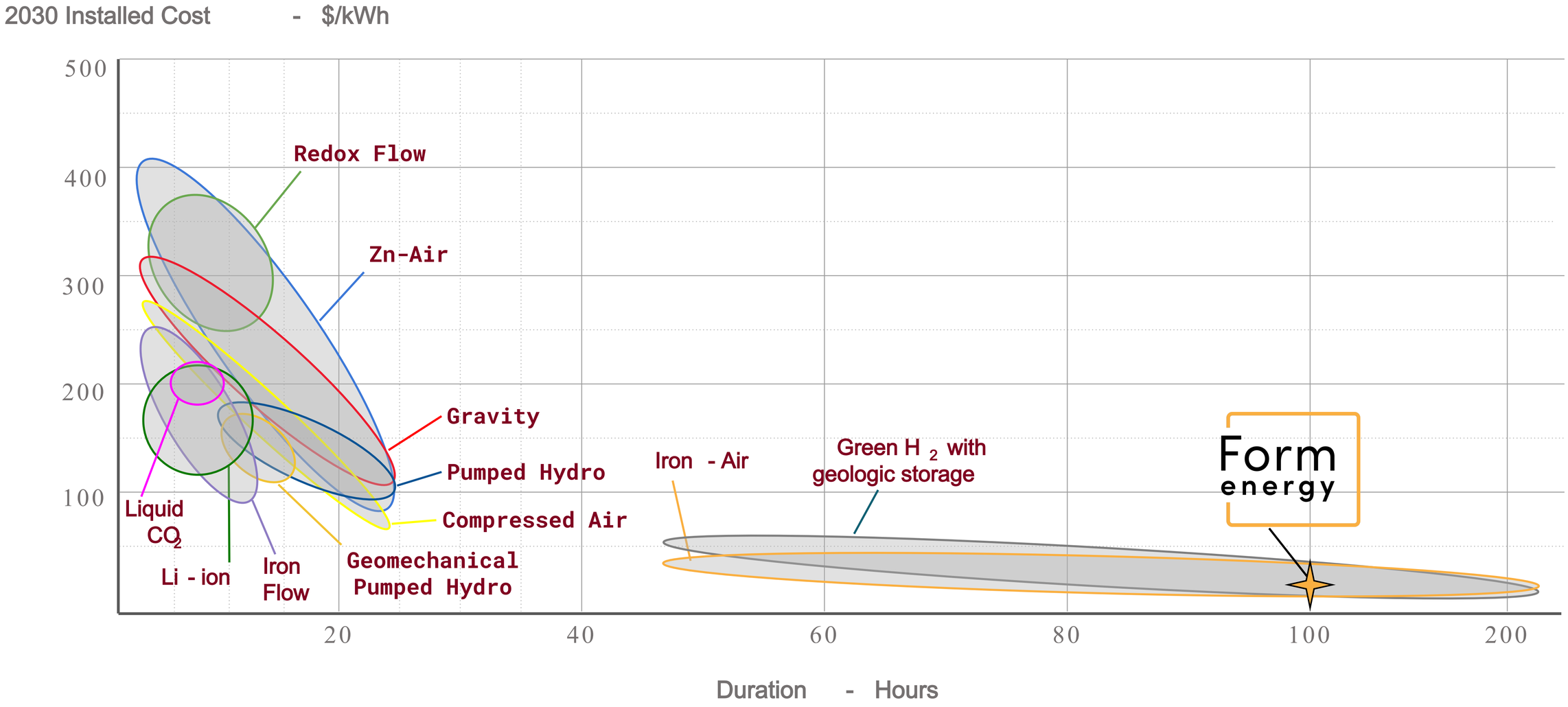
1970 1980 1990 2000 2010 2020

Late 1970s: Siemens, Westinghouse and Swedish National Development Co.
Industrial R&D programs on Fe-air batteries for automotive applications with target durations of 1 -7 hours. Fe-air beat in the market by valve-regulated lead-acid (VRLA) + internal combustion engine.

2018: Form Energy Selects Iron-Air
Iron-air provides best cost and performance entitlement for **low-cost, multi-day storage** application

Form energy

Form MDS is the only technology targeting multi-day duration without geographic constraints



Accelerating progress towards a decarbonized grid

2017

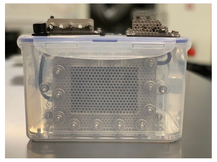
- Form Energy spun out of MIT and founded to address multi-day energy storage technology gap

2018

- Iron-air technology selected after exhaustive technology evaluation and downselection effort
- $4M ARPA-E award

2019

- Key iron-air cell performance proof points demonstrated at laboratory scale (~100 cm^2)



2020

- 1.5MW Pilot Project with GRE announced
- $2M CA Energy Commission award
- Large-format testing (>3,000 cm^2)
- Acquired NantEnergy air cathode IP

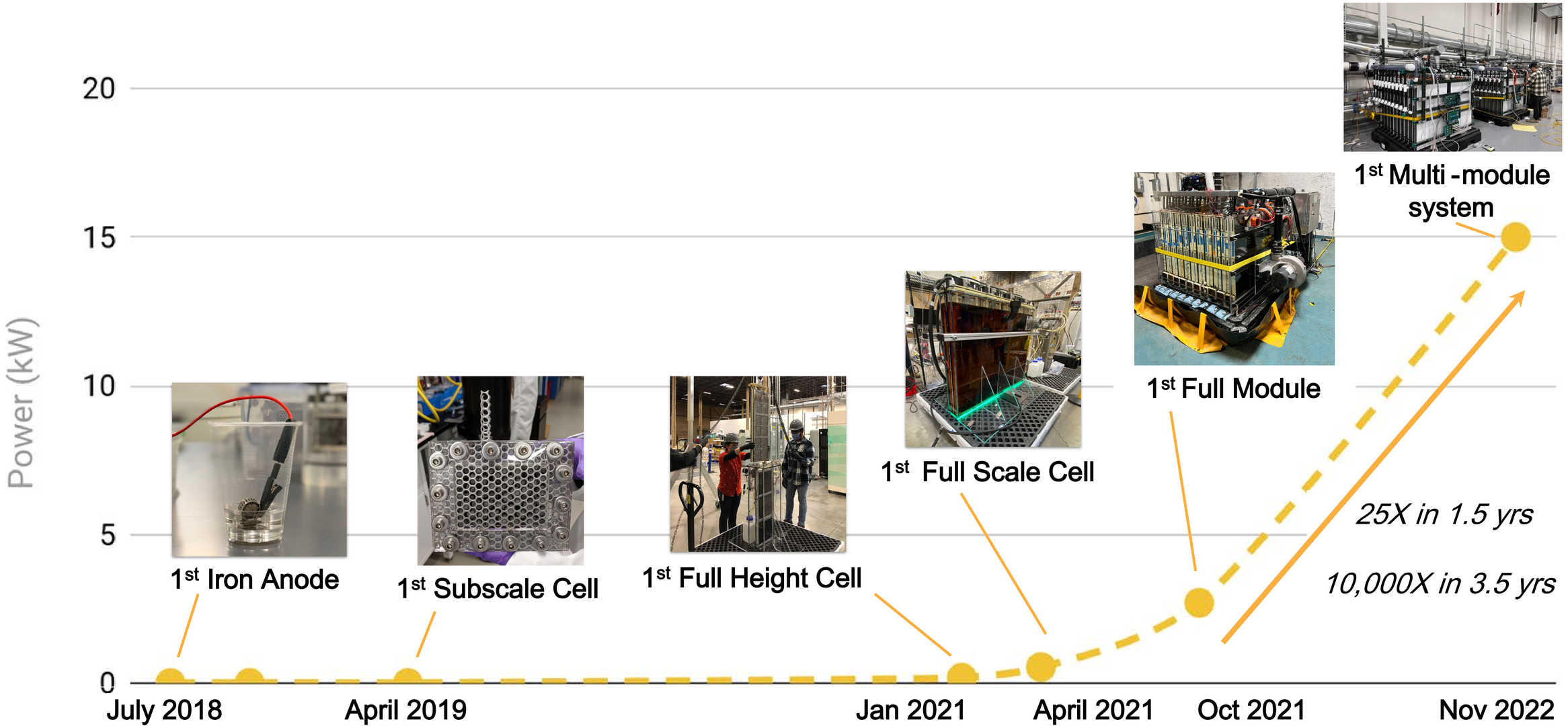
2021

- $240M Series D, led by ArcelorMittal
- First module (>1m^3) on test
- First production scale electrode from pilot manufacturing facility

2022

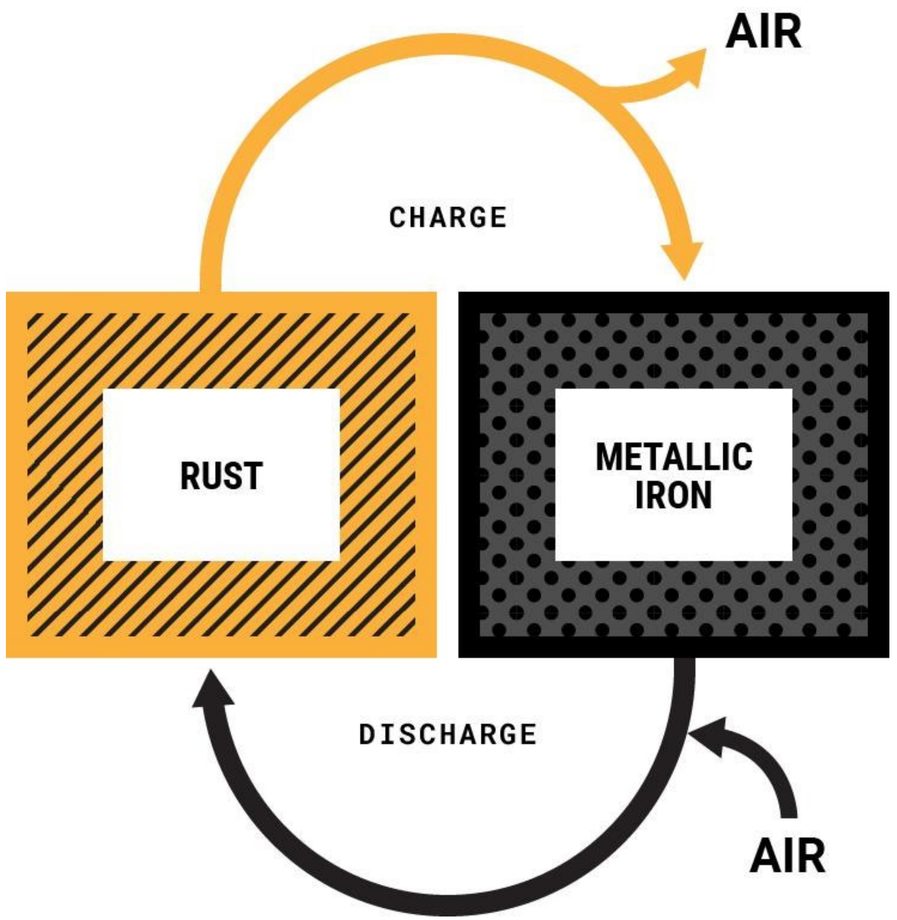
- Up to 15 MW Pilot Project with Georgia Power announced
- $450M Series E, led by TPG Rise
- First multi-module system on test
- 500MW/yr production site selection process initiated

Form Energy has been able to rapidly scale our iron-air technology



Rechargeable iron-air is the best technology for multi-day storage

Reversible Rust Battery



COST

Lowest cost rechargeable battery chemistry.
Chemistry entitlement <$1.00/kWh

SAFETY

No dendrite formation (unlike li-ion)
Non-flammable aqueous electrolyte

SCALE

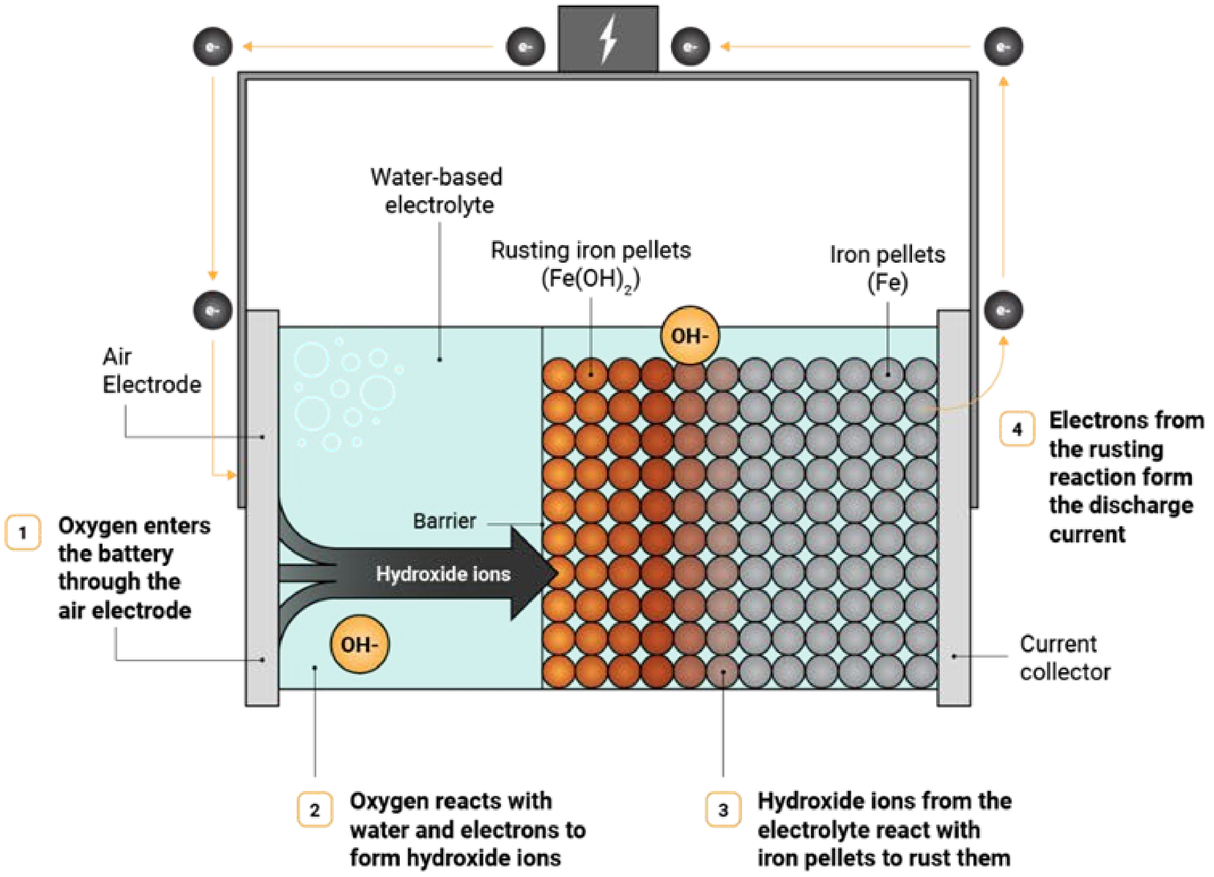
Iron is the most globally abundant metal
Easily scalable to meet TW demand for storage

DURABILITY

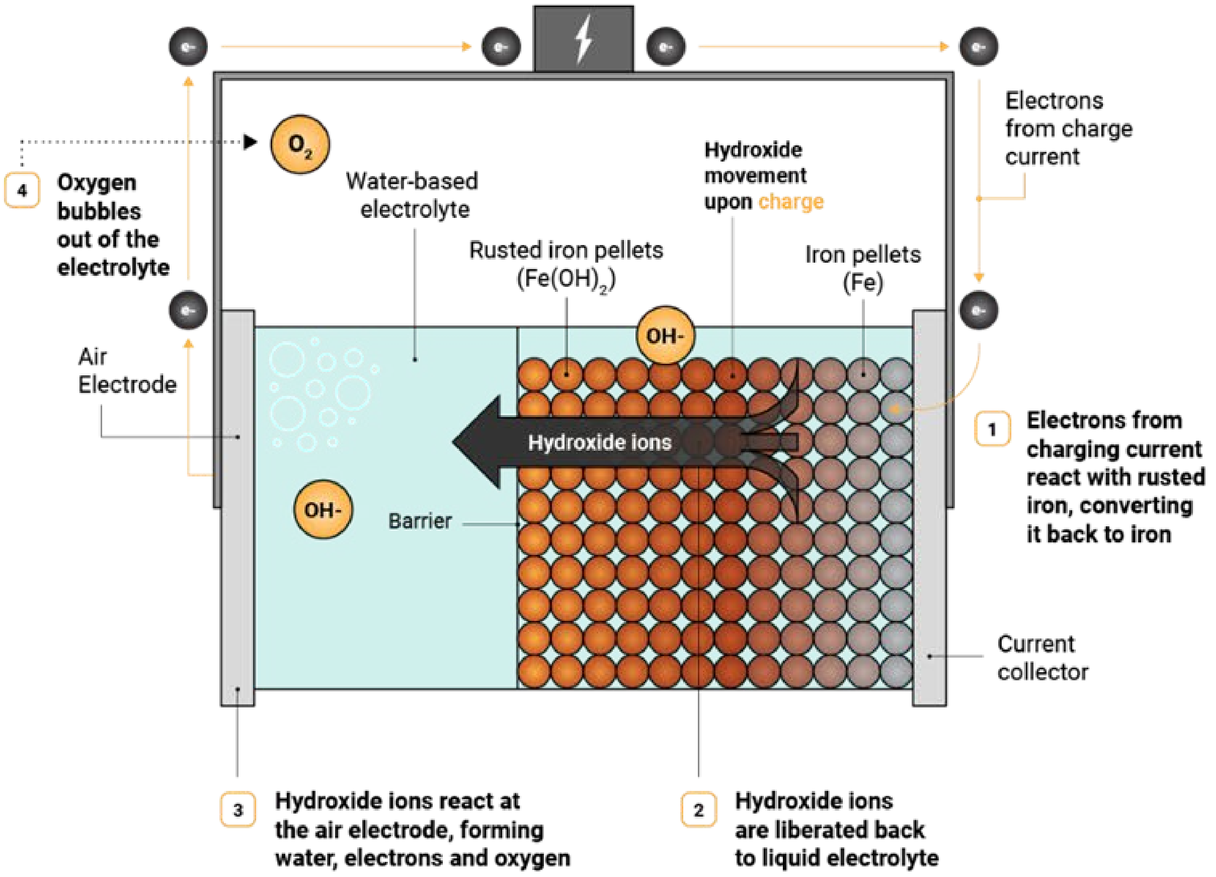
Iron electrode durability proven through decades of life and 1000's of cycles (FeNi)

Iron-Air Principle of Operation: "Reversible Rust"

Discharge



Charge



Form Energy's iron-air battery leverages lowest-cost iron materials from the steelmaking supply chain

Iron Ore

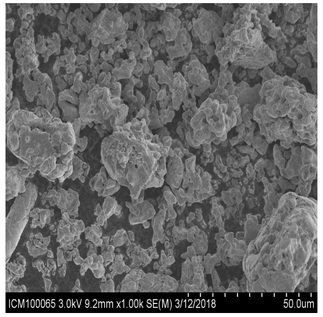
Fe-ore Pellets

Direct Reduced Iron (DRI)

Hot Briquetted Iron (HBI)

Pig Iron

Atomized / Sponge / Carbonyl Irons



More oxidized
Higher impurities
Lower cost

More metallic
Lower impurities
Higher cost

Direct Reduced Iron (DRI) is the lowest cost form of metallic iron

Form Energy's Iron-Air system uses an inherently safe chemistry and is designed to highest safety standards

Inherent Safety of Iron Air

SAFE COMPONENTS

Non-flammable materials, no heavy metals
Iron, air, & alkaline water-based electrolyte

NO DENDRITES

No mechanism for internal short-circuit due to dendrite formation

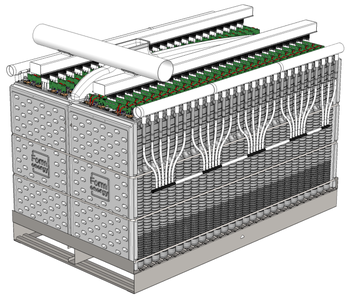
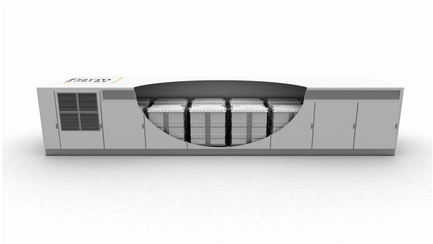
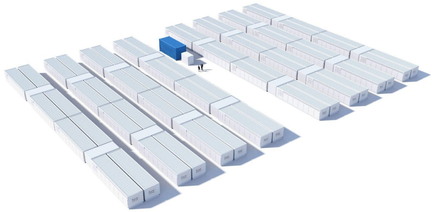
System Standards & Features

- **Target Certifications**
  - *Battery: NRTL certified to UL 1973*
  - *ESS: NRTL certified to UL 9540; UL 9540A tested*
  - *Inverter: IEEE 1547; UL 1741*
- **Design Safety Codes & Standards**
  - *Installation: NFPA 855*
  - *Electric: NFPA 70 (NEC)*
  - *Fire/Building: NFPA 1; IBC 2021, IFG 2021*
- **System Safety Features**
  - *Monitoring, detection, alarms at BMS*
  - *Redundant fault detection & mitigation*
  - *Containment at cell, module, & system*
  - *Exhaust system coupled to modules & enclosure*

Product

What makes up a Form Energy system

Modular design enables easy scaling to GWh systems

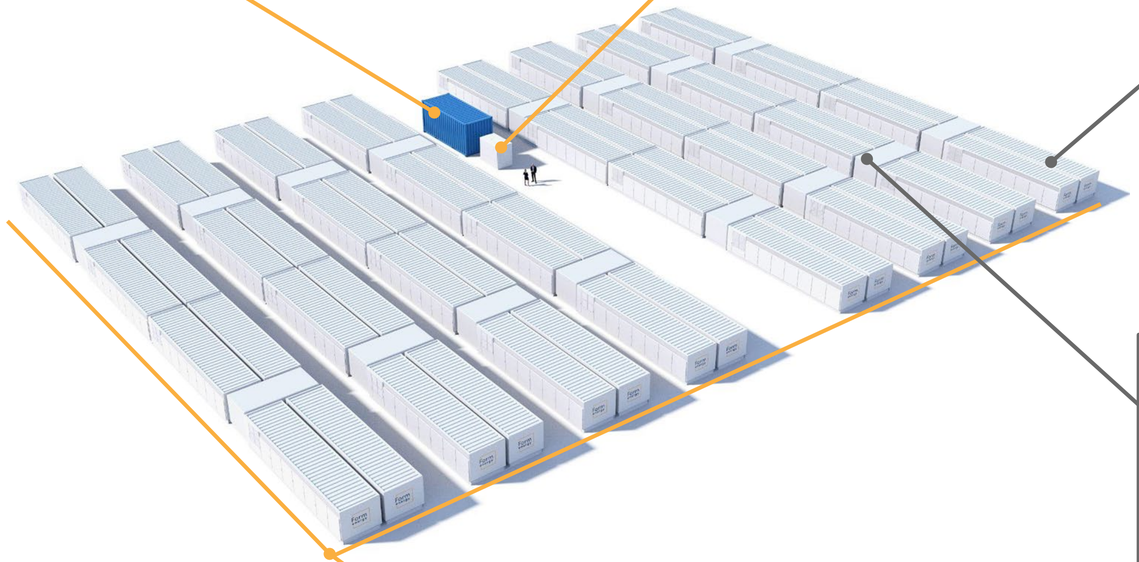
Cell	Battery Module	Enclosure	Power Block	System
				
~0.10 kW / 10 kWh	**~5 kW / 500 kWh**	**~50 kW**	**~3.5 MW / 350 MWh**	**100+ MW / 10 GWh**
~3.3’ x 2.0’	~7.5' x 4.3’ x 4.3’	8.5’ x 40’	<2 acres	50+ acres
Electrodes + Electrolyte	~50 **Cells**	~10 **Modules**	~50 - 100 **Enclosures**	10s - 100s of **Power Blocks**
Smallest **Electrochemical** Functional Unit	Smallest Building Block of **DC** Power	Product Building Block with **integrated module auxiliary systems**	Smallest independent system and **AC Power** building block	Commercial Intent System

What makes up a Form Energy system

Sample 3.5 MW Power Block

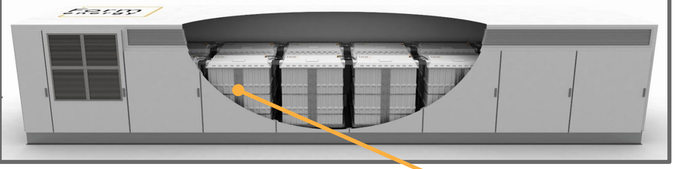
Water treatment skid
(optional water storage not shown)

2-4 MW Inverter



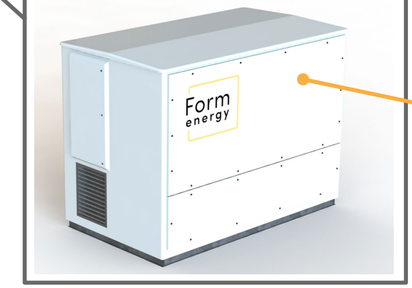
~200 ft
(2-3 MW/Acre)

50 kW Battery Enclosure



~10x battery modules per enclosure

Auxiliary Enclosure



Each Auxiliary enclosure houses supports air & water management systems of 4 Battery Enclosures

Form Energy Multi-Day Storage delivers grid-scale reliable capacity year-round

System Performance: Commercial Launch

Rated AC System Power	10 - 500+ MW
System Capacity	1 - 50 GWh
Repeatable Power Block	3.5 MW / 350 MWh
Discharge Duration	100 hr
Round Trip Efficiency*	35-38%
Ramp (offline to full power)	< 10 minutes
Areal Energy Density	> 200 MWh/acre
Operating Temperature	-40°C to 50°C
System Lifetime	20 years

**AC-AC round-trip efficiency, full charge and full discharge at rated power; inclusive of losses from power conversion and auxiliary loads*

Commercialization

First pilot project is contracted

- **Partner:** Great River Energy
- **Location:** Cambridge, Minnesota
- **Size:** 1.5 Megawatt, 150 Megawatt-hours
- **Online Date:** 2024

Over 3 GWh of Commercial Engagements

Partnering with Great River Energy to deploy a first-of-its-kind **1.5 megawatt/150 megawatt hour** multi-day energy storage project in Cambridge, Minnesota in 2024

"Great River Energy is excited to partner with Form Energy on this important project. Commercially viable long-duration storage could increase reliability by ensuring that the power generated by renewable energy is available at all hours to serve our membership," said **Great River Energy Vice President and Chief Power Supply Officer Jon Brekke.**

Collaborating with Georgia Power on a project application of **up to 15 megawatts/1,500 megawatt hours (MW/MWh)** of energy storage systems to be located in the utility's service area

"At Georgia Power, we know that we must make smart investments and embrace new technologies now to continue to prepare for our state's future energy landscape," said **Chris Womack, Chairman, President and CEO of Georgia Power.** "We're excited to have Form Energy as a partner to help us build on Georgia's solid energy foundation."

