Public

ELECTRIC GRID BOOTCAMP

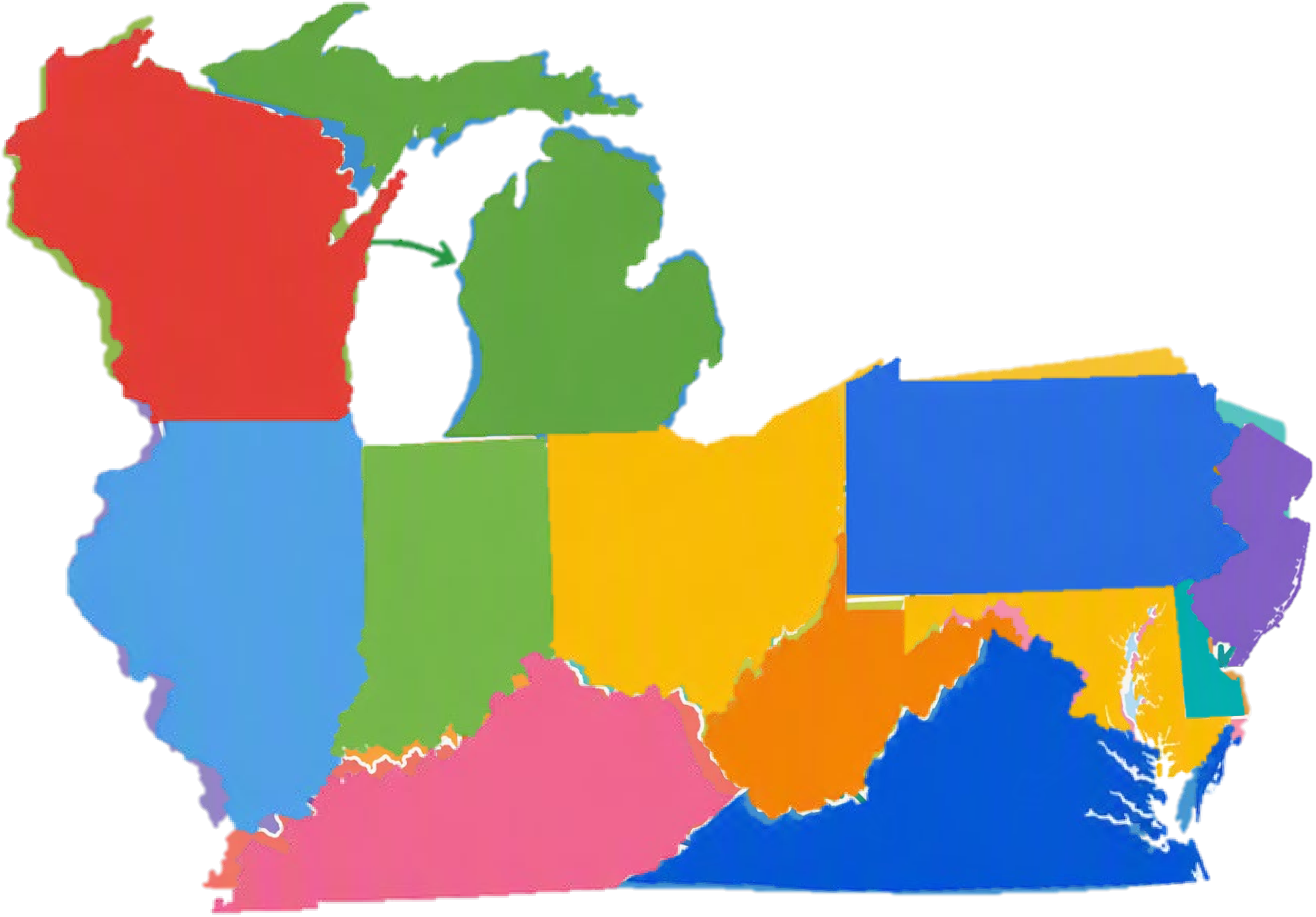
Diane Holder

VP, Engineering and Strategic Engagement

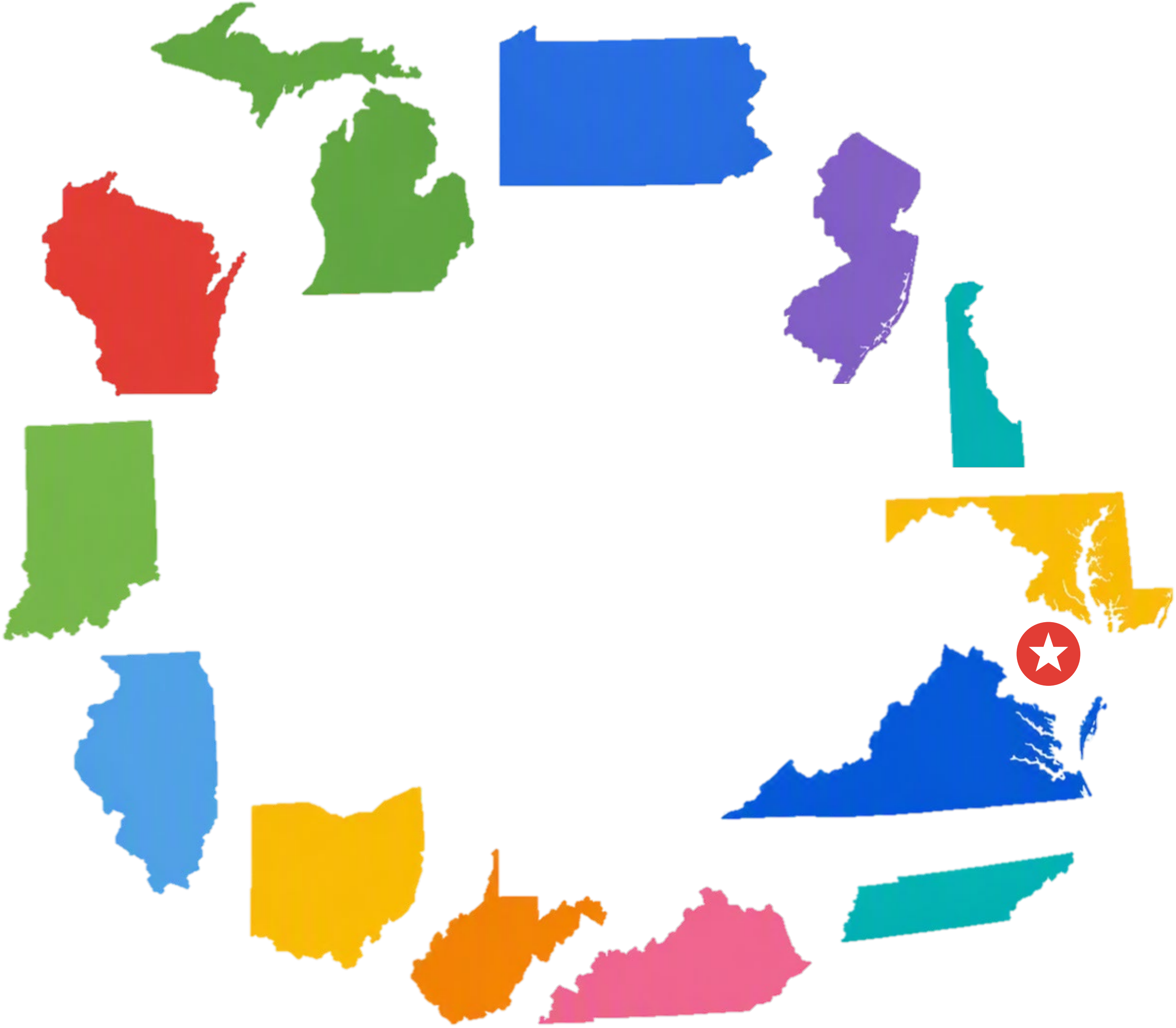
August 18, 2026

RELIABILITY FIRST

WELCOME



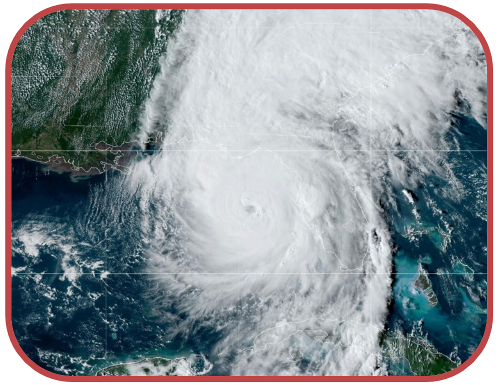
Public



FORWARD TOGETHER RELIABILITYFIRST

2025 NERC Risk Report Five Critical Risks

01 Grid Transformation



02 Resilience to Extreme Events

03 Critical Infrastructure Interdependencies

04 Security

05 Energy Policy

Energy Policy Volatility & Misalignment Key Concerns

Grid Reliability

- Misaligned policies and implementation timelines, combined with permitting delays, limit efforts to meet rising load growth and upgrade aging infrastructure

Infrastructure Bottlenecks

- Lengthy development and construction processes, driven in part by jurisdictional complexity and local opposition, delay transmission and generation projects

Energy Resource Integration

- Integrating diverse power sources requires enhanced transmission and storage infrastructure to meet growing demand and withstand extreme weather

What To Do?

Recommendation	Timeframe	Interdependence	Risk Addressed
1. Policymakers should adopt a three-pronged principles-based approach to decision-making.	1-2 years	Broad – applicable to all risk profiles	Policy volatility; Policy misalignment
2. Policymakers should adopt a durable "all of the above" approach that considers energy sufficiency and the full spectrum of resource options and services required to keep the BPS reliable.	1-2 years	Grid Transformation, Resilience to Extreme Events, and Critical Infrastructure Dependencies	Policy volatility; Policy misalignment
3. Prioritize technical education for policy makers	1-2 years	Broad – applicable to all risk profiles	Technical deficiencies in policy development
4. Prioritize increased coordination and collaboration	1-2 years	Broad – applicable to all risk profiles	Policy misalignment

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

INITIATIVES, INSIGHTS, & RECOMMENDATIONS

Data Centers & Large Loads

IBR Registration

Natural Gas-Electric Coordination

Modernization of Standards

IBR REGISTRATION

Phase 1:
May 2023 – May 2024

- Complete Rules of Procedure revisions and approvals
- Commence Category 2 GO and GOP candidate outreach and education

Phase 2:
May 2024 – May 2025

- Complete identification of Category 2 GO and GOP candidates
- Continue Category 2 GO and GOP candidate outreach and education

Phase 3:
May 2025 – May 2026

- Complete registration of Category 2 GO and GOP candidates thereafter subject to applicable NERC Reliability standards
- Conduct specific Category 2 GO and GOP outreach and education

Region:	# Category 2 Sites Registered:
ReliabilityFirst	60
NPCC	38
WECC	231
TexasRE	31
MRO	58
SERC	118

BACKGROUND
LARGE LOADS WORKING GROUP (LLWG)

Develop load models

Identify metering & protection changes

Assess impact on resource adequacy

Collect data to identify unique characteristics

Improve planning process for integrating Large Loads

Classification of different Large Loads

Identify processes & standards that do not fully address risk of emerging Large Loads

Whitepaper 1:
Characteristics and Risks of Emerging Large Loads

Whitepaper 2:
Assessment of Gaps in Existing Practices, Requirements, and Reliability Standards for Emerging Large Loads

Whitepaper 3:
Reliability Guideline Risk Mitigation for Emerging Large Loads

Public

DATA CENTERS & LARGE LOADS

Large Loads Action Plan

Q3 2026	Q4 2026	Q1–Q4 2027
• Host a webinar on the Level 3 Alert (July 8) • Publish the Data Center Load Modeling Technical Reference (July, subject to RSTC approval) • Responses Due: Level 3 Alert (August 3) • Post glossary and standard(s) for comments (August) • Organize a Data Center Load Modeling Workshop (September 15–16)	• Post registry criteria, glossary, and standard(s) for additional comment period (October 21 if needed) • Request Board approval of registry criteria, glossary, and standard(s) (December 25) • File registry criteria, glossary, and standard(s) (December 31, subject to Board approval)	• Draft and file addditional applicable Reliability Standards as needed

NERC RELIABILITY | RESILIENCE | SECURITY

Level 3 Essential Action Alert

- Highest level of alert that NERC releases-only for actions that are deemed "essential" for BPS reliability
- Issued as NERC observed customer-initiated large load reductions and significant oscillations that occur in seconds…threatening BPS reliability
- Outlines action registered entities must implement to address immediate risks posed by computational loads interfacing with the BPS

MODERNIZATION OF STANDARDS

Governance (Partner with Legal)

- ROP/Charter Revisions
- Standards Committee Transition
- RISC Subcommittee
- RSTC

Tools (Partner with IT)

- Comment and Ballot System
- Enterprise Document Library
- AI Tools
- Website Enhancements
- Standards Initiation Request and Term Sheet

Pilot (Owner Standards)

- AI Tools
  - Comment summary
  - Standard draft
- Short-Term Advisory Group
  - Computational Load
- Solicit SARs Biannually
- Increase Stakeholder Engagement
- Standards Initiation Request and Term Sheet

MODERNIZATION OF STANDARDS

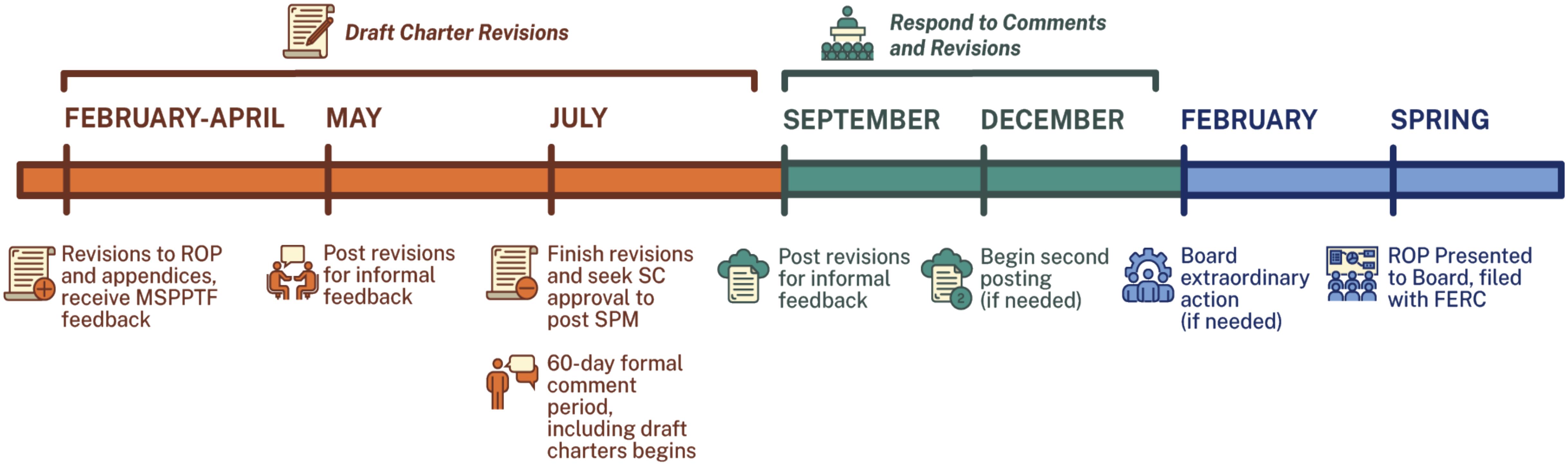
IMPLEMENTATION TIMELINE

QUARTERLY WORKSTREAM PROGRESSION 2026-2027

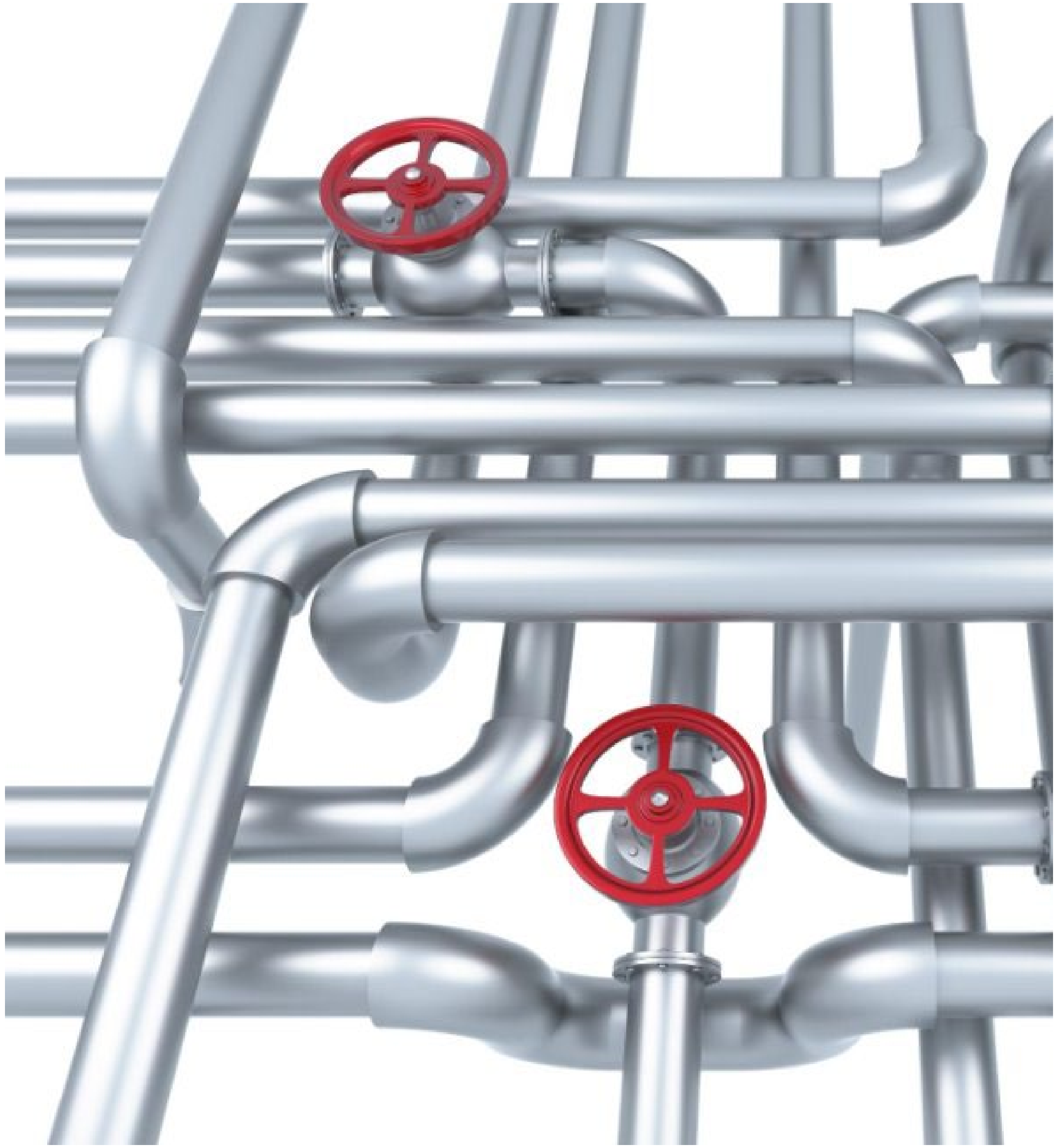
	Q2 2026	Q3 2026	Q4 2026	Q1 2027	Q2 2027	Q3 2027
GOVERNANCE	Draft ROP revisions Post ROP for informal comment period Hold industry workshop to gather feedback on ROP revisions	SC to approve SPM posting Post ROP changes and charter revisions for formal 60-day comment period	Respond to formal posting comments Prepare Board presentation	Board to adopt revised ROP Begin implementation Set up subcommittee and launch SME Pool	Initiate MSPP standards process	Hold first workshop with new RISC subcommittee
PILOT	Form Short-Term Advisory Group Create Standards Initiation Request and Term Sheet templates	Identify additional projects and pilots as SARs are submitted	Phase 1 Computational Loads filed – disband advisory group			

MODERNIZATION OF STANDARDS

2026-2027 GOVERNANCE TIMELINE



NATURAL GAS-ELECTRIC COORDINATION



NERC Reliability Insights article

Gas-Electric System Interdependence
Growing reliance on natural gas generation creates new reliability risks due to system interdependence and supply disruptions.

Vulnerabilities in Gas Transportation
Limited firm transportation and reliance on interruptible contracts increase outage risks during peak demand or extreme weather.

Coordination and Communication
Improved communication among operators and real-time information sharing enhance situational awareness and risk mitigation.

Fuel Assurance and Planning
Evaluating fuel strategies and incorporating gas risks into planning improves reliability during disruptions and extreme conditions.

NATURAL GAS-ELECTRIC COORDINATION

Electricity-Natural Gas Strategy

August 2025

- ERO 3 Step Strategy: Identify the Risk, Assess and Prioritize the Risk, & Mitigate and Remediate the Risk
- Identified risks include supply and transportation, market harmonization, resource adequacy and ramping, & winterization

NERC Comments on FERC NOPR

January 2026

- NERC submitted comments on the FERC 2025 NOPR
- The comments supported the proposed incorporation by reference of the North American Energy Standards Board's (NAESB) Standard for Business Practices of Interstate Natural Gas Pipelines

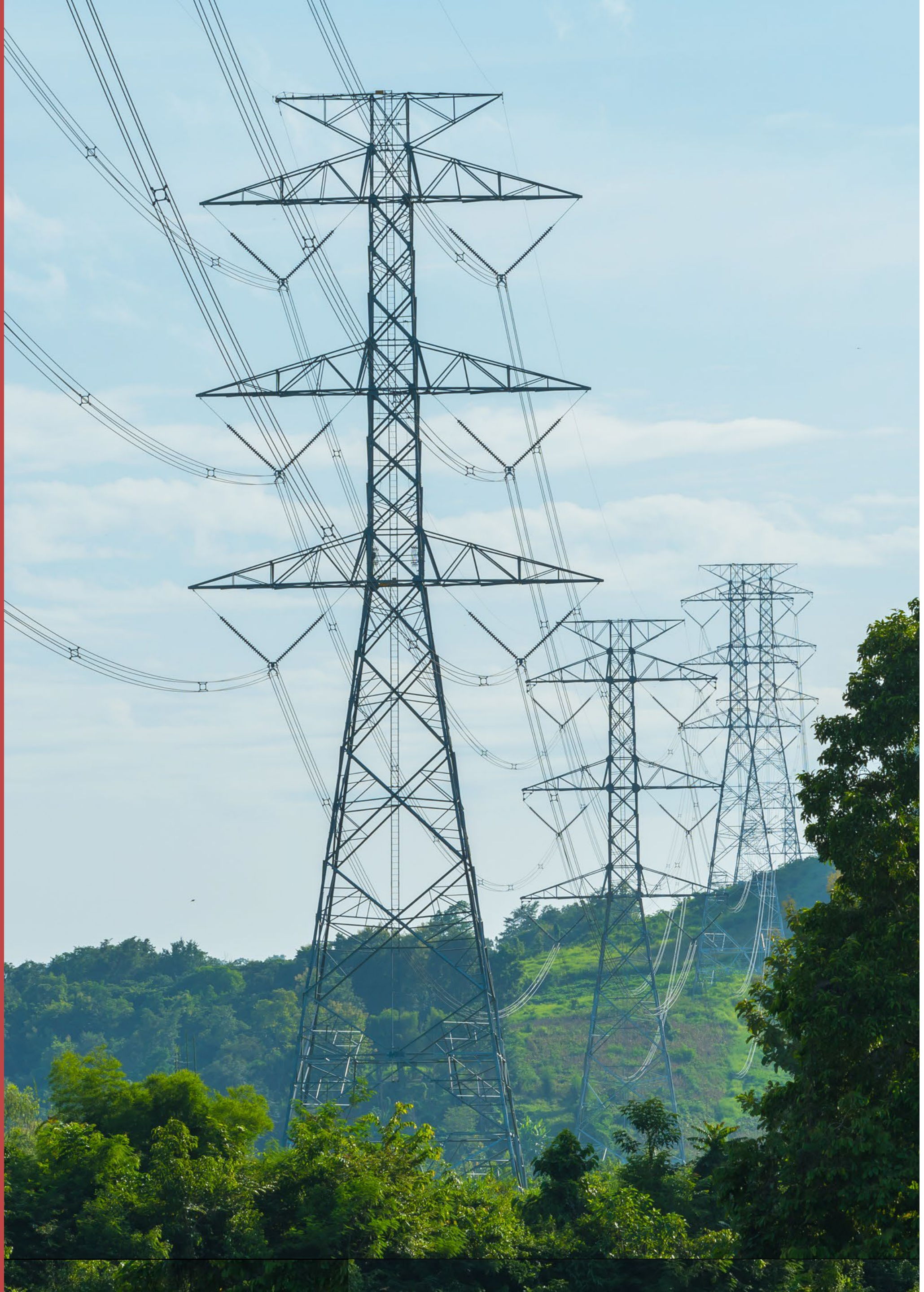
RELIABILITY IS A JOURNEY, not a destination

It's not as easy as 1-2-3,
but we want to help you!