Partnering with Xcel Energy to deploy **two 10 MW / 1,000 MWh** multi-day storage systems; one in Becker, MN and one in Pueblo, CO. Both projects are expected to come online as early as 2025

"As we build more renewable energy into our systems, our partnership with Form Energy opens the door to significantly improve how we deliver carbon-free energy so that we can continue to provide reliable and affordable electric service to our customers well into the future." said **Bob Frenzel, Xcel Energy President and CEO.**

Form Energy's path to transform the global grid

2023/2024

- **Prove Technology at Scale**
- 1-5 MW scale projects
- Demonstrate value in real world environment

2025/2026

- **Initial Commercial Projects**
- 10-50 MW scale projects
- Demonstrate bankability

2027/2028

- **Full Scale Installations**
- 50-100+ MW scale projects
- Bankable utility scale asset

2030s

- **Deep Decarbonization**
- GW-scale projects
- Meet carbon goals and manage risk

Piloting → **Scale - Up** → **Expansion** → **Global Transformation**

30 years after commercial availability, global lithium-ion manufacturing capacity was 500 GWh/yr in 2020.

Form Energy will achieve that scale by 2030.

Thank you

OG&E

We Energize Life

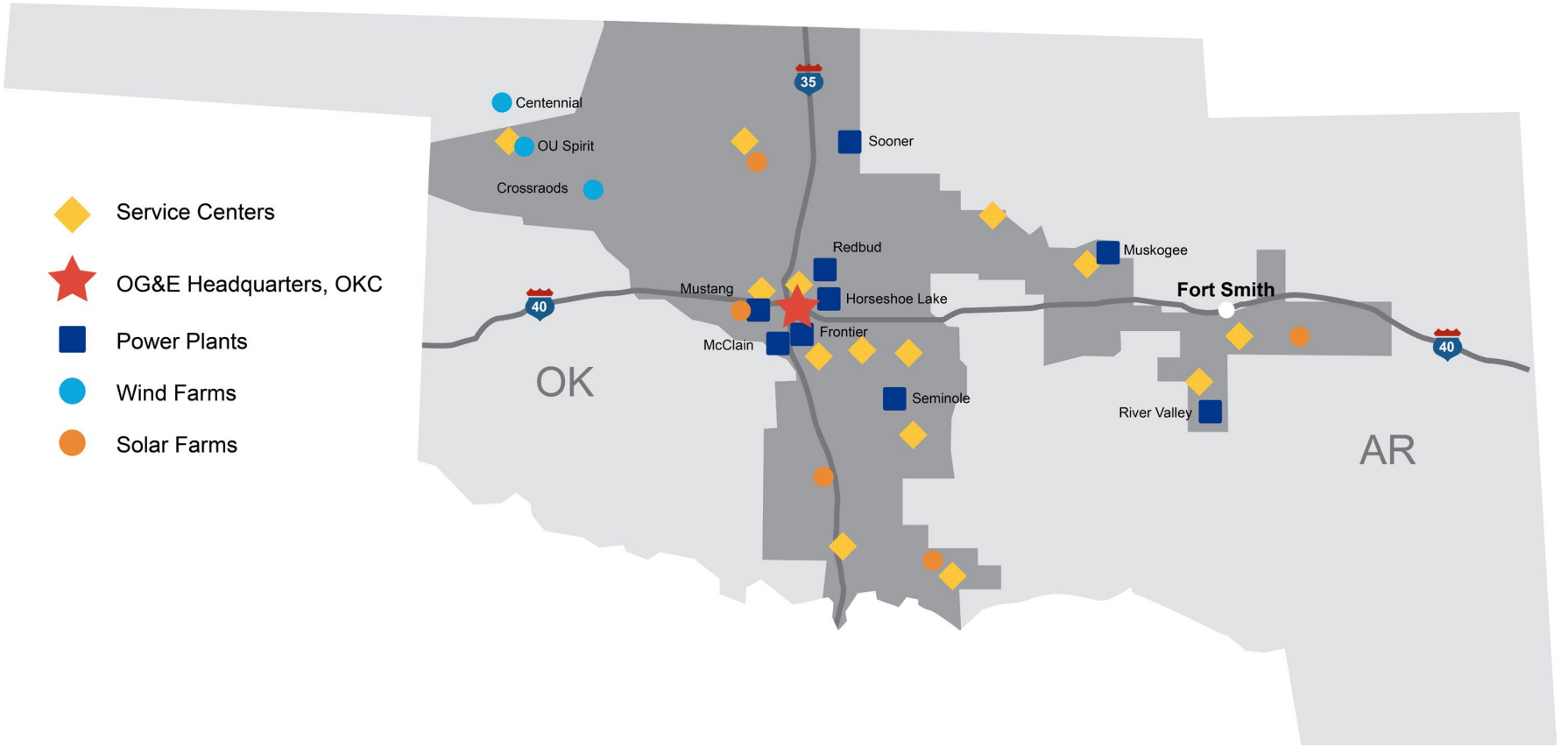
Operational Resiliency in Response to Emerging Security Threats

Bob Taylor – Mgr Emergency Preparedness – Oklahoma Gas and Electric

May 2023

About OG&E

- Since 1902
- 2,185 Members
- 887,000 customers
- 30,000 square mile distribution system
- 7,200 MW Generation Capacity



Operational Resiliency

How we respond to an event

Incident Response Maturity

Incident Command Structure

Began using Incident Command System in 2007.

Added Enterprise Event Management Team and Executive Response Team in 2017

Workstreams to Address Challenges

Incident Reporting, Escalation, and Notification

Risk Informed Dispatch

Updated Incident Response Plans

Rapid Response Team

Spare Parts Strategy

Risk Informed Facility Design

Incident Reporting, Escalation and Notification

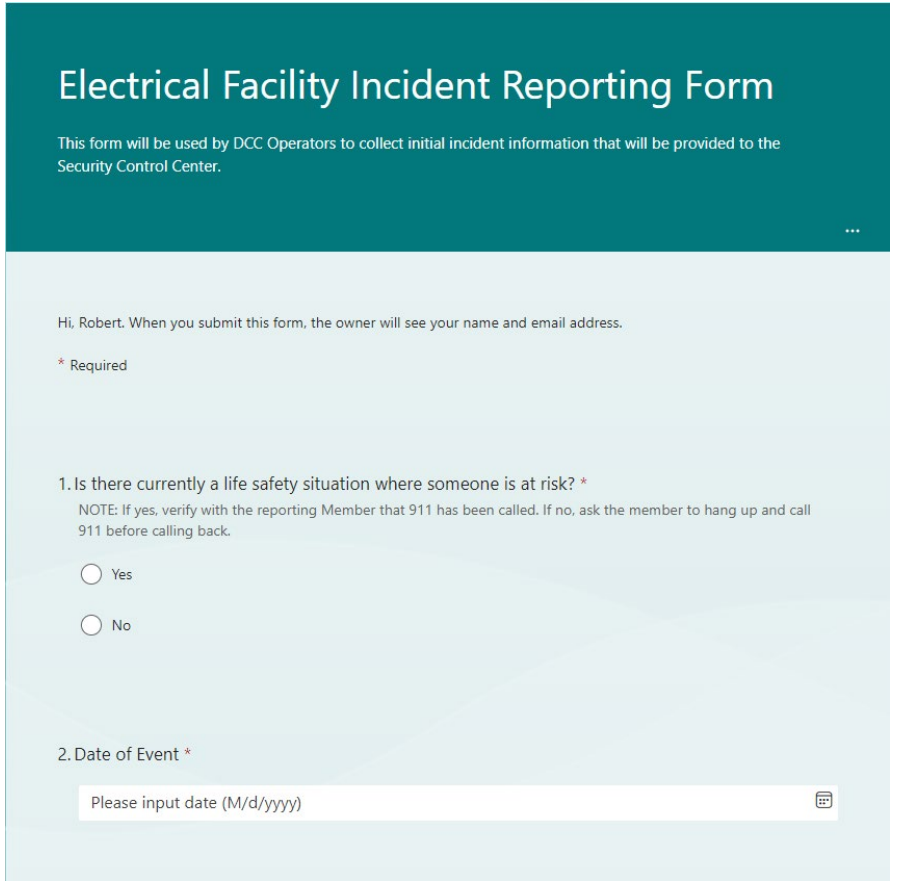
Working with those that have access to Substations to recognize what needs to be reported

“If you see something, say something”

Electronic Reporting tool will capture important info and pass along to Security Control Center

- This may drive further investigation or the need for local law enforcement to respond

Reporting will generate data for security team to better track trends on our system



Risk Informed Dispatch

What information do our control centers have access to in order to better inform our field members what situation they are heading to

- What can the SCADA network tell us?
- Review security camera footage for any activity

Updated Incident Response Plans

Using current ICS structure to help respond faster and keep more parties informed

- Mass Notification Tool
- Pre-defined meeting attendance and meeting cadence
- Quick Reference Annex's to know what to do

Rapid Response Teams

Tasked to look at “What Now” after outage has been addressed?

- Additional Security Needed at other facilities?
- Look at Seasonal Loading and firming studies to make sure system configuration will hold until return to normal
- What does our Spare Parts inventory look like?
- Are Critical Customers at higher risk now?
- Is there a potential impact to any neighboring Utilities?

- Tabletops to Exercise Team

Spare Parts Strategy

Looking at quantity and location of spare parts inventory

- Should items be stored centrally or dispersed?
- Do we need to adjust critical spares due to increased threat?
- Looking more into STEP, RESTORE, and Grid Assurance Programs

Risk Informed Facility Design

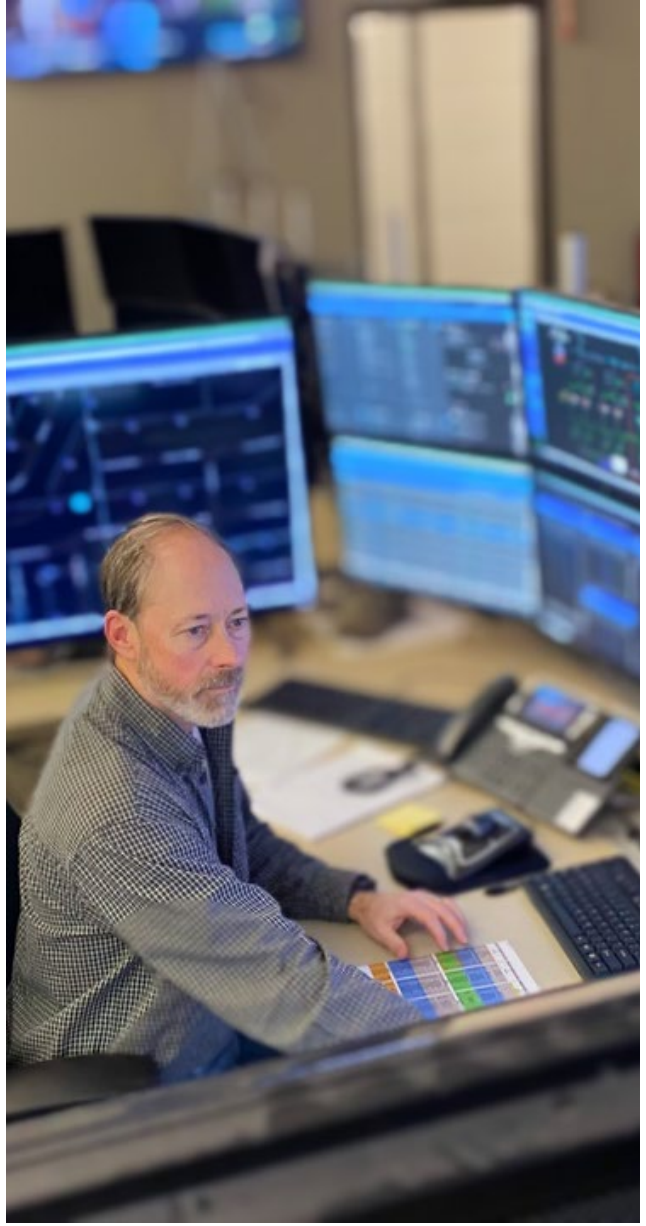
What can we do to design resiliency into our new subs or other facilities?

- Better security?
- Better fencing?
- More SCADA/Data feeds to help with response?

OG&E

We Energize Life

Questions



Human Performance Improvement & Substation Operations

Gary Riibe Jr.

Substation Operations Manager-West

MIDAMERICAN ENERGY COMPANY®

My Background

- From Sioux City, Intern with MEC (Sub Ops, Thermal Gen)
- Graduated U of Neb-Lincoln in Electrical Engineering, Dec 2002
- Started w/ MEC at Davenport in Substation Engineering, Jan 03’
  - Played fantasy football 2003-2005 and met many MEC employees
- Transferred to Substation Operations 2006 at Council Bluffs
  - Supervisor of a team of substation electricians and techs to complete compliance tasks, projects and job packages in SW Iowa
    - (like a fantasy roster, who are the “sleepers”, “must starts” and PUPs each week)
- Transferred to Sioux City, Sub Ops in 2011
  - Back to engineer for a bit, 2014 the manager of NW an SW Iowa
  - Met a new team in SC, they were somewhat the same but different than the team in Council Bluffs

Understanding People and Their Differences

- Around this time, I thought that **parts** of people are the same
  - These **parts** come together to make up who they are, their personality
  - Different parts, make a different person…and different personalities
    - Part of Person A + part of Person B + part of Person C = Person Z
    - Could be a totally different person that any of A/B/C
- In connecting my “Ideation” strands, this shows diversity among people of similar ethnicity/race/gender/etc.…we are all different and the same!

Clifton Strengths (34 of them)

- Jan 2020 I completed a Clifton Strengths assessment
  1. Arranger:
     - Can organize but have flexibility. Likes to figure out how to arrange for maximum productivity
  2. Ideation:
     - Fascinated by ideas. Able to find connections between seemingly disparate phenomena
  3. Positivity:
     - Contagious enthusiasm. Upbeat and can get others excited about what they will do
  4. Achiever:
     - Work hard and posses a great deal of stamina. Have satisfaction in staying busy and productive
  5. Developer:
     - Recognize and cultivate potential in others. Spot small improvements and derive satisfaction from this evidence of progress
  - Learned what these strengths meant about me and my team

Personal Importance Level

- What is it?
  - Imaginary number system used to understand level of interest and understanding in conversations

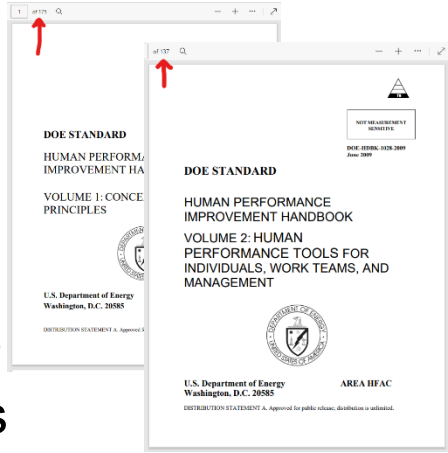
- How do we use it?
  - We'll look at the number above the listener's head when we're speaking and see if the other person cares or understands what we are talking about (improved interpersonal communication!)
  - If the number is low, give more details or be more interesting…if possible
  - If the number is high, they understand or care
  - If the listener sees that the speaker's number is high, they'd know when to listen or pretend to care about what the speaker is saying

Evolution of Human Performance

- 3/3/1979, born on my dad's birthday, same name, same work
  - Identity theft was created that same day (needs verified)
- 3/16/1979, **movie** about a core meltdown "*The China Syndrome*" that occurs at a power plant in California
  - China Syndrome: a nuclear meltdown scenario, so named for the fanciful idea that there would be nothing to stop the meltdown tunneling its way to the other side of the world (China)
- 3/28/1979, **Three Mile Island** in Middleton, PA has a *partial meltdown* of Unit 2 (TMI-2) reactor due to human error
  - The most significant accident in US commercial nuclear power history
  - By 12/1979, Institute of Nuclear Power Operations (INPO) was formed

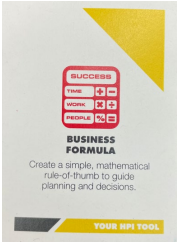
Evolution of Human Performance

- DOE developed Human Performance Manual (300+ Pgs., 2 Vol)
  - DOE was created in 1977, post 1973 oil crisis
- 5 Principles of Human Performance
  1. Error is normal. Even the best people make mistakes.
  2. Blame fixes nothing.
  3. Learning and Improving is vital. Learning is deliberate
  4. Context influences behavior. Systems drive outcomes
  5. How you respond to failure matters. How leaders act and respond counts.



MEC Commitment to Excellence (C2E)

- MEC, Part of BHE (which has NV Energy)
  - NV Energy started a C2E for company/union relationships
  - Tossed out all HR Disciplinary Logs
- 2023 marked 5 YR milestone with C2E
  - Annual meetings in DSM, baseball game, community improvement events, and multi-day meetings discussing progress, outcomes and goals of the company from union and company leadership
  - Weekly supervisor/steward meetings
  - Zero or nearly zero filed grievances in this period (from a couple 100)
- The importance of this? (See Principles of Human Performance)
  - Less blame, more feedback from front line, more encouragement/reinforcement by leaders, peers and direct reports



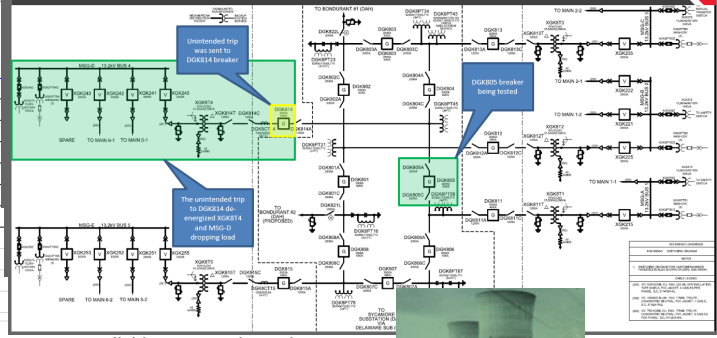
Evolution of Human Performance at MidAmerican

- MEC starts doing ‘NERC Testing’
- MEC Timeline:
  - 2012 MEC using ENOSERV
  - 2013 NERC testing starts Q4
  - 2014 full NERC testing year
  - 2016 *Deploy HPI Kits-Sub Ops
  - 2019 Written isolation plans req’d
  - 2020 Develop Standard Practices
    - For all parts NERC Testing (PRC-005)
  - 2021 HPI Champ Program (2019)
    - Created HPI Relay Testing eBook
  - 2022+ More champs, tool plans, etc.

Event Review & Learning (06/18/19)-Pony Creek

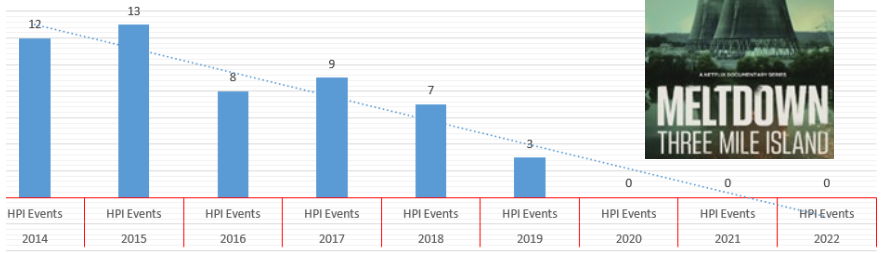
Event Review & Learning (07/31/19)-Southland

Event Review (09/11/19)-34th Ave NW



		Annual Total
2014	HPI Events	12
2015	HPI Events	13
2016	HPI Events	8
2017	HPI Events	9
2018	HPI Events	7
2019	HPI Events	3
2020	HPI Events	0
2021	HPI Events	0
2022	HPI Events	0
	Total Events	52

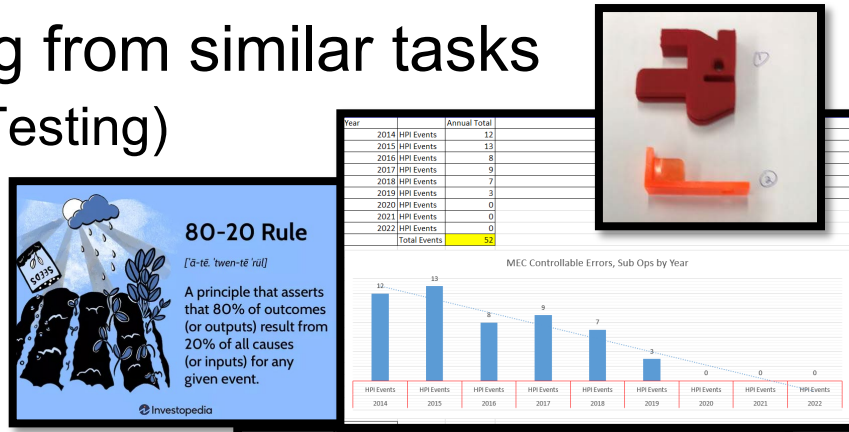
MEC Controllable Errors, Sub Ops by Year



Notes:	
2012	EnoServe assisted relay testing began 2012
2013	Formal NERC Testing/DC Trip Path Testing Began late 2013
2014	began first full year of NERC testing-DC Trip Path, tracking controllable errors (NERC Trip Path, Relay Tests, Wiring)
2016	Deployment of HPI Tool Kit to Substation Employees, Jan 2016
2019	written isolation and test procedures required, critical work
2020	Develop standard practices for Techs (on NERC/Trip Path/Etc Testing, Jan/Feb/Mar)
2021	Developed HPI Champions across MEC (6 in Sub Ops), created HPI Ebook
2022	Added to Sub Ops HPI Champions list (+3), developed HPI Plans for every dept in MEC

Sub Tech Workshop Pays Off

- We found where our holes were and developed more layers of defense. (used Pareto Principle, 80% peas/20% pea pods
- Found that most errors were coming from similar tasks
  - CT circuit errors (now use Thru Fault Testing)
  - Drawing/Drafting errors, latent errors
  - Use of *JUMPERS* in NERC testing!
  - Different methods being implemented
- The Layers of Defense
  - Developed common methods
  - Banned use of jumpers in relay panels
  - Use flags and barriers down to the test switch

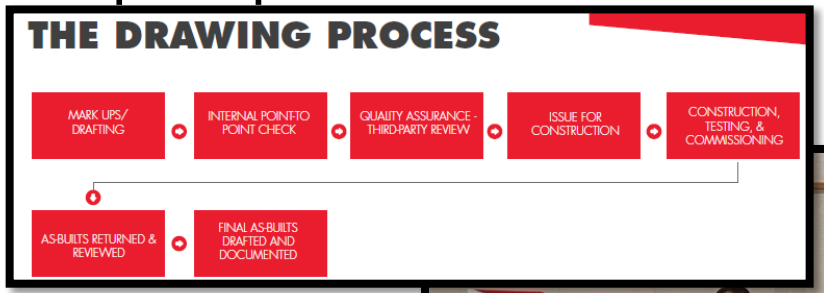


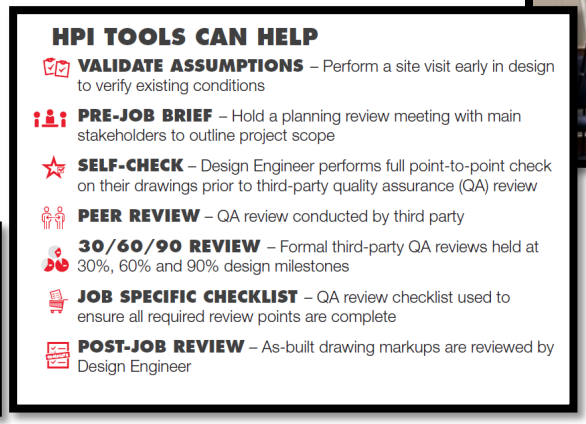
Work Smarter Not Harder

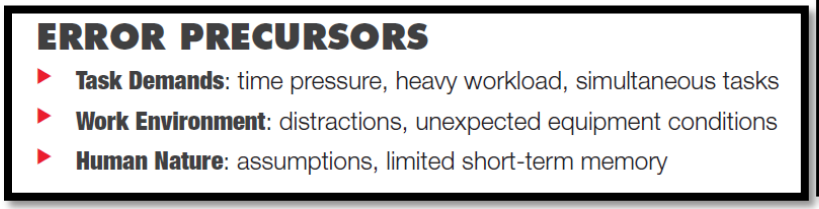
- Developed MEC HP Playbook, Work Zone, and Culture!

Substation Engineering

- Substation Engineering HPI Champion presented on use of HPI Tools in NATF HPI Workshop.
- Presentation was over
  - the HPI tools used in design
  - QA (peer review) physical prints
  - QA of protection/control wiring and schematics
  - Use of 30/60/90 review
    - Below grade-Electrical-P&C
    - Track milestones
    - Follows a checklist of tasks





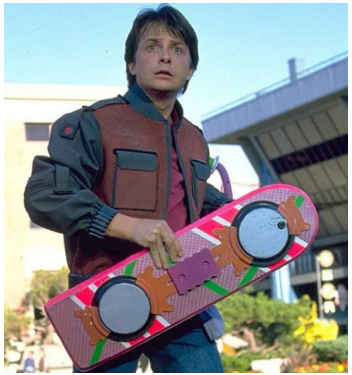


Substation Operations

- Sub Ops followed up the presentation form Sub Eng
- Talked about how we work with Sub Eng
  - Take their design package to successful outcome
  - Could have errors noted on previous slide
  - Apply our HPI tools, different 30/60/90 milestones
- Sub Ops follow T/C contractors
  - Must do the same HPI tasks as MEC, HPI Training
  - Use the PRC-005 Sheets and HPI Tool Kits
- Presented on HPI eBook and AR Apps
  - Used to aid in training apprentices, engineers, supervisors, journeymen, and contractors

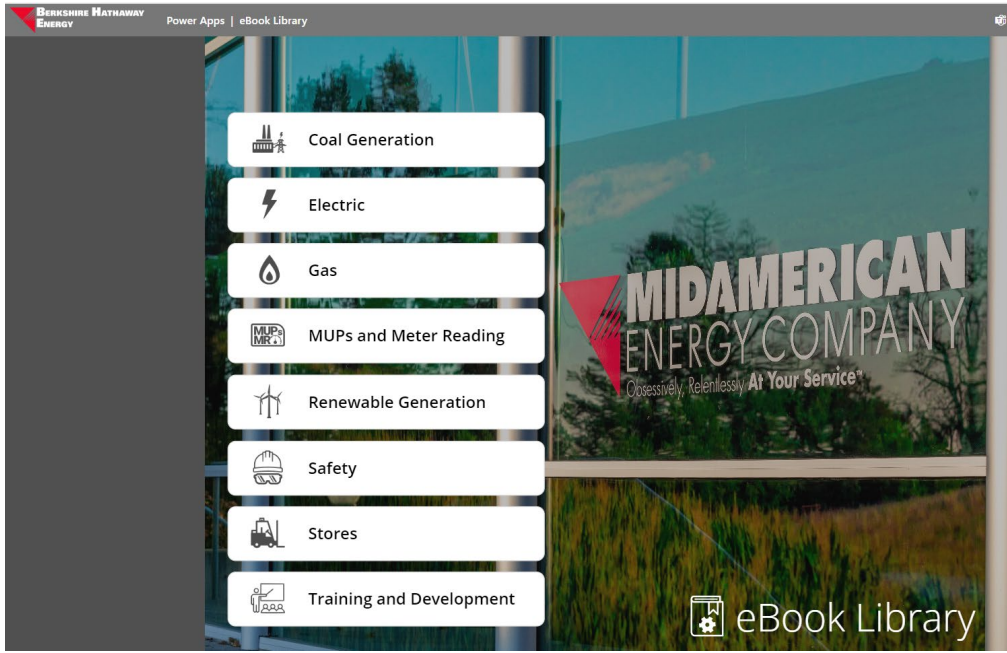
Augmented Reality

- Forget about Hover Boards, we need “Free Guy” glasses
  - Overlay important details “virtually” to the real world (Augmented Reality)
  - Would allow us to “see” error precursors, increasing human performance
  - We’d have “AI” awareness, brought to our human attention in real-time
  - “Personal Importance Levels” are now shown in conversations!
  - Reminders of our personal strengths and weaknesses displayed!



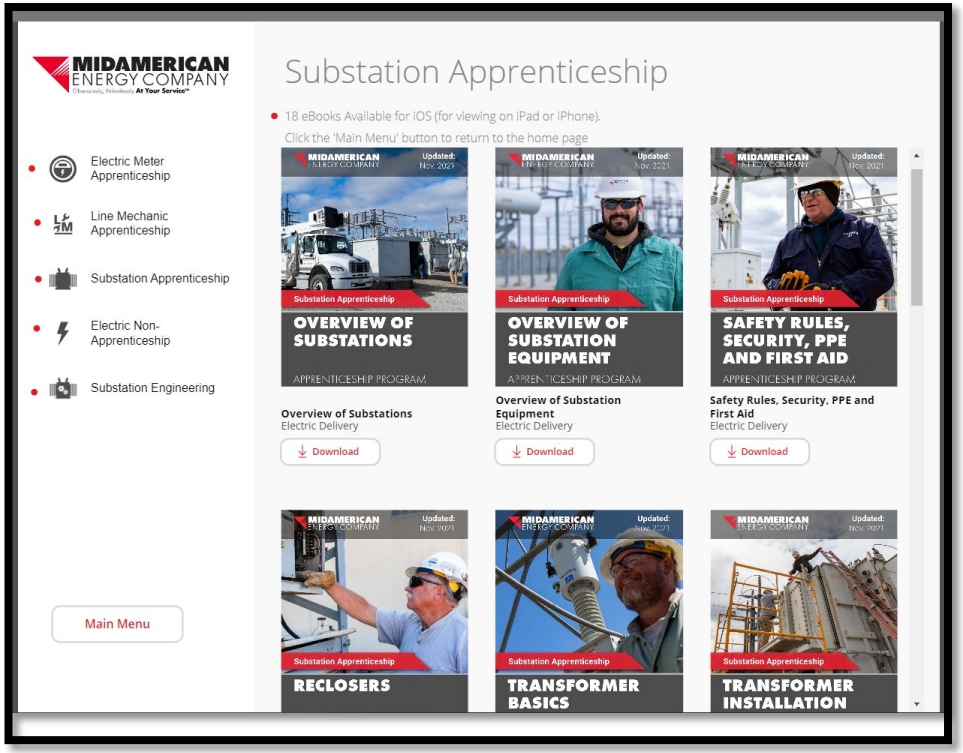
eBooks and Apps

- MEC eBook Library
  - Access from apple devices
  - Access from MEC network
  - iOS and PC
- AR Apps (iPad Only)
  - Can ‘walk up’ to a virtual device
  - Can animate processes
  - Virtually wire a panel



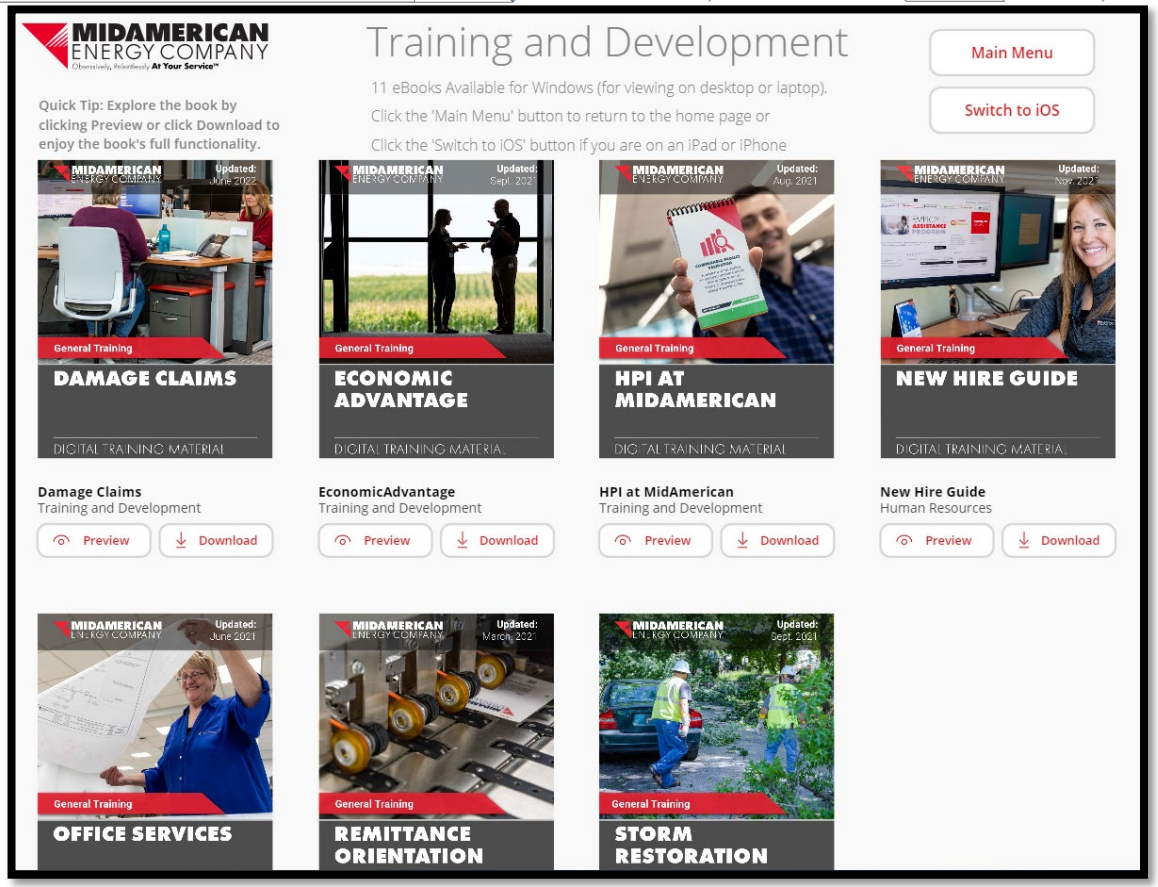
Apprenticeship eBooks

- MEC eBook Library
  - Many stacks to the library
  - Usable across other skills
- AR Apps (iPad)
  - Develop very specific apps
  - Memorialize rare tasks
  - Test set specific
  - Task specific for
    - Mobile sub install
    - Degasification trailer
    - Standard task checklists…



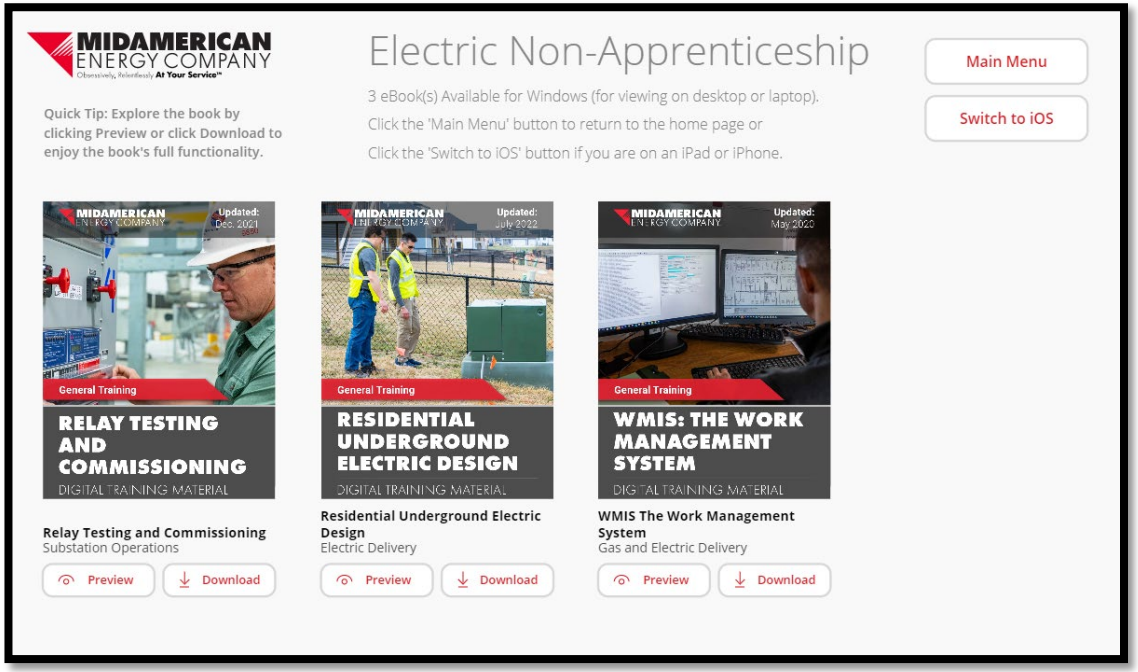
MEC Department eBooks

- MEC eBook Library
  - HPI Champions
  - Non operations groups
  - Shared groups
- HPI Champion Prog
  - Started with small set
  - Goal, 1 in each group
  - 1+ in each group
  - Culture changed
  - HPI in every meeting!



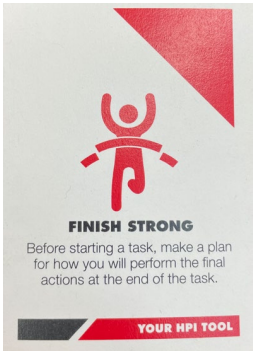
Other Company eBook

- MEC eBook Library
  - Ideas are endless
  - Budget can come from
    - Own department
    - Training Department
    - HPI Department



Questions?

- MEC Champion Prog
- AR Apps/eBooks
- HPI and NERC PRC-005
- Tool Kits and Contents
- C2E and accountability



HP Certification Instructional Guides

HP Project Preview or Learning Team

This activity involves participating or attending an HP Project Preview or Learning Team.

This activity is worth 2 points.

For information on how to complete this activity, refer to Chapter 9, Section 3, which contains a complete list of instructional guides for HP Champion certification.

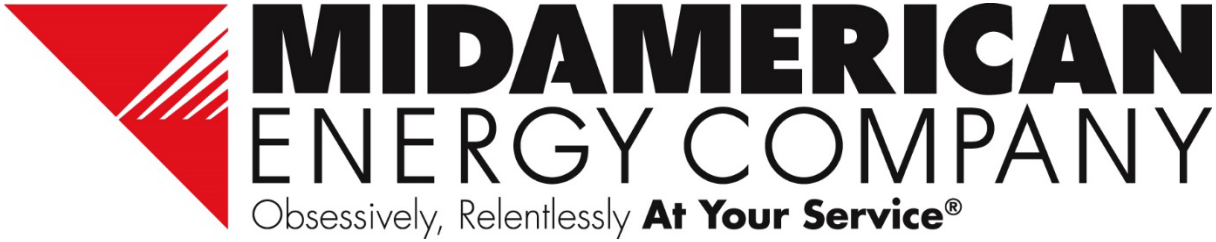
Learning Team Activity

This activity involves facilitating or attending an Event Learning Team.

This activity is worth 4 points.

For information on how to complete this activity, refer to Chapter 9, Section 3.

An HP Champion showing the HP Project Preview tool from the HPI Flipbook.


MIDAMERICAN
ENERGY COMPANY
Obsessively, Relentlessly At Your Service®

MidAmerican Energy
Ambient Adjusted Ratings (AARs)

Dan Custer, GM System Control & Grid Technology
May 17, 2023

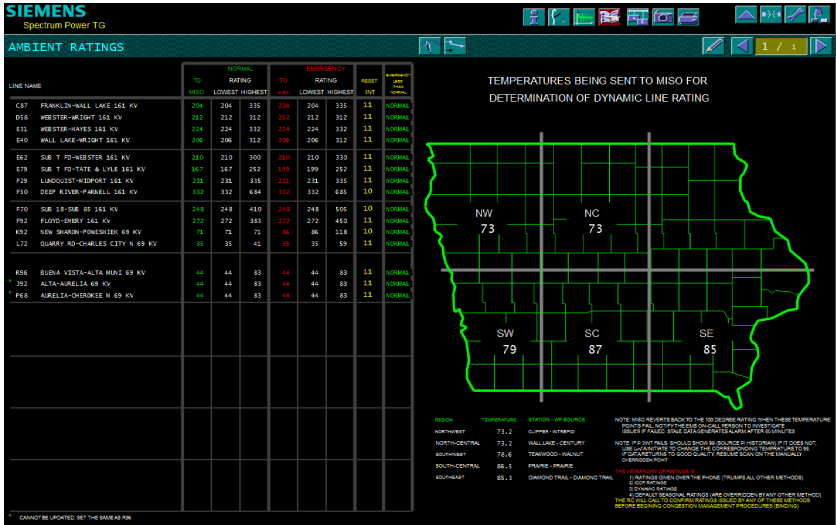
MIDAMERICAN ENERGY COMPANY

MidAmerican AAR Background

- MidAmerican began applying ambient temperature adjusted ratings in 2003 (prior to joining MISO)
  - Initiated by real-time operations group, for increased operating flexibility and reduced instances of Transmission Loading Relief (TLR)
  - Expanded over 5-10 years to include all >100 kV facilities (and most 69 kV facilities)
- Outline of historical AAR approach
  - Ambient adjusted ratings tables (100 deg F → 0 deg F, in 10 deg increments) prepared by System Planning
  - Ratings available to system operators via look-up tables or operating guides
  - MISO Reliability Coordinator contacts MidAmerican system operator when a line is expected to exceed its seasonal rating, and confirms Normal/Emergency ratings prior to implementing congestion management
  - MidAmerican provides Normal/Emergency ratings based on forecasted high temperature
  - MISO updates its real-time model with the temporary ratings; all temporary ratings reset to seasonal ratings at midnight
- Ratings methodology
  - IEEE-738 used for conductor ratings (ambient temperature adjustment only, solar conditions/wind conditions unchanged)
  - IEEE/ANSI standards for ambient adjusted ratings to terminal equipment
  - Excel spreadsheet macro cycles through each temperature increment, calculates normal/emergency adjustment factor for each equipment type and compares to get overall limit at each temperature
  - http://www.oasis.oati.com/woa/docs/MEC/MECdocs/MidAmerican_100_kV_and_Above_Transmission_Facility_Ratings_Methodology_Version_3.7_05272020.pdf

MidAmerican AAR Background

- Recent AAR developments
  - Fall 2021 -> Implemented MISO temperature tables to automate the rating look-up process
  - Ratings tables provided to MISO in advance, real-time temperature sent from 5 regions in MidAmerican footprint
  - Temperature received from existing MET stations installed at wind generation sites
  - Safeguards added to detect/reject bad or stale temperature data
  - MISO tool refreshes real-time ratings for all lines in the table every 5 minutes (tie-lines still use manual process)
  - MISO tool also allows conditional ratings based on breaker status (ring open ratings)
  - .CSV file provided to MISO, transitioning to model manager
- Temperature & wind adjusted ratings applied to 14 transmission lines that are conductor limited
  - Four wind categories (seasonal assumptions, 10-15 mph, 15-20 mph, > 20 mph)
  - Each wind category also applies ambient temperature adjustments
  - Wind data obtained by operators from public sites
  - Ratings entered manually by operators (look-up table) and sent to MISO via ICCP
  - Safeguards/alarms/resets added to prevent stale ICCP rating data



Future AARs and Challenges

- FERC Order 881 contains numerous requirements beyond the existing MidAmerican AAR approach, so adjustments to the existing process will be required
- MISO has been working with its transmission owners/transmission operators to delineate requirements from the Order, and develop interface requirements for exchange of ratings data
- Largest challenges from FERC Order 881 are being supported by MISO:
  - Interaction with other TOs to determine overall tie-line rating -> rating clearing house (MISO)
  - 10-day hourly forecast ratings (MISO temperature table vs. web file)
  - Data logging (majority MISO)
  - MidAmerican plans to take advantage of MISO offerings… no need to duplicate efforts
- Largest remaining challenges for TOs
  - Software tools (legacy EMS application), need for interim solution
  - Facilities Rating Methodology decisions (terminal equipment, transformers, conditional ratings)
  - Ratings raw data management

- MidAmerican will continue to apply its existing approach as the coordinated updates for Order 881 are implemented

Ratings Table for System Operators

MEC TRANSMISSION LINE MVA RATINGS (345 & 161 kV

Click Button to Recalculate Ratings

Wind Speed below 10mph

Limiting Element Abbreviations	
Overhead / Underground Line Conductor	conductor
Circuit Breaker	B
Current Transformer	C
Disconnect or other Switch	D
Jumper or Bus	J
Miscellaneous equipment	M
Operating Limit	OL
Wave Trap	W

Overall rating of the line under the most limiting set of conditions.This includes the ratings of MEC & any foreign owned facilites.
SCADA analog alarms are set for these conditions and the 100 deg F Normal Rating of the line.

Rating of MEC facilites for the listed Ring Status. This does not include the ratings of any foreign owned facilites on the line.

Ring Open -	Indicates that there is Limiting Element in the ring bus or breaker and one-half bus arrangement that would restrict line capacity if there is an open circuit breaker or disconnect switch in the ring bus or breaker and one-half bus.
Ring Closed -	Indicates Limiting Element that is in series with the transmission line that would restrict line capacity when all applicable breakers and switches in the ring bus or breaker and one-half bus are closed.
NA -	Ring Status is not applicable because there is no ring or breaker and one-half bus or the status of this equipment does not impact the line ratings.
Normal Limit -	The MVA rating of the transmission line that can be applied continuously at the given ambient air temperature
Emergency Limit -	The MVA rating of the transmission line that can be applied for a period up to one-hour at the given ambient air temperature.

Updated - 04/18/2023 Ben Dayman & Alex Carpenter & Nick Marquardt- Electric System Planning

AMBIENT TEMPERATURE ADJUSTED MVA OPERATING RATINGS AND LIMITING ELEMENT FOR LINE

From	To	Special Conditions	kV	FAC Code	Other Owners	Rating Type	Ring Status	Temperature (F)	100	90	80	70	60	50	40	30	20	10	0
[redacted]	[redacted]		345	[redacted]	NONE	Overall Line Rating	[redacted] 903 or 906 OPEN	Normal Rating	1189	1195	1195	1220	1275	1318	1339	1359	1379	1399	1419
								Limiting Element	conductor	C	C	C	C	B	B	B	B	B	B
								Emergency Rating	1189	1229	1252	1274	1297	1318	1339	1359	1379	1399	1419
								Limiting Element	conductor	B	B	B	B	B	B	B	B	B	B
							[redacted] 901 or 903 or 904 OPEN	Normal Rating	1189	1208	1298	1349	1374	1397	1421	1443	1465	1465	1465
								Limiting Element	conductor	D	D	D	D	D	D	D	D	D	D
								Emergency Rating	1189	1260	1325	1388	1447	1505	1559	1613	1664	1712	1761
								Limiting Element	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor
							Ring CLOSED	Normal Rating	1189	1208	1298	1349	1374	1397	1421	1443	1465	1465	1465
								Limiting Element	conductor	D	D	D	D	D	D	D	D	D	D
								Emergency Rating	1189	1260	1325	1388	1447	1505	1559	1613	1664	1712	1761
								Limiting Element	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor
[redacted]	[redacted]		345	[redacted]	NONE	Overall Line Rating	[redacted] 904 or 905 OPEN	Normal Rating	1022	1109	1187	1261	1331	1397	1460	1519	1577	1633	1686
								Limiting Element	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor
								Emergency Rating	1022	1109	1187	1261	1331	1397	1460	1519	1577	1633	1686
								Limiting Element	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor
							[redacted] 901 or 902 or 903 or 906 or 908 OPEN	Normal Rating	1022	1109	1187	1261	1331	1397	1460	1519	1577	1633	1686
								Limiting Element	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor
								Emergency Rating	1022	1109	1187	1261	1331	1397	1460	1519	1577	1633	1686
								Limiting Element	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor	conductor

Ambient Adjusted Conditional Ratings Table

	A	B	C	D	E	F	G	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	C	IDENTIFIE	IDENTIFIER	IDENTIFIE	IDENTIFIE	IDENTIFIE	IDENTIFIE	AUTUMN	AUTUMN	AUTUMN	WINTER	WINTER	WINTER	-10	-10	-10	0	0	0	10	10	10	20
2	C	EQUIPTY	NAME1	NAME2	COMPAN	WEATHEI	CONDITIC	NORMAL	EMERGEI	LOADSHE	NORMAL	EMERGEI	LOADSHE	NORMAL	EMERGEI	LOADSHE	NORMAL	EMERGEI	LOADSHE	NORMAL	EMERGEI	LOADSHE	NORMAL
3	D	LN	[redacted]	1	MEC	SC		1189	1189	1189	1374	1447	1447	1465	1761	1761	1465	1761	1761	1465	1712	1712	1465
4	D	LN		1	MEC	SC	CND01	1189	1189	1189	1275	1297	1297	1419	1419	1419	1419	1419	1419	1399	1399	1399	1379
5	D	LN		1	MEC	SC	CND02	1189	1189	1189	1275	1297	1297	1419	1419	1419	1419	1419	1419	1399	1399	1399	1379
6	D	LN		1	MEC	SW		1022	1022	1022	1331	1331	1331	1686	1686	1686	1686	1686	1686	1633	1633	1633	1577
7	D	LN		1	MEC	NW		961	961	961	1287	1287	1287	1593	1593	1593	1593	1593	1593	1593	1593	1593	1544
8	D	LN		1	MEC	NW	CND01	961	961	961	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195
9	D	LN		1	MEC	NW	CND02	961	961	961	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195	1195
10	D	LN		1	MEC	NW		1010	1010	1010	1356	1356	1356	1746	1746	1746	1746	1746	1746	1687	1687	1687	1628
11	D	LN		1	MEC	SW		1012	1012	1012	1316	1316	1316	1667	1667	1667	1667	1667	1667	1614	1614	1614	1559
12	D	LN		1	MEC	SC		1740	1740	1740	1945	1945	1945	2128	2128	2128	2128	2128	2128	2099	2099	2099	2069
13	D	LN		1	MEC	SC		1195	1319	1319	1374	1549	1549	1465	1835	1835	1465	1835	1835	1465	1790	1790	1465
14	D	LN		1	MEC	SE		1022	1022	1022	1331	1331	1331	1458	1686	1686	1458	1686	1686	1458	1633	1633	1458
15	D	LN		1	MEC	SE	CND01	1022	1022	1022	1275	1331	1331	1458	1686	1686	1458	1686	1686	1458	1633	1633	1458
16	D	LN		1	MEC	SE	CND02	1022	1022	1022	1275	1331	1331	1458	1686	1686	1458	1686	1686	1458	1633	1633	1458
17	D	LN		1	MEC	SC		1195	1195	1195	1268	1297	1297	1367	1419	1419	1367	1419	1419	1352	1399	1399	1335
18	D	LN		1	MEC	NW		1333	1333	1333	1565	1565	1565	1855	1855	1855	1855	1855	1855	1810	1810	1810	1765
19	D	LN		1	MEC	NW		1064	1064	1064	1361	1361	1361	1707	1707	1707	1707	1707	1707	1654	1654	1654	1601
20	D	LN		1	MEC	SW		1022	1022	1022	1331	1331	1331	1678	1686	1686	1678	1686	1686	1633	1633	1633	1577
21	D	LN		1	MEC	SW		1594	1594	1594	1930	1930	1930	2198	2339	2339	2198	2339	2339	2198	2276	2276	2198
22	D	LN		1	MEC	SW	CND01	1594	1594	1594	1930	1930	1930	2128	2128	2128	2128	2128	2128	2099	2099	2099	2069
23	D	LN		1	MEC	SW	CND02	1594	1594	1594	1930	1930	1930	2128	2128	2128	2128	2128	2128	2099	2099	2099	2069
24	D	LN		1	MEC	SW	CND03	1594	1594	1594	1930	1930	1930	2128	2128	2128	2128	2128	2128	2099	2099	2099	2069
25	D	LN		1	MEC	SW	CND04	1594	1594	1594	1930	1930	1930	2128	2128	2128	2128	2128	2128	2099	2099	2099	2069
26	D	LN		1	MEC	SW	CND05	1594	1594	1594	1930	1930	1930	2128	2128	2128	2128	2128	2128	2099	2099	2099	2069
27	D	LN		1	MEC	SC		1247	1319	1319	1492	1549	1549	1794	1835	1835	1794	1835	1835	1746	1790	1790	1699
28	D	LN		1	MEC	SE		1195	1209	1209	1268	1468	1468	1367	1607	1607	1367	1607	1607	1352	1590	1590	1335
29	D	LN		1	MEC	SE		1195	1202	1202	1268	1464	1464	1367	1607	1607	1367	1607	1607	1352	1590	1590	1335

AMERICAN ELECTRIC POWER

BOUNDLESS ENERGY℠

Facility Data Management: Challenges & Opportunities

Evan R. Wilcox – Director Advanced Transmission Studies & Modeling

MRO Reliability Conference
May 17, 2023

AMERICAN ELECTRIC POWER

BOUNDLESS ENERGY℠

AEP Overview

40k
TRANSMISSION MILES
Nation's largest electric transmission system

225k
DISTRIBUTION MILES
One of the largest distribution systems in the U.S.