1

2

3



QUESTIONS & ANSWERS

Diane Holder

diane.holder@rfirst.org

ReliabilityFirst Introduction

Michelle Cross

August 18, 2026

RELIABILITY FIRST

FORWARD TOGETHER RELIABILITYFIRST

ASK QUESTIONS

Join the conversation at

SLIDO.com

#RFBootcamp

THE ERO AND RELIABILITYFIRST

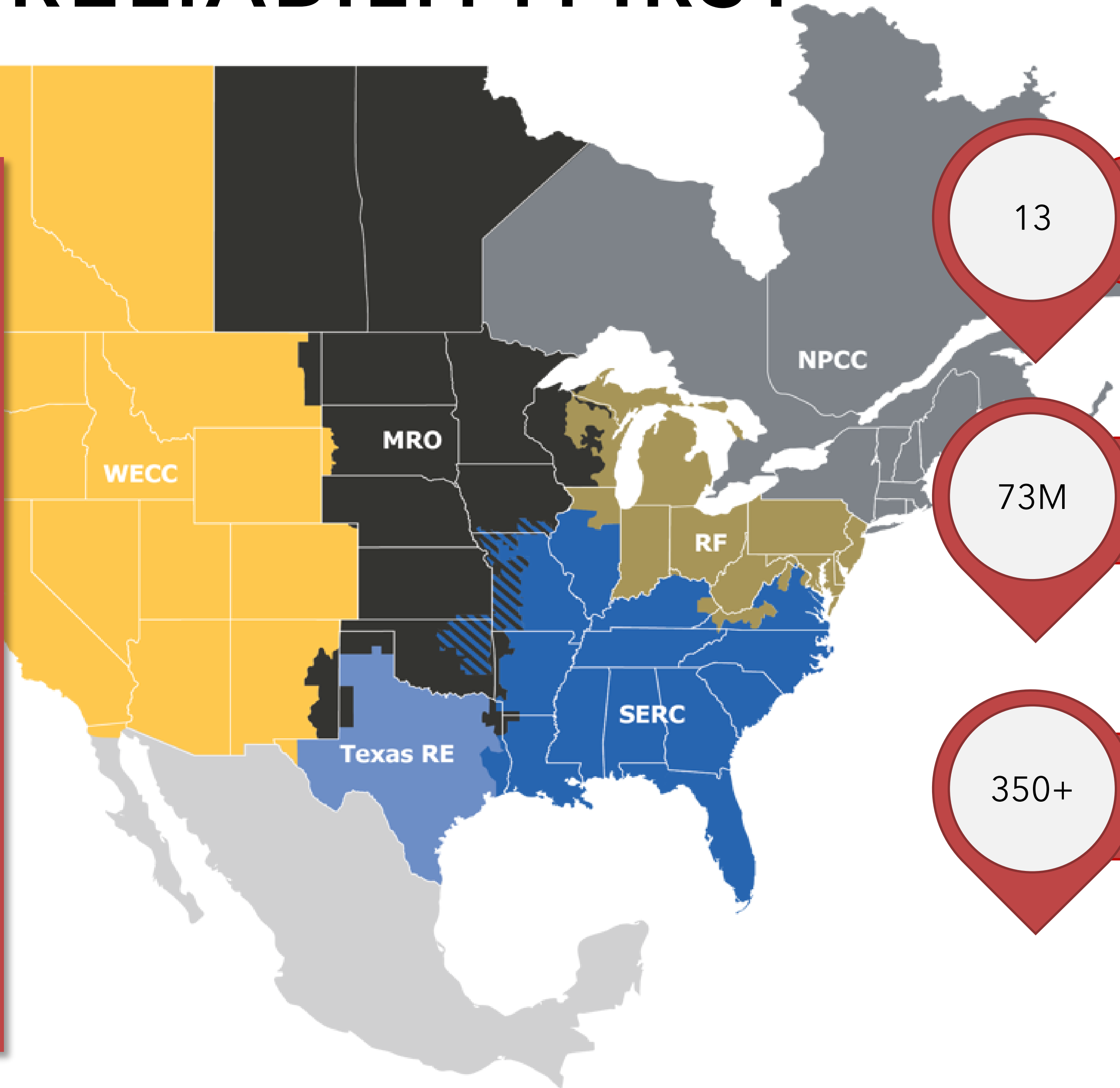
Our mission is to ensure the reliability and security of the bulk power system

We are an objective and independent resource

We, along with the other regional entities & NERC, make up the ERO Enterprise

We are regulators of the electric industry

We do not own or operate grid assets or energy markets



13 Number of States and DC

73M Estimated Population

350+ Registered Entities

FORWARD TOGETHER RELIABILITYFIRST

ELECTRIC RELIABILITY ORGANIZATION GOVERNANCE MODEL

Federal Energy Regulatory Commission

North American Electric Reliability Corporation

ReliabilityFirst

History

- 2003 – US-Canada Blackout affecting over 50 million people for up to 4 days.
- 2005 – The Energy Policy Act of 2005 authorized the creation of an Electric Reliability Organization (ERO).
- 2006 – The Federal Energy Regulatory Commission (FERC) certified NERC as the ERO.
- 2006 – ReliabilityFirst was created as a NERC regional Entity
- 2007 – Compliance with approved NERC Reliability Standards became mandatory and enforceable in the United States

ERO ENTERPRISE RESPONSIBILITIES

NERC

Standards Development	Assessments	Studies	White Papers
More than 90 Reliability Standards	Long-Term and Seasonal	Risk Reliability Studies, Transfer Capability	Technical White Papers and Reports

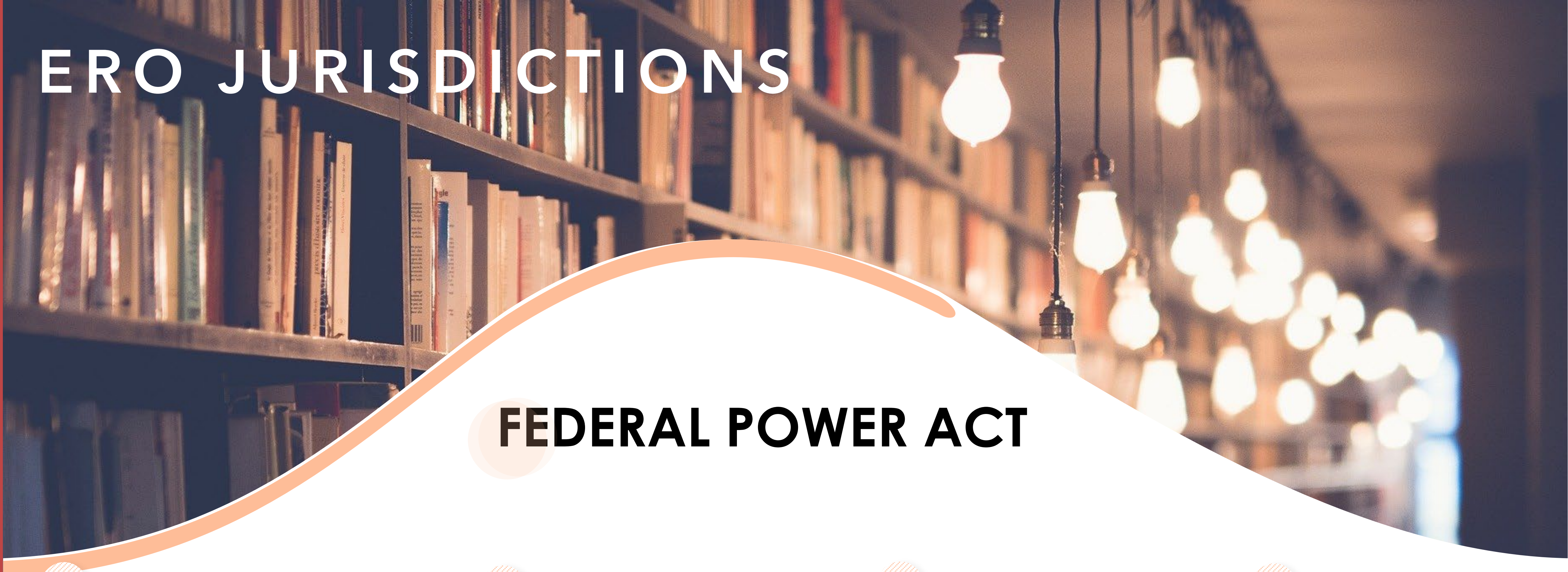
Regions

Audits	Enforcement	Outreach	Regional Assessments & Studies
In-the-Field and On-site Verification of Compliance	Penalties for Non-Compliance	Training, Webinars, Workshops, Newsletters	Regional Reliability Assessments and Event Analysis

As the ERO, NERC develops and enforces mandatory Standards, assesses current and future reliability trends, analyzes system events, and recommends improved practices. NERC maintains several technical committees which assist in the development of standards and grid assessments. NERC has oversight of the six regions and evaluating reliability risk on an international scale.

The Regions have the authority to audit and enforce entities against the NERC Reliability Standards. They also provide region-specific studies and assessments as well as outreach and training.

ERO JURISDICTIONS



FEDERAL POWER ACT

01 Section 215(c)

Section 215(c) states that the Electric Reliabilityy Organization (ERO) has the ability to **develop and enforce, reliability standards** that provide an adequate level of reliability of the bulk power system

02 Section 215(g)

Section 215(g) requires that the ERO conduct periodic **assessments of the reliability and adequacy** of the bulk power system.

03 Section 215(i)

Section 215(i) states that the ERO **does not** have the authority to set or enforce mandatory standards for **adequacy or safety** of electric facilities or services.

04 Statue

The statute makes clear that the ERO **does not** have the authority to require the **construction** of generation or transmission assets.

ENERGY TRILEMMA CONSIDERATIONS

RELIABILITY

- Resource Adequacy and Fuel Assurance
- Essential Reliability Services
  - Voltage
  - Frequency Response
  - Inertia and Short-Circuit
- Blackstart Resources
- Transfer Capabilities
- Distributed Energy Resources
- Energy Efficiency and Demand Response

COST

- Affordability and Energy Equity
- Supply Chain Considerations
- Net Energy Efficiency
- Impact on Economy
- Job Growth (short-term and long-term)
- Life-expectancy of new resources

ENVIRONMENT / SUSTAINABILITY

- Land / Water usage
- Carbon and Emissions
- Siting and Permitting
- Wildlife and deforestation
- Recycling and Decommissioning
- Renewable Resources

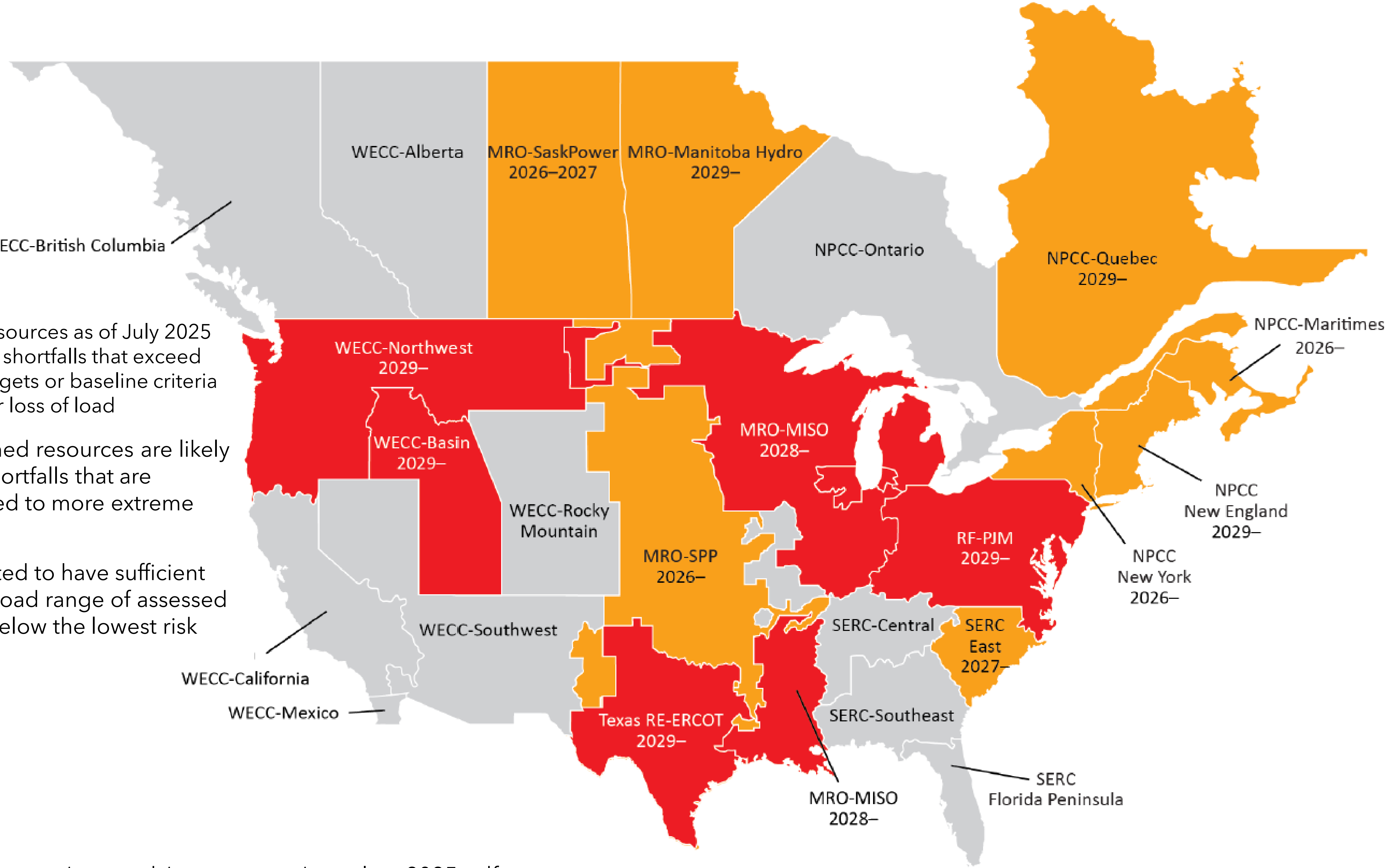
RESOURCE ADEQUACY: NERC 2025 LTRA

Increasing Risk

High Risk: Planned resources as of July 2025 would result in energy shortfalls that exceed resource adequacy targets or baseline criteria for unserved energy or loss of load

Elevated Risk: Planned resources are likely to result in energy shortfalls that are expected to be limited to more extreme weather conditions

Normal Risk: Expected to have sufficient resources under a broad range of assessed conditions and are below the lowest risk criteria level

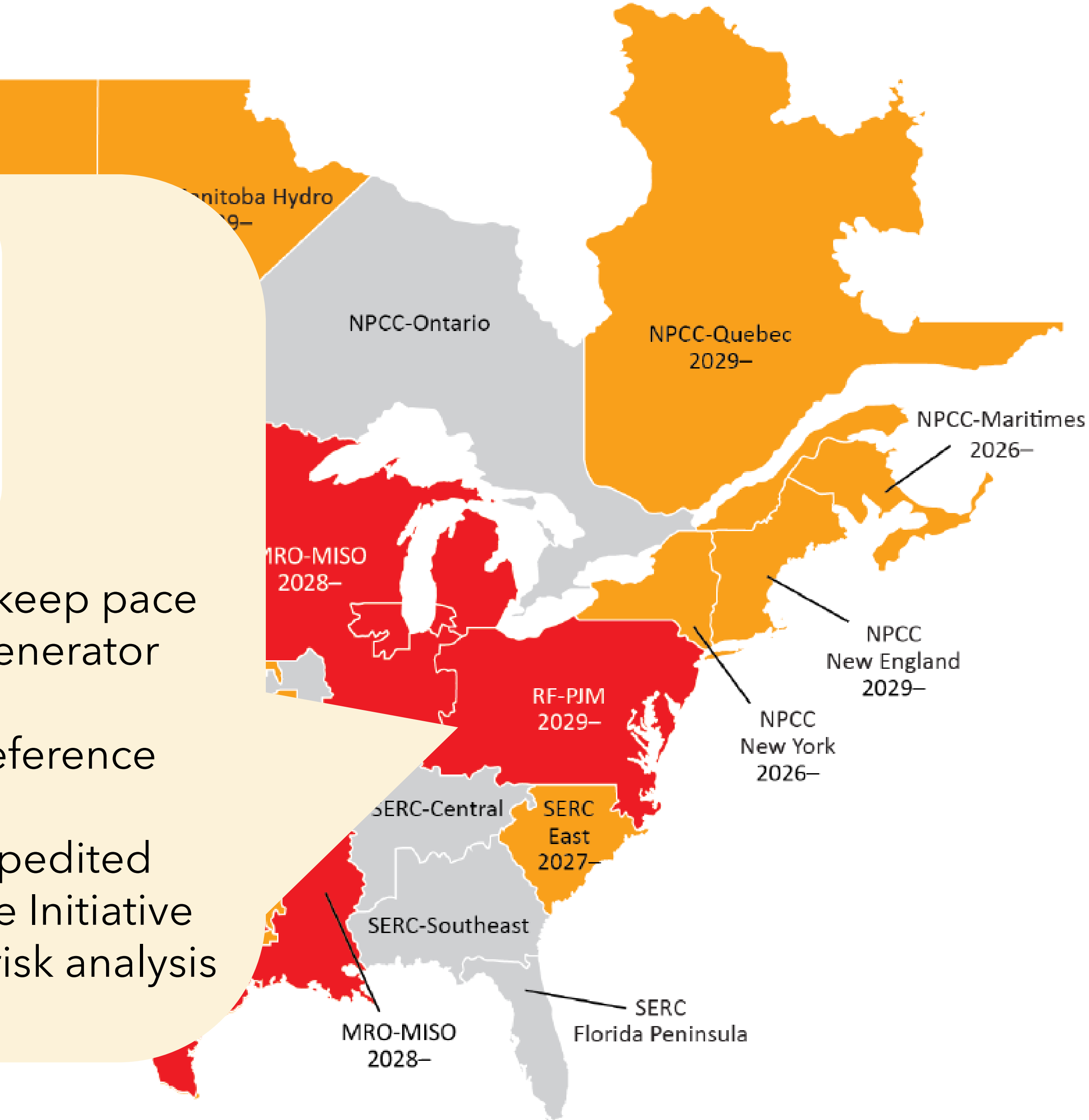


https://www.nerc.com/globalassets/our-work/assessments/nerc_ltra_2025.pdf

RESOURCE ADEQUACY: NERC 2025 LTRA

PJM Focus

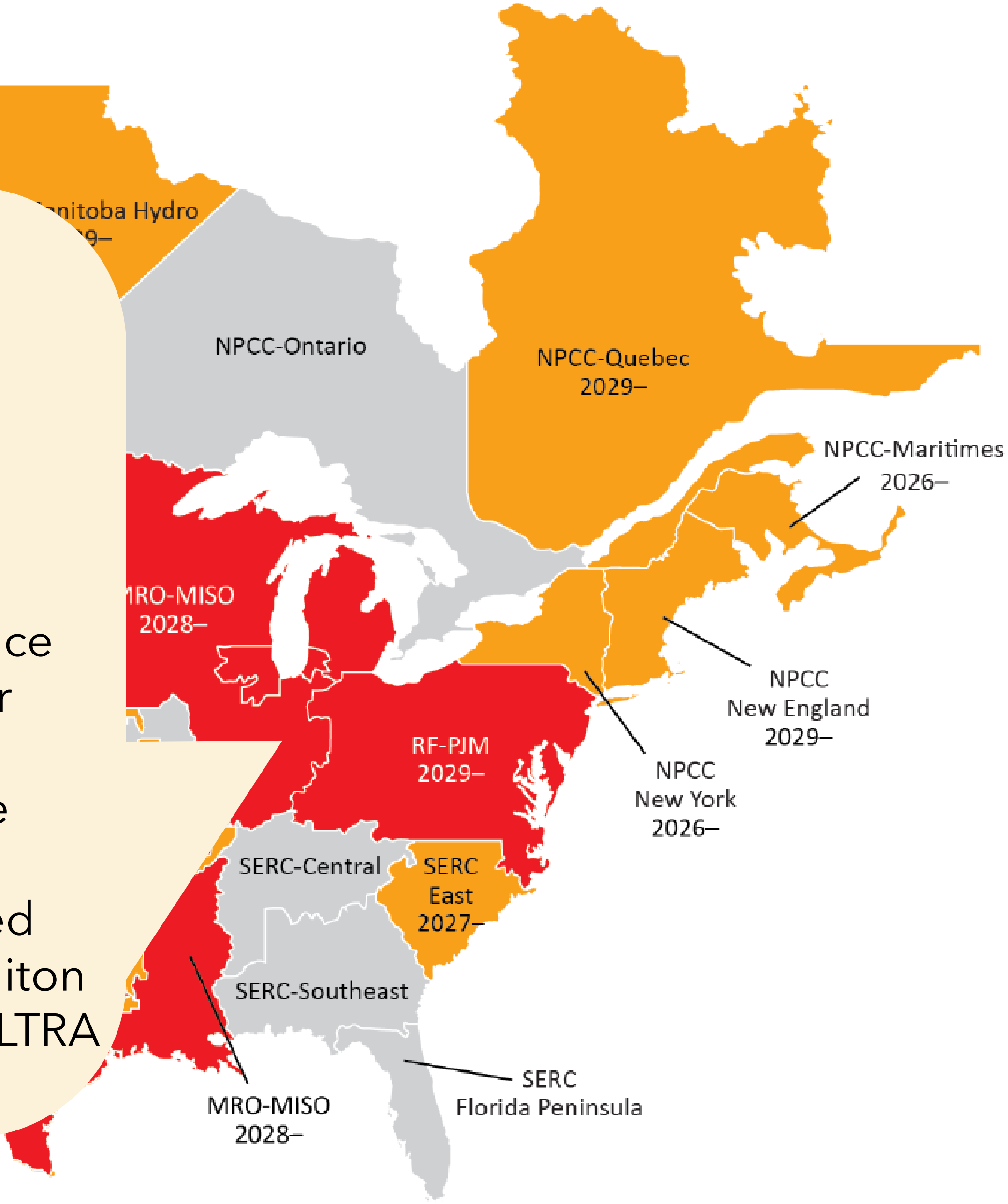
- Current projections for resource additions do not keep pace with escalating demand forecasts and expected generator retirements
- The anticipated resource margin falls below the Reference Margin Level starting in 2029
- Recently approved new generation projects for expedited interconnection under the PJM Reliability Resource Initiative were not far enough along to include in the LTRA risk analysis



https://www.nerc.com/globalassets/our-work/assessments/nerc_ltra_2025.pdf

RESOURCE ADEQUACY: NERC 2025 LTRA

MISO Focus



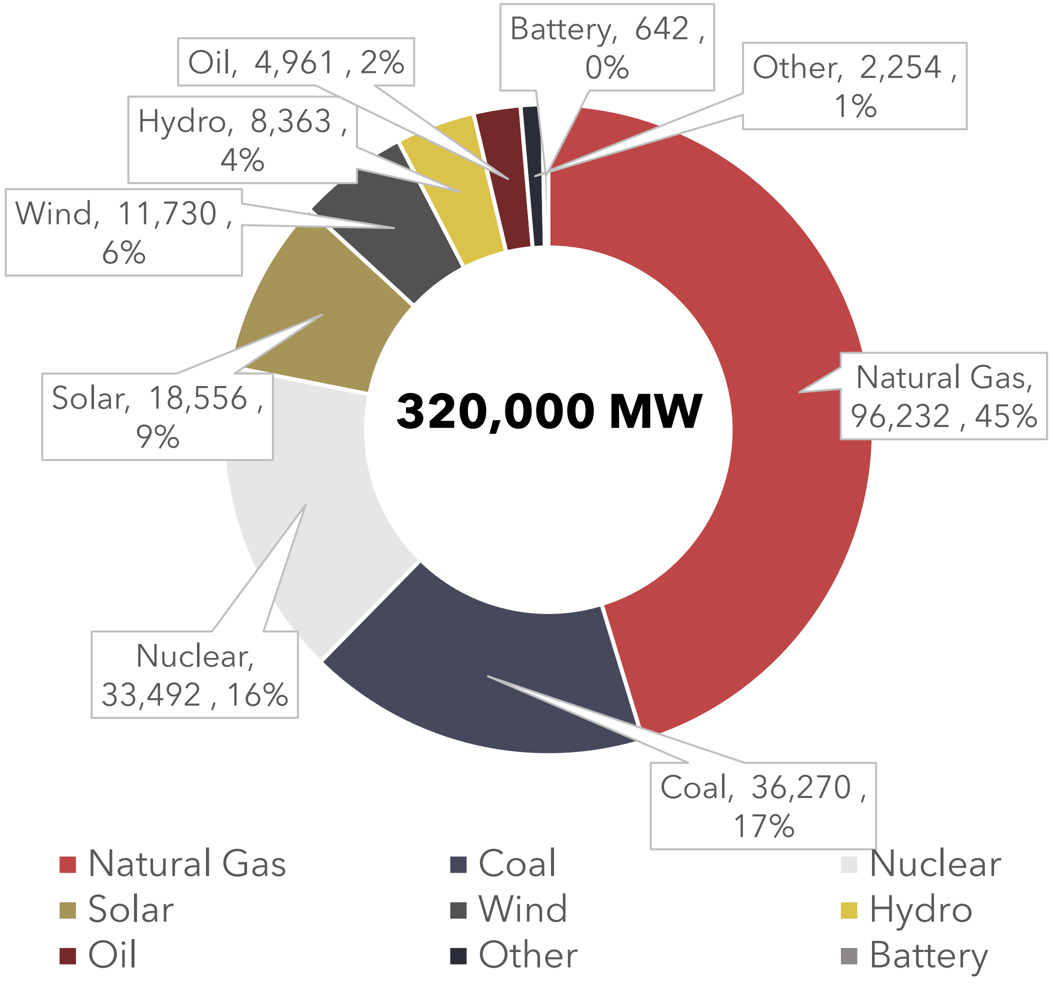
- Current projections for resource additions do not keep pace with escalating demand forecasts and expected generator retirements
- The anticipated resource margin falls below the Reference Margin Level starting in 2028
- Recently approved new generation projects for accelerated interconnection under the MISO Expedited Resource Additon Study (ERAS) were not far enough along to include in the LTRA risk analysis

nerc_ltra_2025.pdf

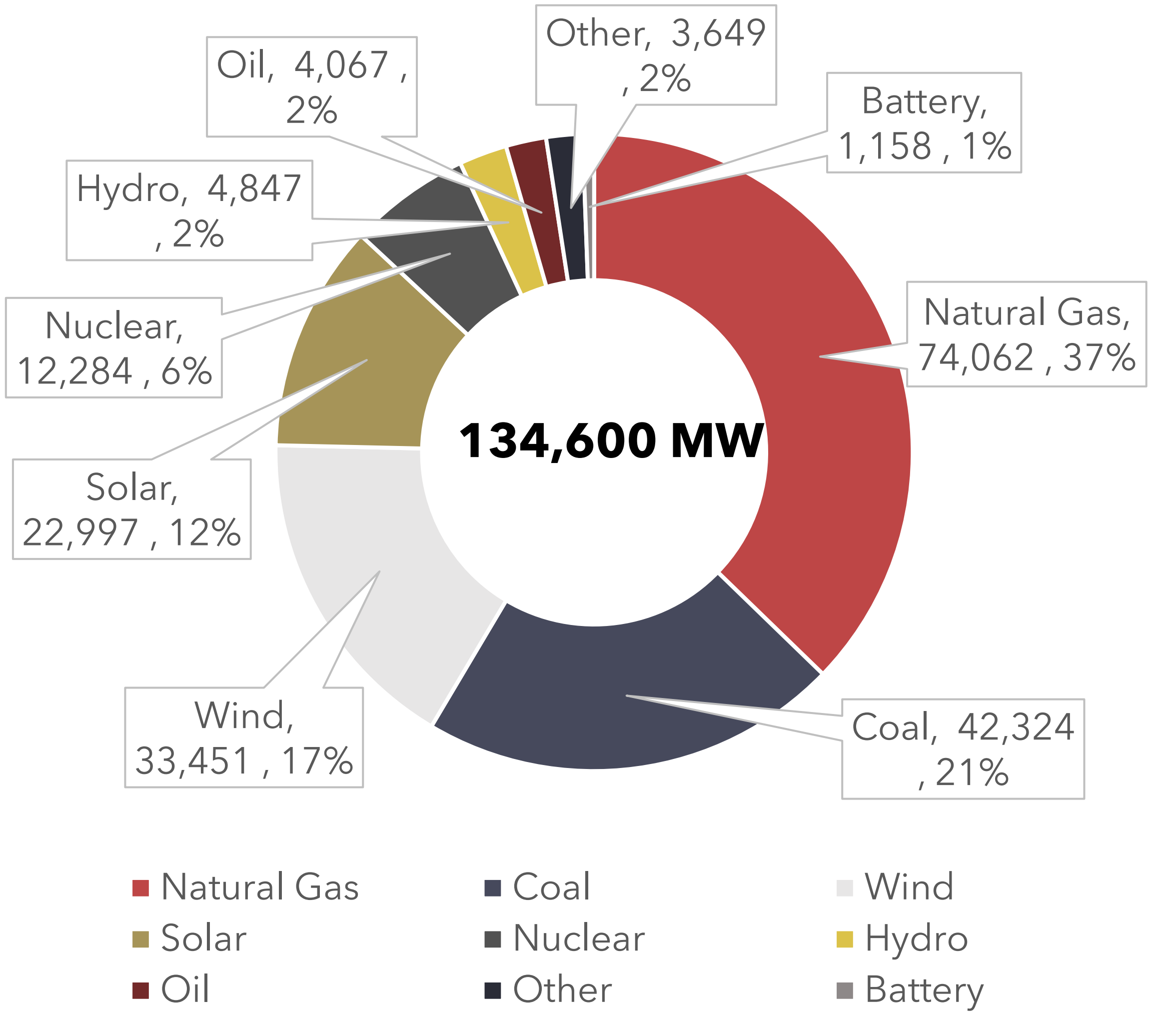
FORWARD TOGETHER RF RELIABILITYFIRST

EXISTING GENERATION CAPACITY

PJM Summer Capacity (MW)



MISO Summer Capacity (MW)



Source: EIA 860M data

ESSENTIAL RELIABILITY SERVICES

	Frequency Response	Voltage Control	Dispatchable for Ramping	On-site Fuel Availability	Fast Start-up <30 minutes	Availability on and off peak	Blackstart Capability
Biomass	🟡	🟢	🟡	🟡	🟡	🟢	🔴
Hydro	🟢	🟢	🟢	🟡	🟢	🟡	🟢
Natural Gas - CT	🟢	🟢	🟢	🔴	🟢	🟢	🟢
Oil - Steam	🟢	🟢	🟢	🟢	🔴	🟢	🟢
Coal - Steam	🟢	🟢	🟢	🟢	🔴	🟢	🔴
Oil/Diesel - CT	🟢	🟢	🟢	🟢	🟢	🟢	🟢
Nuclear	🟡	🟢	🔴	🟢	🔴	🟢	🔴
Solar	🟡	🟡	🟡	🔴	🟢	🟡	🔴
Battery	🟢	🟡	🟢	🔴	🟢	🟡	🟡
Solar + Battery	🟡	🟡	🟢	🔴	🟢	🟡	🟡
Wind On-Shore	🟡	🟡	🟡	🔴	🟢	🟡	🔴
Wind Off-Shore	🟡	🟡	🟡	🔴	🟢	🟡	🔴