25GW
OWNED GENERATION
Diverse generation fleet

$94B
TOTAL ASSETS
Strong balance sheet

$61B
RATE BASE
As of December 31, 2022

$47B
CURRENT MARKET CAPITALIZATION
As of April 4, 2023

17,000
EMPLOYEES
Across the system

5.6M
CUSTOMERS
Throughout 11 states

Statistics are as of December 31, 2022 except for market capitalization; data on this page currently includes Kentucky operations and Unregulated Contracted Renewables until sale transactions close.

Past Challenges

- 2017 spot check/RFI with TexasRE resulted in the identification of elements missing from the Facility Ratings (FR) database which ultimately led to an inaccurate Facility Rating.
  - Elements missing in the Facility Ratings Database, i.e. 1 instance of conductor listed when there are 5 of that same conductor in the series. The element type was accounted for but not each explicitly.
  - Sampling reviews resulted in the identification of issues in the other RE's that AEP operates.

- Mitigation Plans were developed as a result.
  - Full Engineering review of all series elements.
    - Update systems of record.
    - Update FR database and revise impacted Facility Ratings
  - Developed Preventative (monthly pre-energization review) and a Detective (post-energization sampling) controls.
  - Revised the internal Facility Rating Process.

- Some remediation projects were necessary.
  - Studied de-rates for system impact, developed remediation projects for major affected facilities.

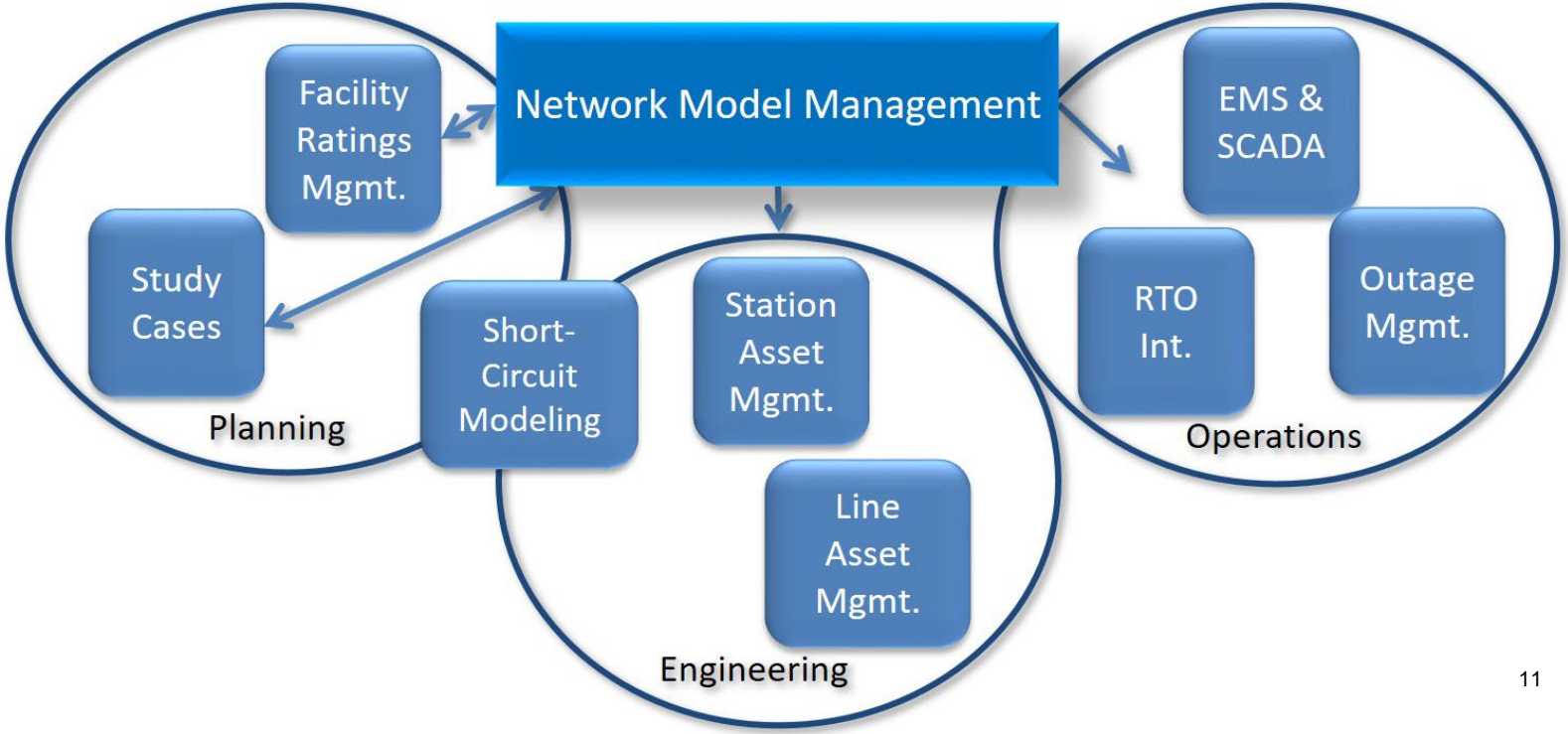
Process Improvements

- Asset Management Improvements
  - Full engineering review and inventory of BES Assets.
  - Facility Rating Database programmatically linked to Asset Management databases to improve FR accuracy.

- New Facility Ratings Process
  - Attestation performed for all in-servicing of planned system changes prior to energization.
  - Unified process across all of AEP Transmission facilities.
  - Improved education on FAC-008 and training on the revised process.

- Field Verifications
  - AEP collaborated with ReliabilityFirst during settlement and committed to performing field verifications.
  - 5% annual review of BES Elements applicable to FAC-008.
  - Field vs Asset Management Database vs Facility Ratings Database.

T-NEXUS: The Future of Network Model Management



AMERICAN ELECTRIC POWER

BOUNDLESS ENERGY℠

Thank You!

Q&A

ATC's Facility Ratings Program

Preventive and Detective Control Examples

PRESENTED BY:

Jon Radloff

Manager – Asset Data and Ratings, ATC

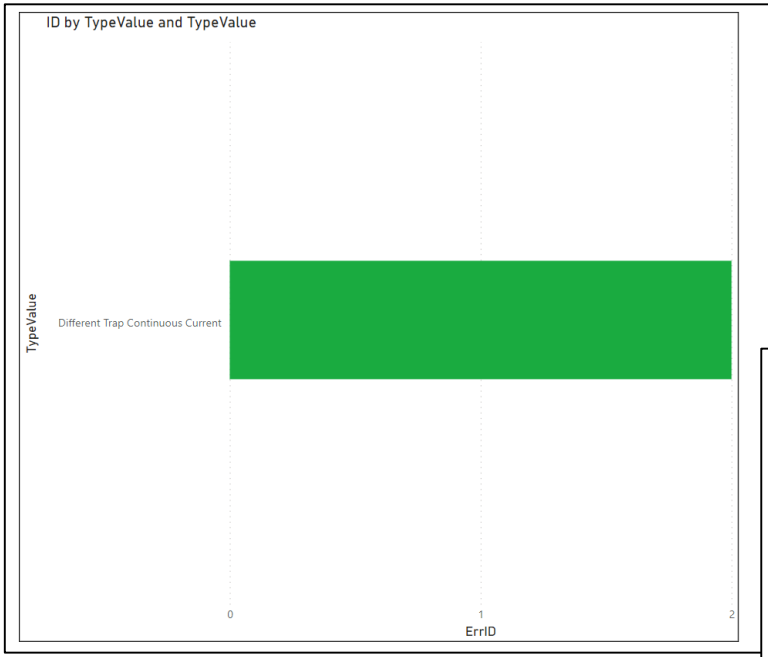
May 17, 2023

Detective Control

Ratings Data / CMMS Data Comparison

- Ratings database vs. CMMS
  - Compare 13 ratings-related data fields
  - Help ensure separately-managed data is consistent
  - Potential to show gaps in process
  - Preventive control if discrepancy on active project

- Notes:
  - CMMS does not automatically update Ratings database
  - Some inconsistencies are color-coded in Ratings database



TypeValue

- [ ] Different Breaker Continuous Current
- [ ] Different Breaker Types
- [ ] Different Cap Bank MVAR
- [ ] Different CT Rating Factor
- [ ] Different CT Rating Factors between SELD/Cascade
- [ ] Different Switch ACCC
- [ ] Different Switch Continuous Current
- [ ] Different Transformer Voltage
- [x] Different Trap Continuous Current
- [ ] No Equipment Number Match for CT
- [ ] No Equipment Number Match for Switch
- [ ] No Equipment Number Match for Transformer

Table view with details

ErrID	TypeValue	Location	Description
28	Different Trap Continuous Current	[redacted]	Continuous Current for '2000 A, C-Phase' (TRAP-[redacted] SELD contains:'2000' and [redacted] is blank'
28	Different Trap Continuous Current	[redacted]	Continuous Current for '2000 A, C-Phase' (TRAP-[redacted] SELD contains:'2000' and [redacted] is blank'

TypeValue

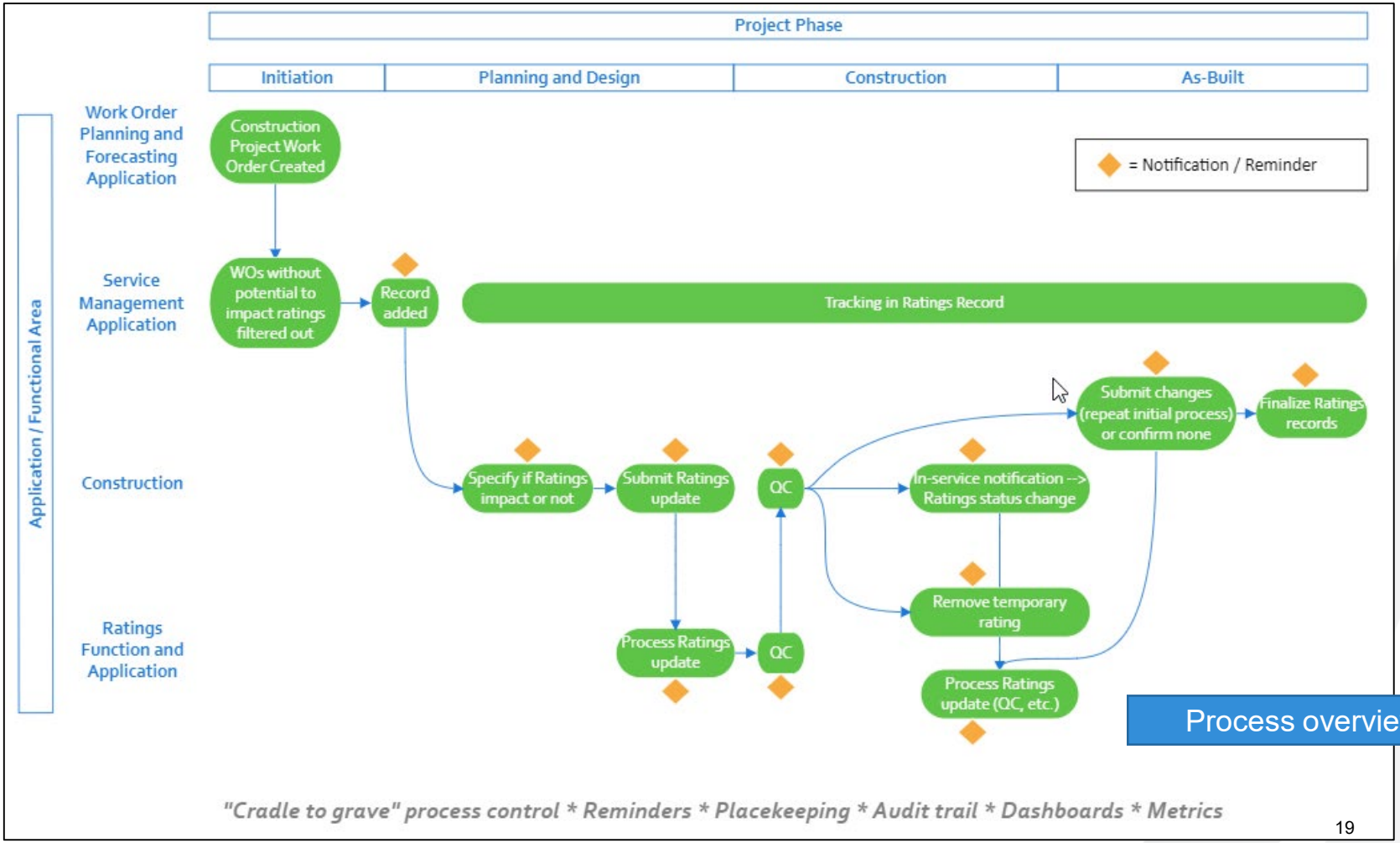
- [ ] Different Cap Bank MVAR
- [ ] Different CT Rating Factor
- [ ] Different CT Rating Factors between SELD/Cascade
- [ ] Different Switch ACCC
- [ ] Different Switch Continuous Current
- [ ] Different Transformer Voltage
- [x] Different Trap Continuous Current
- [ ] No Equipment Number Match for CT
- [ ] No Equipment Number Match for Switch
- [ ] No Equipment Number Match for Transformer

Dashboard

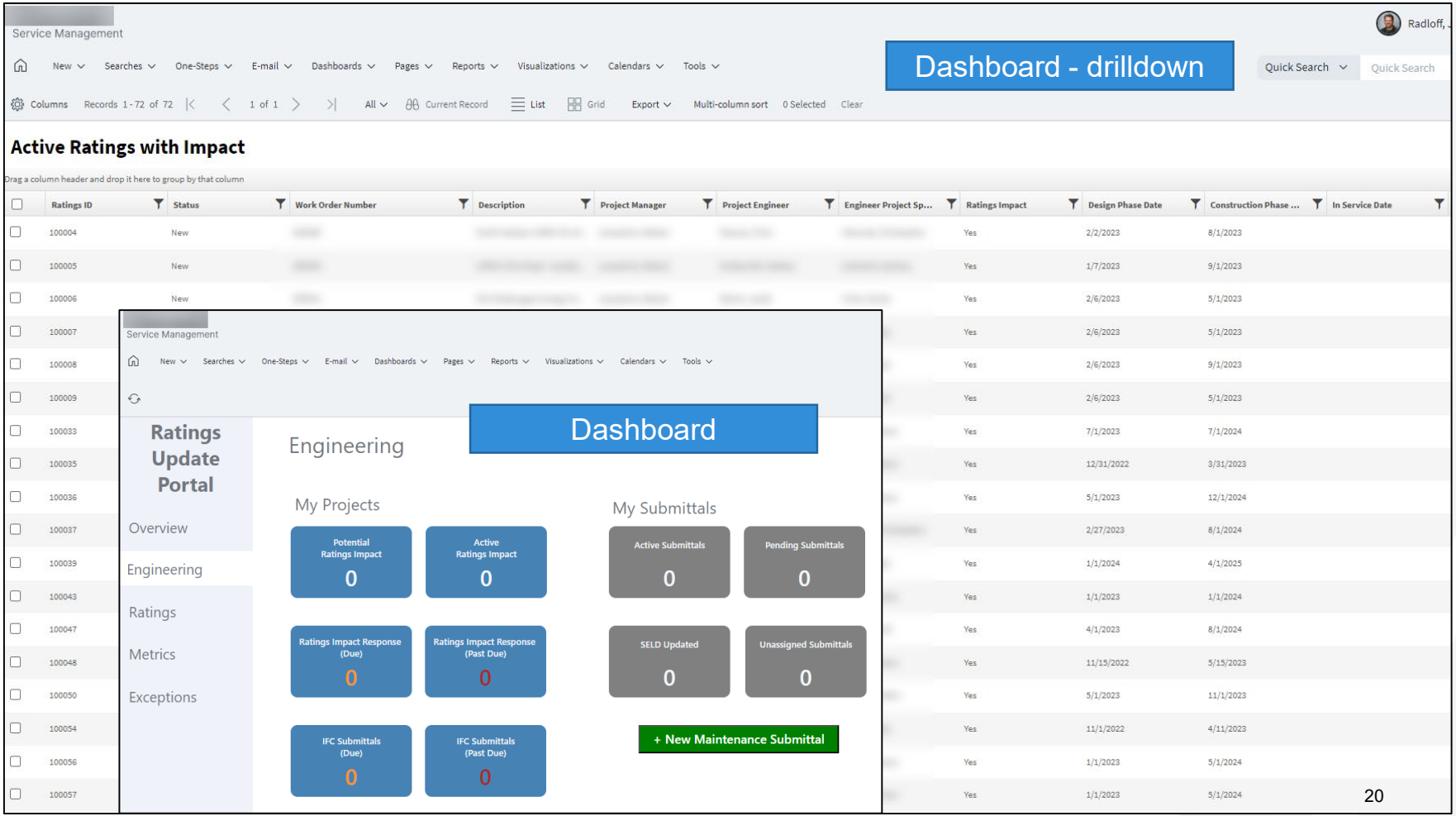
Preventive Control

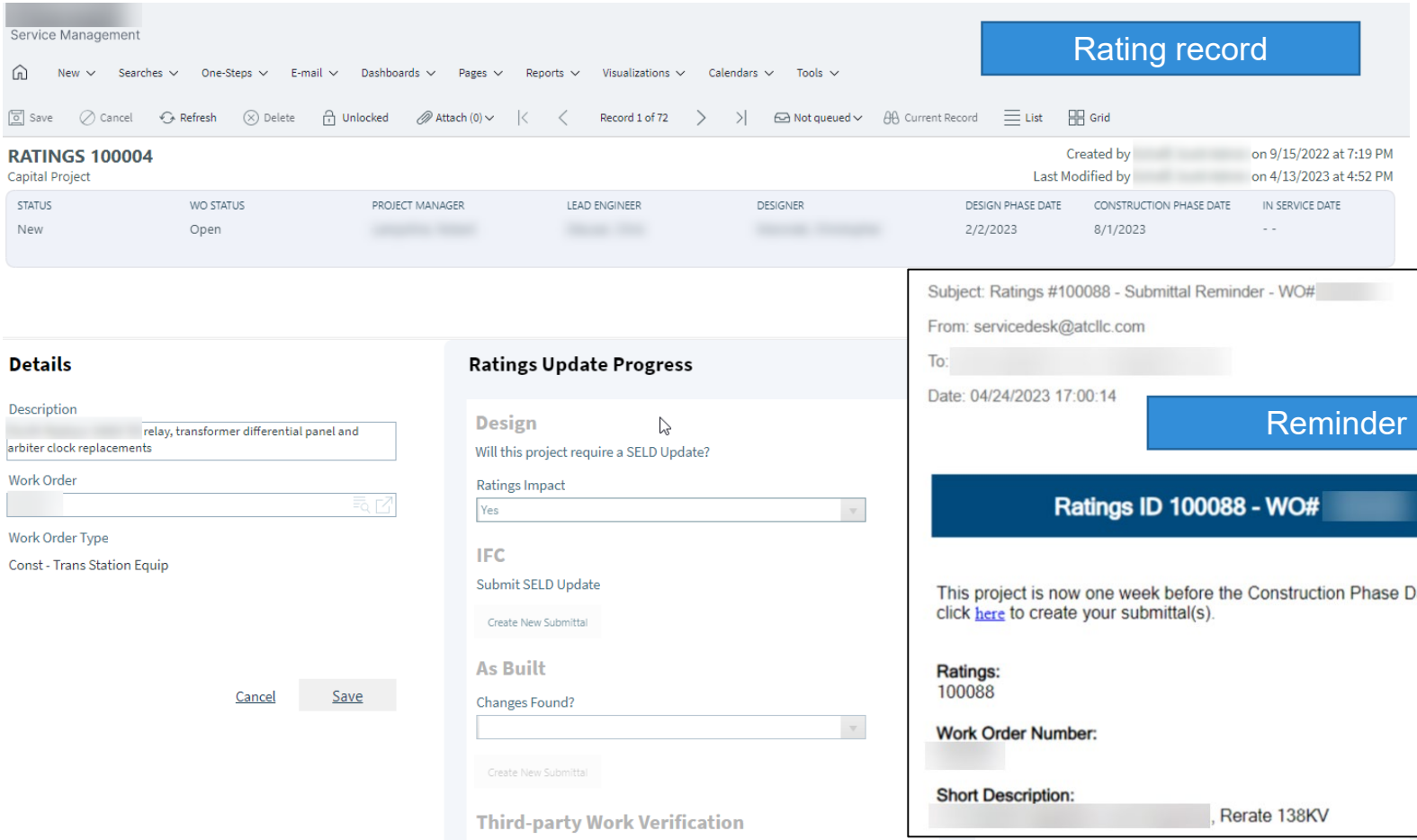
Ratings Update Process Control

- Using a Service Management Software Application
- Help ensure execution of ATC's ratings update process
  - "Cradle to grave" process control
  - Reminders
  - Place-keeping
  - Audit trail (people, time/date stamps)
  - Dashboards
  - Metrics (volume and volatility, quality)



Process overview






Q&A

North American Transmission FORUM

Community *Confidentiality* *Candor* *Commitment*

MRO Reliability Conference
Facility Ratings Panel

May 17, 2023

Open Distribution

NATF Members

Guiding Principles

Community *Confidentiality* *Candor* *Commitment*

97 members

90 affiliates

Member Types

IOUs

Federal/Provincial Cooperatives

State/Municipal

ISOs/RTOs

Coverage (US/Canada)

~85% miles 100 kV+

~90% net peak demand

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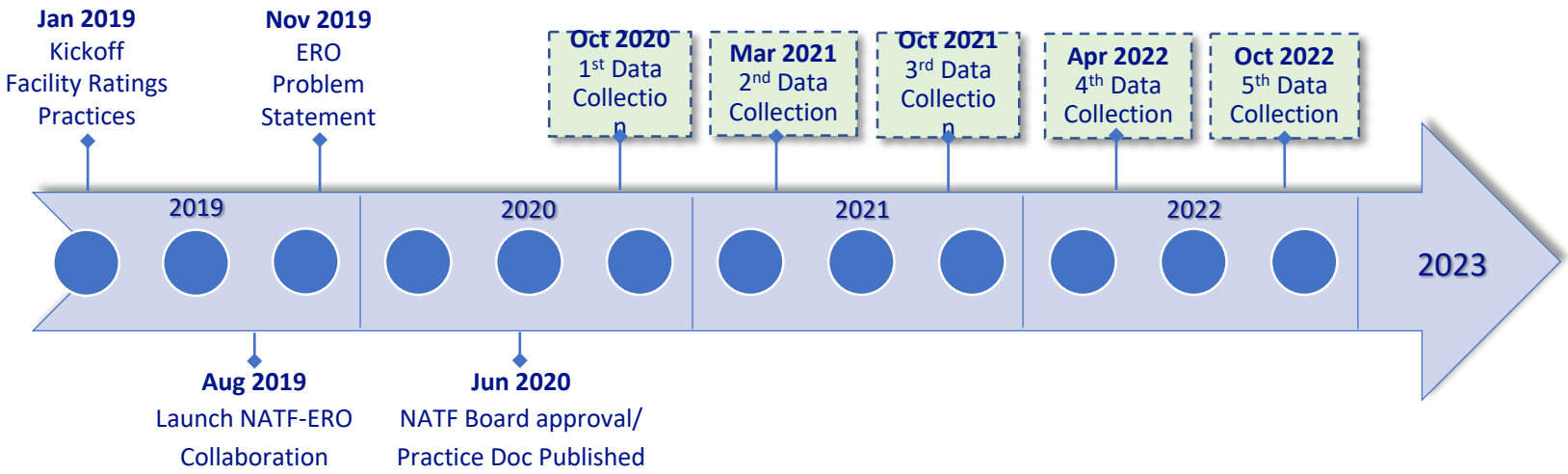
Facility Ratings Initiative Background



Key Foundational Elements/Practices

- Identify a facility ratings **sponsor and owner**
- Establish **clarity on the foundational components** of the facility ratings process or program
- **Manage data** to ensure accuracy
- Establish an **accurate baseline** to determine accuracy of facility ratings
- Establish **comprehensive work practices** for planned construction, acquired facilities, and unplanned or restoration work
- Validate through **periodic reviews**
- Implement **human performance measures**

Internal Controls – embedded throughout the practice areas

Incorporation of these elements facilitates sustainability of the program/processes!