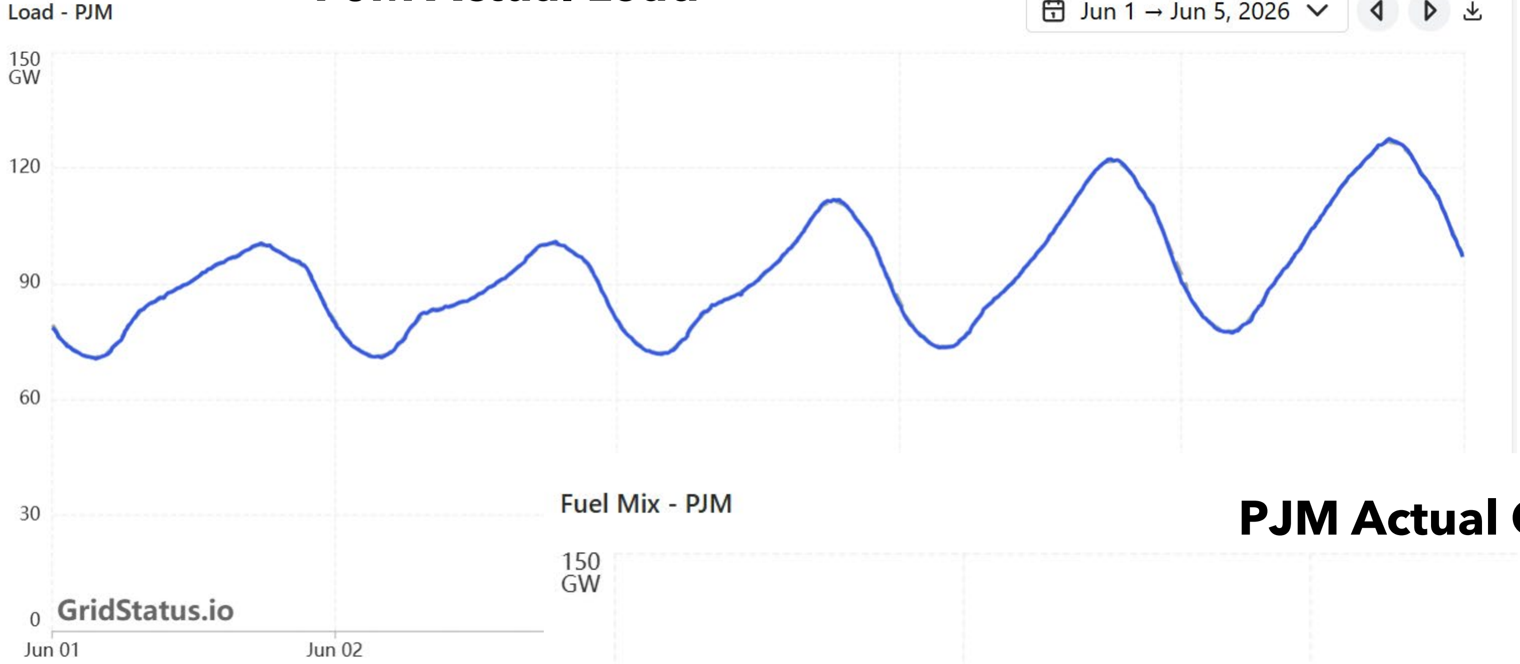
🔴 Does Not Exhibit Attribute

🟡 Partially Exhibits Attribute

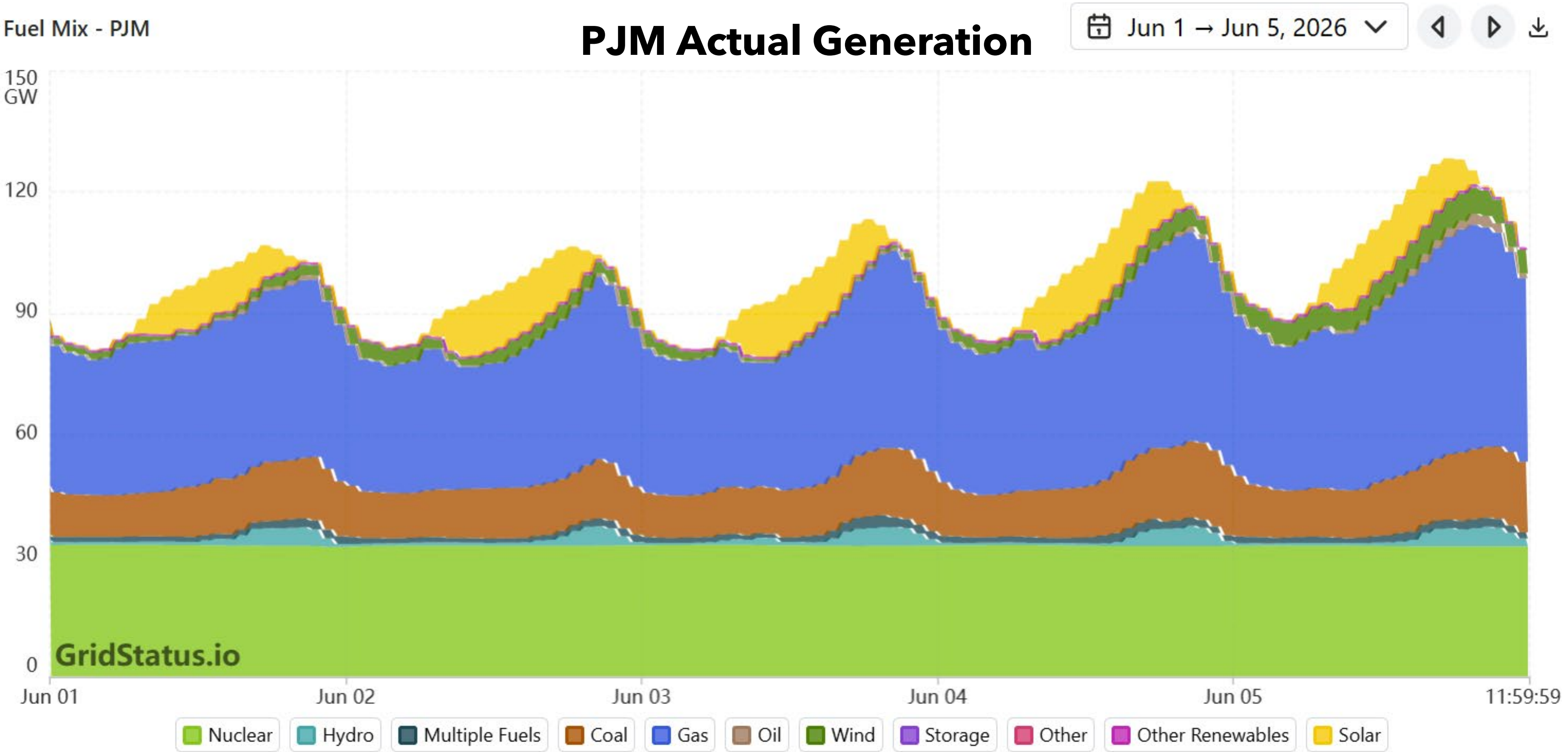
🟢 Exhibits Attribute

DISPATCHABILITY

PJM Actual Load

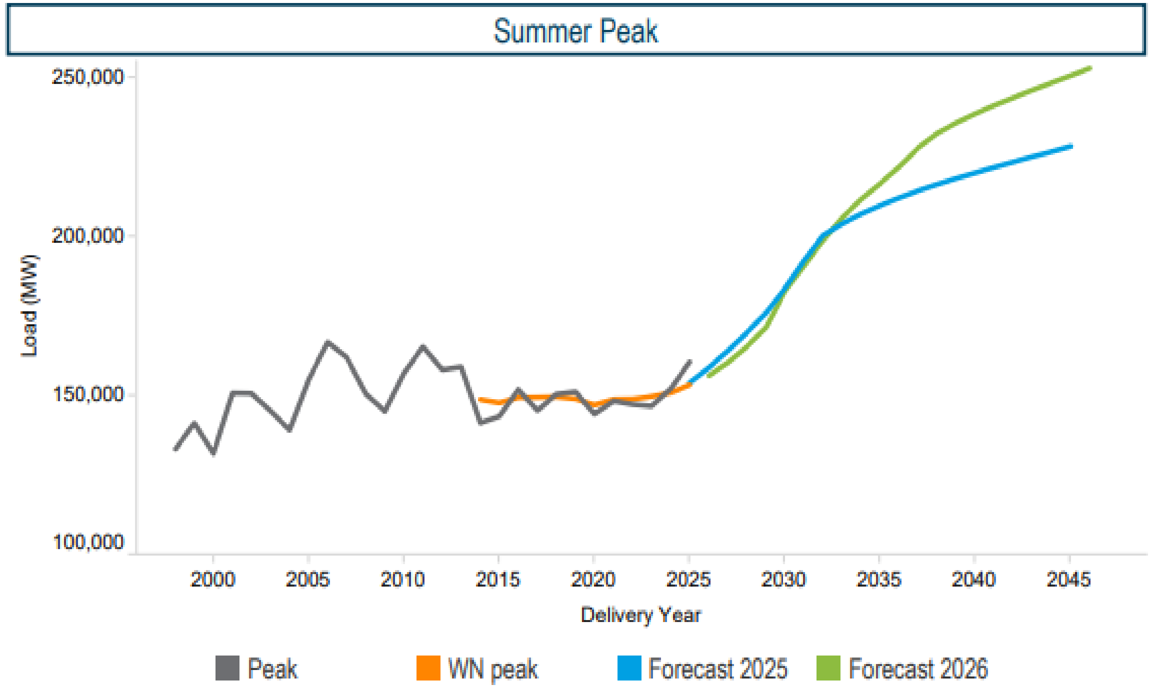


PJM Actual Generation

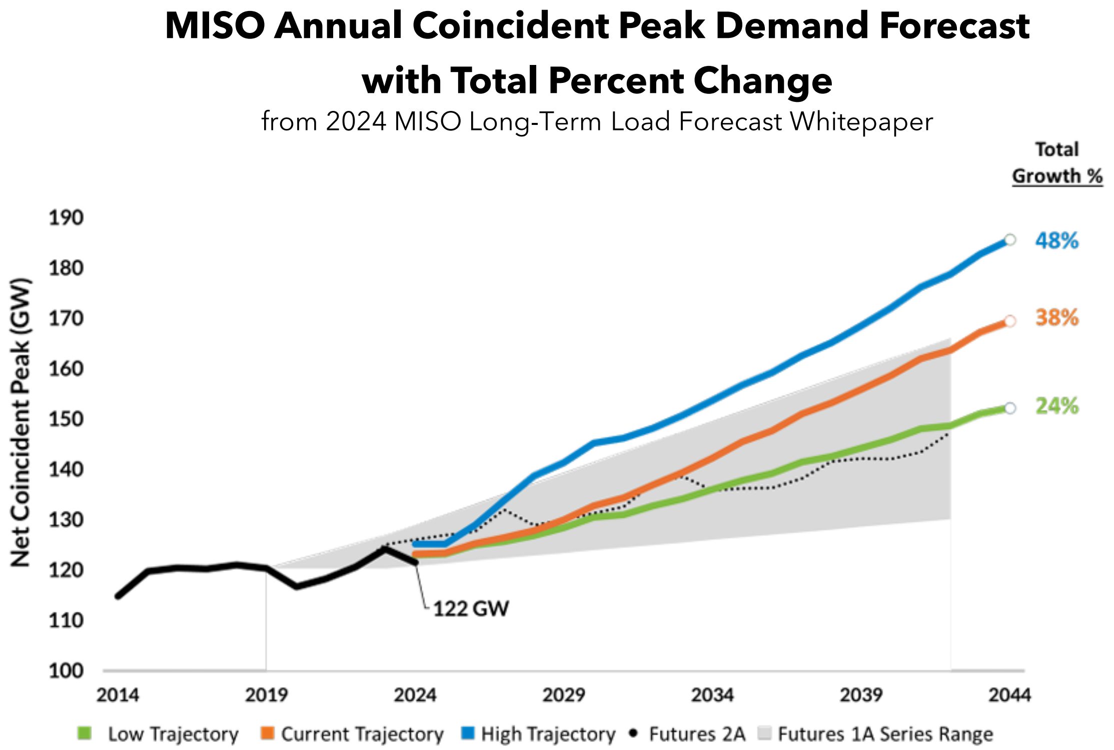


LOAD GROWTH FORECAST

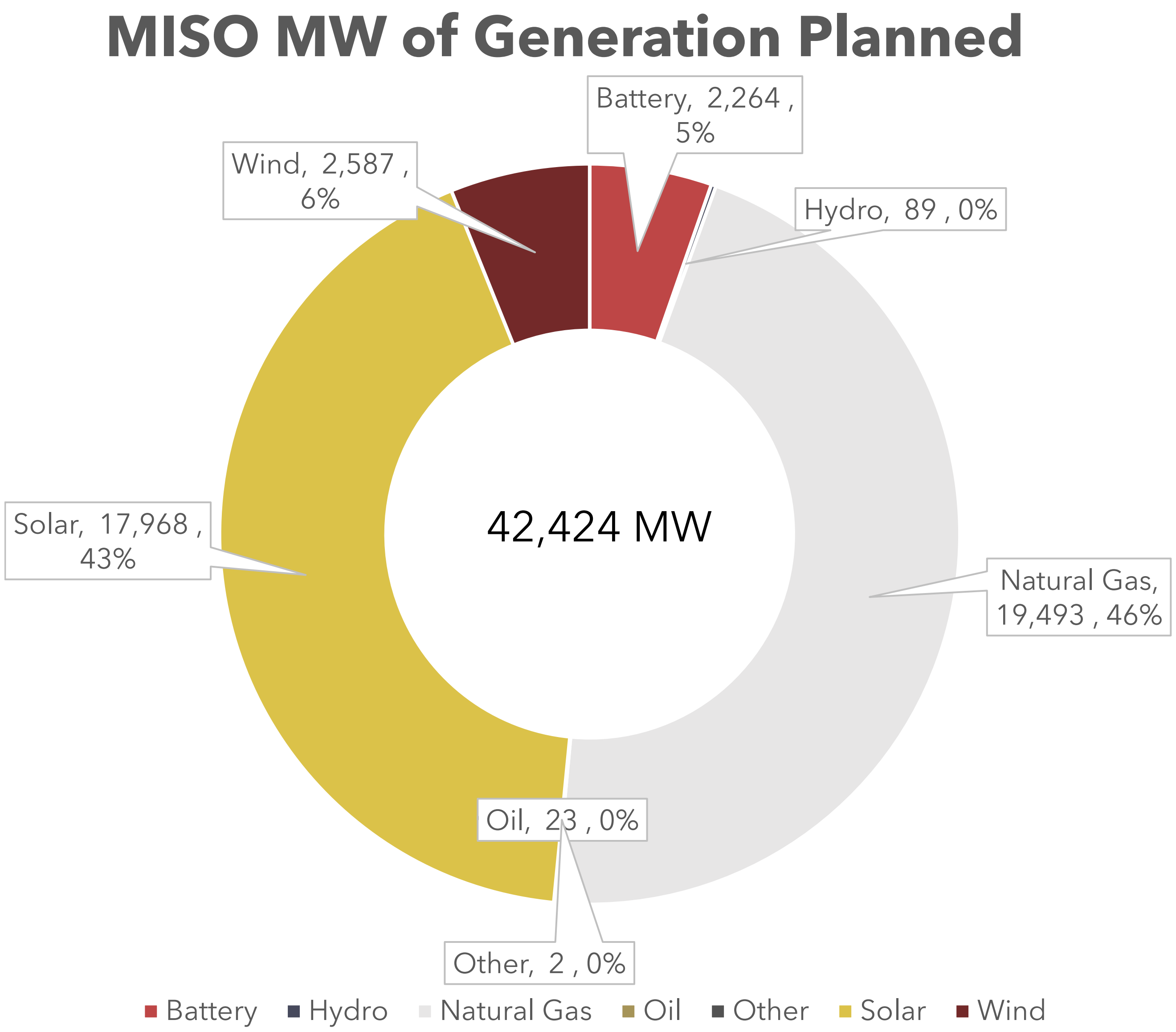
PJM Load Forecast

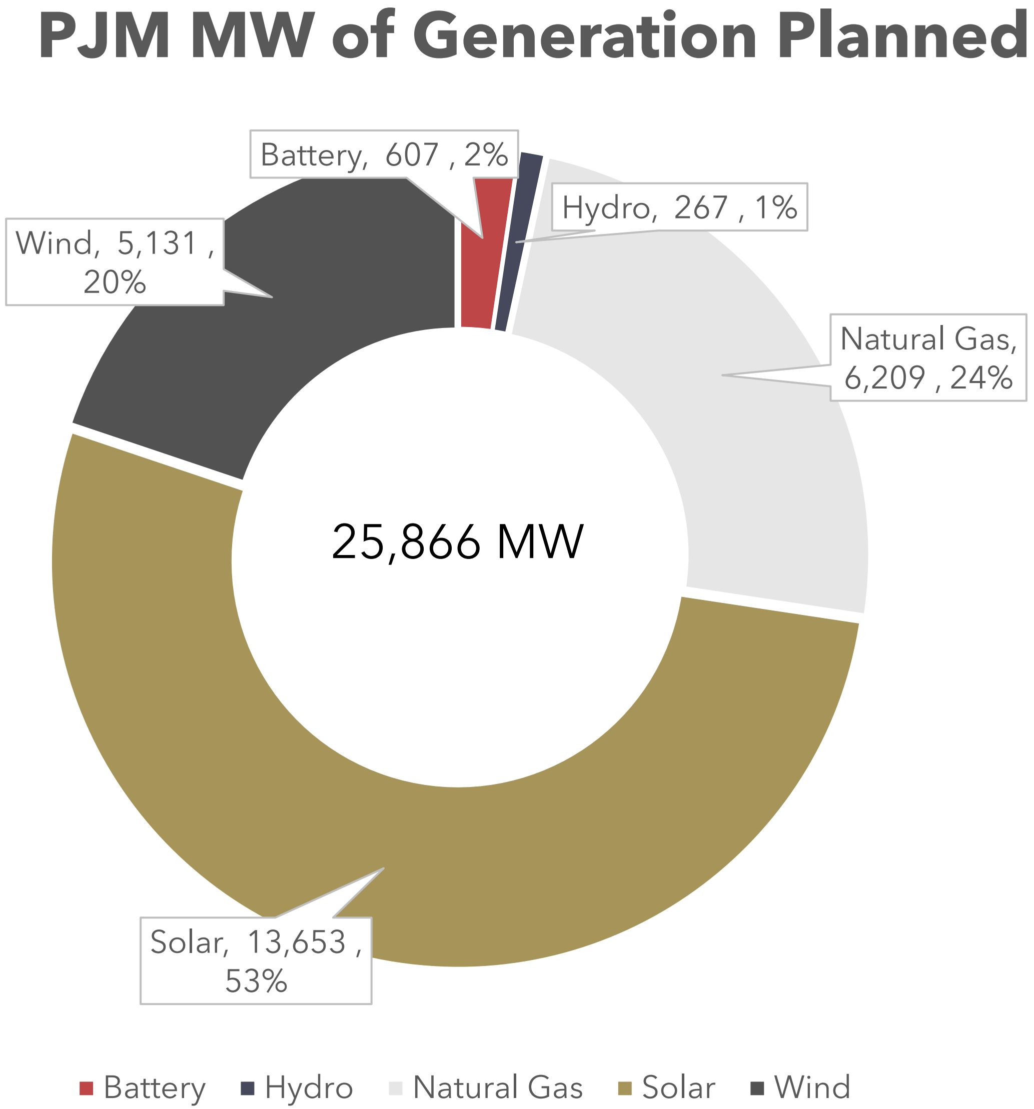


Load Forecast Range



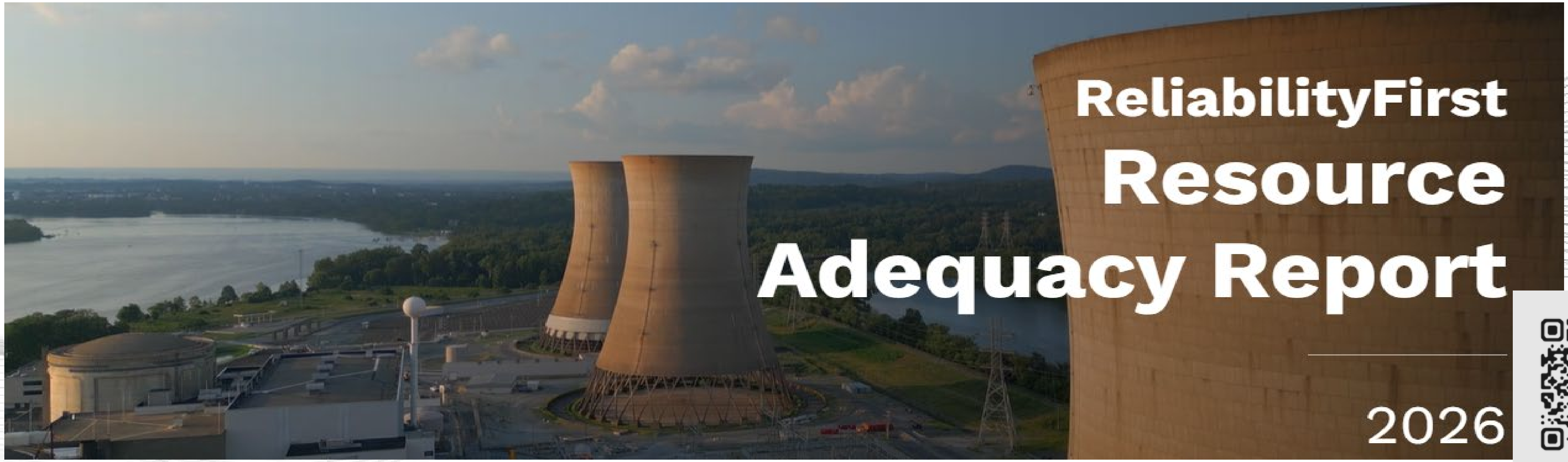
EIA GENERATION PLANNED





Source: EIA 860M data

FORWARD TOGETHER RELIABILITYFIRST



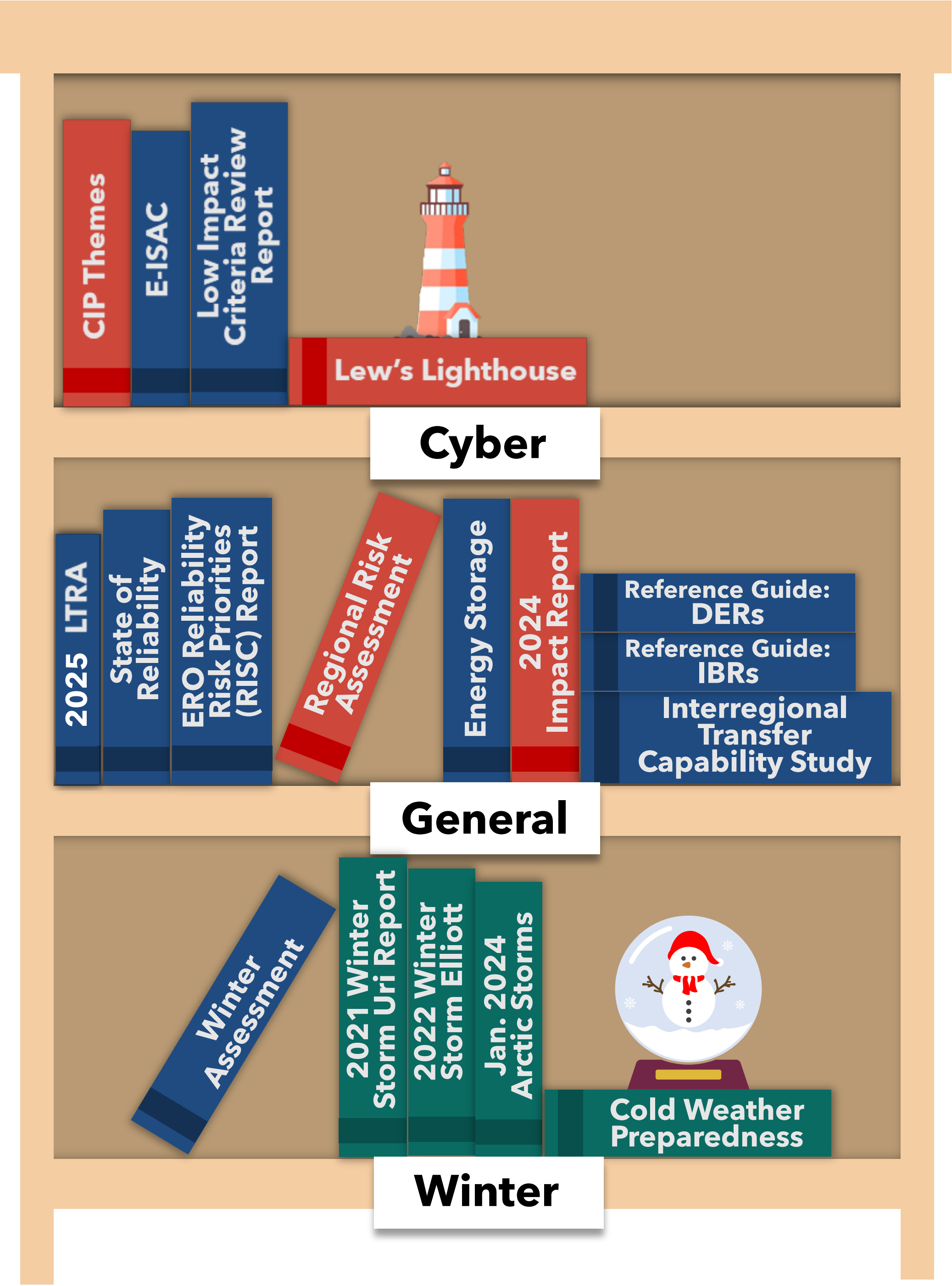
Scan for full report

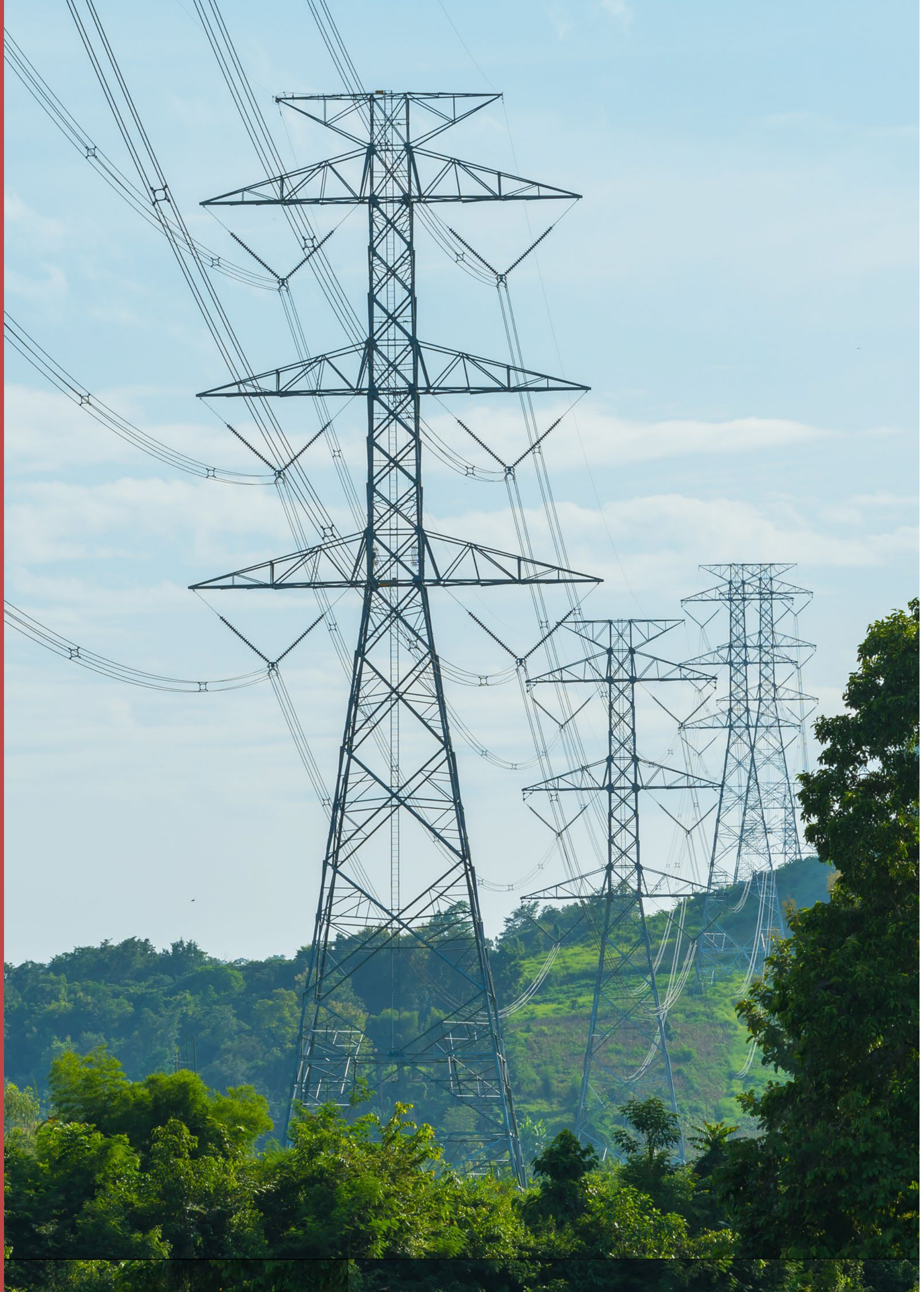
Executive Summary

- The RF region is at **high risk for shortfalls** as we approach end of the decade (PJM and MISO areas).
- Key drivers impacting our current and future resource mix are policy decisions, supply chain disruptions, economic conditions, and availability of skilled labor
- Our **challenges are compounded** by additional risks such as environmental factors (extreme weather), volatile (but rapidly increasing) load forecasts, along with grid security challenges
- Key findings underscore the need for proactive, coordinated action among policy makers, utilities, and stakeholders to **ensure infrastructure development keeps pace with reliability requirements**

WHAT'S ON OUR BOOKSHELF?

Scan for full report





FORWARD TOGETHER RELIABILITYFIRST

QUESTIONS & ANSWERS

Michelle Cross

Michelle.cross@rfirst.org

MONITORING AND ENFORCEMENT OF NERC STANDARDS

Kristen Senk, Deputy General Counsel, ReliabilityFirst

Cleveland, August 18, 2026

RELIABILITY FIRST

RF MISSION

- ***Preserve and enhance the reliability and security of the bulk power system in our footprint.***
- RF uses multiple tools to accomplish our mission, including:

Audits	Enforcement	Outreach	Regional Assessments & Studies
In-the-Field and On-site Verification of Compliance	Penalties for Non-Compliance	Training, Webinars, Workshops, Newsletters	Regional Reliability Assessments and Event Analysis

REGISTERED ENTITIES

- All owners, users and operators who have a material impact on the Bulk Power System must register as "Registered Entities"
- Registered under one or more Function Type(s)
- Registered functions determine Standards applicability
- Current Registered Entities: 384

Function Type

- Reliability Coordinator (RC)
- Transmission Operator (TOP)
- Balancing Authority (BA)
- Planning Authority/Coordinator (PA/PC)
- Transmission Planner (TP)
- Transmission Service Provider (TSP)
- Transmission Owner (TO)
- Resource Planner (RP)
- Distribution Provider (DP)
- Distribution Provider UFLS (DP-UFLS)
- Generator Owner (GO-1) (Category 1)
- Generator Owner (GO-2) (Category 2)
- Generator Operator (GOP-1) (Category 1)
- Generator Operator (GOP-2) (Category 2)
- Reserve Sharing Group (RSG)
- Frequency Response Sharing Group (FRSG)
- Regulation Reserve Sharing Group (RRSG)

RELIABILITY STANDARDS

Operations and Planning (OPS)

- Resource and Demand Balancing (BAL)
- Communication (COM)
- Emergency Preparedness and Operations (EOP)
- Facilities Design, Connections and Maintenance (FAC)
- Interchange Scheduling and Coordination (INT)
- Modeling, Data, Analytics (MOD)
- Nuclear (NUC)
- Personnel Performance, Training and Qualifications (PER)
- Protection and Control (PRC)
- Transmission Operations (TOP)
- Transmission Planning (TPL)
- Voltage and Reactive (VAR)

Critical Infrastructure Protection (CIP)

- Cyber System Categorization (CIP-002)
- Security Management Controls (CIP-003)
- Personnel & Training (CIP-004)
- Electronic Security Perimeter (CIP-005)
- Physical Security (CIP-006)
- System Security Management (CIP-007)
- Incident Reporting & Response Planning (CIP-008)
- Recovery Plans (CIP-009)
- Change & Vulnerability Management (CIP-010)
- Information Protection (CIP-011)
- Communications between Control Centers (CIP-012)
- Supply Chain Risk Management (CIP-013)
- Physical Security (CIP-014)
- Internal Network Security Monitoring (CIP-015)

RISK-BASED COMPLIANCE MONITORING

Considerations for Scheduling

- Rules of Procedure (required)
- Entity Risk
- ERO/ Regional Risks (CMEP IP)
- Event/ Complaint

Types of Engagements

- Audit
- Spot Check
- Self-Certification
- Compliance Investigation

ENFORCEMENT OVERVIEW

- High Volume Enforcement Work
  - Intake average of 425 violations per year (472 in 2025)
  - Process average 450 per year (489 in 2025)
- Discovery Methods
  - Self-Report: Entity identifies noncompliance on its own and reports it to the Region (most common discovery method – ~85%)
  - Monitoring (e.g. audits): Region identifies noncompliance through monitoring activity
- Risk-Based Enforcement
  - Focus resources on violations posing higher risk to grid; streamline minimal risk issues
  - Monetary penalties in ~5% of cases (can also issue non-monetary penalties tied to risk)

FORWARD TOGETHER RELIABILITYFIRST

ENFORCEMENT PHILOSOPHY

A balanced approach that strengthens reliability, rewards improvement, and applies enforcement to reduce future risk.

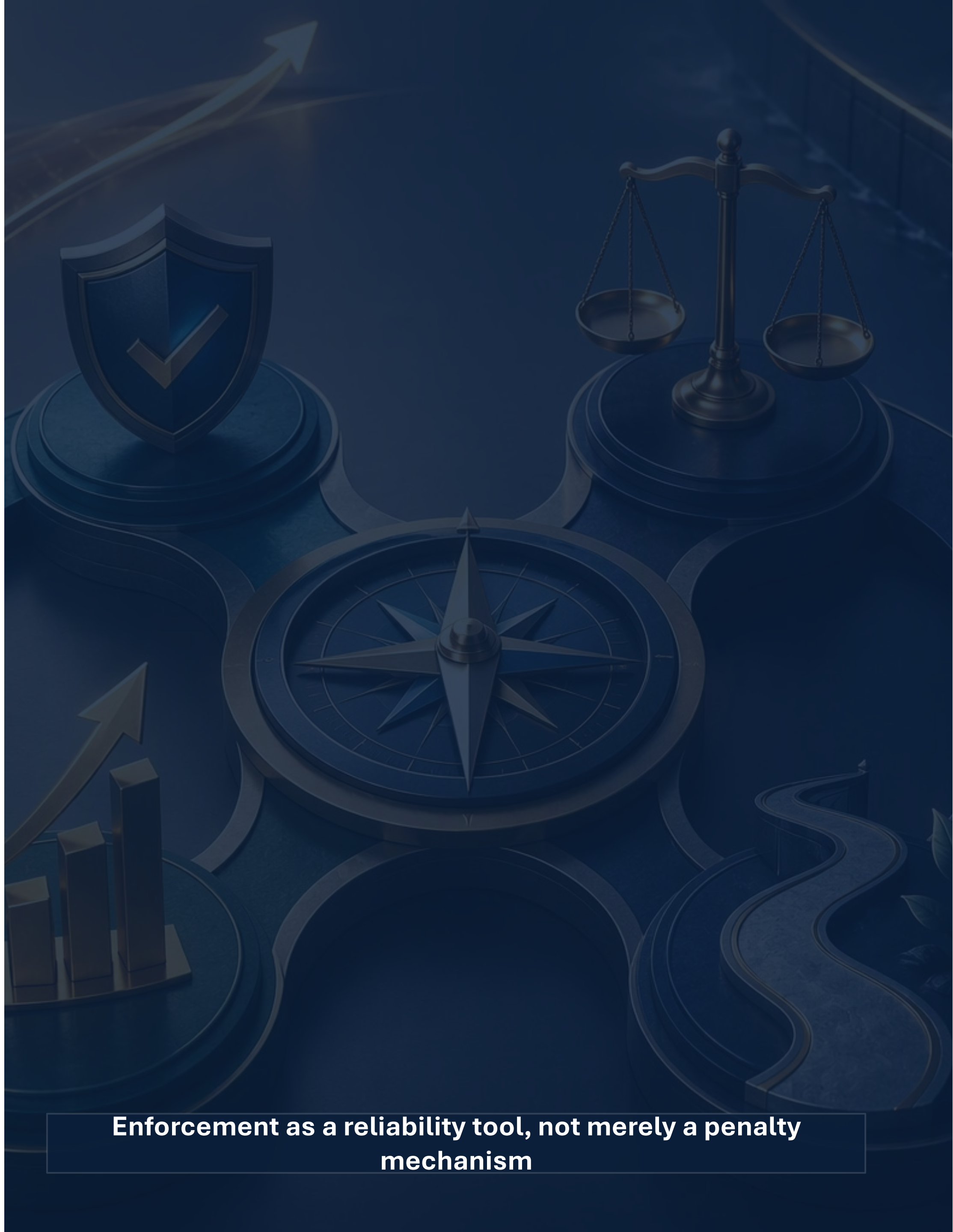
Core message: reliability and continuous improvement

1
Mitigation focus
Encourage meaningful steps that remediate risk and prevent recurrence

2
Incent continuous improvement
Credit self-identification, transparency, and strong compliance programs

3
Deter undesired conduct
Use proportionate penalties to discourage repeat violations and significant risk

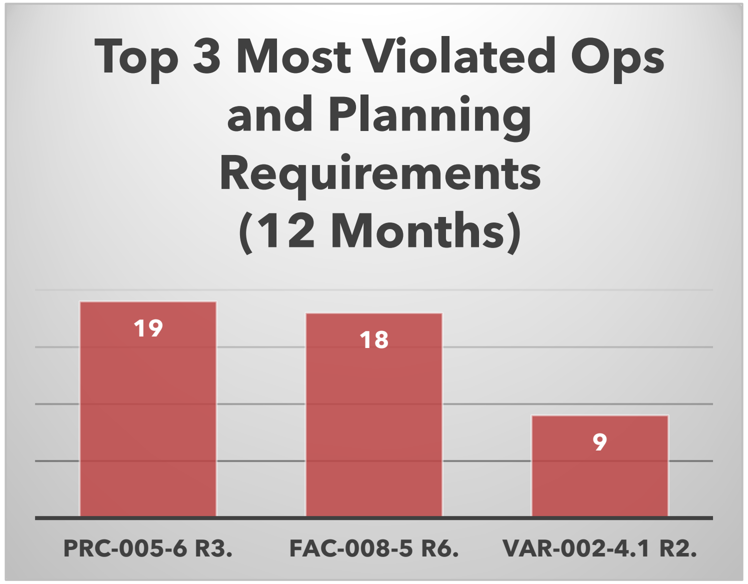
4
Reliability lens
Prioritize outcomes that strengthen dependable operations and public confidence.

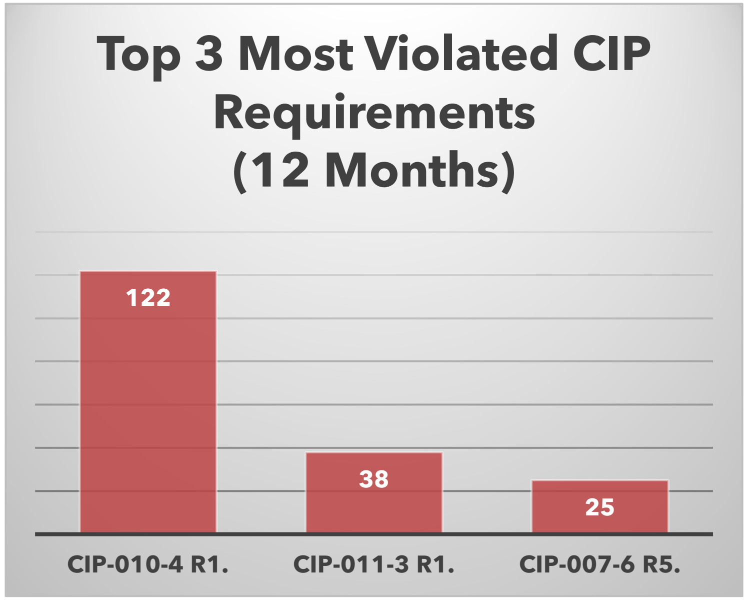


VIOLATION TRENDS

High Priorities (High Risk)

- Facility Ratings
- Vegetation Management
- Protection System Settings/Coordination
- Cyber Security (sensitive information management; systems access control; access management)
- Physical Security (protecting critical assets; physical security incidents)
- Operating Instructions
- Voltage Control





ENFORCEMENT RESOURCES

FORWARD TOGETHER RELIABILITYFIRST

A YEAR IN REVIEW: ENFORCEMENT 2025

Marian Kousaie Toney, Counsel

January 12, 2026

RELIABILITY FIRST

THIRD EDITION

CRITICAL INFRASTRUCTURE PROTECTION

THEMES AND LESSONS LEARNED

MITIGATING RISKS BEHIND THE CRITICAL INFRASTRUCTURE PROTECTION RELIABILITY STANDARDS

2024

NERC · RELIABILITY FIRST · SERC · WECC · MIDWEST RELIABILITY ORGANIZATION · TEXAS RE · NPCC

SUMMARY – ENFORCEMENT DATA

Public

The following slides include enforcement data relating to some key enforcement metrics that ReliabilityFirst tracks.

The data shows that violation intake remains high. The overwhelming majority of violations were self-reported or self-logged as opposed to identified through a compliance monitoring engagement. Regarding violations processed (i.e., filed with NERC) between January 1, 2025, and April 8, 2025, most were lower risk violations. The team expects to process over 420 violations by year end. There is a slide summarizing ReliabilityFirst's violation inventory. Most of the cases are considered relatively new, with 57% identified in 2024 and 2025, 33% identified in 2023, 9% identified in 2022, and only 1% identified in 2021.

The last slide includes intake commentary (e.g., examples of the types of conduct at issue) for CIP-004-7 R5, CIP-003-8 R2, CIP-007-6 R2, and FAC-008-5 R6 violations based on recent intake (i.e., cases that were reported between December 2024 and present). Similar commentary was provided in the Reference Materials from the August 21, 2024, and December 4, 2024, Risk and Compliance Committee Meetings.

INTAKE COMMENTARY

Public

Standard and Requirement[1]	Summary of Requirement	Intake Volume	Examples of Issues/Comments
CIP-004-7 R5	Access revocation	15	• Delinquent revocation of physical and electronic access for employees and contractors
CIP-003-8 R2	Security Management Controls (Low Impact Bulk Electric System Cyber Systems)	8	• Most instances focus on Cyber Security Incident Response Plans (CSIRP), including plan adequacy and plan testing[2]
CIP-007-6 R2	Security patch management	5	• Instances reflect failures to identify patch sources, untimely patch evaluation, and untimely patch applications
FAC-008-5 R6	Establish Facility Ratings consistent with Facility Ratings methodology	5	• Facility Rating accuracy is critical to modeling, analysis, planning, operations, and relaying, and Facility Ratings continue to be an area of focus[3]

1 - CIP-010-4 R1 and CIP-004-7 R4 violation intake remain high. Please refer to Reference Materials from the August 21, 2024, Risk and Compliance Meeting for intake commentary specific to these Standards/Requirements, which is still pertinent today.

2 - Please refer to Reference Materials from the December 4, 2024, Risk and Compliance Meeting for additional intake commentary specific to CIP-003-8 R2, which is still pertinent today. The current commentary reflects a shift in reported issues to focus on CSIRP creation and testing.

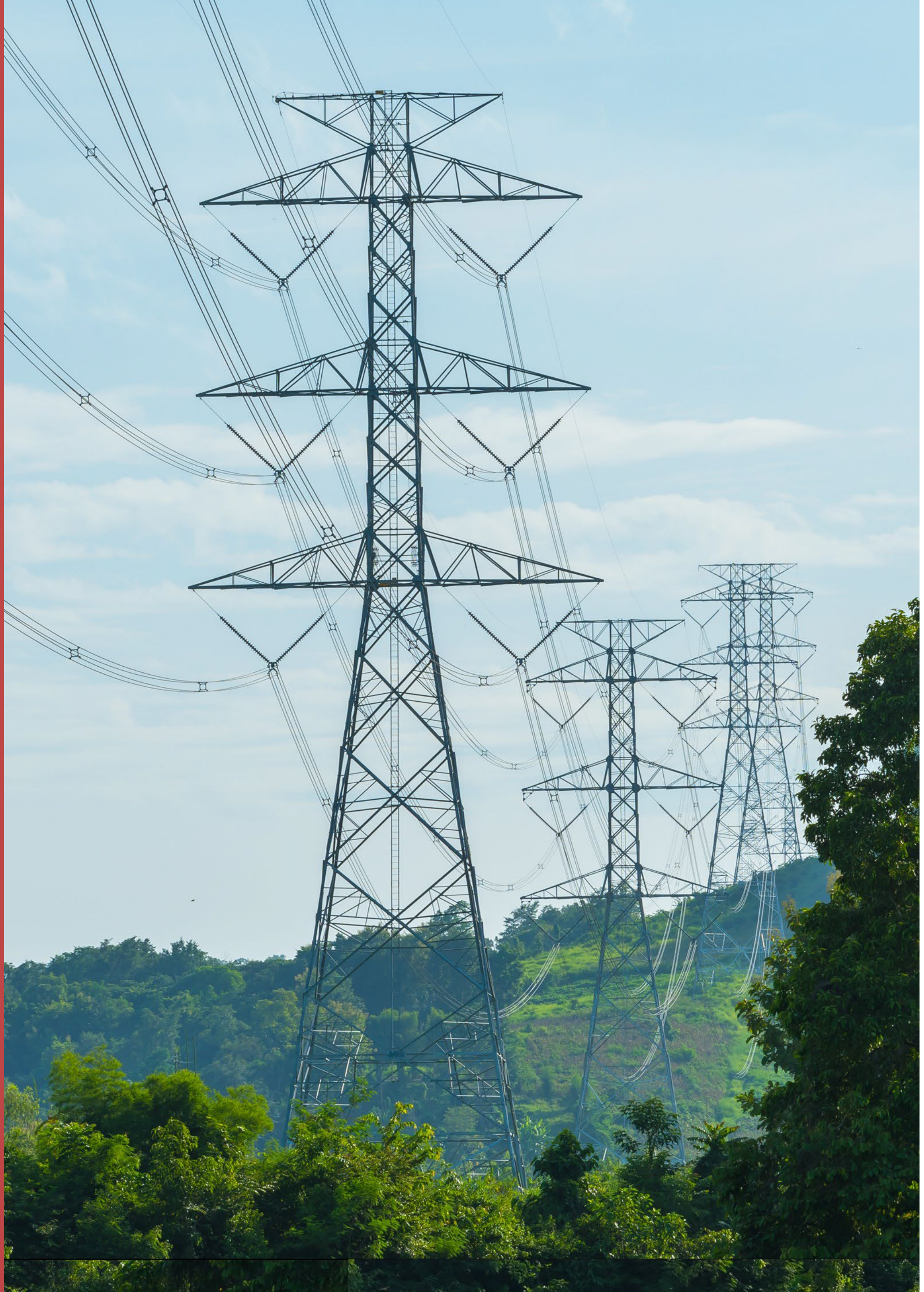
3 - Please refer to the 2025 ERO Enterprise Compliance Monitoring and Enforcement Program Implementation Plan: https://www.nerc.com/pa/comp/CAOneStopShop/ERO%20CMEP%20Implementation%20Plan%20v2.0%20-%202025.pdf.

Enforcement Explained: Trends in vegetation management

By **Max Reisinger**, Senior Counsel, Legal & Enforcement

In this column, ReliabilityFirst Enforcement Staff share information on a variety of topics with a focus on communicating risk and providing transparency into the enforcement process. This includes: (a) identification of concerning violation trends, common failure types, and suggested solutions; (b) communication of expectations; and (c) commentary on enforcement approaches and specific factors that may affect the outcome in any given case. If you want to learn more about any of the topics discussed herein, please reach out to the author or your case manager.

ENERGY BAR ASSOCIATION



QUESTIONS & ANSWERS

LIMITED DISCLOSURE

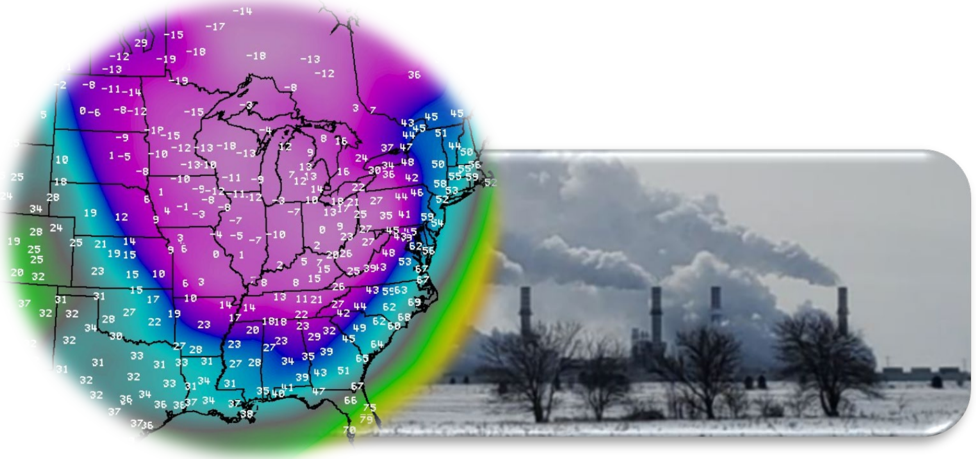
MONITORING SYSTEM EVENTS AND OPS-X DEMONSTRATION

Brian Thiry
Director, Strategic Engagement

FORWARD TOGETHER RELIABILITYFIRST

THE ELECTRIC GRID

Is the grid ***reliable?***



Is the grid ***resilient?***

Is the grid ***secure?***

Is the grid ***clean/sustainable?***

Is the grid ***affordable?***

Is the grid ***scalable?***

ERO RISK FRAMEWORK

RISK IDENTIFICATION

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

North American Electric Reliability Corporation
Digitally signed by North American Electric Reliability Corporation
Date: 2026.02.03 14:24:09 -05'00'

Rules of Procedure

Effective: November 28, 2023

THINKING ABOUT SYSTEMS EVENTS

events

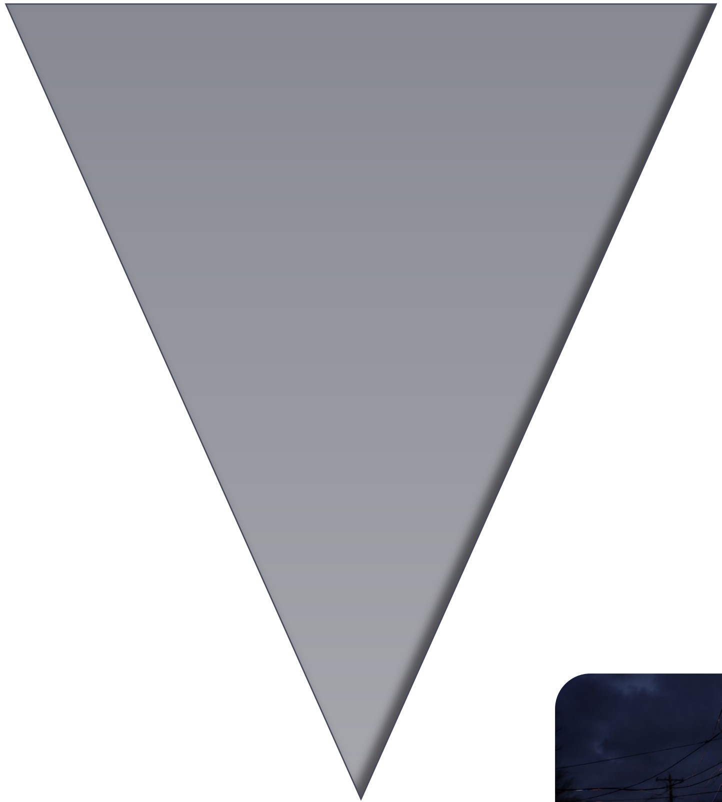
- Disturbance; an unplanned, abnormal condition on the grid

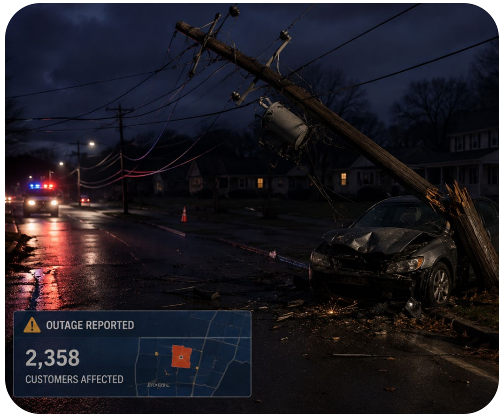
Events

- Occurrence that meets the criteria of NERC Standard EOP-004, Department of Energy OE-417, CIP-008, or NERC's Event Analysis Process (i.e., categorized event)

EVENTS

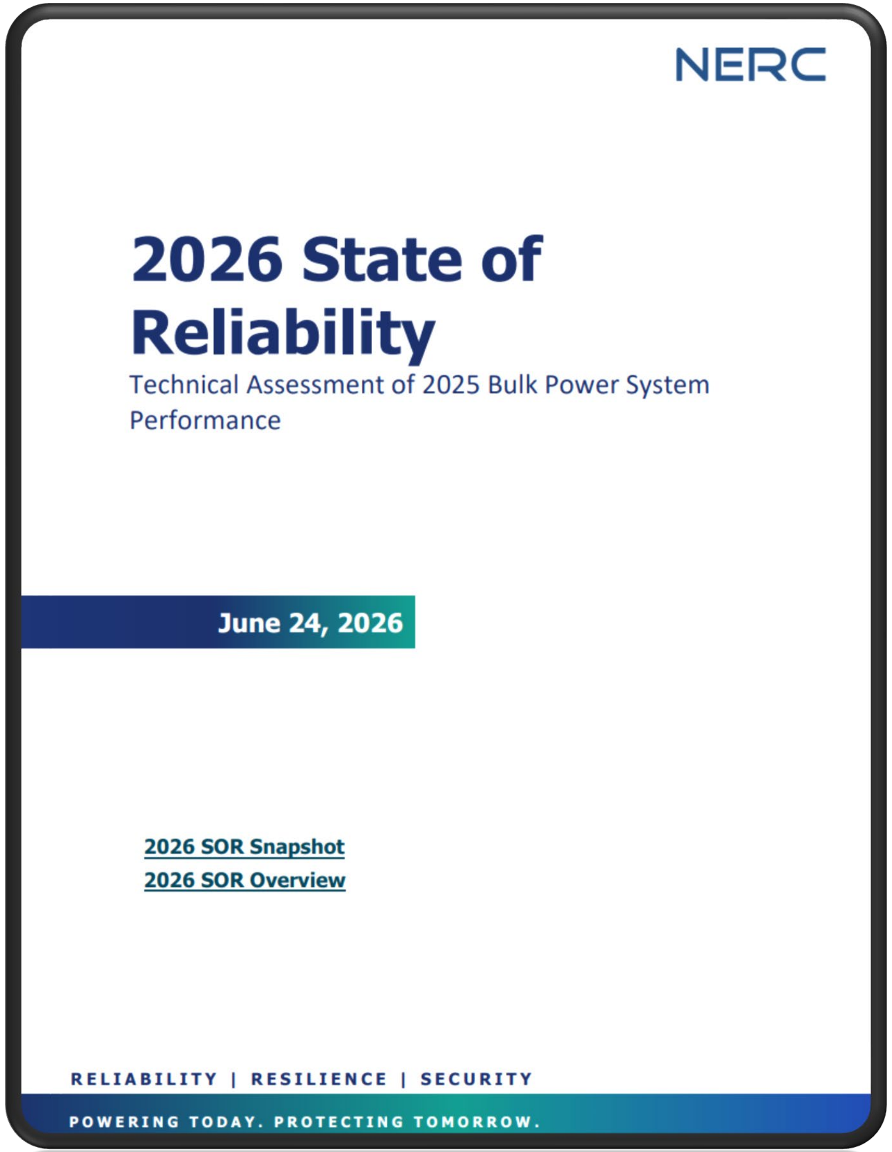
- Major blackouts, load shed events (i.e., things that will be on the news)





Disclaimer: these definitions are of the presenter and not official NERC Glossary terminology

EVENT DATA AND REPORTS


NERC

2026 State of Reliability

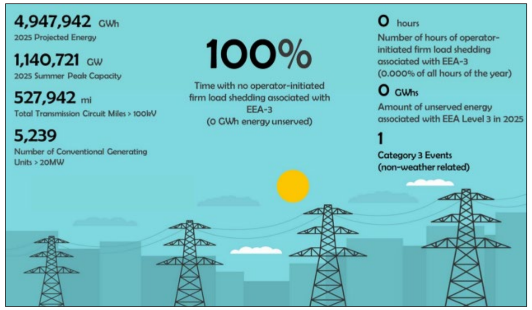
Technical Assessment of 2025 Bulk Power System Performance

June 24, 2026

2026 SOR Snapshot
2026 SOR Overview

RELIABILITY | RESILIENCE | SECURITY

POWERING TODAY. PROTECTING TOMORROW.



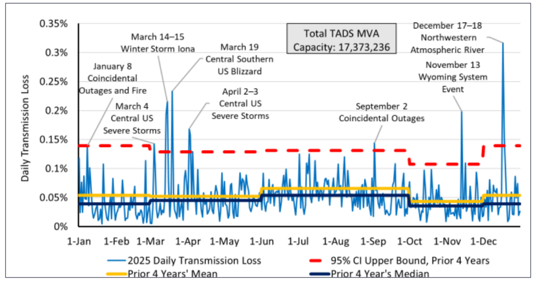
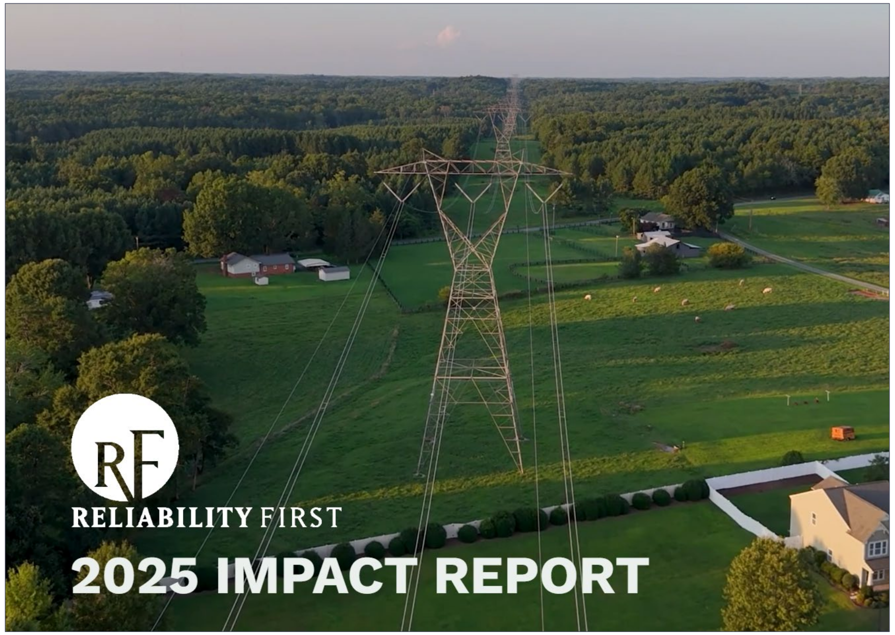
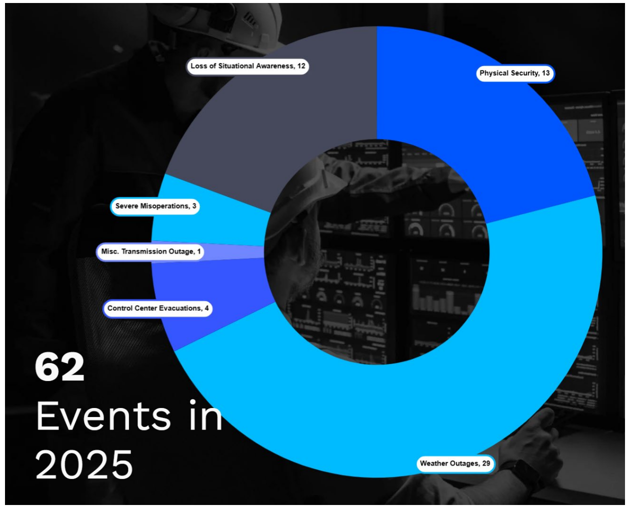


Table 2.4: Top Transmission Initiating Outage Causes on Extreme Days Ranked by MVA Capacity

Area	Cause #1	Cause #2	Cause #3	Cause #4	Cause #5
All NERC Regional Entities	Weather (Excluding Lightning) 156,789	Failed AC Substation Equipment 31,586	Unknown 31,515	Power System Condition 28,585	Contamination 23,963
Eastern–Québec Interconnections	Weather (Excluding Lightning) 142,446	Failed AC Substation Equipment 35,696	Lightning 24,057	Human Error 19,268	Failed AC Circuit Equipment 15,094
Texas Interconnection	Weather (Excluding Lightning) 18,052	Failed AC Substation Equipment 10,536	Lightning 6,993	Power System Condition 4,911	Unknown 4,315
Western Interconnection	Weather (Excluding Lightning) 49,701	Unknown 39,187	Fire 37,074	Power System Condition 30,008	Other 20,165

https://www.nerc.com/our-work/reports/state-of-reliability





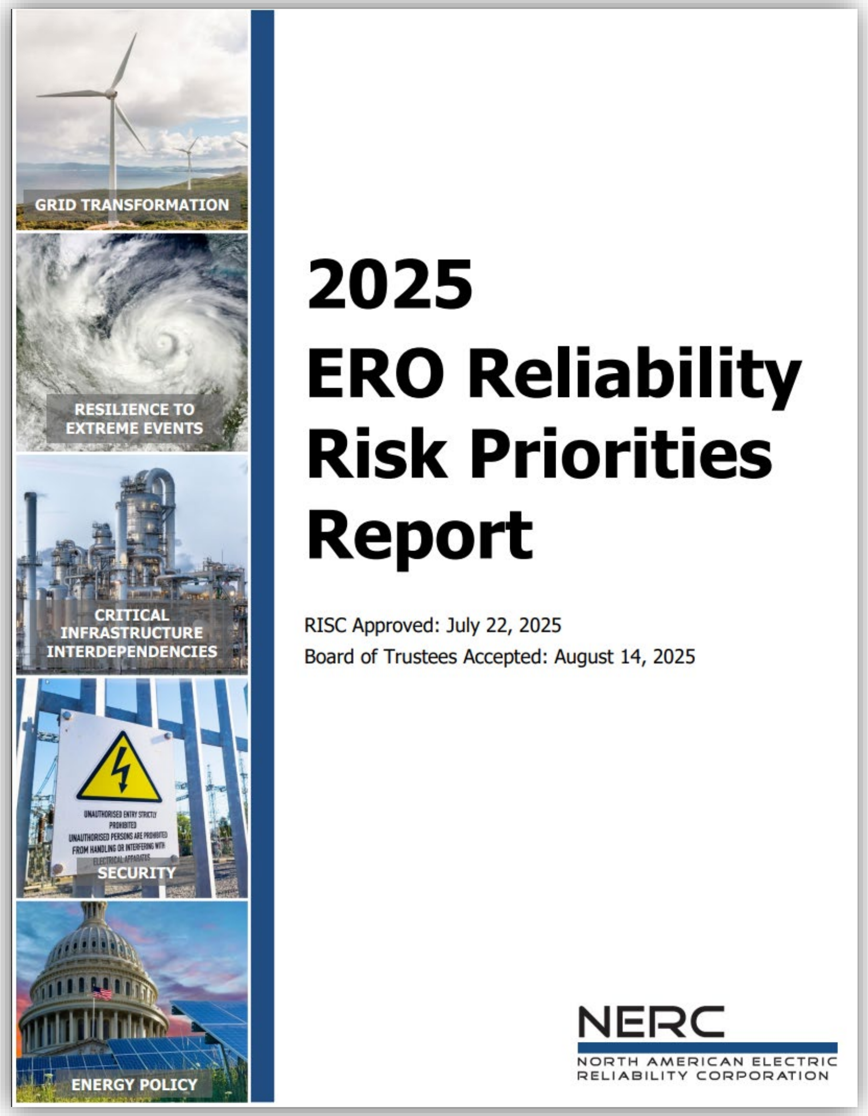
SIGNIFICANT GRID EVENTS

FORWARD TOGETHER RELIABILITYFIRST

FORWARD TOGETHER RF RELIABILITYFIRST

SECURITY EVENTS

- Stuxnet (2010)
- Ukraine Grid Attack (2015)
- NotPeyta (2017)
- SolarWinds (2020)
- Colonial Pipeline Ransomware (2021)

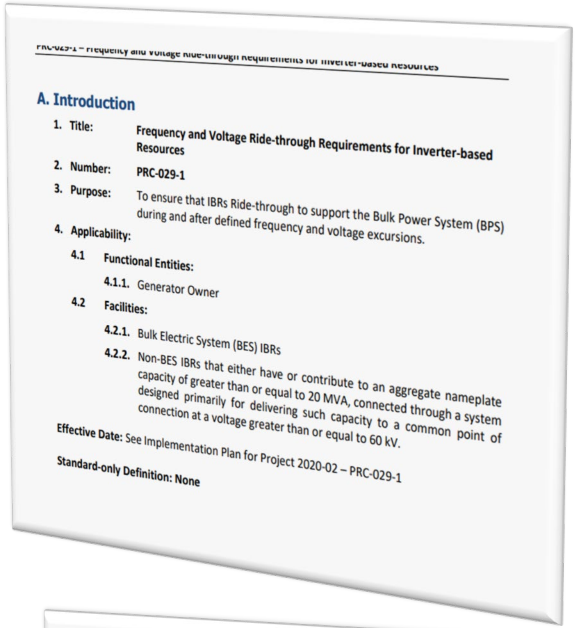


OUR RESPONSE

Compliance and Coordination

New/Revised Standards, New Registrations, and NERC Alerts

- Winterization
- Ride-Through Settings
- Physical Security
- Virtualization, Cloud, Supply Chain
- IBR Category 2
- Computational Load Owners/Operators (coming soon)



PRC-029-1 – Frequency and Voltage Ride-through Requirements for Inverter-based Resources

A. Introduction

1. **Title:** **Frequency and Voltage Ride-through Requirements for Inverter-based Resources**
2. **Number:** **PRC-029-1**
3. **Purpose:** To ensure that IBRs Ride-through to support the Bulk Power System (BPS) during and after defined frequency and voltage excursions.
4. **Applicability:**
   - 4.1 **Functional Entities:**
     - 4.1.1. Generator Owner
   - 4.2 **Facilities:**
     - 4.2.1. Bulk Electric System (BES) IBRs
     - 4.2.2. Non-BES IBRs that either have or contribute to an aggregate nameplate capacity of greater than or equal to 20 MVA, connected through a system designed primarily for delivering such capacity to a common point of connection at a voltage greater than or equal to 60 kV.

Effective Date: See Implementation Plan for Project 2020-02 – PRC-029-1

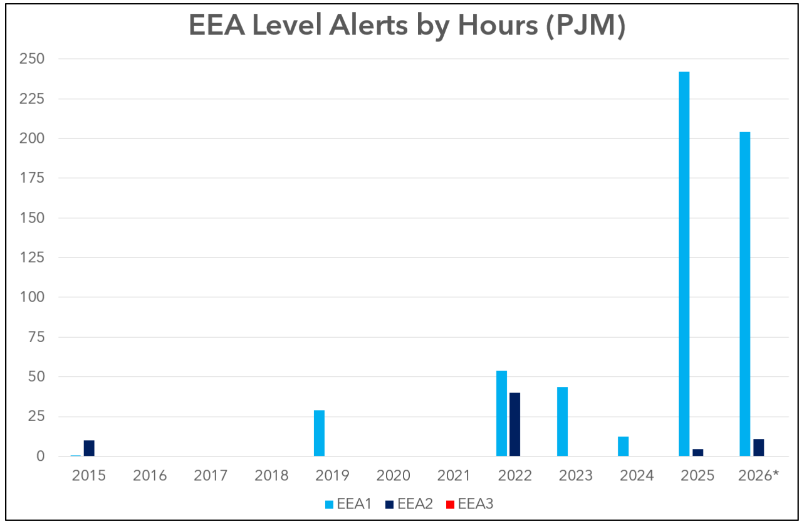
Standard-only Definition: None

Outreach, Training, and Education

- Guidelines, White Papers, Newsletters, Bulletins
- Cold Weather Winterization (CWW) Visits
- Industry Assist Visits and Tabletops
- Workshops, Webinars (*Tech Talk with RF*), and the Fall Summit
- **State Outreach**
  - Hearings, Testimonies, Written Remarks, 1:1 Meetings, Panel Discussions, Briefings

FORWARD TOGETHER RELIABILITYFIRST

HIGH RISK TIMES



https://emergencyprocedures.pjm.com/ep/pages/dashboard.jsf

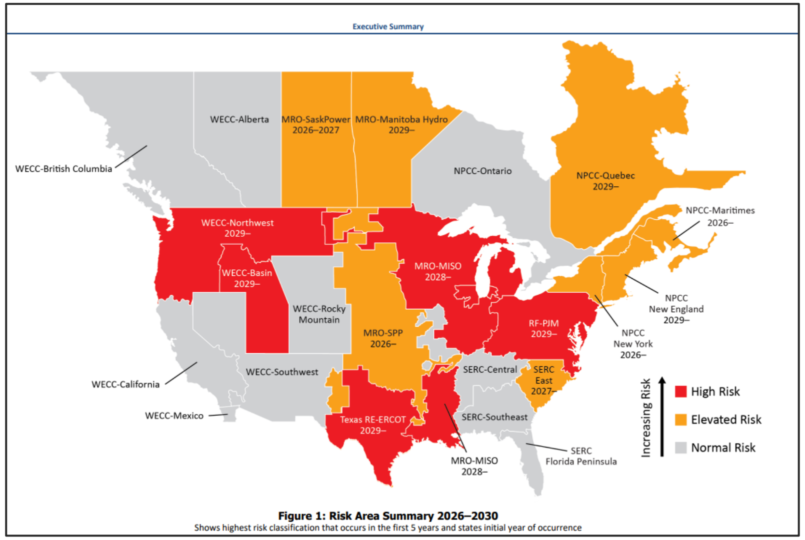


Figure 1: Risk Area Summary 2026–2030

Shows highest risk classification that occurs in the first 5 years and states initial year of occurrence

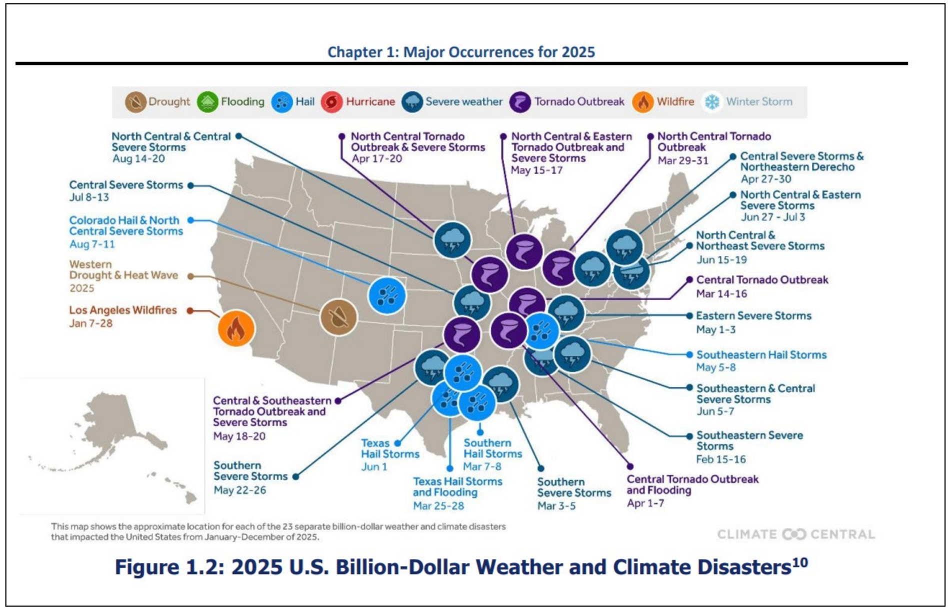
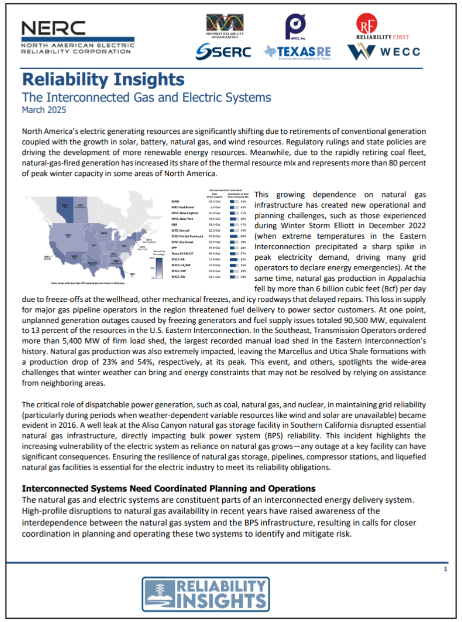


Figure 1.2: 2025 U.S. Billion-Dollar Weather and Climate Disasters[10]



NERC NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION — MIDWEST RELIABILITY ORGANIZATION — NPCC, Inc. — RELIABILITY FIRST — SERC — TEXAS RE — WECC

Reliability Insights

The Interconnected Gas and Electric Systems

March 2025

North America's electric generating resources are significantly shifting due to retirements of conventional generation coupled with the growth in solar, battery, natural gas, and wind resources. Regulatory rulings and state policies are driving the development of more renewable energy resources. Meanwhile, due to the rapidly retiring coal fleet, natural-gas-fired generation has increased its share of the thermal resource mix and represents more than 80 percent of peak winter capacity in some areas of North America.