About 50 practices overall, some with "sub-practices"

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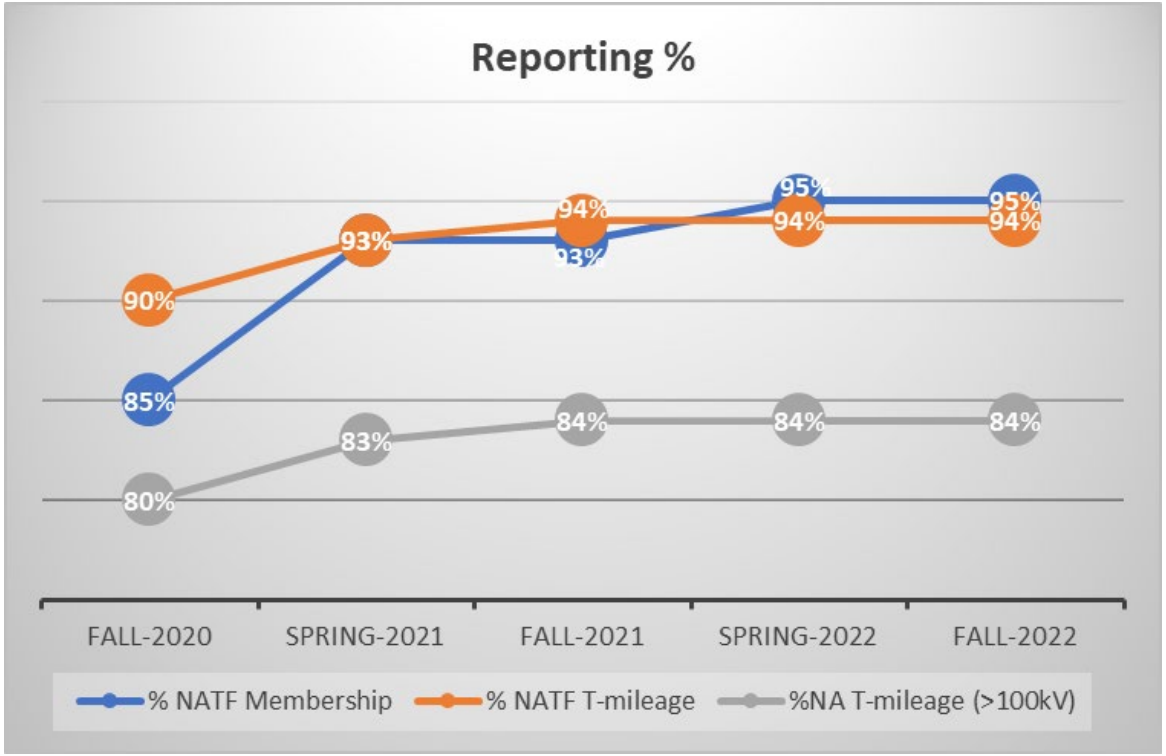
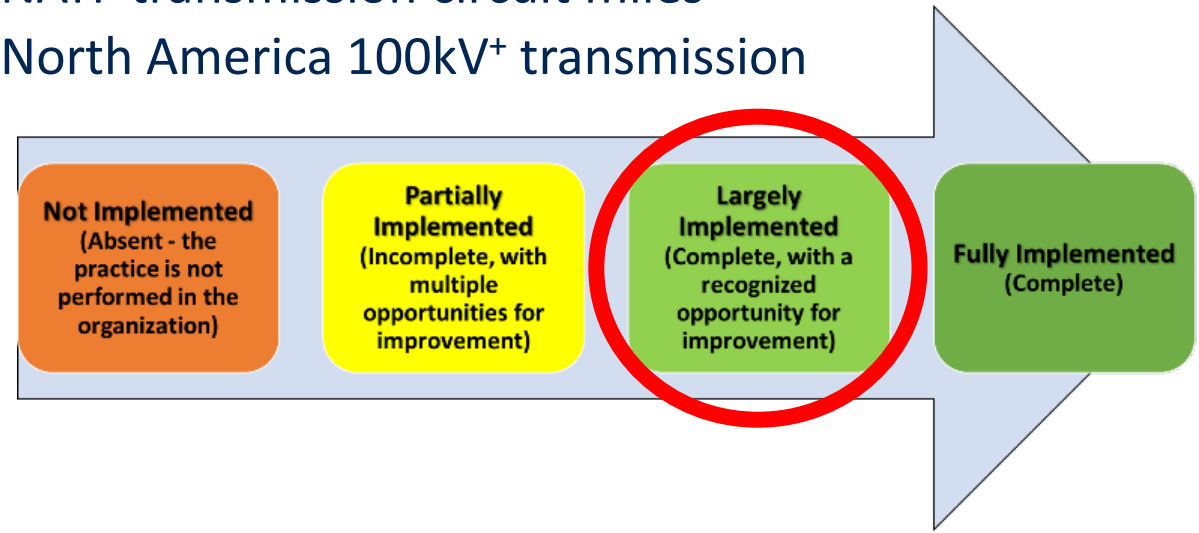
Fall 2022 Facility Ratings Data Collection



Fall 2022 Facility Ratings Data Collection

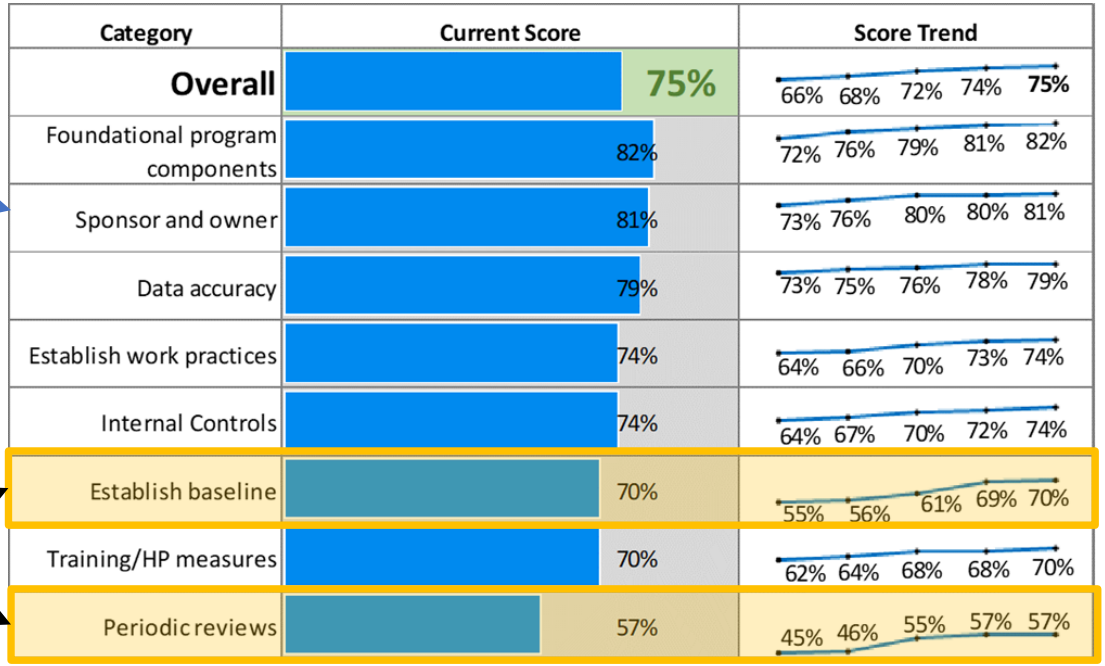
- Fifth iteration of data collection conducted Oct-Nov 2022
  - 95% of applicable member entities
  - 94% of NATF transmission circuit miles
  - 84% of North America 100kV+ transmission



Upward Trend Across All Practices

Internal Controls are embedded throughout the practice areas

Focus Areas



TARGET ACHIEVED: Aggregate membership at largely implemented

NATF Actions to Enhance Implementation

Continued emphasis by NATF board and member executive leaders on the importance of the facility ratings initiative

Special webinars; document highlighting key learnings, observations, and recommendations; dedicated page on member portal

Revision to practice document to incorporate risk construct for prioritization and inclusion of internal controls examples

Targeted work with members to develop activities to increase member performance in areas with lower implementation progress (*e.g., targeted 1:1 assistance*)

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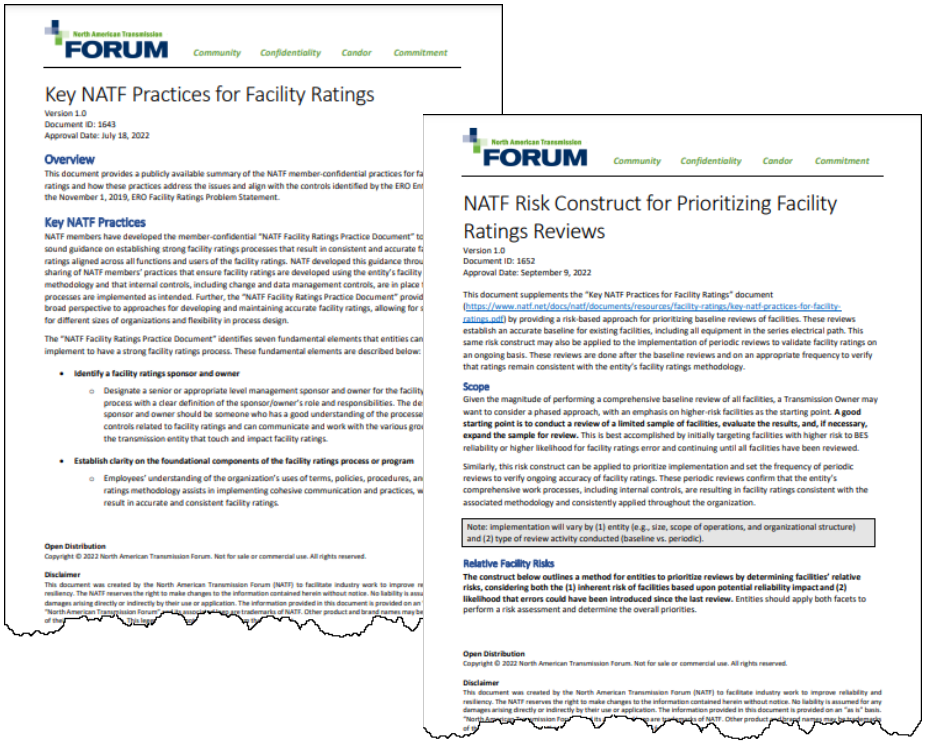
NATF Resources Made Available to Industry

- *Key NATF Practices for Facility Ratings*
- *NATF Risk Construct for Prioritizing Facility Ratings Reviews*
- Presentations to NERC BOTCC; BOT



North American Transmission FORUM Community Confidentiality Candor Commitment

Key NATF Practices for Facility Ratings

Version 1.0
Document ID: 1643
Approval Date: July 18, 2022

Overview

This document provides a publicly available summary of the NATF member-confidential practices for fa
ratings and how these practices address the issues and align with the controls identified by the ERO En
the November 1, 2019, ERO Facility Ratings Problem Statement.

Key NATF Practices

NATF members have developed the member-confidential "NATF Facility Ratings Practice Document" to
sound guidance on establishing strong facility ratings processes that result in consistent and accurate f
ratings aligned across all functions and users of the facility ratings. NATF developed this guidance throu
sharing of NATF members' practices that ensure facility ratings are developed using the entity's facility
methodology and that internal controls, including change and data management controls, are in place t
processes are implemented as intended. Further, the "NATF Facility Ratings Practice Document" provid
broad perspective to approaches for developing and maintaining accurate facility ratings, allowing for s
for different sizes of organizations and flexibility in process design.

The "NATF Facility Ratings Practice Document" identifies seven fundamental elements that entities can
implement to have a strong facility ratings process. These fundamental elements are described below:

- **Identify a facility ratings sponsor and owner**
  - Designate a senior or appropriate level management sponsor and owner for the facility
    process with a clear definition of the sponsor/owner's role and responsibilities. The de
    sponsor and owner should be someone who has a good understanding of the processe
    controls related to facility ratings and can communicate and work with the various gro
    the transmission entity that touch and impact facility ratings.
- **Establish clarity on the foundational components of the facility ratings process or program**
  - Employees' understanding of the organization's uses of terms, policies, procedures, an
    ratings methodology assists in implementing cohesive communication and practices, w
    result in accurate and consistent facility ratings.

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NATF Risk Construct for Prioritizing Facility Ratings Reviews

Version 1.0
Document ID: 1652
Approval Date: September 9, 2022

This document supplements the "Key NATF Practices for Facility Ratings" document (https://www.natf.net/docs/natf/documents/resources/facility-ratings/key-natf-practices-for-facility-ratings.pdf) by providing a risk-based approach for prioritizing baseline reviews of facilities. These reviews establish an accurate baseline for existing facilities, including all equipment in the series electrical path. This same risk construct may also be applied to the implementation of periodic reviews to validate facility ratings on an ongoing basis. These reviews are done after the baseline reviews and on an appropriate frequency to verify that ratings remain consistent with the entity's facility ratings methodology.

Scope

Given the magnitude of performing a comprehensive baseline review of all facilities, a Transmission Owner may want to consider a phased approach, with an emphasis on higher-risk facilities as the starting point. **A good starting point is to conduct a review of a limited sample of facilities, evaluate the results, and, if necessary, expand the sample for review.** This is best accomplished by initially targeting facilities with higher risk to BES reliability or higher likelihood for facility ratings error and continuing until all facilities have been reviewed.

Similarly, this risk construct can be applied to prioritize implementation and set the frequency of periodic reviews to verify ongoing accuracy of facility ratings. These periodic reviews confirm that the entity's comprehensive work processes, including internal controls, are resulting in facility ratings consistent with the associated methodology and consistently applied throughout the organization.

Note: implementation will vary by (1) entity (e.g., size, scope of operations, and organizational structure) and (2) type of review activity conducted (baseline vs. periodic).

Relative Facility Risks

The construct below outlines a method for entities to prioritize reviews by determining facilities' relative risks, considering both the (1) inherent risk of facilities based upon potential reliability impact and (2) likelihood that errors could have been introduced since the last review. Entities should apply both facets to perform a risk assessment and determine the overall priorities.

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North American Transmission FORUM

Collaboration Positive Achievements

- NATF developed practices for strong, sustainable facility ratings programs
- Confirmed alignment of practices with ERO-wide problem statement
- Members representing vast majority of N.A. transmission participated
- Members achieved target maturity level for practice implementation
- Reporting status to ERO highlighted the NATF ability to achieve results
- Increased NERC BOT and FERC awareness of NATF /industry efforts to improve facility ratings accuracy
- NATF open distribution of practices summary and risk construct

Questions?

Comments?

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Midwest Reliability Organization (MRO)

May 17th, 2023

Steven Breeding
Direct of Sales

Acknowledgement and Disclaimer

This material is based upon work supported by the Department of Energy under Award Number DE-NE0008928.

NuScale has developed a transformational small modular reactor ("SMR") that delivers scalable, safe and reliable carbon-free nuclear power essential to meeting global decarbonization targets

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NuScale at a Glance

1st
And Only SMR to Receive NRC Standard Design Approval and Certification

$1.4B
Cumulative Capital Invested to Date

545
Employees with Unparalleled Nuclear Experience

644
Total Patents

15
Years of R&D and Testing
Founded in 2007

8
Strategic Investors Supporting Global Customer Adoption[1]

28
PhDs

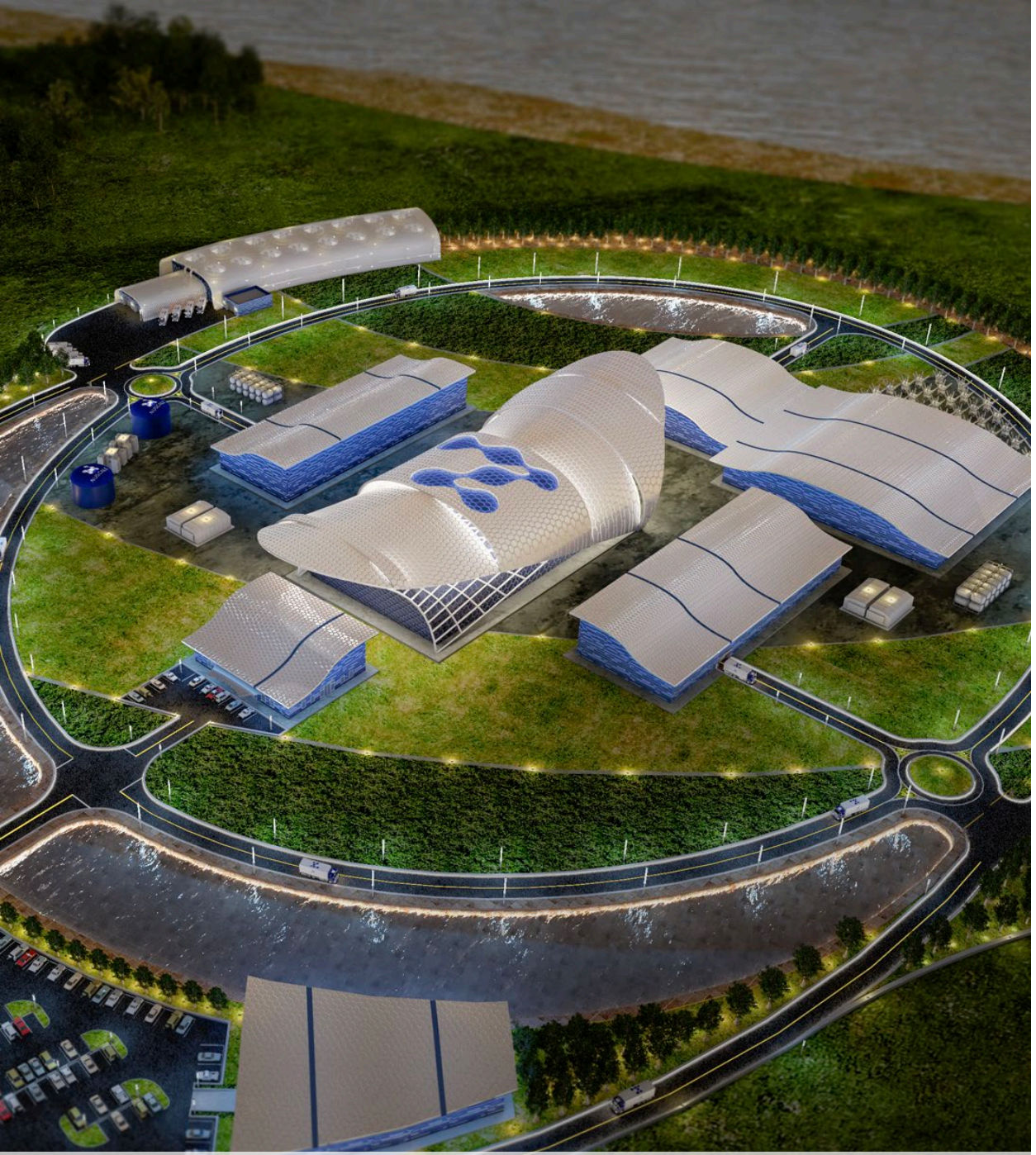
180
Masters in Engineering/ Science Degrees

453
Granted

191
Pending Extensive Trade Secrets

Smarter | Cleaner | Safer | Cost Competitive

1. Established Supply Chain Network with Continued DOE Support



Artistic concept of the NuScale Power Plant

NuScale VOYGR™ Power Plant Solutions

- Each VOYGR plant is comprised of a different configuration of NuScale Power Modules and output:

12-Module (924 MWe)	6-Module (462 MWe)	4-Module (308 MWe)
VOYGR™-12	VOYGR™-6	VOYGR™-4

- Reference plant design
  - 924 Mwe VOYGR-12 plant
  - Design approved by U.S. NRC in August 2020
  - Certified in 2023
- VOYGR-4 and VOYGR-6 contain all features and capabilities of reference plant
- Flexibility in size and cost, with the same operational flexibility and unparalleled safety case.
  - Each module feeds one turbine generator train, eliminating single-shaft risk.
  - Demonstrated resiliency for every configuration (black-start, island mode, seismically robust, cyber secure, etc.)

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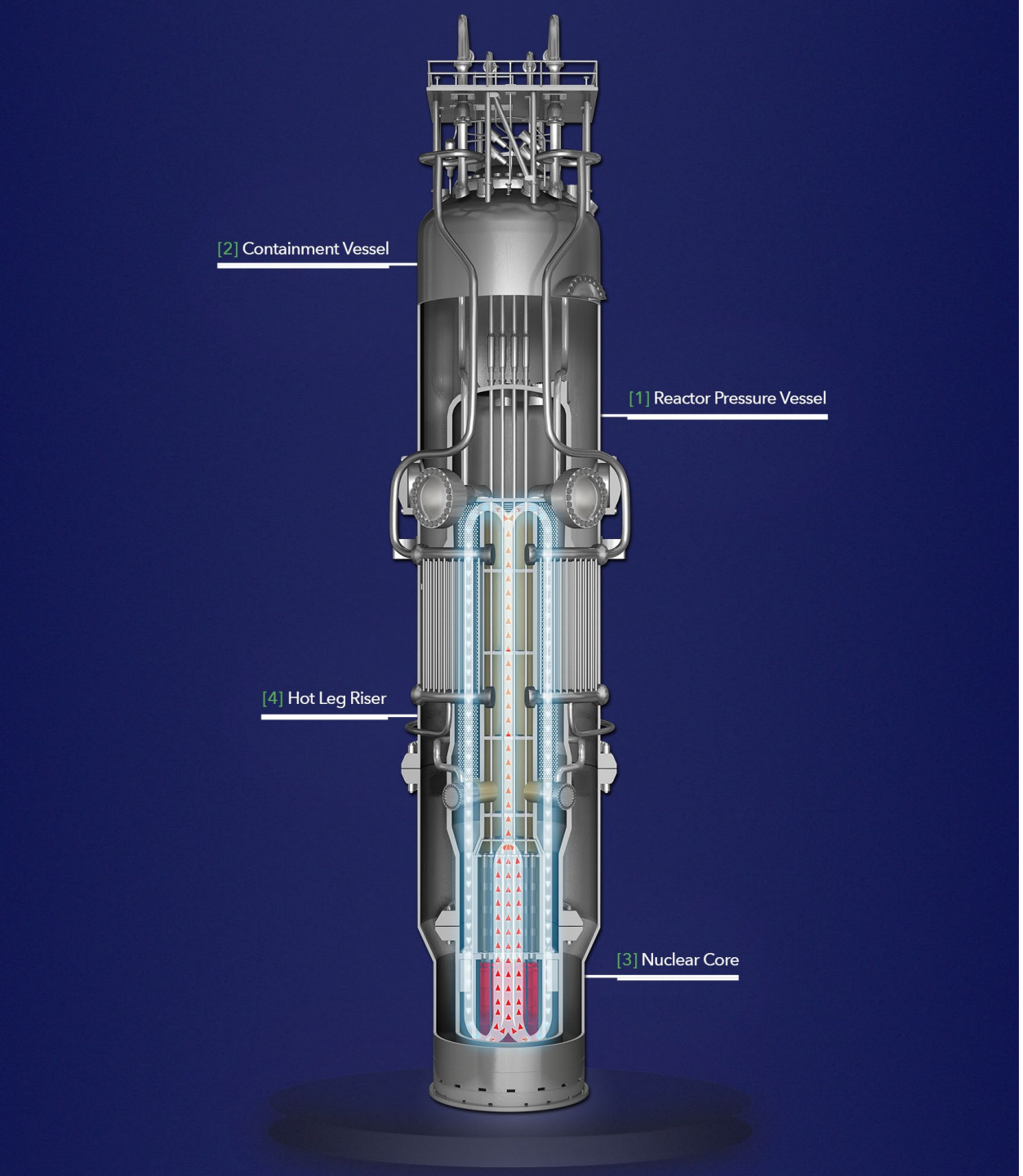

Core Technology: NuScale Power Module™

- Simple design in one integral package that includes:
  - Steam generators
  - Pressurizer
  - Containment
- Eliminates:
  - Reactor coolant pumps
  - Large bore piping
  - Other systems and components found in conventional reactors
- Each module produces up to 77 MWe
  - Factory built for easy transport and installation
  - Dedicated power conversion system for flexible, independent operation
- Modules are incrementally added to match load growth

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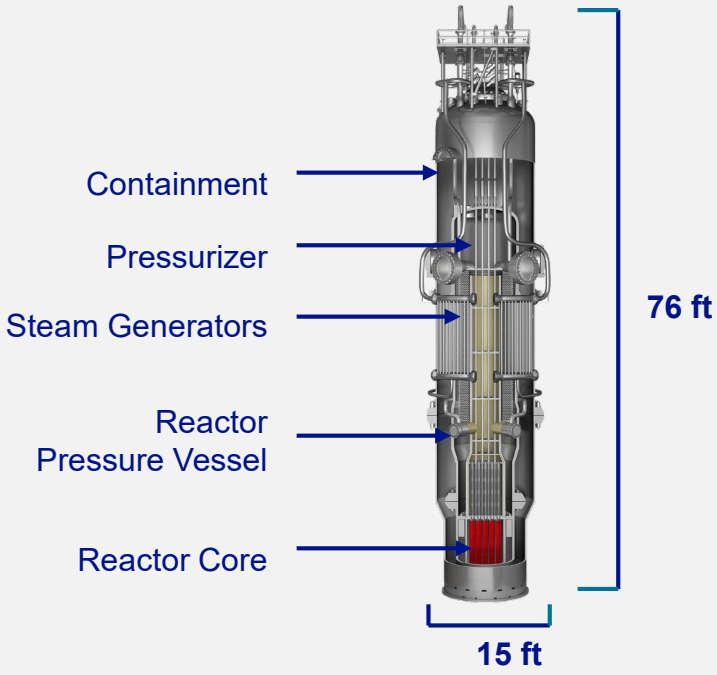
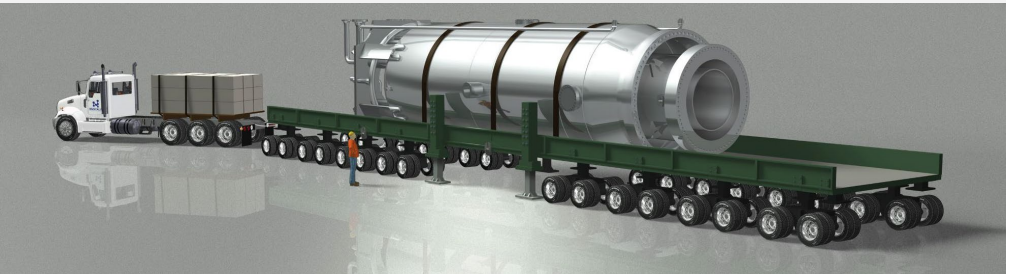
NuScale's Core Technology: the NuScale Power Module™





- Groundbreaking technology features a **fully factory fabricated** SMR referred to as a NuScale Power Module™ consisting of an **integral nuclear steam supply system** in which the reactor core, steam generators and pressurizer are all contained in a single vessel
- **Simple design** eliminates reactor coolant pumps, large bore piping and other systems and components found in conventional reactors
- Simplicity results in an extremely **strong safety case** and **reduced capital and operational costs**
- Modules can be incrementally added to match load growth

NuScale Power Module™ Specifications	
Electrical Capacity	77 MWe
Modules per Plant	Up to 12 (924 MWe)
Design Life	60 years
Fuel Supply	Existing light water reactor nuclear fuel
Safety	Walk-away safe
Emergency Planning Zone (EPZ)	Supports site boundary EPZ

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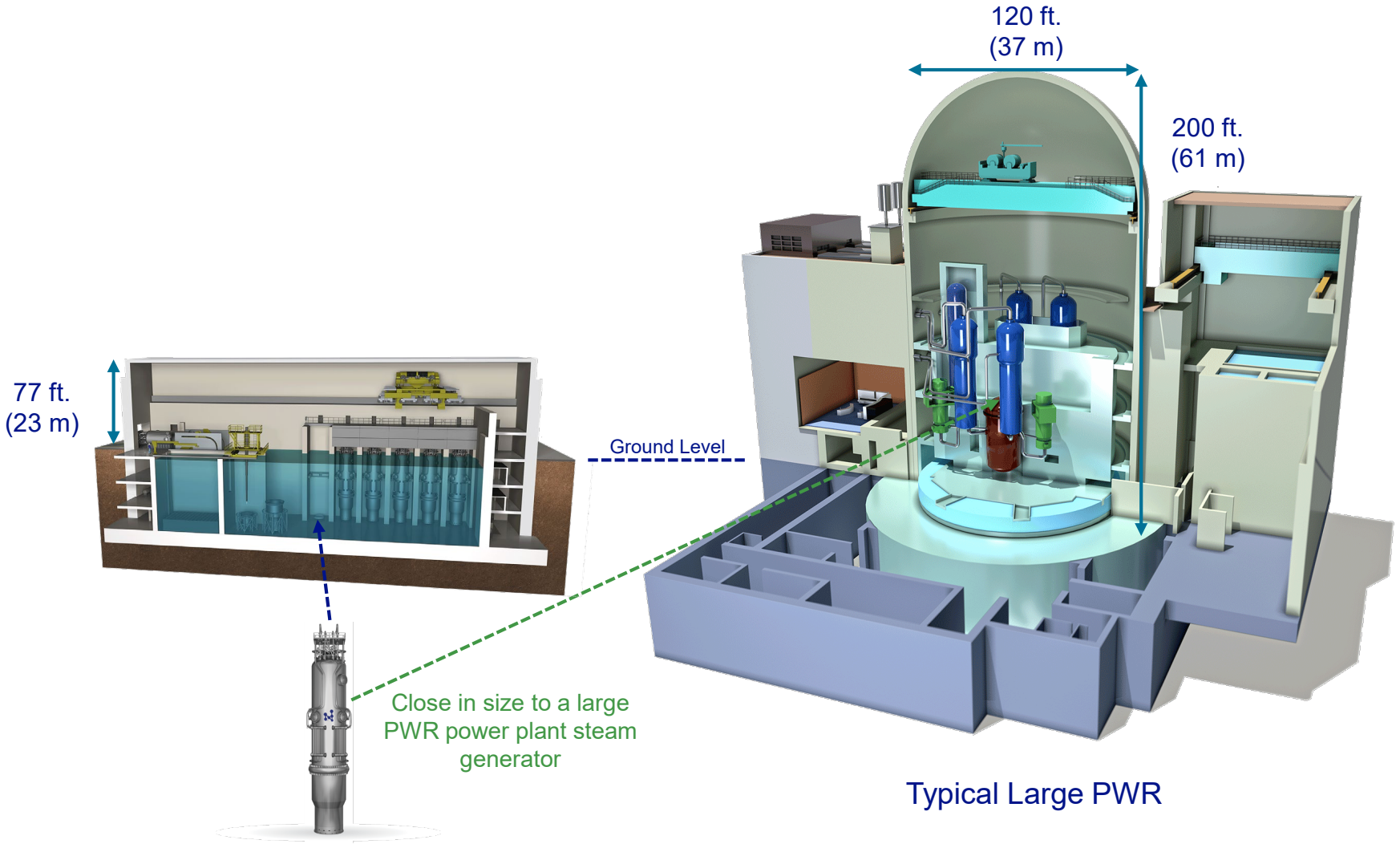
Comparison to a Large Pressurized Water Reactor (PWR)



Images not to scale

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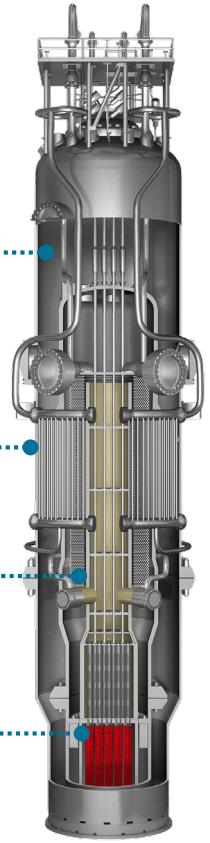
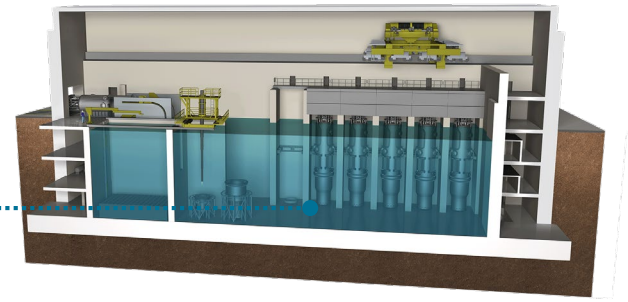
Key Enabling Features Dependent on Patented Technology

1. Evacuated Containment Design
2. Passive Safety System
3. Integral Steam Generator
4. Natural Circulation System

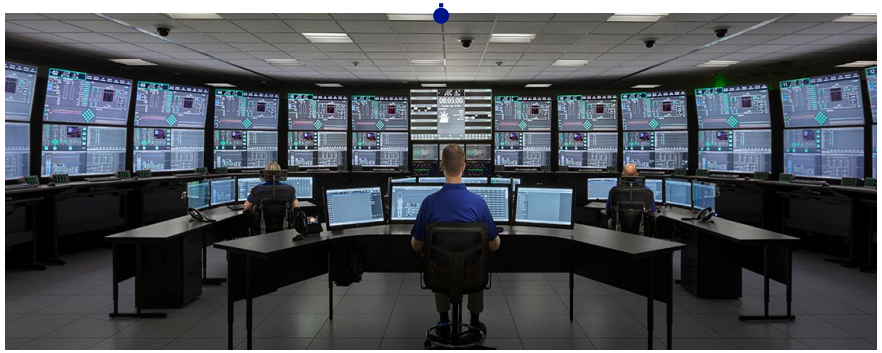


NuScale Power Module™

5. Scalable Reactor Building Design



6. Cyber-secure FPGA Based Module Protection
7. Digital Multi-Module Control Room



NuScale Plant Control Room

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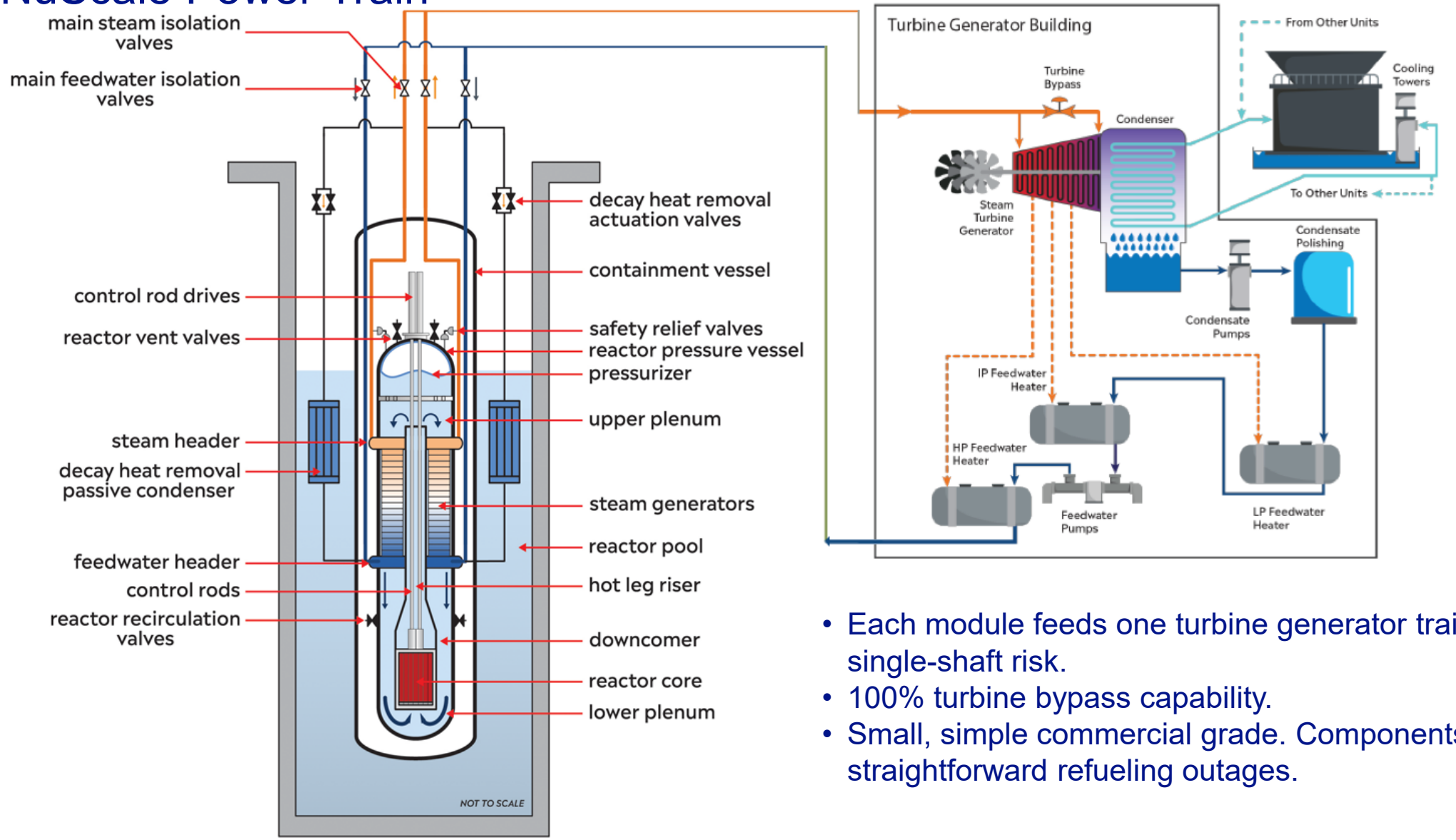
NuScale Power Train



- Each module feeds one turbine generator train, eliminating single-shaft risk.
- 100% turbine bypass capability.
- Small, simple commercial grade. Components support short straightforward refueling outages.

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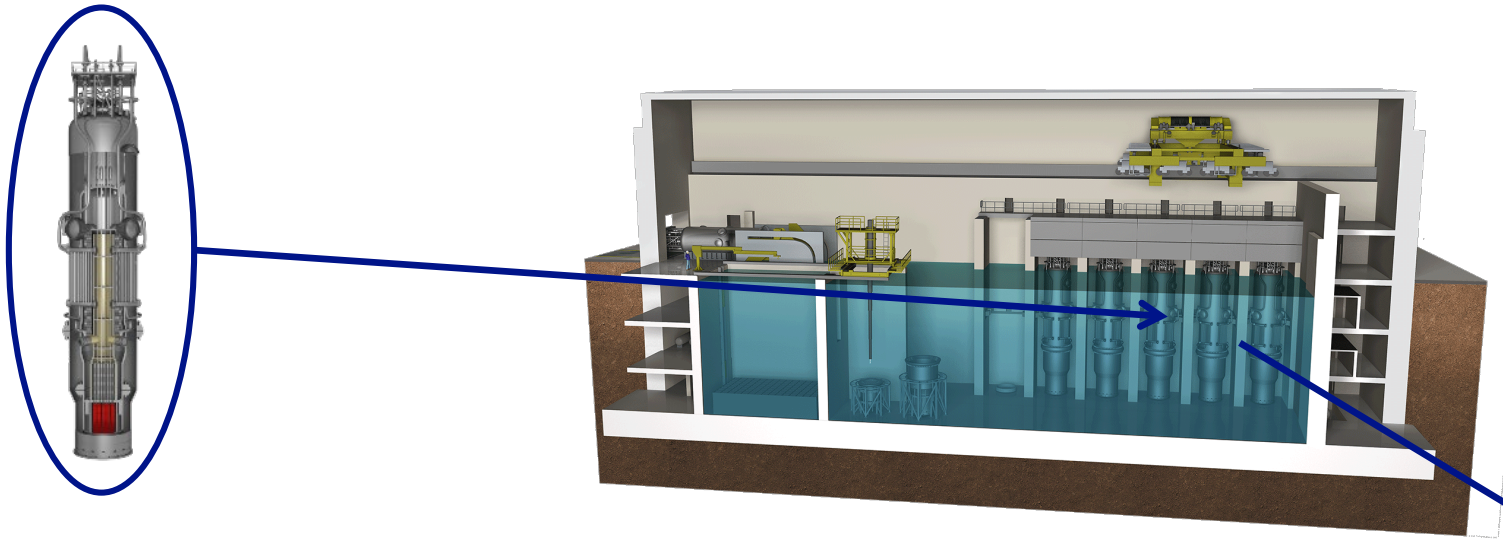
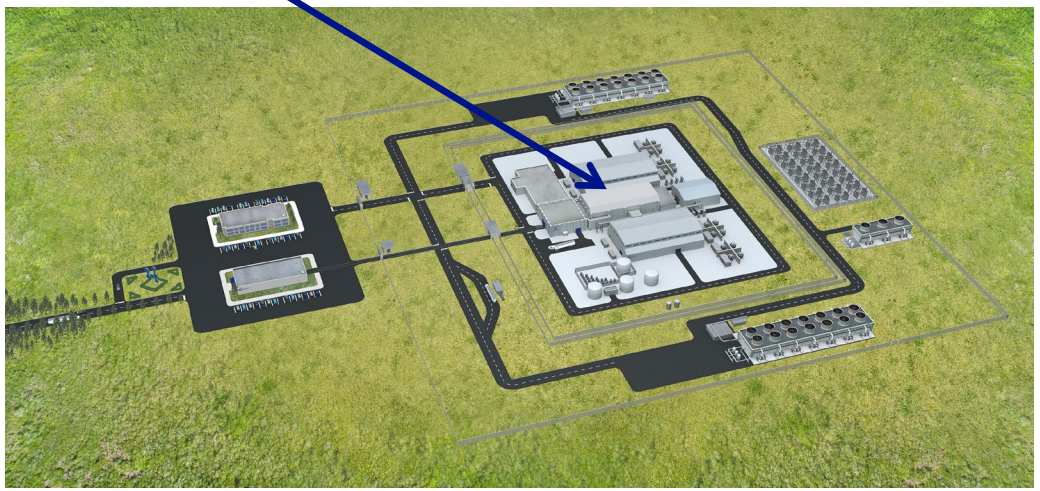
NuScale Advanced Small Reactor Overview



- Each module produces up to 77 MWe
- Up to 12 modules for 924 MWe gross plant output
- Smaller power plant solutions available for 4-module (308 MWe) and 6-module (462 MWe) plants

- NuScale Plant safely shuts down with:
  - No operator or control system actions
  - No AC/DC power
  - No additional water
- Emergency planning zone (EPZ) ends at site boundary



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What About the Waste, i.e., Used Fuel?

- What you normally hear about as nuclear “waste” is really the used fuel removed from a reactor, which still contains **~96% of the unused energy** that can be recovered to produce new fuel.
- All of the used nuclear fuel produced by the nuclear energy industry in the last 60 years has been safely managed and stored, primarily at plant sites in pools or dry cask storage.
- The NuScale power plant design includes a proven **safe and secure used fuel management system**.
- Used fuel management, storage, and disposal is regulated by U.S. Nuclear Regulatory Commission (NRC) and the **U.S. Department of Energy (DOE)** has responsibility for its ultimate disposal.
- **Recycling used fuel** could significantly reduce the burden of mining and disposing of used fuel, making our nuclear fuel cycle more sustainable.

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Used Fuel Management at NuScale VOYGR™ Plants

- NuScale reactor building and plant design incorporates a proven safe, secure, and effective used fuel management system.
- Stainless steel lined concrete pool holds used fuel for at least 10 years under 60 feet of water.
- The used fuel is protected both by the ground and the Seismic Category 1 reinforced concrete reactor building designed to withstand an aircraft impact, and a variety of natural and man-made phenomena.

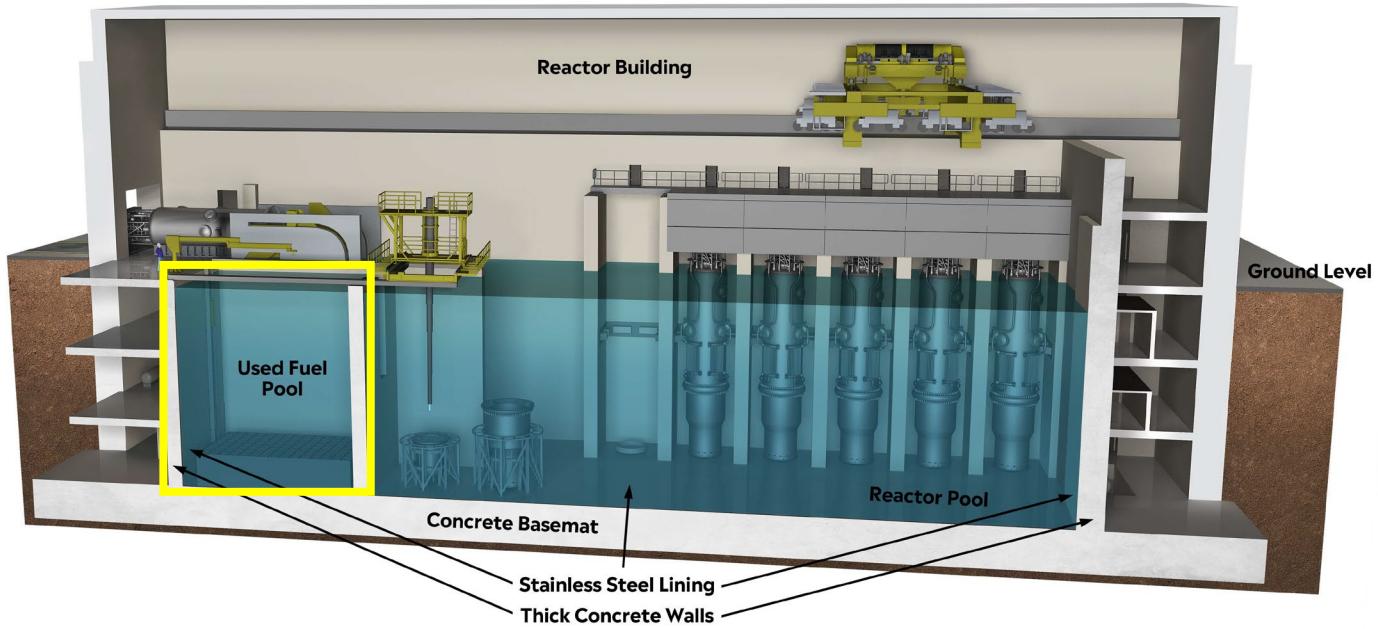
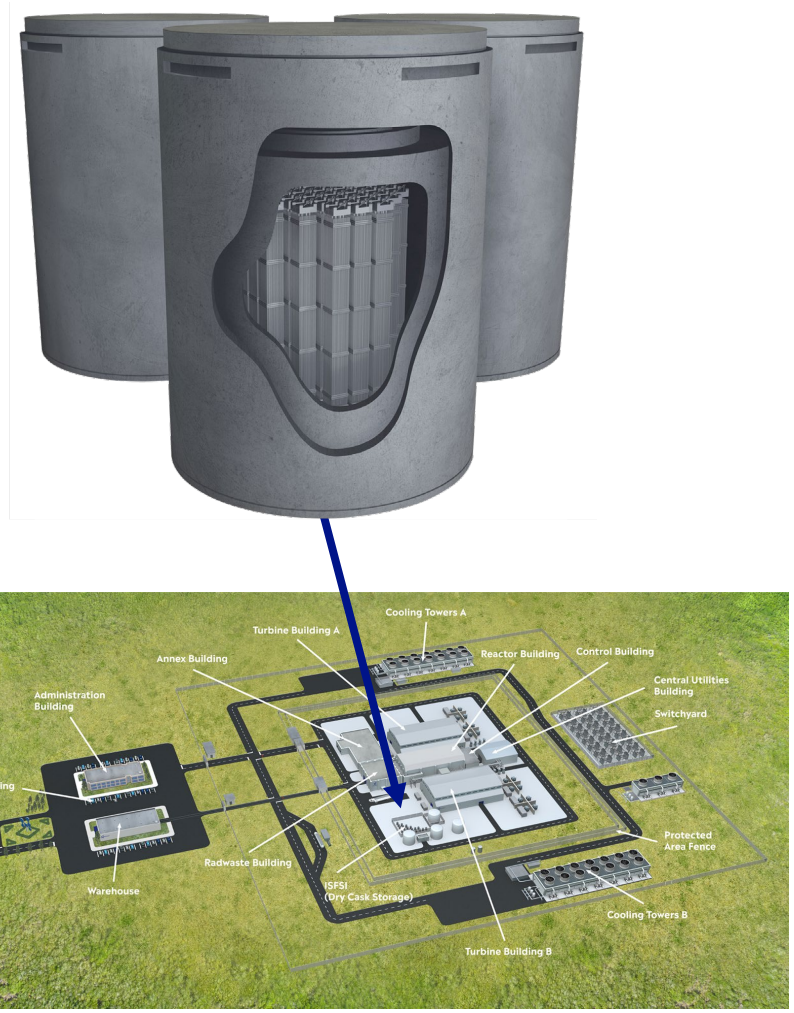


Image Credit: Nuclear Energy Institute

Used Fuel Storage & Disposal



- After cooling in the spent fuel pool, used fuel is placed into certified casks – steel containers with concrete shells – on site of the plant.
  - NRC's Waste Confidence Rule states that dry cask storage is a safe and acceptable way to store used fuel for an interim period at the plant up to 60 years beyond the licensed life of any reactor (i.e., for up to 120 years).
  - **NuScale's standard facility design includes an area for the dry storage of all of the spent fuel produced during the 60-year life of the plant.**
- U.S. Department of Energy (DOE) has responsibility for the final disposal of used fuel under the Nuclear Waste Policy Act.
  - Under the Act, the generators of electricity from nuclear power plants must pay into a fund to be used for the long-term disposal of this used fuel; over $40 billion is currently in the Nuclear Waste Fund.

Sources: U.S. NRC; U.S. DOE; Nuclear Energy Institute

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Used Fuel Recycling – A Better Option?

- Recycling used fuel could significantly reduce the burden of mining and disposing of spent fuel, making our nuclear fuel cycle more sustainable and further reducing the already-low carbon total footprint of nuclear power.
- Recycled fuel and mixed uranium-plutonium oxide (MOX) fuel are suitable for use in the NuScale SMR.
- Recycling has been in successful use in several markets, such as France, for decades
    - Some new advanced designs will utilize this used fuel in its reactors as a means to reduce the overall quantity.