This growing dependence on natural gas infrastructure has created new operational and planning challenges, such as those experienced during Winter Storm Elliott in December 2022 (when extreme temperatures in the Eastern Interconnection precipitated a sharp spike in peak electricity demand, driving many grid operators to declare energy emergencies). At the same time, natural gas production in Appalachia fell by more than 6 billion cubic feet (Bcf) per day due to freeze-offs at the wellhead, other mechanical freezes, and icy roadways that delayed repairs. This loss in supply for major gas pipeline operators in the region threatened fuel delivery to power sector customers. At one point, unplanned generation outages caused by freezing generators and fuel supply issues totaled 90,500 MW, equivalent to 13 percent of the resources in the U.S. Eastern Interconnection. In the Southeast, Transmission Operators ordered more than 5,400 MW of firm load shed, the largest recorded manual load shed in the Eastern Interconnection's history. Natural gas production was also extremely impacted, leaving the Marcellus and Utica Shale formations with a production drop of 23% and 54%, respectively, at its peak. This event, and others, spotlights the wide-area challenges that winter weather can bring and energy constraints that may not be resolved by relying on assistance from neighboring areas.

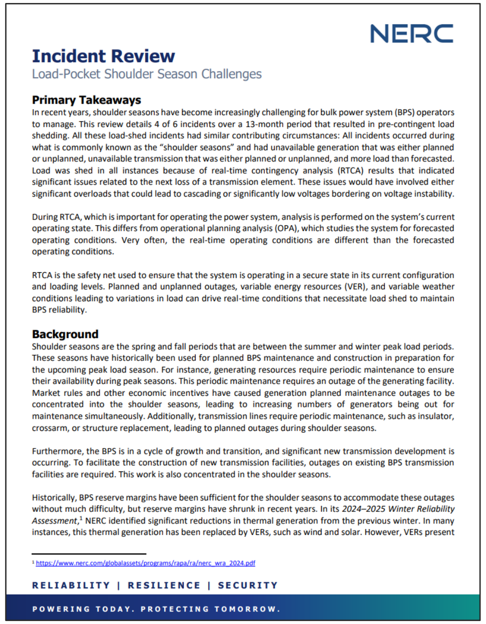
The critical role of dispatchable power generation, such as coal, natural gas, and nuclear, in maintaining grid reliability (particularly during periods when weather-dependent variable resources like wind and solar are unavailable) became evident in 2016. A well leak at the Aliso Canyon natural gas storage facility in Southern California disrupted essential natural gas infrastructure, directly impacting bulk power system (BPS) reliability. This incident highlights the increasing vulnerability of the electric system as reliance on natural gas grows—any outage at a key facility can have significant consequences. Ensuring the resilience of natural gas storage, pipelines, compressor stations, and liquefied natural gas facilities is essential for the electric industry to meet its reliability obligations.

Interconnected Systems Need Coordinated Planning and Operations

The natural gas and electric systems are constituent parts of an interconnected energy delivery system. High-profile disruptions to natural gas availability in recent years have raised awareness of the interdependence between the natural gas system and the BPS infrastructure, resulting in calls for closer coordination in planning and operating these two systems to identify and mitigate risk.

1

RELIABILITY INSIGHTS



NERC

Incident Review

Load-Pocket Shoulder Season Challenges

Primary Takeaways

In recent years, shoulder seasons have become increasingly challenging for bulk power system (BPS) operators to manage. This review details 4 of 6 incidents over a 13-month period that resulted in pre-contingent load shedding. All these load-shed incidents had similar contributing circumstances: All incidents occurred during what is commonly known as the "shoulder seasons" and had unavailable generation that was either planned or unplanned, unavailable transmission that was either planned or unplanned, and more load than forecasted. Load was shed in all instances because of real-time contingency analysis (RTCA) results that indicated significant issues related to the next loss of a transmission element. These issues would have involved either significant overloads that could lead to cascading or significantly low voltages bordering on voltage instability.

During RTCA, which is important for operating the power system, analysis is performed on the system's current operating state. This differs from operational planning analysis (OPA), which studies the system for forecasted operating conditions. Very often, the real-time operating conditions are different than the forecasted operating conditions.

RTCA is the safety net used to ensure that the system is operating in a secure state in its current configuration and loading levels. Planned and unplanned outages, variable energy resources (VER), and variable weather conditions leading to variations in load can drive real-time conditions that necessitate load shed to maintain BPS reliability.

Background

Shoulder seasons are the spring and fall periods that are between the summer and winter peak load periods. These seasons have historically been used for planned BPS maintenance and construction in preparation for the upcoming peak load season. For instance, generating resources require periodic maintenance to ensure their availability during peak seasons. This periodic maintenance requires an outage of the generating facility. Market rules and other economic incentives have caused generation planned maintenance outages to be concentrated into the shoulder seasons, leading to increasing numbers of generators being out for maintenance simultaneously. Additionally, transmission lines require periodic maintenance, such as insulator, crossarm, or structure replacement, leading to planned outages during shoulder seasons.

Furthermore, the BPS is in a cycle of growth and transition, and significant new transmission development is occurring. To facilitate the construction of new transmission facilities, outages on existing BPS transmission facilities are required. This work is also concentrated in the shoulder seasons.

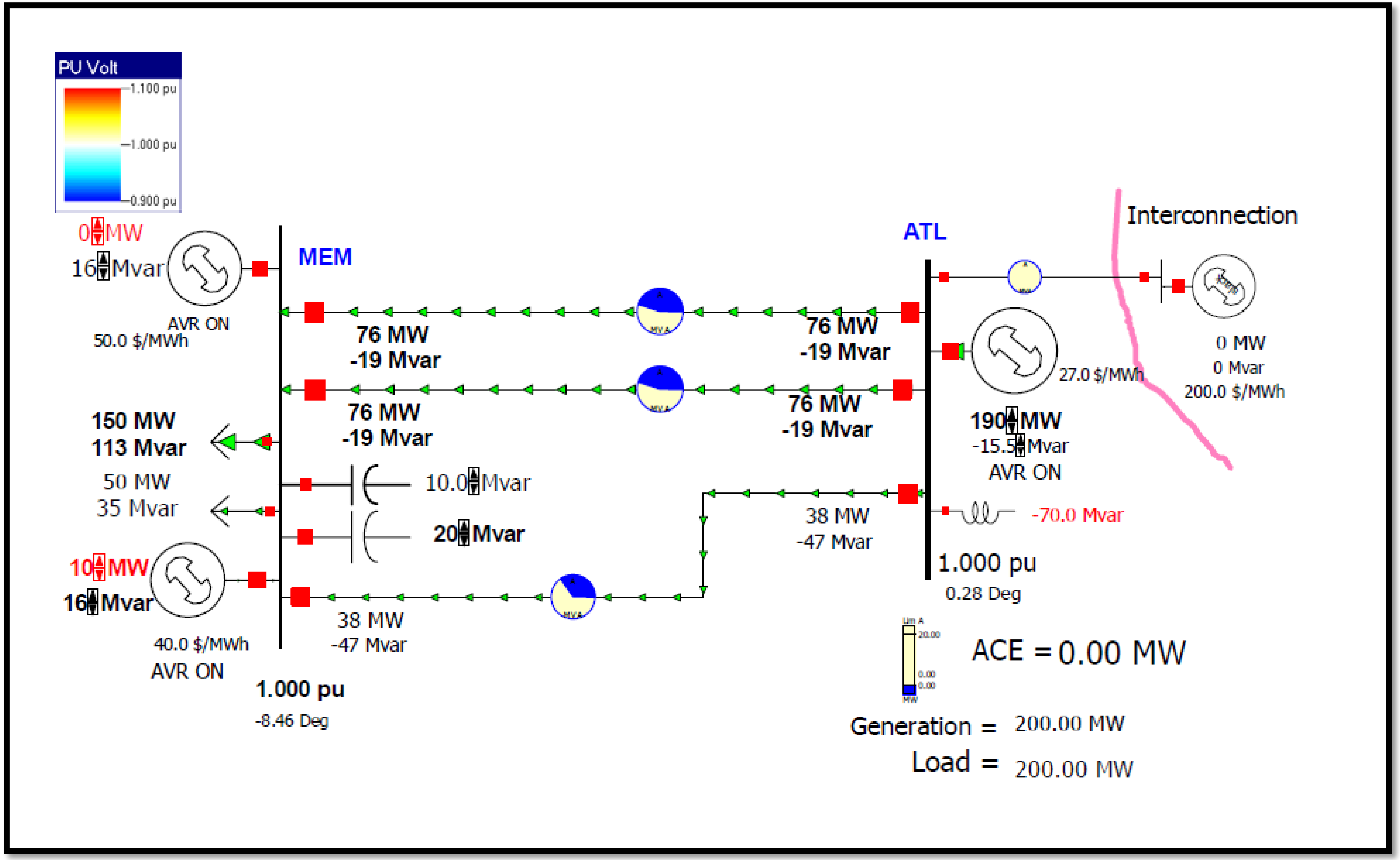
Historically, BPS reserve margins have been sufficient for the shoulder seasons to accommodate these outages without much difficulty, but reserve margins have shrunk in recent years. In its *2024–2025 Winter Reliability Assessment*,[1] NERC identified significant reductions in thermal generation from the previous winter. In many instances, this thermal generation has been replaced by VERs, such as wind and solar. However, VERs present

[1] https://www.nerc.com/globalassets/programs/rapa/ra/nerc_wra_2024.pdf

RELIABILITY | RESILIENCE | SECURITY

POWERING TODAY. PROTECTING TOMORROW.

OPS-X GRID SIMULATOR



FORWARD TOGETHER RELIABILITYFIRST

QUESTIONS & ANSWERS

LIMITED DISCLOSURE

FORWARD TOGETHER RELIABILITYFIRST

ENGINEERING ASSESSMENTS – MODELING, ANALYSIS, AND ENERGY ASSESSMENTS

Johnny Gest

Manager, Engineering & System Performance

ReliabilityFirst Electric Grid Bootcamp

08-18-2026

RELIABILITY FIRST

FORWARD TOGETHER RELIABILITYFIRST

LIMITED DISCLOSURE

AGENDA

ELECTRIC GRID OVERVIEW

PLANNING CASES, MODELS, AND STUDIES

RESOURCE ADEQUACY

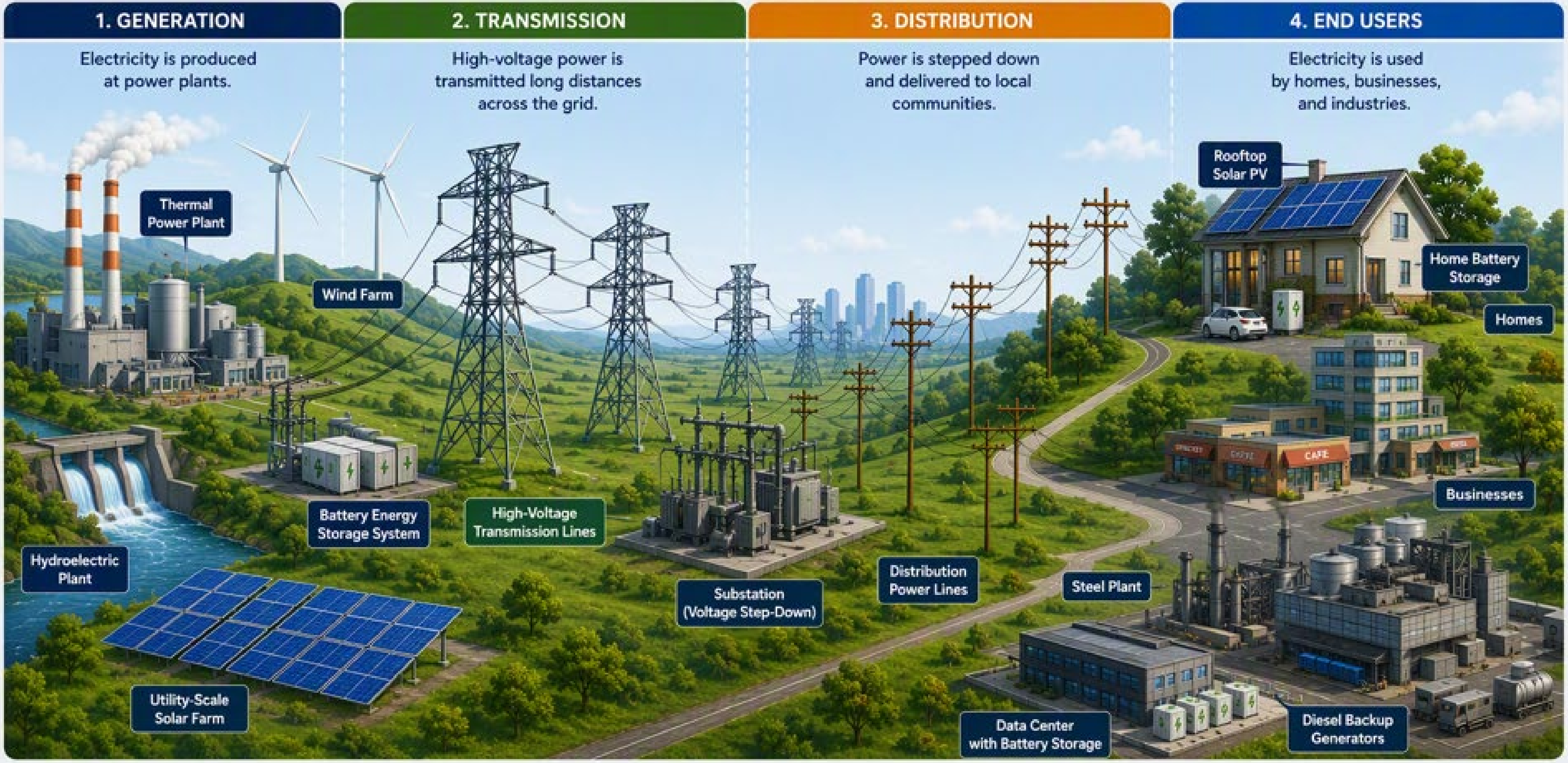
ENERGY ASSESSMENTS

DEMAND-SIDE CONSIDERATION

SOLUTIONS FOR CONSIDERATION

THE ELECTRIC GRID

From Power Generation to End Users



Reliable
Delivering power when it's needed.

Resilient
Withstanding storms, faults, and disruptions.

Efficient
Operating the grid safely and economically.

Sustainable
Integrating clean energy for the future.

Planning Cases, Models, and Studies

Transmission Planning Analysis

WHAT CAN GO WRONG?

Reliability studies intentionally ask how the grid performs after equipment becomes unavailable, not just during normal conditions.

Equipment outages: Lines, Transformers, Generators

Loss of a key path or resources can force power onto remaining lines and create overload risk and reduce operating flexibility.

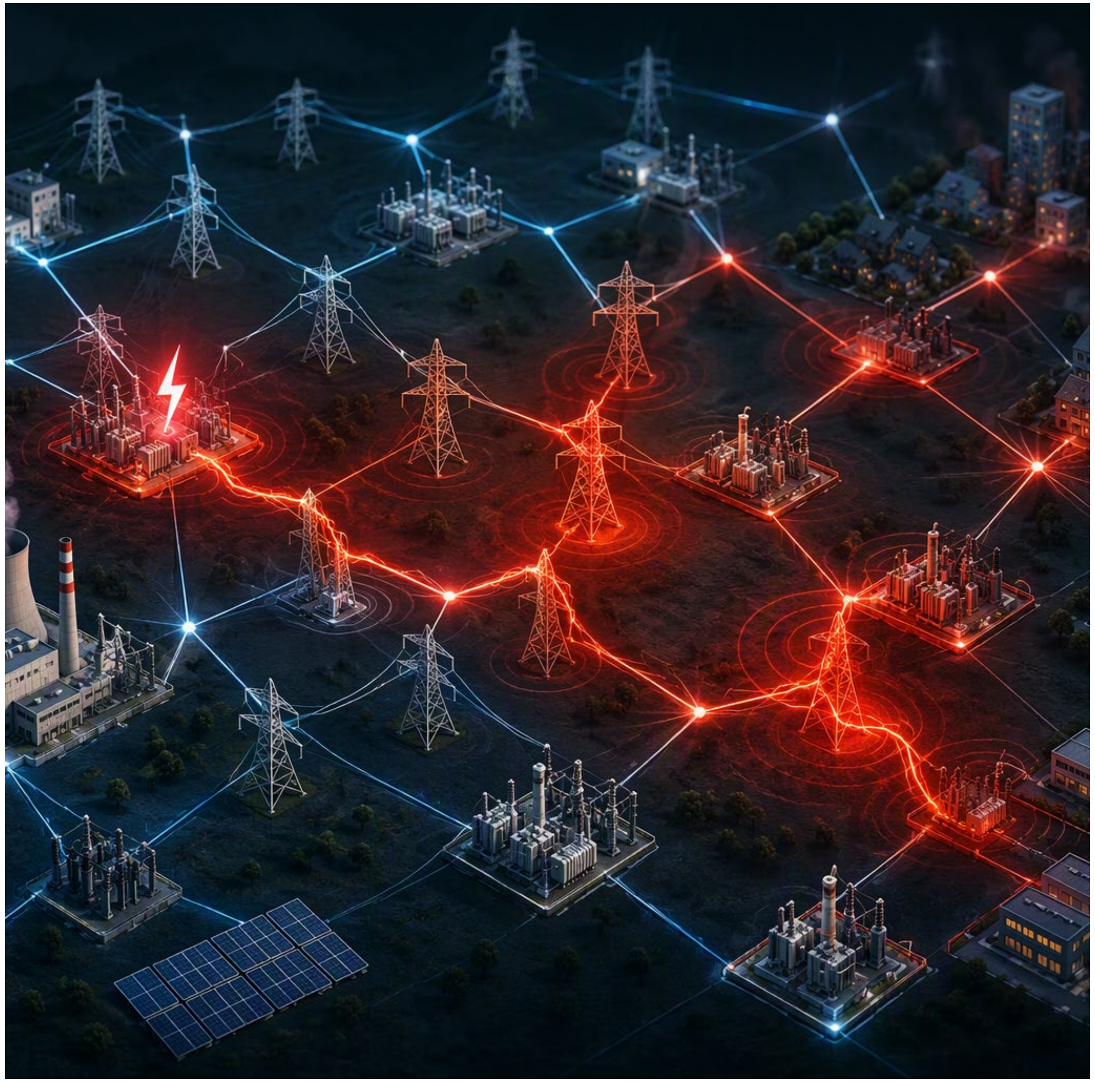
More severe events

Study combinations or higher-impact scenarios to identify vulnerabilities and mitigation needs.

Planning Value

System model and study results help determine whether operating procedures, upgrades, or other mitigation measures are needed.

Planning studies utilize criteria in NERC Reliability Standard TPL-001



CASE AND MODEL APPLICATION

Case is a "digital twin" that tests whether the grid can reliably move electricity from supply to demand.

1. Inputs/Models

Generation, demand, transmission facilities (e.g., lines, transformers, etc.), facility ratings, voltage limits, and system assumptions.

2. Case Run

Simulate how power moves across the network under various operating conditions and outages.

3. Results

The simulation results identify overloaded facilities, voltage concerns, transfer limits, and potential system events.

SERVING GROWING DEMAND

Power-flow analysis converts growth assumptions into physical grid impacts. Improper planning may delay regional economic growth.

Can the grid serve new load?

Transmission planners test whether facilities can carry projected demand without exceeding reliability limits.

Computational load impacts

Data centers, manufacturing, and electrification can concentrate demand in locations where the grid was not originally designed for that scale.

Concerns turn to action

Modeled overloads or voltage concerns indicate where upgrades, and timing issues require attention.

Why it matters

Reliability risk can constrain economic development if infrastructure cannot keep pace with demand growth.

MAKING GENERATION DELIVERABLE

The question is not just “how much supply?” – it is “can it reach load?”

Generation location matters

New resources may be far from the customers or load centers they are intended to serve.

Transmission paths matter

The model identifies whether existing lines and transformers can support the expected flows.

Constraints matter

A bottleneck can limit deliverability even when enough generation exists in the region. It can also restrict dispatch of lower cost resources.

Timing matters

Generation additions and transmission reinforcements may not move on the same schedule.

Deliverability impacts operational limitation, cost to connect, interconnection timing, and local reliability.

TRANSMISSION EXPANSION

Planning, permitting, siting, cost allocation, and construction add complexity before electrons can move

1 Need identified

Simulation flags a reliability or deliverability issue.

2 Options studied

Planners validate initial results, identify mitigations, find best overall solution.

3 Approvals aligned

Design, siting, permitting, and equipment procurement.

4 Facilities built

Scheduled outages, construction, testing or commissioning are sequenced.

Power-flow studies can identify the need early, but physical transmission solutions require multi-step coordination

WHY ACCURACY MATTERS

Accurate Facility Ratings

- Define the operating limits of the transmission system
- Avoid overstating or understating facility capability
- Improve confidence in planning and operational decisions

Accurate Models

- Reflect real-world behavior of transmission, generation, and load
- Capture impacts of emerging technologies and changing grid characteristics
- Improve identification of reliability risks and effective mitigations

Sound Study Assumptions

- Establish a credible foundation for study results
- Address uncertainty through scenarios and sensitivities

PLANNING STUDIES - TAKEAWAYS

- Cases are a "digital twin" of the electric grid using complex models to replicate transmission element operational behavior
- Studies simulate various outages, reroute the power, and identify potential reliability concerns
- Study focus is typically reviewing impacts of ***new generation*** connections or ***demand growth***
- Development of transmission and generation infrastructure takes times to implement
- Study errors can result in:
  - Insufficient time to implement needed solutions
  - Failure to identify potential reliability concerns

Resource Adequacy

Is there enough resource capacity to meet peak demand while experiencing resource unavailability?

LIMITED DISCLOSURE

FORWARD TOGETHER RELIABILITYFIRST

NAMEPLATE, CAPACITY, & ENERGY

Installed generation tells only part of the reliability story. Resource adequacy focuses on resource capacity during the peak hour.

Generator nameplate

Designed megawatt output of the unit

Installed capacity

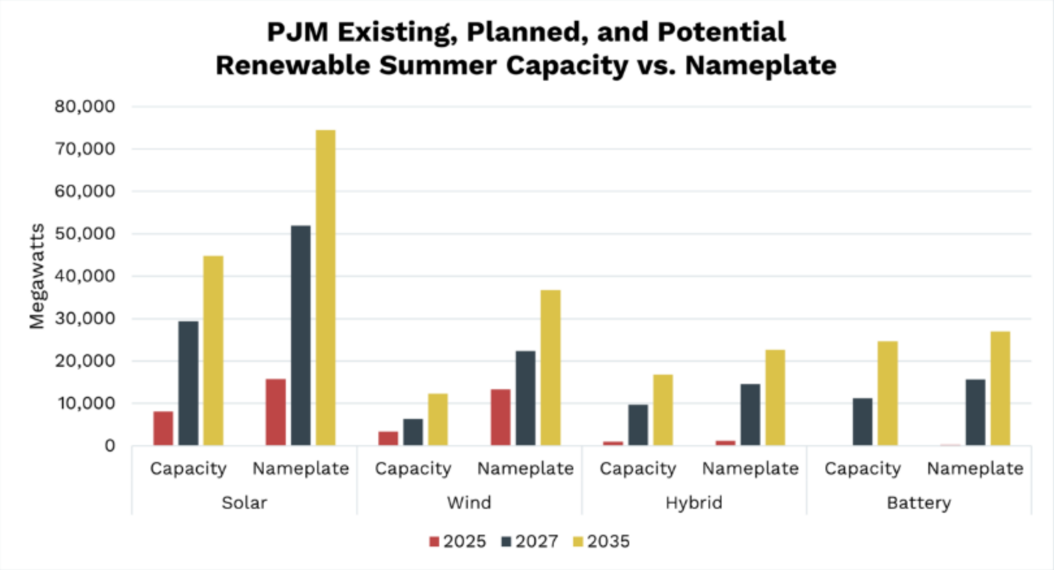
Megawatt output that can be produced at a defined moment

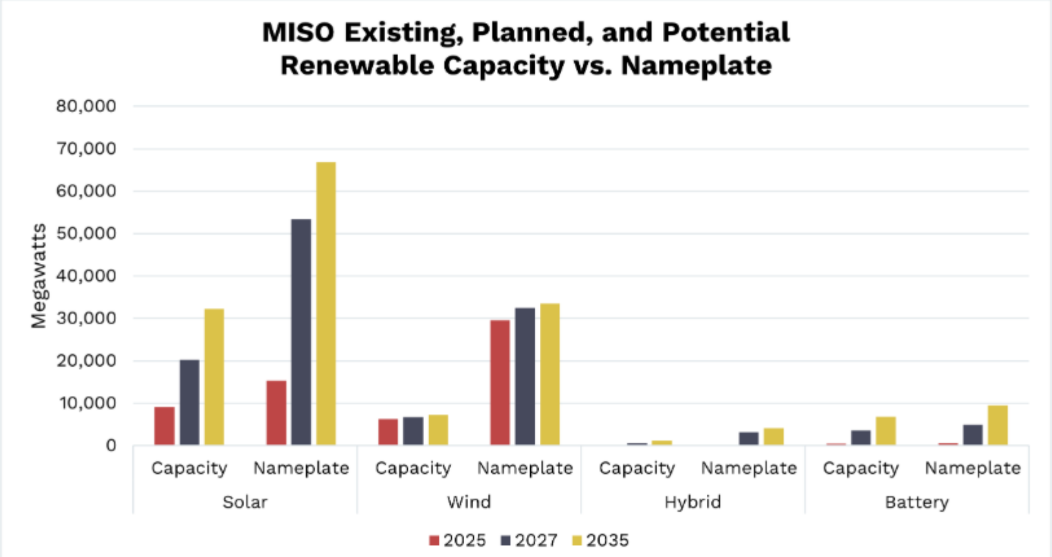
Available energy

Megawatts produced over a defined set of time.

Why does it matter?

A system may appear adequate by nameplate or capacity values but still face risk if fuel, weather, outages, or transfers limit energy availability





Source: ReliabilityFirst 2026 Resource Adequacy Report
https://feature.rfirst.org/resource-adequacy-report-2026/index.html

BALANCING RESOURCES & DEMAND

Key question: Do we have enough resources to keep the lights on in the future?