KEY FACTS

- **96% of the content of the used fuel is reusable energy**
- **Recycling used fuel:**
    - **Saves 25% of natural uranium resources**
    - **Reduces the volume of high-level waste slated for disposal in a repository by 75%**
    - **Reduces the waste's toxicity by about 90%**

Source: Framatome, Third Way

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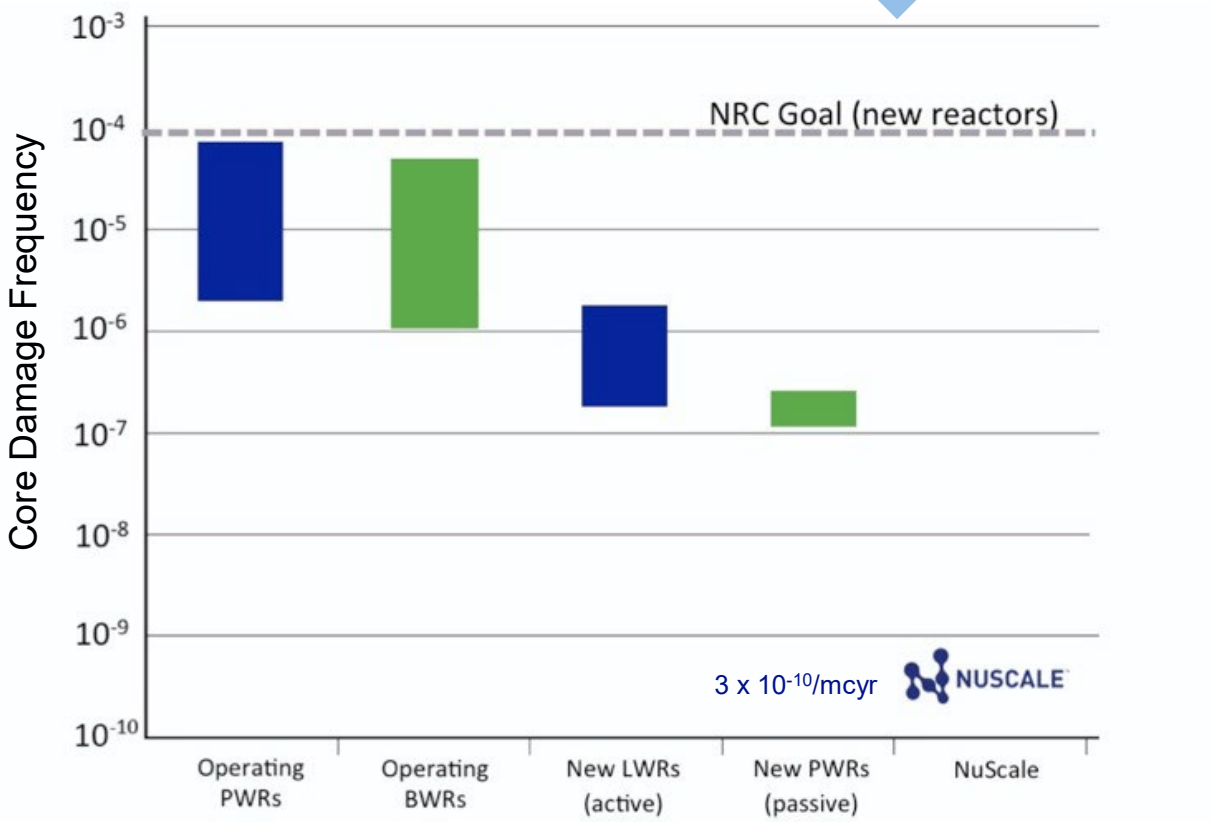
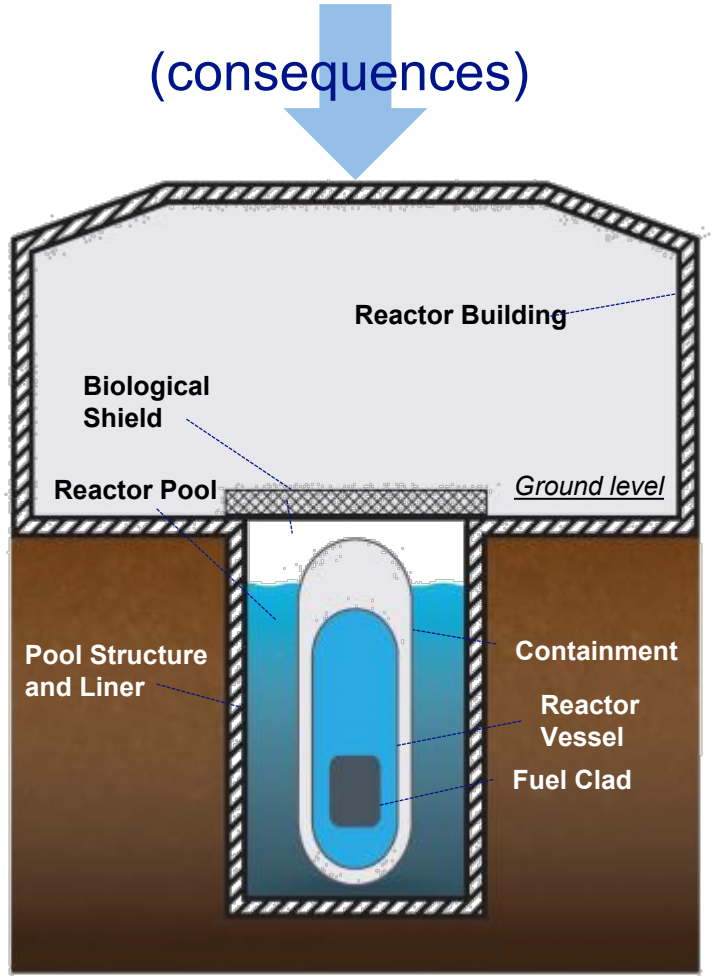
Reducing Plant Risk

Risk = (frequency of failure) X (consequences)



*Probability of core damage (full power, internal events) due to NuScale reactor equipment failures is **1 event per module every ~3 Billion years.***



Four additional barriers to release of radioactivity from a NuScale VOYGR™ plant.

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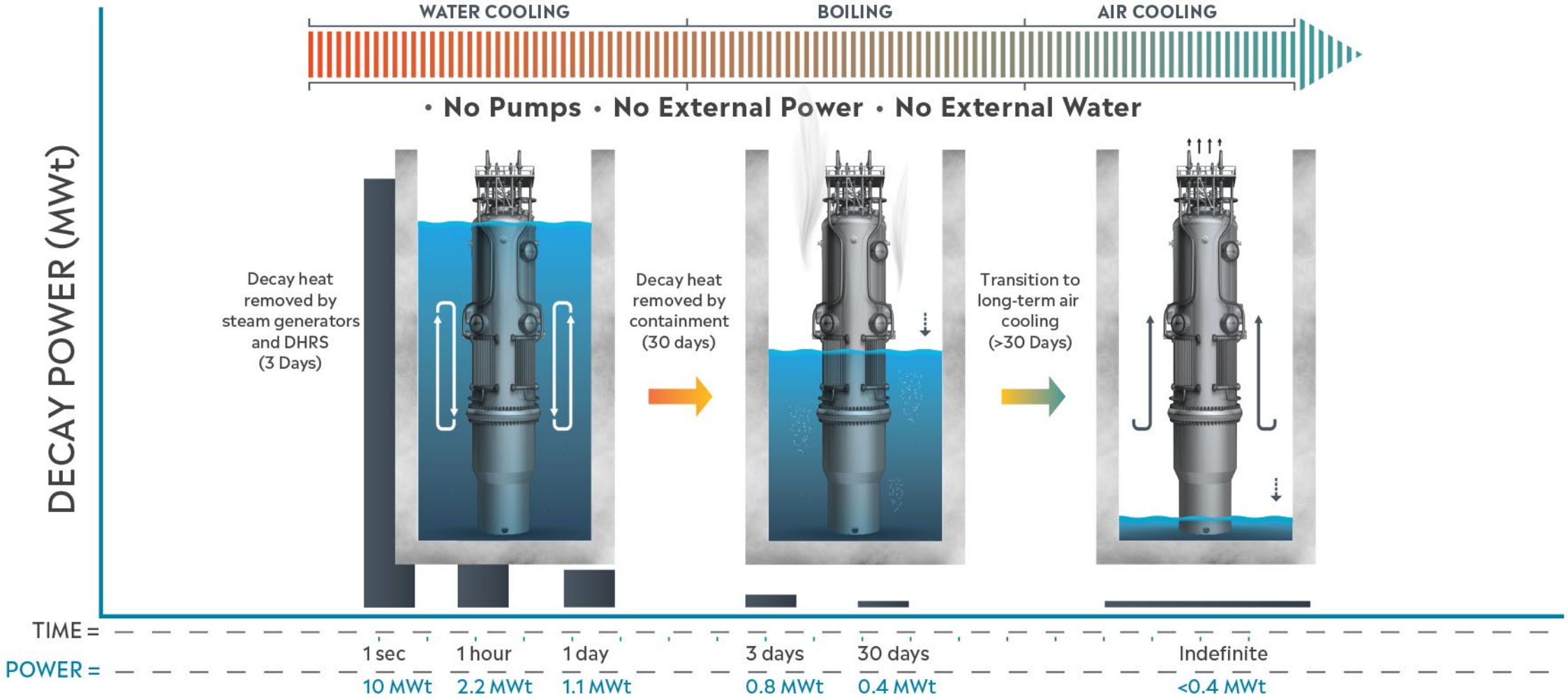
Innovative Advancements to Reactor Safety

Nuclear fuel cooled indefinitely without AC or DC power*



**Alternate 1E power system design eliminates the need for 1E qualified batteries to perform ESFAS protective functions – Patent Granted*

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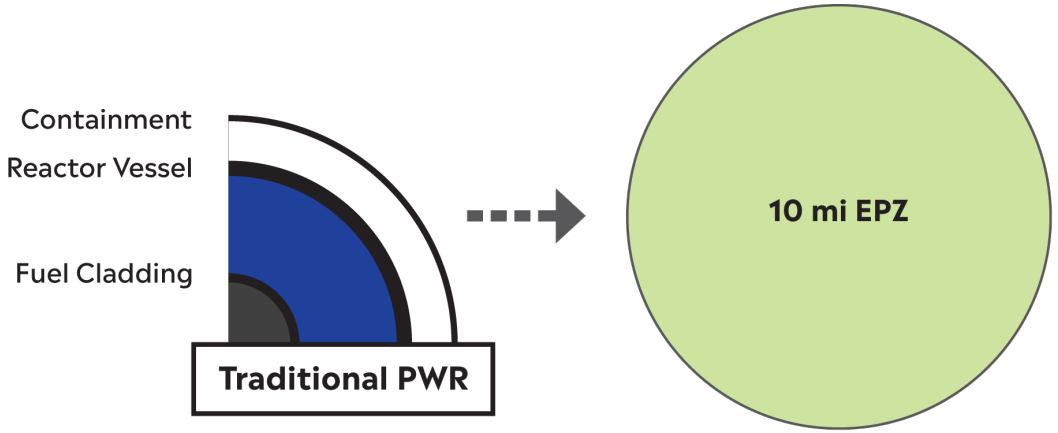
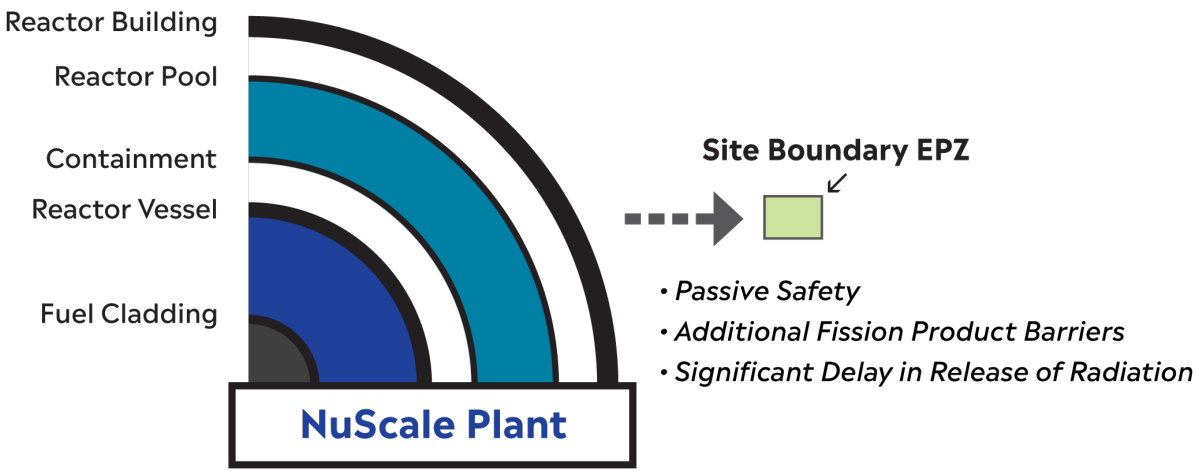
Smaller Emergency Planning Zone (EPZ)



The licensee must have pre-determined protective action plans in place for a large publicly accessible area.



Virtually no publicly accessible area is subject to protective action planning by the licensee.

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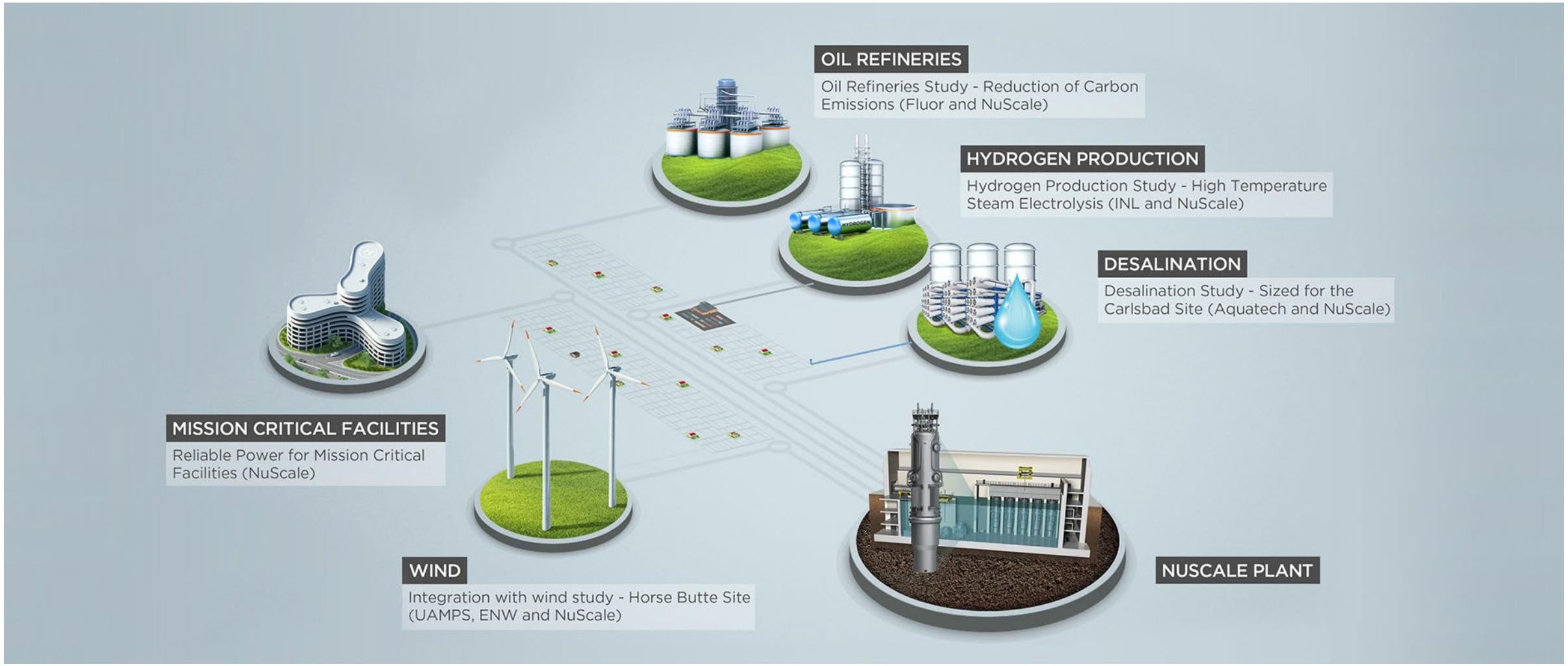
Beyond Baseload: NuScale Diverse Energy Platform

More Than Reliable Baseload and Load-following Electricity Generation



Reports for associated technical studies are available at: www.nuscalepower.com/technology/technical-publications

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NuScale is Well Suited for a Range of Applications Critical to the Energy Transition

Enhancing the Power Grid

Grid Resiliency

- Adverse weather conditions do not impact operations for a NuScale Plant
- A single module can be black-started and can power the entire plant in case of loss of the utility grid
- On loss of offsite grid, all modules in a NuScale Plant can remain at power and be available to provide electricity upon grid restoration

Mission Critical Facilities

- A NuScale Plant can provide highly reliable power to mission critical micro-grids (e.g., hospitals, data centers) with 99.95% availability over the 60-yr life
- Off-grid operations enables a plant to supply power without external grid connection

Energy Transition-Specific Opportunities

Coal Plant Replacement

- ~132 coal plants in the U.S., representing 140+ GW of capacity, are planned for retirement through 2050
- Opportunity to preserve 41,500 power plant jobs by repurposing this lost coal capacity with over 150 NuScale plants (12 NPM), and create or preserve nearly 37,000 manufacturing jobs per year

Support for Wind and Solar Development

- NuScale's load-following capabilities well-suited to both solar and wind's intermittency
- Provides critical ancillary services to support electric grid stability

Carbon Capture & Sequestration (CCS)

- NPMs can power energy-intensive CCS facilities with 100% clean power
- Many global decarbonization pathways anticipate significant CCS deployment
- Direct air capture

Hydrogen Production

- NuScale NPMs can produce cost effective, green hydrogen at scale
- Hydrogen production by conventional renewables faces challenges of scale and cost

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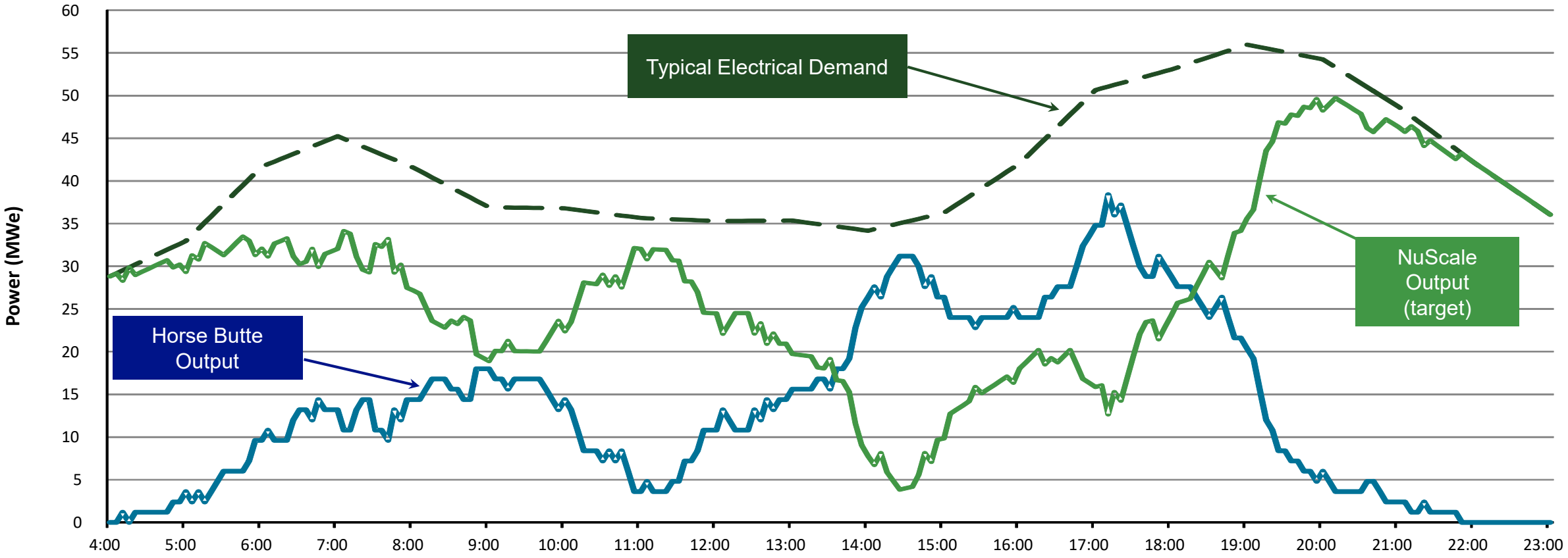
Flexible Operations Enable Further Growth in Renewables



NuScale design meets or exceeds EPRI Utility Requirements Document (URD), Rev. 13, load following and other ancillary service requirements.

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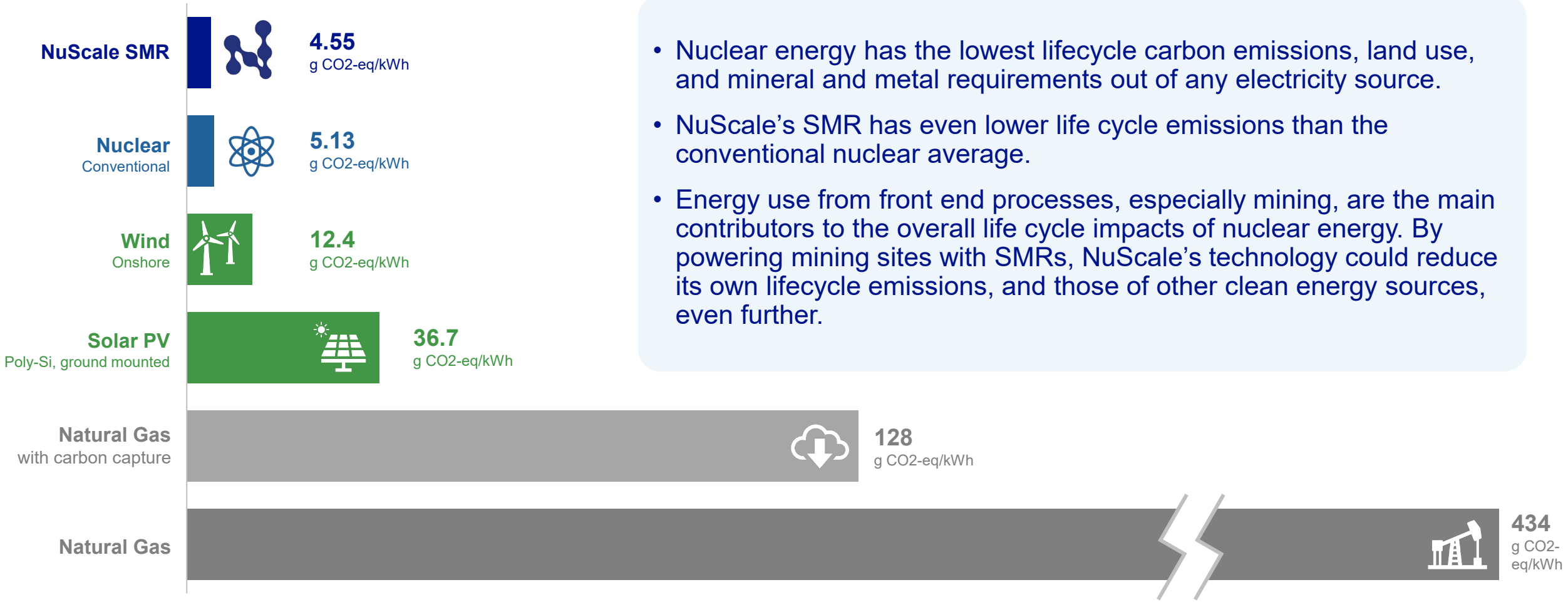
Lifecycle Greenhouse Gas (GHG) Emissions from Electricity Sources



- Nuclear energy has the lowest lifecycle carbon emissions, land use, and mineral and metal requirements out of any electricity source.
- NuScale's SMR has even lower life cycle emissions than the conventional nuclear average.
- Energy use from front end processes, especially mining, are the main contributors to the overall life cycle impacts of nuclear energy. By powering mining sites with SMRs, NuScale's technology could reduce its own lifecycle emissions, and those of other clean energy sources, even further.