Applicable Risks

1) Resource retirements outpace resource additions
2) Demand outpaces resource additions

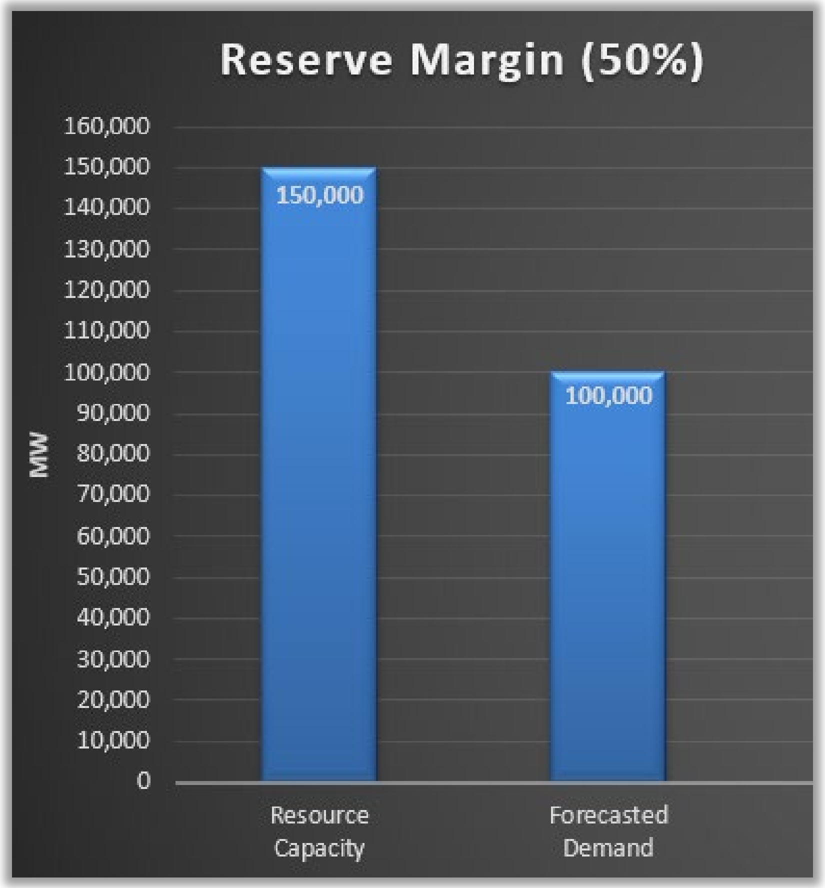
Are policy, market, permitting, and interconnection paths aligned so replacement resources arrive before shortages occur?

RESOURCE MARGINS

Reserve Margin

- Amount resource capacity that exceeds demand

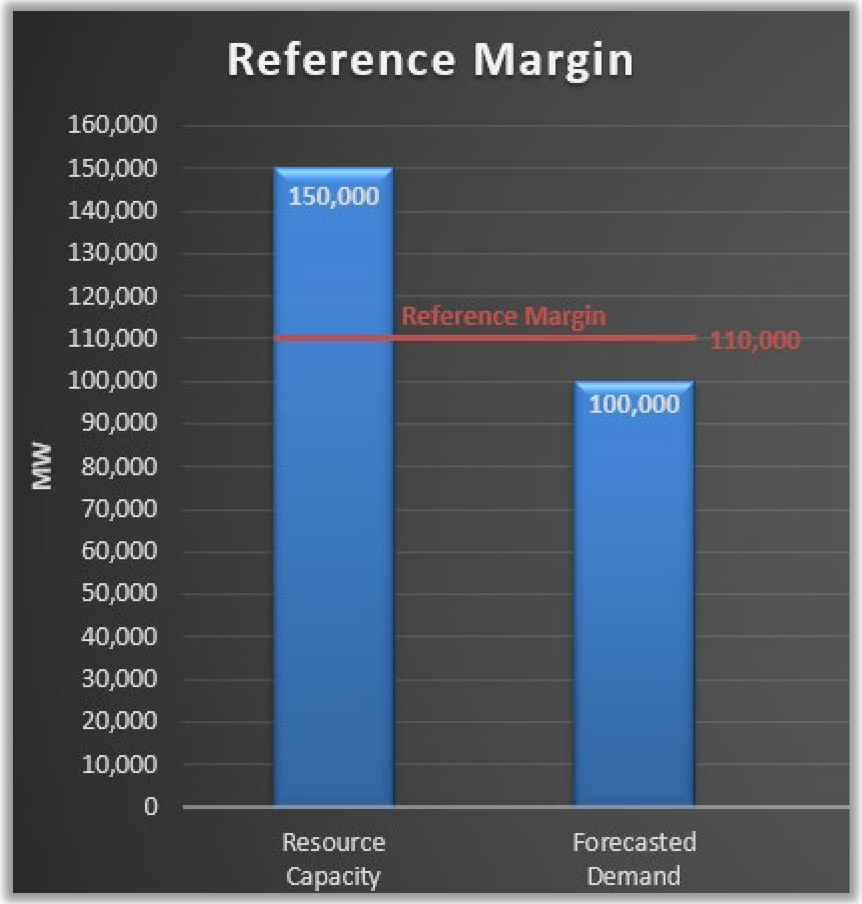
How much of a buffer does my area have?



Reference Margin

- Represents acceptable level of risk for resource planning

Is my buffer sufficient?



RESOURCE ADEQUACY - TAKEAWAYS

Results are constantly in flux: Pace of change in resource additions and retirements plus demand forecasts

- Resources are represented based on output profile impacted by outages, weather, and fuel availability
- Important to plan for resources to be greater than demand ***AND*** the reserve margin
- Reduce uncertainty with accurate forecasting
  - Can generation be built in-time?
  - Will load develop as forecasted?
- Reliable portfolio considers how resources perform together during high-risk periods
- Measures like Demand Response can be used to balance resource shortfalls

Energy Assessments

Is there enough energy to supply demand through sustained events?

WHY IS IT IMPORTANT?

A system may have adequate reserve margins but still face risks if fuel, weather, outages, or transfers limit sustained energy availability.

Energy shortfall risk is shifting away from peak conditions

Extreme weather can impact renewable output, thermal plant performance, and increase risk of transmission outages

Operational complexity increases with flexible demand, fuel storage coordination, and optimizing battery dispatch

Wide-area events can impact ability to deliver energy between regions

DATA UTILIZED

Model

- "Pipe and bubble" – Not as complex as planning or operational models

Demand Inputs

- Forecasted hourly load profiles
- Demand Response assumptions

Transmission Inputs

- Transfer capabilities between areas
- Import/export assumptions

Weather Inputs

- Historical weather and temperatures

Resource Inputs

- Resource nameplate and operating characteristics
- Forced outage rates and maintenance schedules
- Renewable resource profiles (i.e., hydro, solar, and wind)
- Energy Storage nameplate, duration, and dispatch assumptions

Operational Inputs

- Reserve requirements
- Ramp rate and minimum run times
- Seasonal and extreme operating assumptions

PROBABILISTIC RISK METRICS

Loss of Load Expectation LOLE

How often?

Expected number of days in a year when supply could fall short at least once. It is a frequency metric. Common shorthand: 0.1 days/year, often described as "1 day in 10 years."

Loss of Load Hours LOLH

How long?

Expected number of hours in a year when demand could exceed available supply. It gives a more detailed view than counting days, because it looks hour by hour.

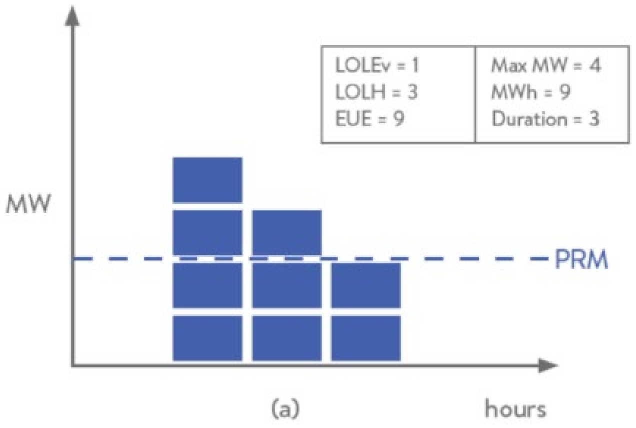
Expected Unserved Energy EUE

How big is the impact?

Expected amount of energy customers would not receive during shortage events, usually shown in MWh or GWh. It captures severity, not just occurrence.

No Perfect Metric

- No single metric tells the whole story.
- LOLE shows frequency, LOLH shows duration, and EUE shows severity.
- Together, they give a clearer picture of reliability risk and the types of solutions that may be needed.



Source: Resource Adequacy Philosophy: A Guide to Resource Adequacy Concepts and Approaches

Demand-Side Considerations

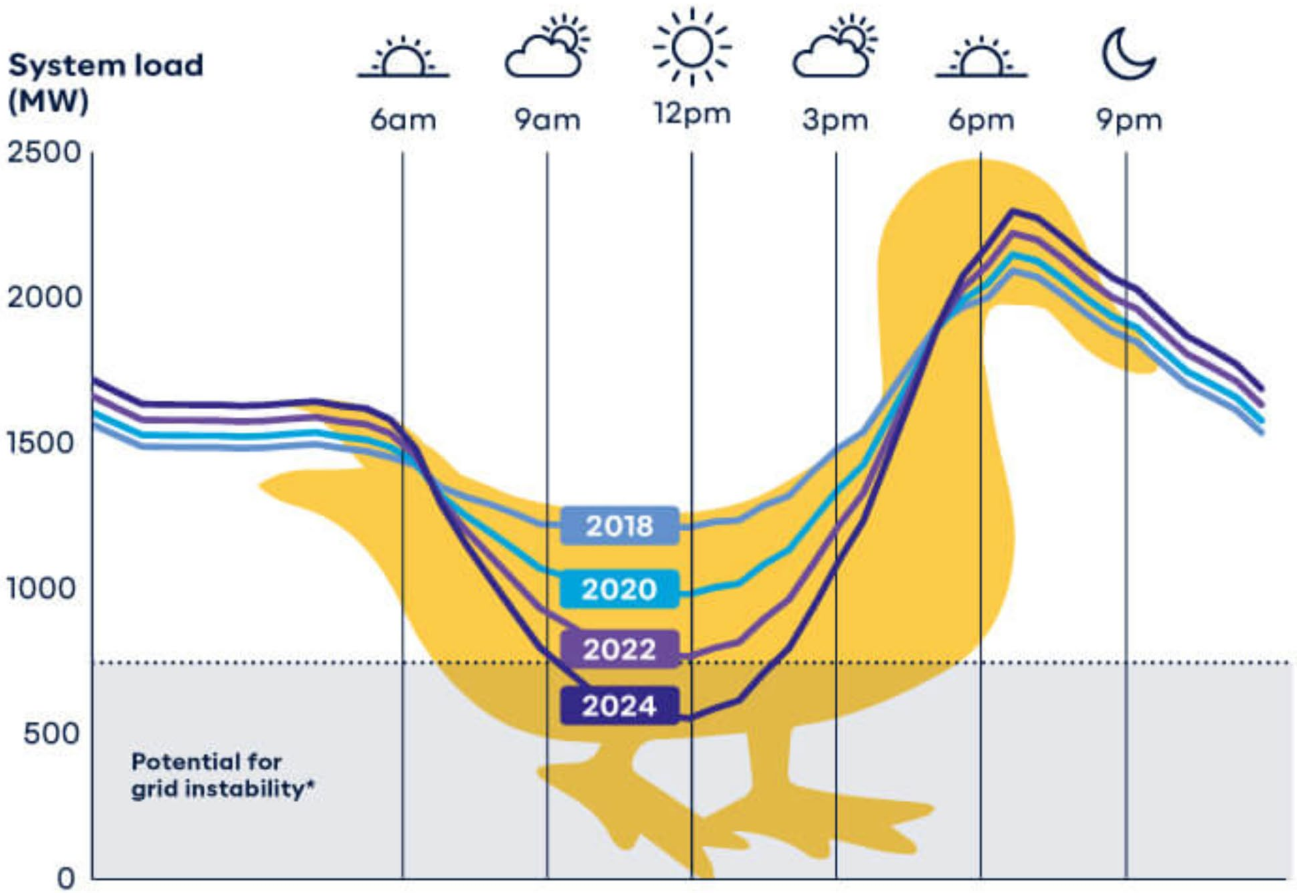
How behind-the-meter elements impact the transmission grid

PRACTICAL EXAMPLE - DUCK CURVE

Demand-Side Management (DSM)
Long-term programs and policies that encourage customers to reduce overall energy consumption or shift electricity use to lower-demand periods.

Demand Response (DR)
Programs that provide financial incentives for customers to temporarily reduce or increase electricity use in response to grid conditions, reliability needs, or price signals.

Energy Efficiency
Permanent improvements to equipment, technology, or processes that reduce energy consumption while delivering the same level of service or output.



A graphical representation of the 'Duck Curve' for the SWIS, created with 2020 data from AEMO.

Solutions for Consideration

What can be implemented to alleviate identified resource and energy shortfalls?

LIMITED DISCLOSURE

SOLUTIONS FOR CONSIDERATION

- Accept the identified risks during extreme events (assuming other reliability thresholds are met)
- Construct local generation
- Increase Demand Response
- Increase transfer capability to neighbors with surplus resources
  - Transmission infrastructure upgrades
  - Remedial action schemes (RAS)

Grid-enhancing Technologies (GETs)

Source: NERC Interregional Transfer Capability Study (ITCS) Strengthening Reliability Through the Energy Transformation, Chapter 5, Page 45

LIMITED DISCLOSURE

FORWARD TOGETHER RELIABILITYFIRST

QUESTIONS & ANSWERS

Johnny Gest

johnny.gest@rfirst.org

RF ELECTRIC GRID BOOTCAMP

Regional Transmission Organization (RTO) Overview

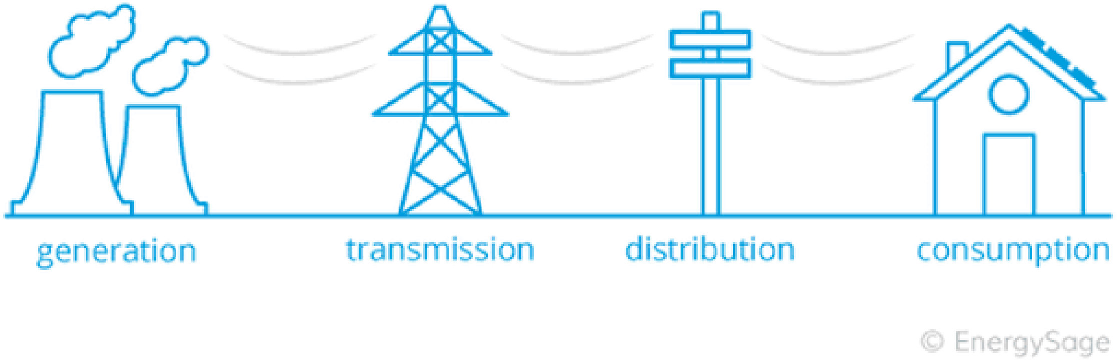
How RTOs run the bulk power grid — with a focus on MISO and PJM

August 2026

LEARNING OBJECTIVES

Today's participants will:

- Understand the footprint and challenges of each RTO.
- Identify the similarities and differences between MISO and PJM RTOs.
- Apply concepts to understand potential policy positions.
- Compare and contrast the operational and market structures of MISO and PJM using real-world examples.
- Understand RTO interconnection/queue challenges.



What is an RTO?

- Non-profit, public-benefit entities that coordinate, control and monitor a multi-state electric grid.
- Because interstate power flow is interstate commerce, RTOs answer to FERC — not to state utility commissions — under a FERC-approved tariff.
- Roots: FERC Orders 888/889 (1996) opened non-discriminatory transmission access; Order 2000 (Dec. 1999) encouraged voluntary RTO formation and set 12 required functions.
- Membership is voluntary; the mission is economic efficiency, reliability and non-discriminatory access.

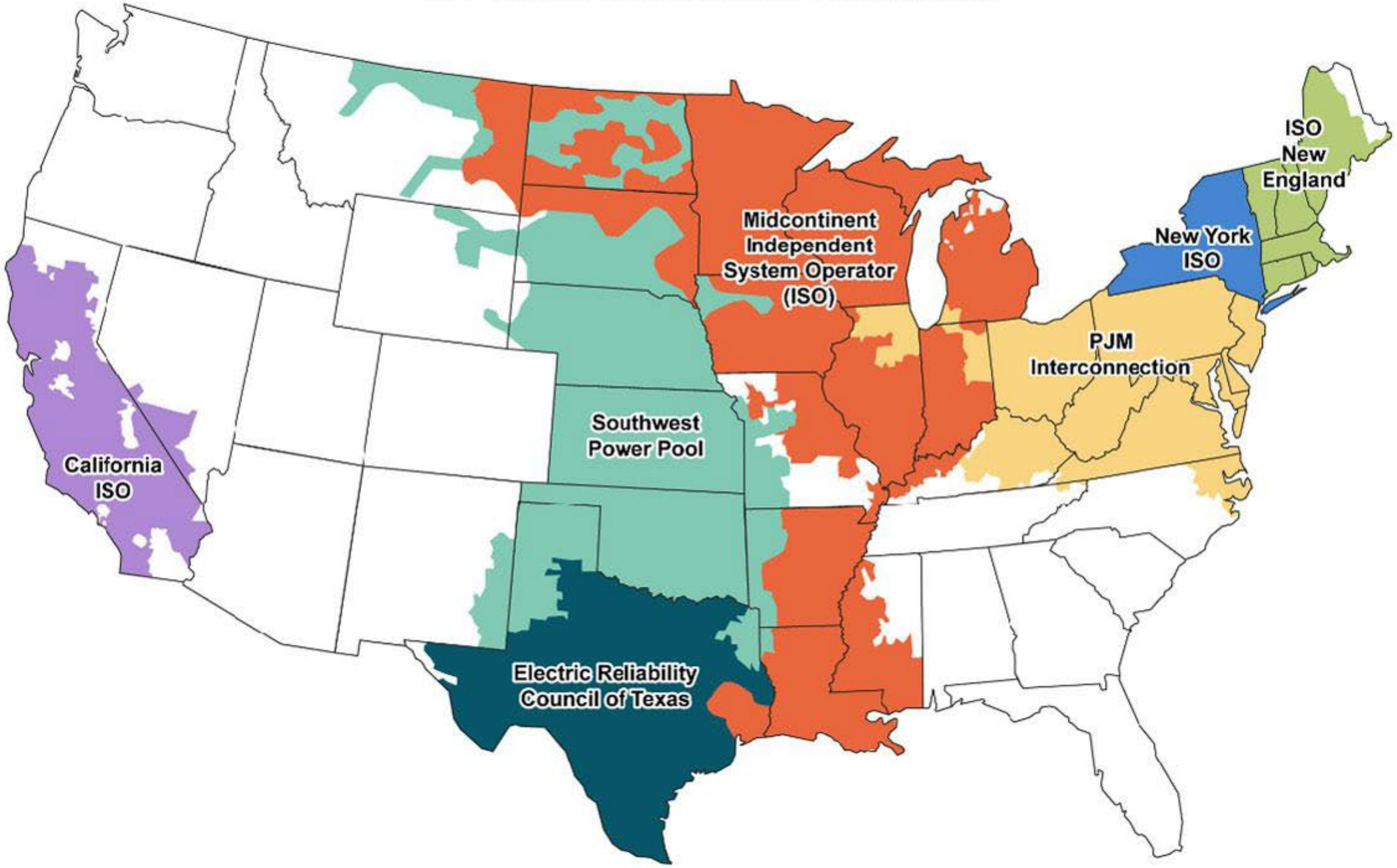
~2/3

of U.S. electricity demand is served by RTOs / ISOs

Order 2000 (1999)

Defined the twelve characteristics and functions an entity must meet to operate as a Regional Transmission Organization.

Regional Transmission Organizations in the United States



Source: GAO 2017

GEOGRAPHY

RTO and ReliabilityFirst footprints

Seven RTOs / ISOs in the U.S.

PJM • MISO • SPP • CAISO • ISO-NE • NYISO • ERCOT

Six fall under FERC jurisdiction; ERCOT operates outside it. Together they serve roughly two-thirds of U.S. electricity consumers.

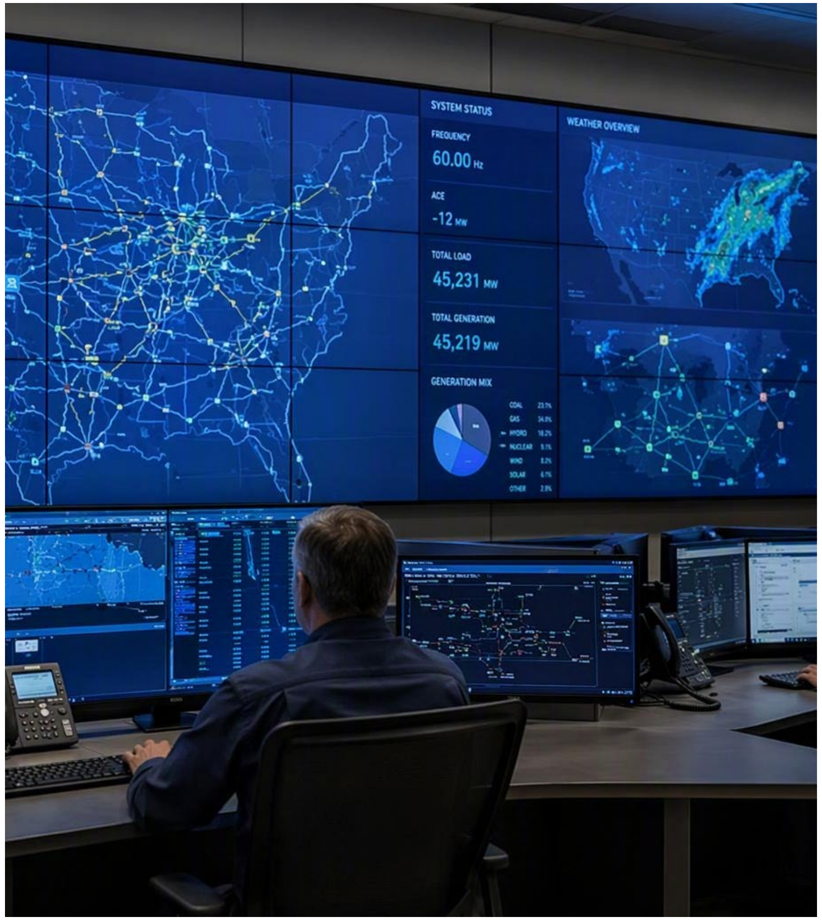
ReliabilityFirst (RF)

- One of six NERC Regional Entities (with MRO, NPCC, SERC, Texas RE and WECC) that enforce Bulk Electric System reliability.
- Regulates BOTH PJM and MISO within its footprint; based in Cleveland, spanning the Great Lakes and Mid-Atlantic.
- Began operations in2006, covering all or parts of 13 states plus D.C.

DAY TO DAY

What RTOs do every day

1. **Run the markets** Operate day-ahead and real-time energy markets plus ancillary services.
2. **Dispatch economically** Match supply and demand in real time, dispatching generation at least cost.
3. **Keep the lights on** Maintain bulk-system reliability and open, non-discriminatory transmission access.
4. **Plan the grid** Conduct regional transmission planning and coordinate system expansion.
5. **Coordinate at the seam** MISO and PJM settle across their border via the Joint & Common Market.



COMPARISON

How MISO and PJM compare

MISO

- Spans a north-south footprint across the Midwest and South.
- Serves 45M+ people across 15 states and part of Canada
- Mostly regulated and vertically integrated utilities
- Annual capacity markets for 5% of load

PJM

- Mid-Atlantic and Great Lakes regions
- The largest U.S. RTO — serves 67M+ people across 13 states and D.C.
- More deregulated utilities
- Conduct 3-year capacity auctions with ~ 95% of load

Common ground: both operate under ReliabilityFirst and coordinate at their shared seam via the Joint & Common Market.

NERC registration roles

NERC is the FERC-certified Electric Reliability Organization. It registers owners, operators and users of the Bulk Electric System by function.

RC
Reliability Coordinator

BA
Balancing Authority

TOP
Transmission Operator

TO
Transmission Owner

TP
Transmission Planner

PC
Planning Coordinator

GO
Generator Owner

GOP
Generator Operator

Certification-required roles in amber must complete formal certification and meet minimum performance criteria before they may operate.

JURISDICTION

Where states still hold the pen

Approve the resource mix

In regulated markets, vertically integrated utilities choose generation with public utility commission (PUC) approval.

Regulate retail service

States keep authority over retail rates and retail-choice — wholesale market rules are set by FERC tariff.

Site the lines

Transmission line siting and permitting remain largely a state function.

Consult on cost allocation

Order 1920-A (Nov. 2024) requires state consultation before amending any long-term regional cost-allocation method.

GOVERNANCE

How stakeholder processes work

RTOs develop market rules through open, member-driven governance — keeping the process competitive and access non-discriminatory.

1
Issue raised
A market or reliability issue enters the process.

2
Committees
Sector committees and work groups debate proposals.

3
Stakeholder vote
Members vote across sectors to refine the package.

4
Board decision
The RTO board endorses a direction.

5
FERC filing
The tariff change is filed with FERC for approval.

Fast lane: PJM's board can invoke a Critical Issue Fast Path (CIFP) under Manual 34 to accelerate urgent proposals, while MISO expedites specific filings less formally.

PLANNING MODELS

Regulated vs. deregulated planning

REGULATED

Integrated Resource Planning

- Vertically integrated utilities plan generation as a regulated monopoly.
- An Integrated Resource Plan (IRP) maps long-term, least-cost supply.
- State PUCs review and comment/approve the plan.
- Utility bears the build-or-buy decision and cost recovery.
- Most common in MISO.

DEREGULATED

Market-Based Additions

- Generation is competitive and unbundled from the wires business.
- Developers sell energy and capacity into RTO markets.
- Resource additions are market-driven, not utility-planned.
- Capacity and energy prices — not an IRP — signal where and when to build.
- Most common in PJM.

THE PRESSURE POINT

Resource adequacy challenges

Retiring generation, slow interconnection and surging demand are squeezing reserve margins — putting resource adequacy at the center of every RTO's agenda.

June 2025

FERC steps in

Commissioner-led technical conference (Docket AD25-7) examined resource-adequacy constructs and the role of capacity markets.

2026/27

MISO's warning

Sufficient across all four seasons, but MISO cautions that near-term shortfalls loom if retirements outpace faster resource additions.