Source: United Nations Economic Commission for Europe (UNECE), 2020 Life Cycle Assessment of Electricity Generation Options

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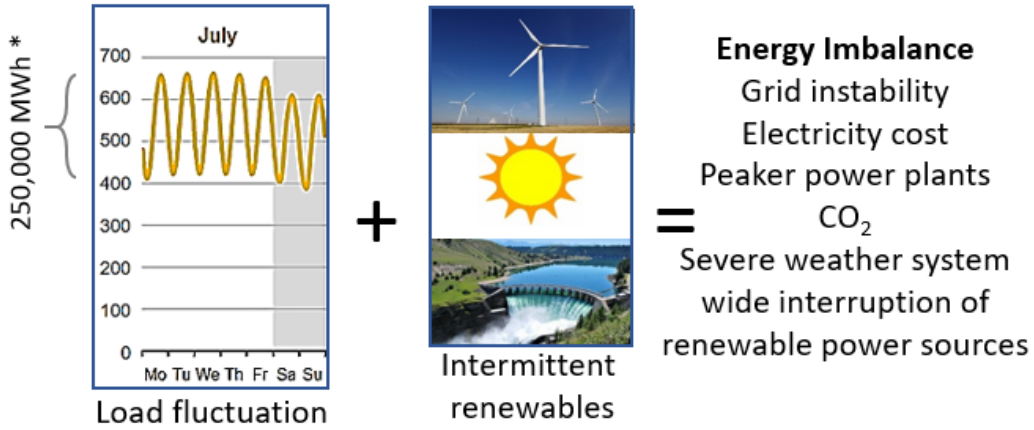

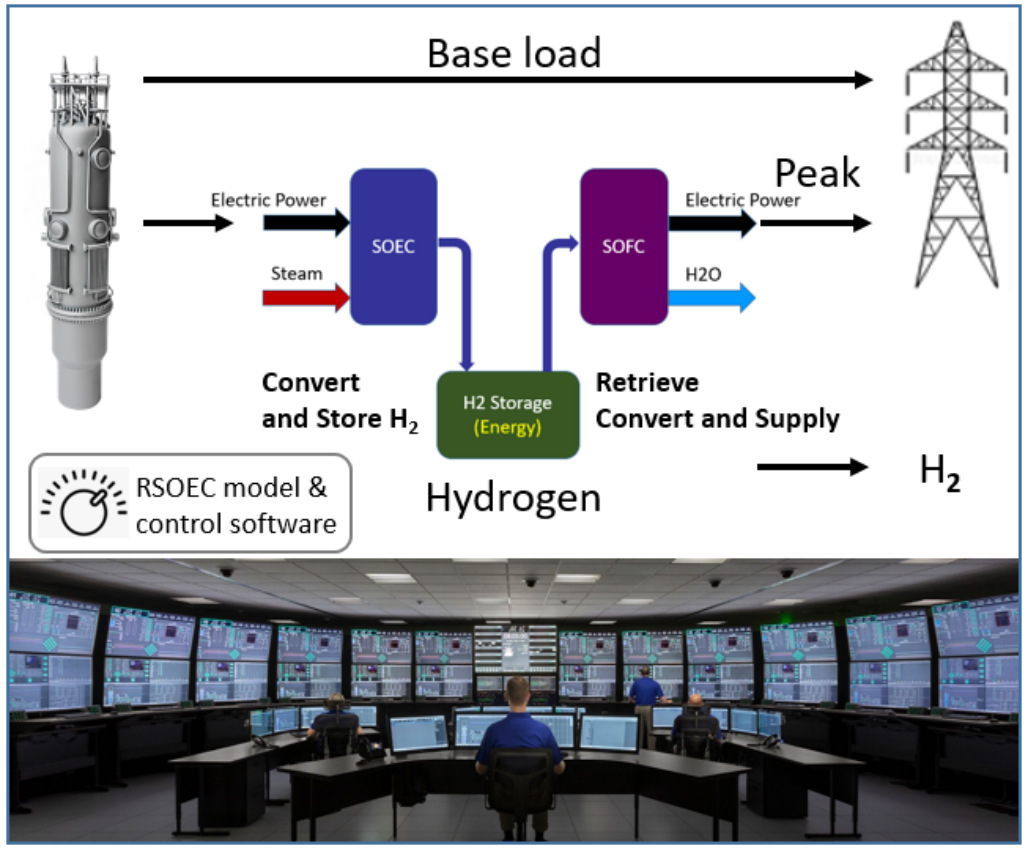

Hydrogen, Energy Imbalance Market

Development and demonstration of a concept for an economically optimized Integrated Energy System (IES)

Produce hydrogen using electricity and process heat, store energy and balance grid with clean power

- Electric power demand fluctuates significantly due to domestic and industrial activity (250,000 GWh)
- Renewables generate power intermittently and the percentage is significant (34% in CA) and growing
- Develop a reversible solid oxide fuel cell model and simulate UAMPS CFPP power demand scenarios
- Perform a techno-economic analysis using state-of-the art Modeling and Simulation techniques
- Identify the optimal configuration for maximum benefit for power and Hydrogen production

Research team: Shell Global solutions, INL, UAMPS, Fuel Cell Energy, FPoliSolutions and GSE Solutions and NuScale Power

* U.S. Average hourly load, Source EIA

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Improved Reliability Through the Use of Multiple Small Units

- **Relatively small turbine generators – allows for simplified and economic BOP design:**
  - Single case turbine (no reheat)
  - Totally enclosed water cooled to air cooled generator (no hydrogen or stator water cooling systems)
  - Commercial grade turbine (no missile threat to nuclear safety)
  - Single heater train, cascading drains
- **No single shaft risk –** Independent turbine generator sets for each reactor module; in a 12 unit plant 92% output is maintained with a single unit out of service
- **Full turbine steam bypass capability –** No reactor trip required for a turbine trip allowing quick return to power after trip condition corrected
- **Capable of Island Mode operation:**
  - Plant can stay online during a loss of grid event supplying house loads
  - Capable of supporting a micro-grid
- **Online refueling outages –** In a 12-unit VOYGR™-12 plant 92% output is maintained with a single unit in a refueling outage

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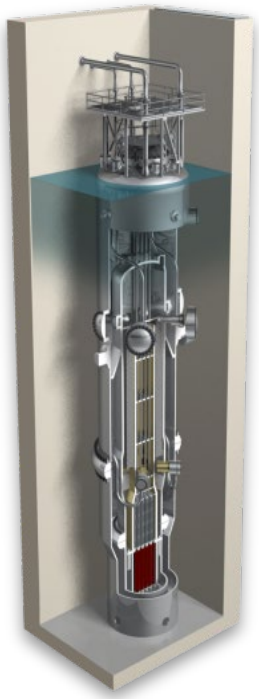
A New Approach to Construction and Operation

NuScale has revolutionized the nuclear supply chain with modular manufacturing of NPM units in-house that are shipped to sites



1

Factory fabrication

2

NuScale Power Module including containment and reactor vessel

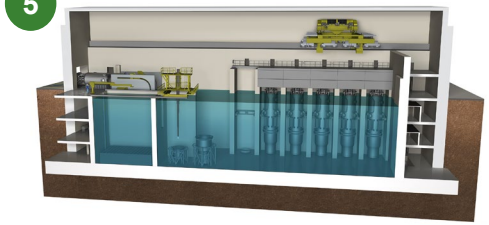
3

Shipped by truck, rail, or barge

4

To the VOYGR plant site

5



Housed in a 12-module reactor building

Low carbon, secure electricity

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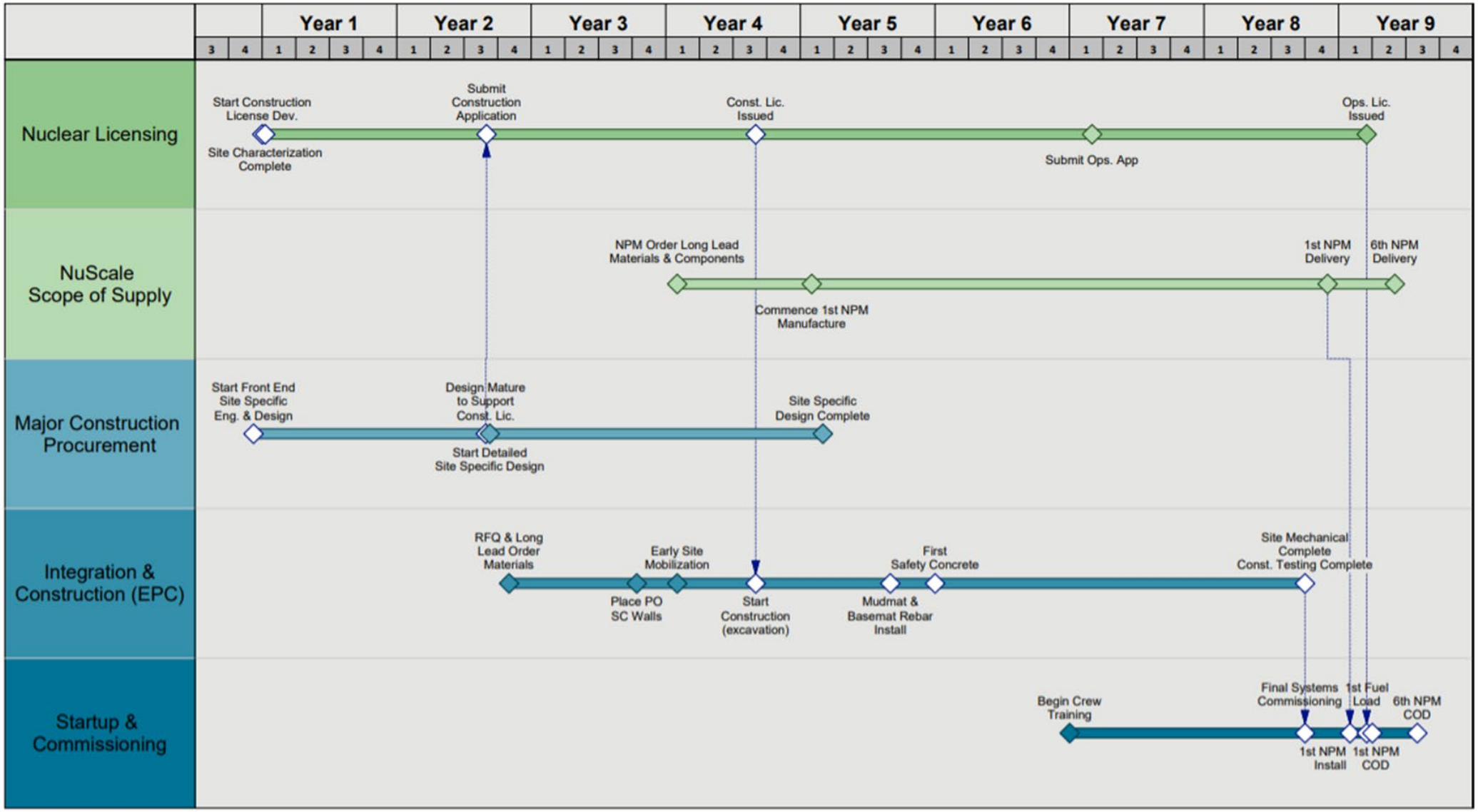
NuScale International NOAK Roadmap
6 NPM / 6 Pack Plant Model
NuScale Nonproprietary



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IRA Provides Significant Tax Credits for Advanced Nuclear, SMRs

Act contains several key provisions that bolster a broad spectrum of new and existing activities in the nuclear industry; nuclear will receive credits that once only applied to wind and solar

- Creates tax credit of 30% towards the cost of building zero-emission advanced nuclear power plants
- Could create up to a 50% reduction in costs for building an SMR at retired coal plant site

Clean Electricity Tax Credits

- **30% ITC** (investment tax credit)
- Technology-neutral tax credits include advanced nuclear
- Start in **2025** and phased out in **2032**, or when CO_2 emissions from electricity production are 75% below 2022 levels
- **10% bonus** for facilities sited in certain energy communities (e.g., coal plant communities)
- **10% bonus** for domestic content

Loan Guarantee Expansion

- Authorizes DOE's Loan Programs Office to employ up to **$40 billion** in additional loan authority until September 2026
- Additional **$3.6 billion** to cover loan guarantee costs

Clean Hydrogen Credit

- **$3/kg-$H_2$** PTC from qualifying facilities producing clean hydrogen
- Facility must begin construction before 2033
- Available for 10 years

Advanced Energy Project Credit

- **30% ITC** for qualifying manufacturing facilities producing components for clean energy
- Extension of the credit, capped at **$10 billion**, with $4 billion required to be located in energy communities

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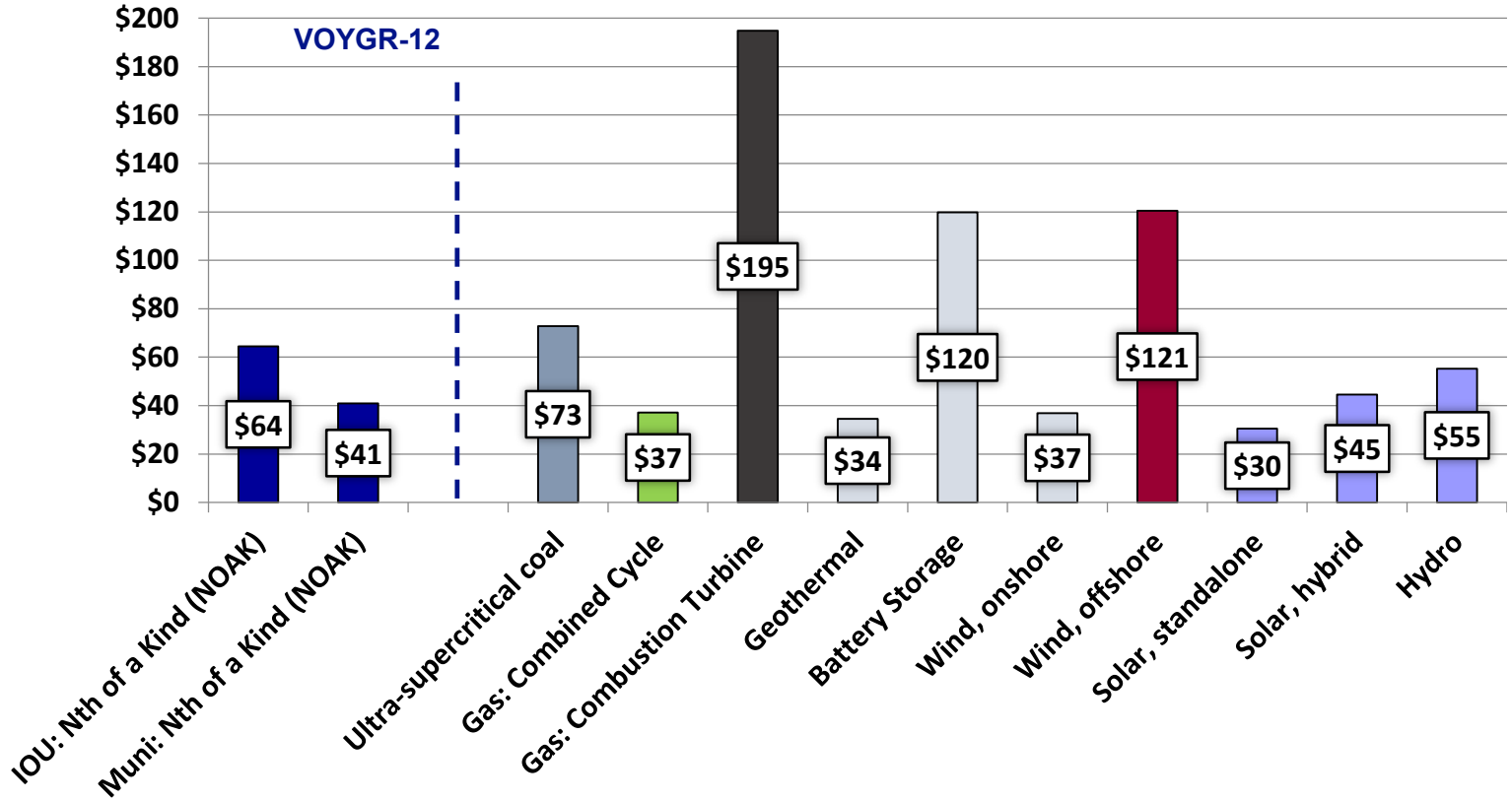
Competitive Economics

- Competitive economics with reduced production cost volatility
- Lower capital at risk in financeable bite sizes
- High capacity factor, baseload and non-carbon emitting power source with extensive load-following capability
- Flexible and safe design meets power needs at competitive cost
- Non-fuel, operational costs much lower than current U.S. fleet top quartile

Estimated Average U.S. Levelized Cost of New Generation Resources (2020$)



Assumptions for EIA and NuScale 12-Pack
WACC of 4.0% to 7.0%; 30 yr cost recovery; 4.0% WACC only for NuScale Muni
NuScale 12-Pack FOAK and Nth LCOE include Owner's Cost of $3.00/MWh. EIA includes transmission investment from $1.00/MWh (Advanced Nuclear) to $4.10.MWh (Solar Thermal).
NuScale included $1.00/MWh for transmission investment in FOAK and Nth LCOE values.

Source: U.S. Energy Information Administration, Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2021, Feb 2021, except NuScale (12-Pack); NuScale Model.
EIA analysis assumes a $2.07/MMBtu natural gas spot price ($2020)

Simplicity of design provides competitive levelized cost of electricity (LCOE) compared to other low carbon options.

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Demonstrated Technology

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Proven LWR Technology

- 67 years of civilian and naval operational experience.
- The NuScale design is based on proven light water reactor (LWR) technology
  - Used in > 350 commercial LWRs globally, and 83 nuclear-powered ships
- It is a natural circulation, light water, Pressurized Water Reactor (PWR) packaged in a small integral reactor vessel.
- Uses commercially available low-enriched uranium dioxide fuel, control rods, off-the-shelf skid mounted turbine generator sets, cooling towers, balance of plant and electrical distribution systems.
- NuScale has expended over $100M is assessing and demonstrating all of the reactor's key components.
- All novel features of the design were tested:
  - Main Control Room
  - NuScale Fuel Bundle (Framatome)
  - Helical Coil Steam Generator (SIET S.p.A)
  - Integral System Safety (Nuscale Integral Systems Test)
  - Full Scale Safety Valves (National Technical Systems)
  - Module Assembly equipment (PaR Systems)

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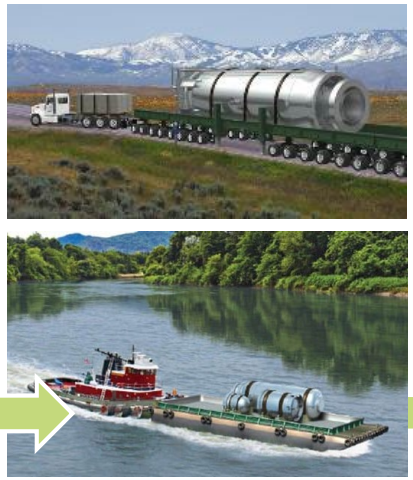
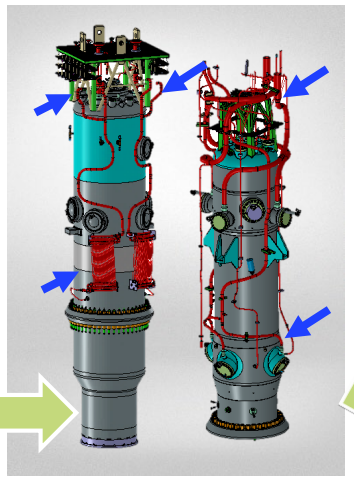
NPM Manufacturing Process Overview

Ingot melt and forging

NPM pressure vessel & component manufacturing at various supplier locations



NPM pressure vessel & component transportation to site



Assemble piping, valves, sensors, and cables to pressure vessels

Manufacturing complete & import to reactor building

Plant construction by EPC in parallel

Reactor Building Construction Complete

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Repurposing Coal Power Plants

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Coal-to-Clean Energy Transition Expected to Accelerate

- Insights from the U.S. Department of Energy Coal-to-Nuclear Report[1]:
  - By repurposing existing infrastructure, compared with a greenfield project, the construction **cost savings are between 15 – 35%** for a nuclear power plant to be built on a coal power plant site.
  - **80%** of 394 active and recently retired coal power plant sites are good candidates to host small modular and advanced reactors.
  - Compared to 150 jobs with a coal power plant, without including jobs from construction, a nuclear power plant yields **650 permanent jobs** across the plant, supply chain and local community, resulting in **additional economic activity of $275 million**, directly leading to **a 92% tax revenue increase.**
- The Inflation Reduction Act changes tax credits for renewable energy into **technology-neutral tax credits** that place advanced nuclear on a level playing field with other zero-carbon generation sources.
- **Additional tax incentives** are available for projects located in energy communities, specifically where coal mines or coal-fired power plants have closed.

1. U.S. DOE, "Investigating Benefits and Challenges of Converting Retiring Coal Plants into Nuclear Plants, 2022 H.R.5376 - 117th Congress (2021-2022): Inflation Reduction Act of 2022

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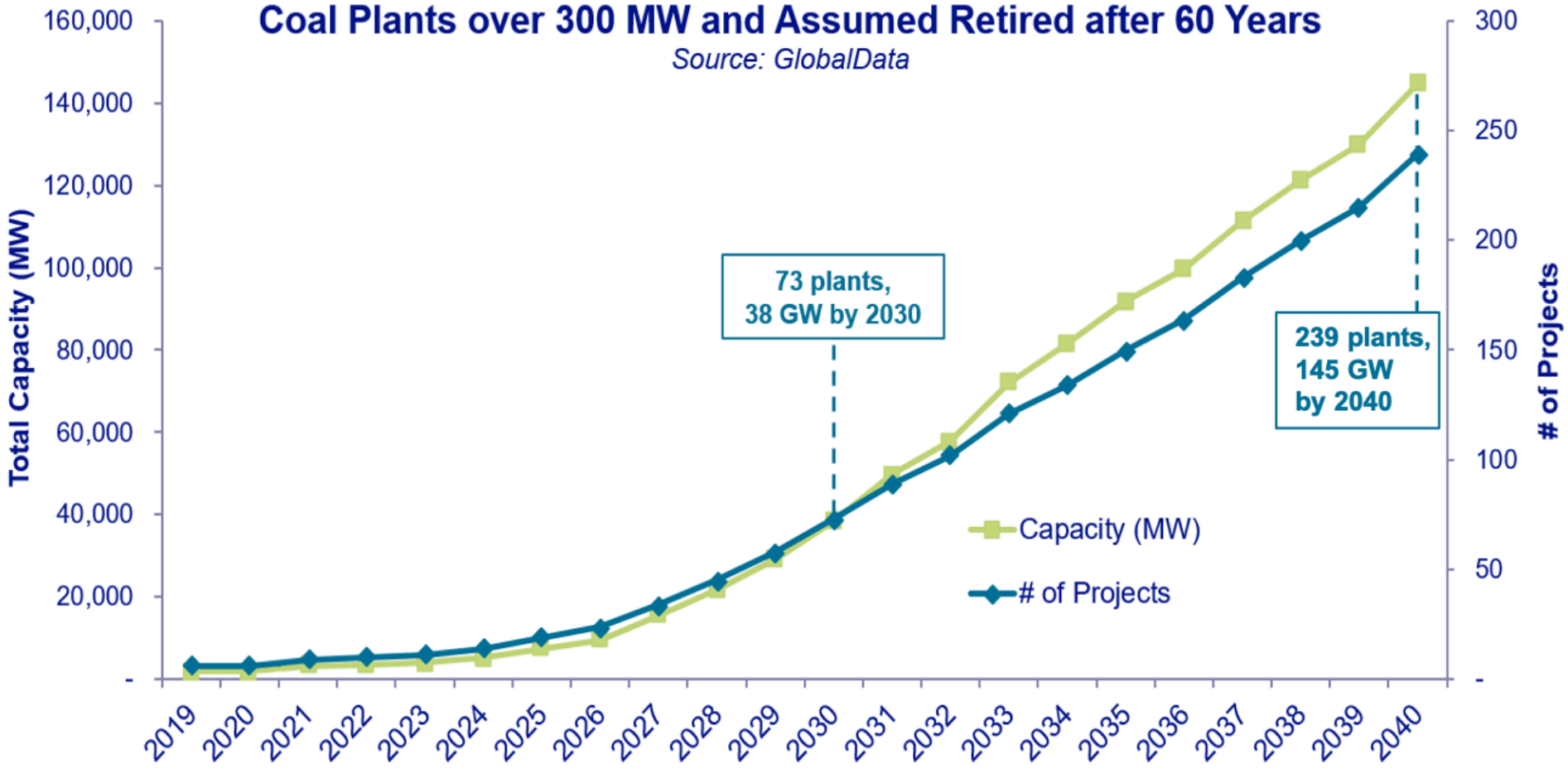
U.S. Coal Power Plant Retirements



- Each VOYGR™-12 plant employs ~270 people full-time, with 1200 peak construction jobs
- VOYGR plants can be scaled to re-power retiring coal power plant capacity

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Retaining Coal Power Plant Workforce

Department	Coal Power Plant Position*	NuScale Equivalent Position
Station Management	Plant Manager Operations Manager	Plant Manager Operations Manager
Operations	Control Room Operator	Reactor Operator
Maintenance Planning	Maintenance Supervisor Engineering Technician	Maintenance Supervisor Work Control Scheduler
Maintenance	Boilermaker, Steamfitter Heavy Equipment Operator	Mechanic Site Support Craftsman
Engineering	Thermal Station Engineer System Engineer	Design Engineer System Engineer
Environmental	Environmental Board Operator Environmental Operator	Radwaste Operator Non-licensed Operator
Coal Yard Railroad	Coal Yard or Railroad Specialist	Site Support Craftsman
Outage Planning	Outage Manager Planner	Generation & Planning Manager

**Representative of some of the typical positions. Others also apply.*

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Department/Position	Estimated Number of Positions*
Plant Manager	1
Department Managers	6
Operations	45
Radiation Protection	17
Chemistry	14
Work Control	13
Outage Planning	21
Instrumentation & Controls (I&C)	10
Mechanics	8
Electricians	11
Plant Systems Engineering	9
Reactor Engineering	5
Licensing	5
Emergency Preparedness	2
Training	19
Site Support/Facilities	13
Corrective Action Program (CAP)	2
Supply Chain	5
Fix It Now (FIN) Team	15
Backshift Supervisor	1
Security	48

NuScale Plant Staffing

- For a 12-unit VOYGR™-12 plant, approximately **270 plant personnel** support operations, online maintenance, refueling, outage maintenance, security, and more.

* This is a standalone facility staffing estimate. Further staffing reduction is possible through the centralized facility support services offered and provided by NuScale.

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Repowering Our Energy Communities

- A VOYGR™ power plant represents a century long investment in the host community
  - 1,200 construction jobs over three years
  - 270 operation jobs for 60 years
  - 677 induced/indirect jobs for 60 years
  - $16M in local taxes, $470M in local goods and services yearly
- Siting VOYGR power plants at retiring coal plants can equitably transition and repower communities clean energy
  - Retain and retrain coal/gas plant workforce
  - Re-use coal/gas plant infrastructure
  - Preserve local tax base and economy, worker families and communities

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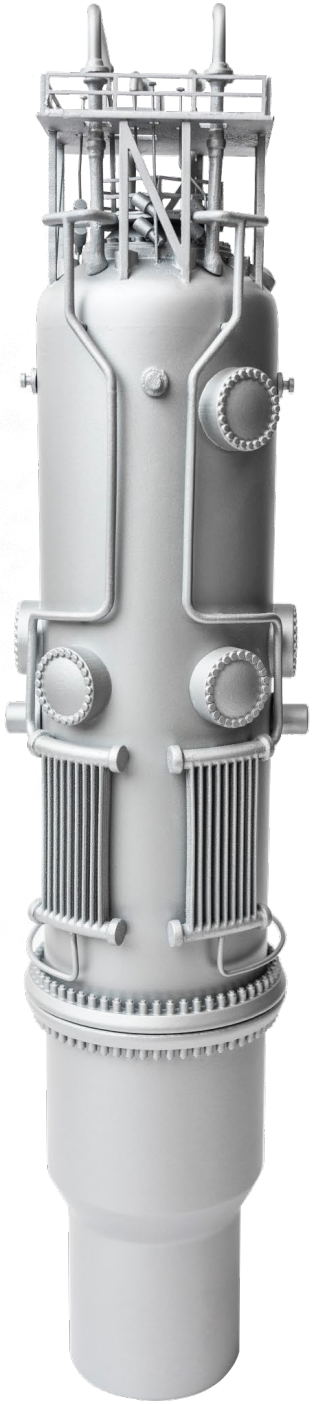

So What is Different?

- Steady-state manufacturing on a factory assembly line versus a site construction job.
- Select and develop a set of supplier partners for all NuScale plants, not a bid list for one plant
  - Close partnerships are critical.
  - Pricing modules and terms negotiated in advance.
  - Suppliers are vested in the long-term viability of NuScale.
  - Standard specifications.
- Nuclear Steam Supply System is all contained in the NuScale Power Module™ (NPM).
  - The NPM is factory built and then shipped onsite of the plant.
  - The NPM is an ASME Selection III reactor pressure vessel inside of an ASME Section III containment vessel.
- Each NPM feeds steam to its own steam plant – that means 12 steam turbines associated equipment.
- The turbine buildings do not have nuclear safety related equipment.

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