2026+

Proactive steps are underway

FERC held a PJM Governance reform conference and demanded reforms by Sept 2026.

FERC ordered NERC to develop new reliability standards for large loads by Dec 2026

INTERCONNECTION

Queue status: MISO and PJM

MISO

- Queue reforms since 2023 to clear the backlog.
- Expedited Resource Addition Study (ERAS) runs alongside the cycle to relieve the most urgent reliability needs.

TRACK IT

- Current Queue Activity interactive map
- GI Interactive Queue spreadsheet (downloadable)
- Generator Interconnection Queue

PJM

- Historically shorter process than MISO
- Annual, cluster-based cycle.
- New-generation timelines run 36–60 months.
- Created Reliability Resource Initiative (RRI) final agreements late 2026.

TRACK IT

- Cycle Service Request Status page (exportable list)
- Interconnection media update, May 2026
- PJM - Interconnection / Upgrade Requests

MISO FAST-TRACK

Expedited Resource Addition Studies (ERAS)

A temporary MISO process that fast-tracks the study and approval of interconnection projects needed for resource adequacy and reliability.

Mar. 17, 2025

Final proposal filed at FERC (effective ~May 17, 2025)

Aug. 6, 2025

Applications open; projects studied serially each quarter

Sunset

Ends at the 68th ERAS project or Aug. 31, 2027

Strict eligibility

- ✓ 100% site control demonstrated
- ✓ RERRA (state regulator) notification
- ✓ Executed off-take agreement in hand
- ✓ Non-refundable $100,000 entry fee

The high bar keeps the fast path reserved for shovel-ready projects that relieve genuine reliability needs.

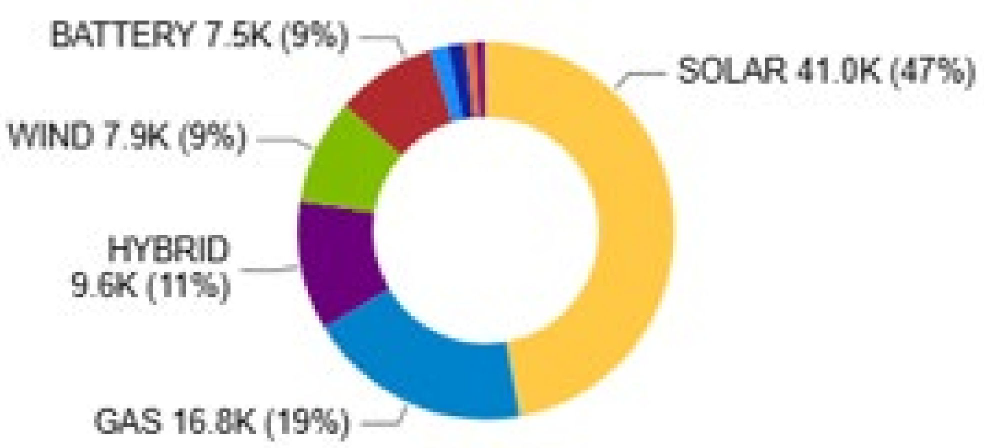
June 2026 status report

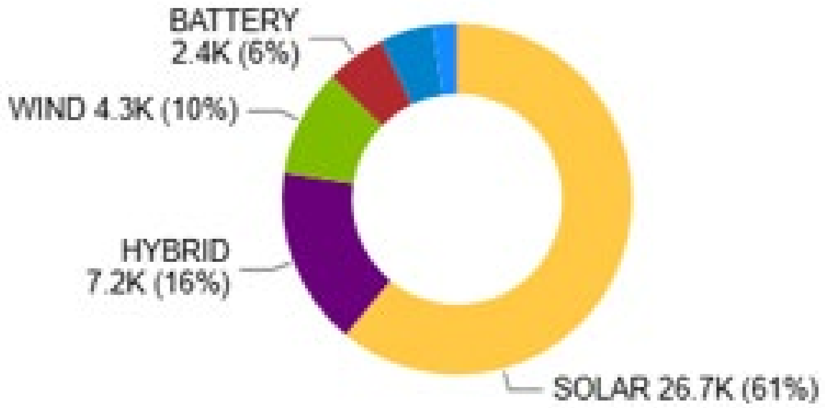
487 *CP Nodes Waiting*

87,080 *MW Waiting*

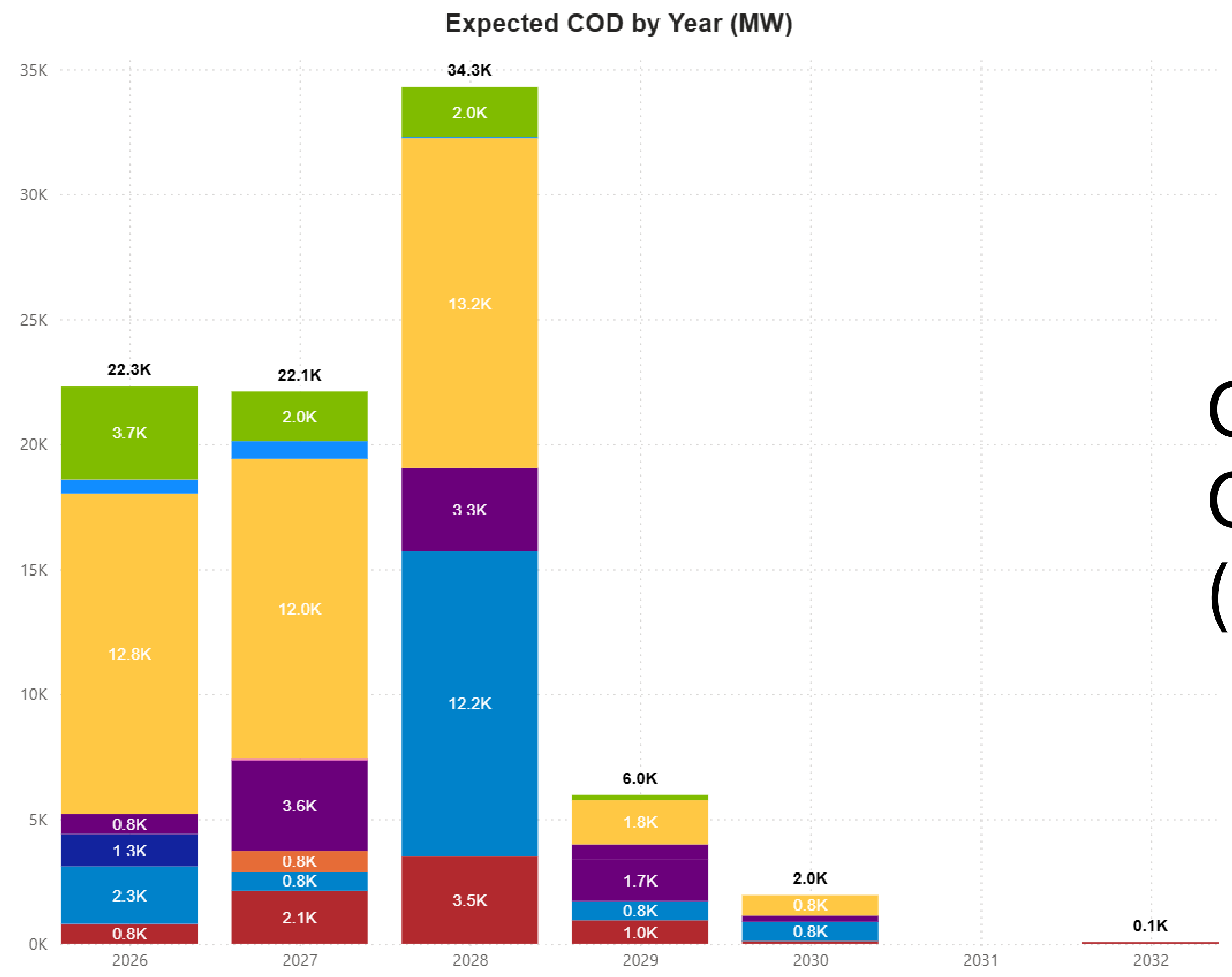
286 *CP Nodes Delayed*

43,702 *MW Delayed*



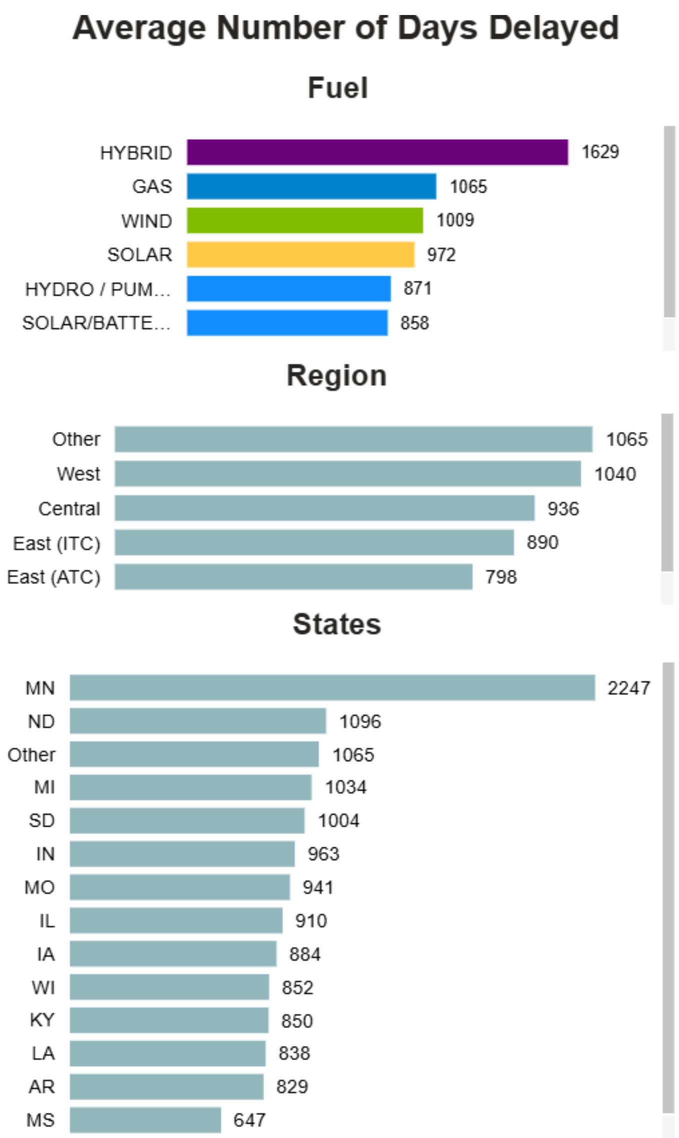


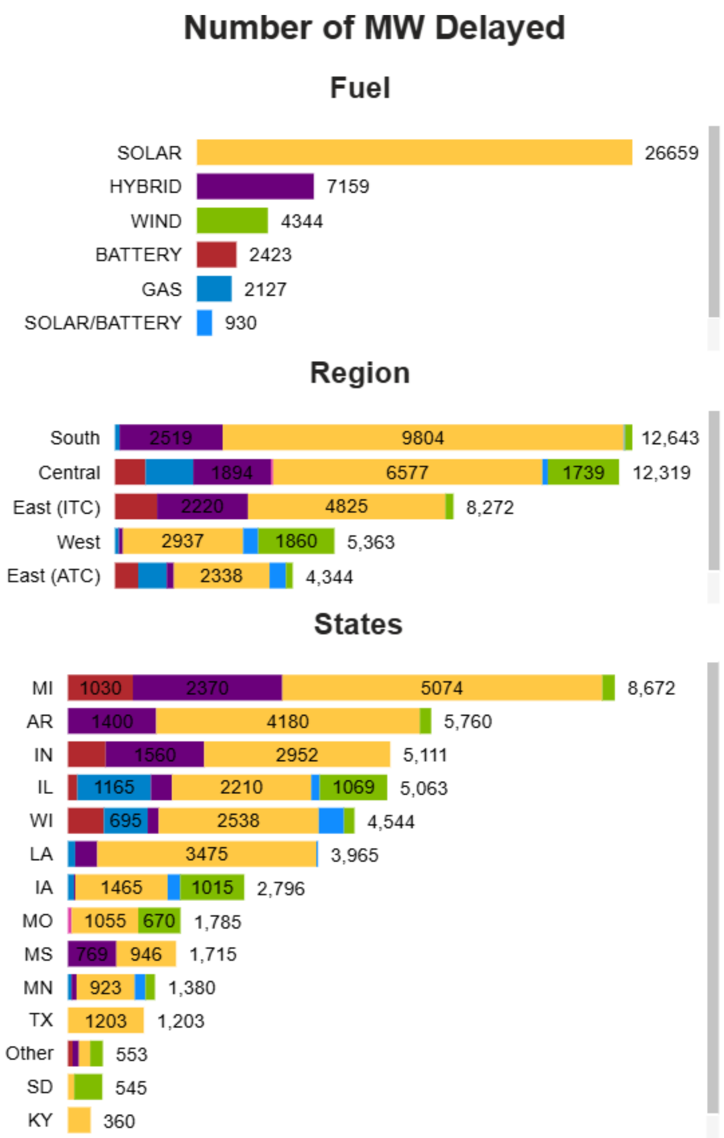
Waiting generation is expected to come on-line following the original forecasted date. Delayed generation is a subset of waiting generation for which the asset owner reported a delay.



Commercial Operations Date (C.O.D.) forecast

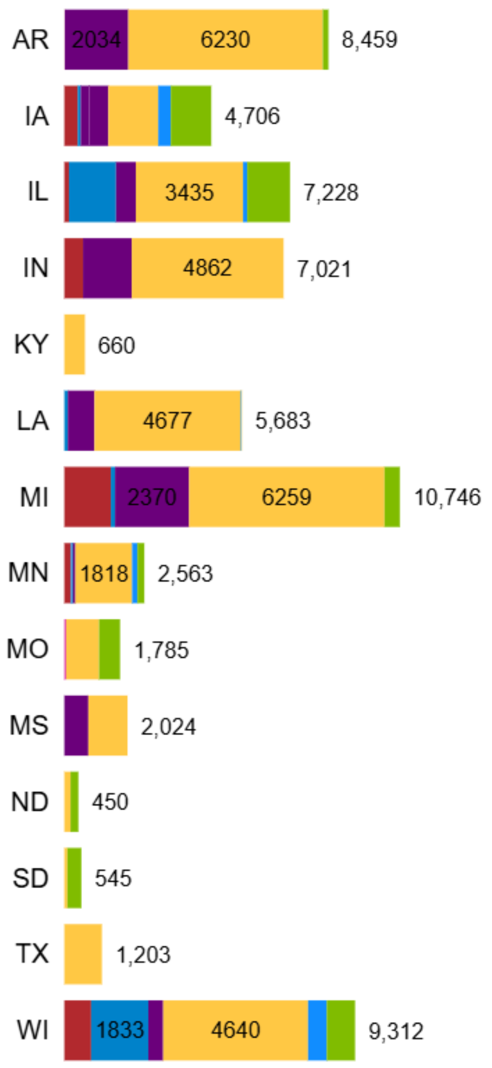
Regional and state views



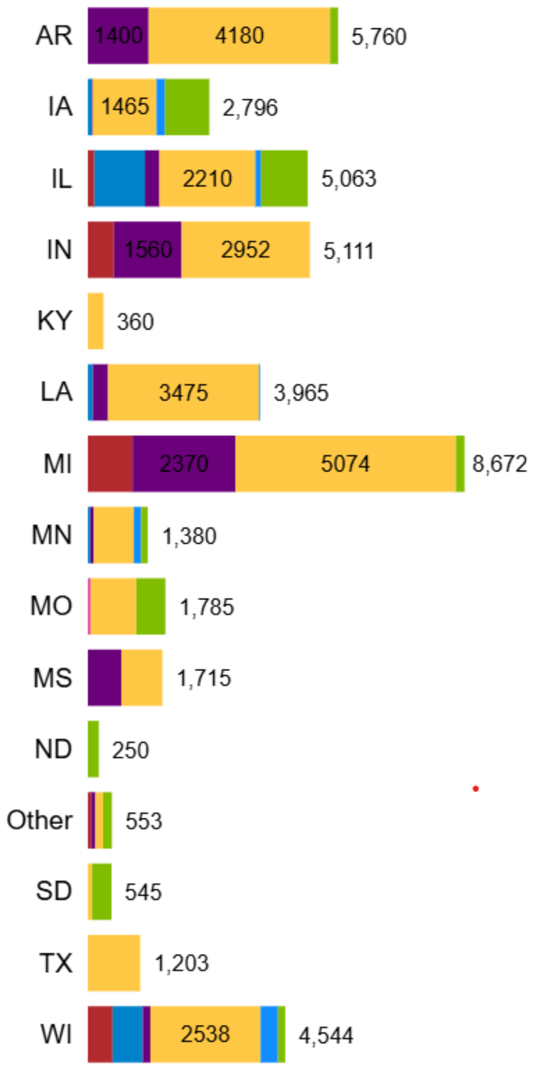


State comparisons

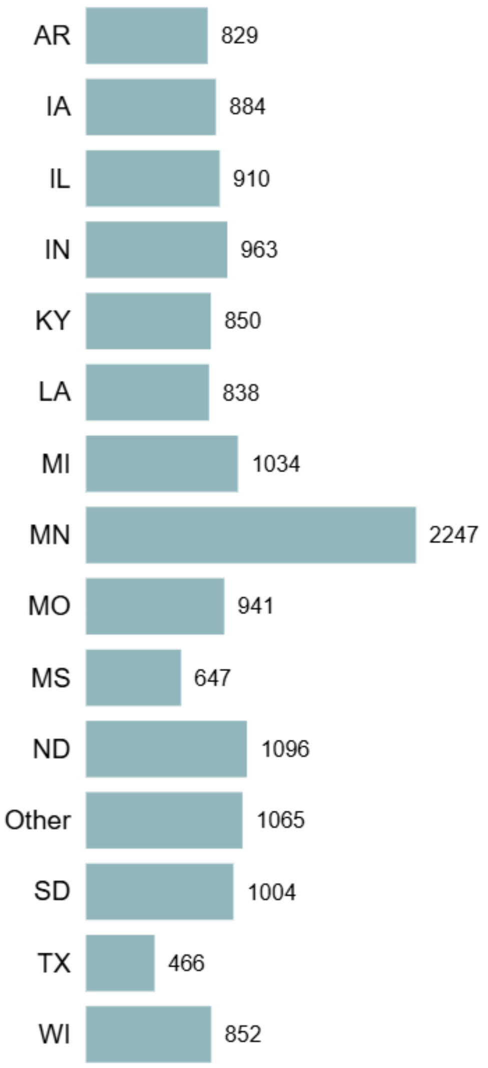
Waiting Generation (MW)



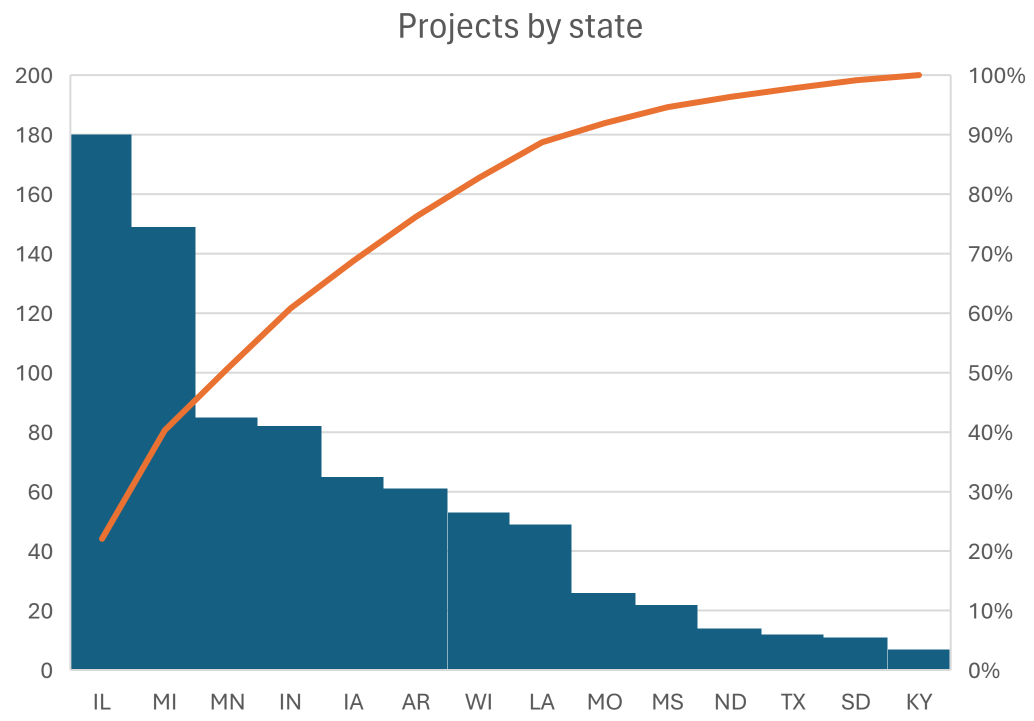
Delayed Generation (MW)

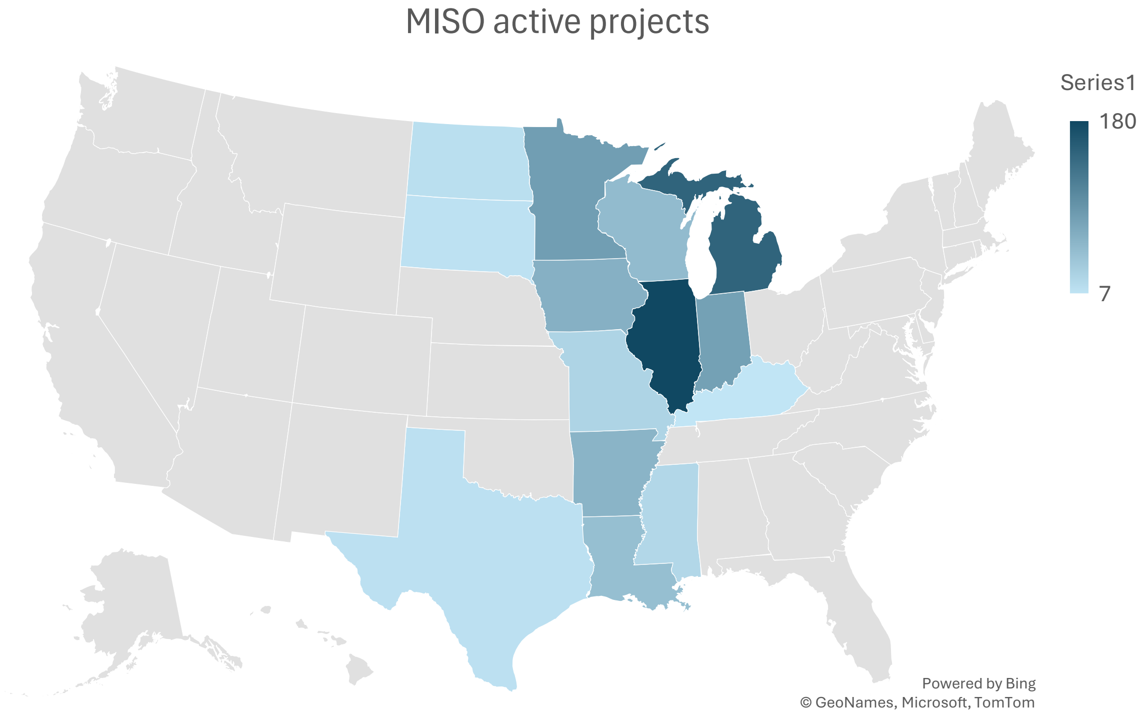


Average Days of Delay



Breakdown by state





GI Interactive Queue

PJM FAST-TRACK

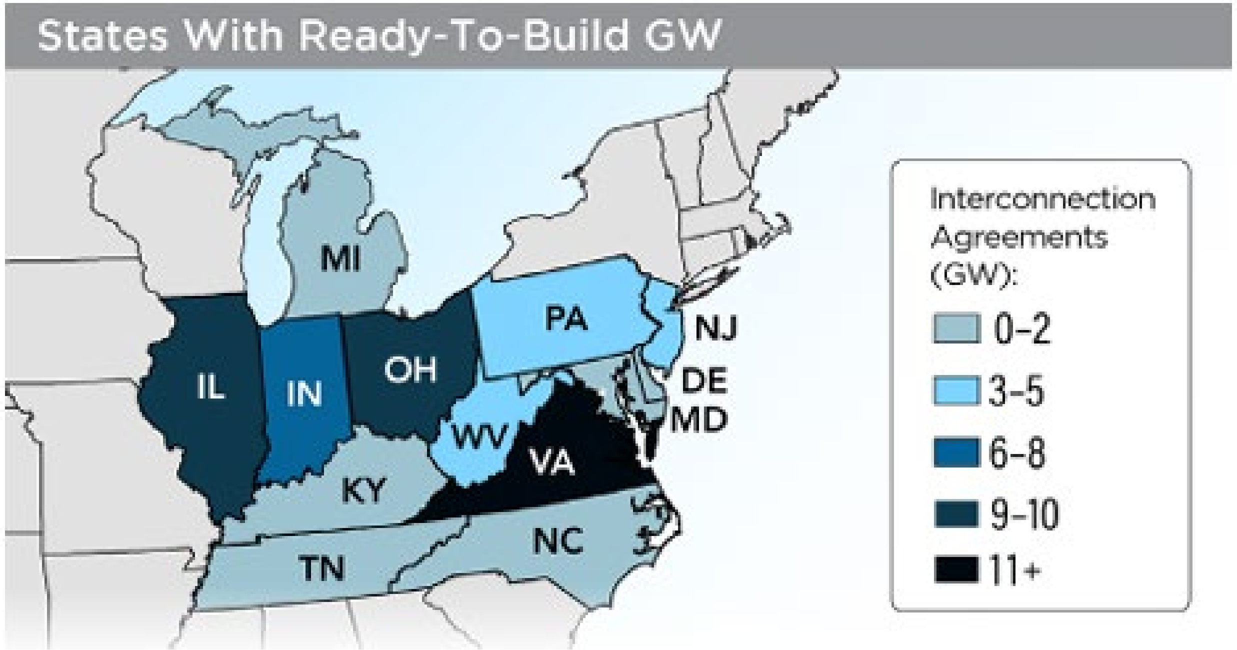
Reliability Resource Initiative (RRI)

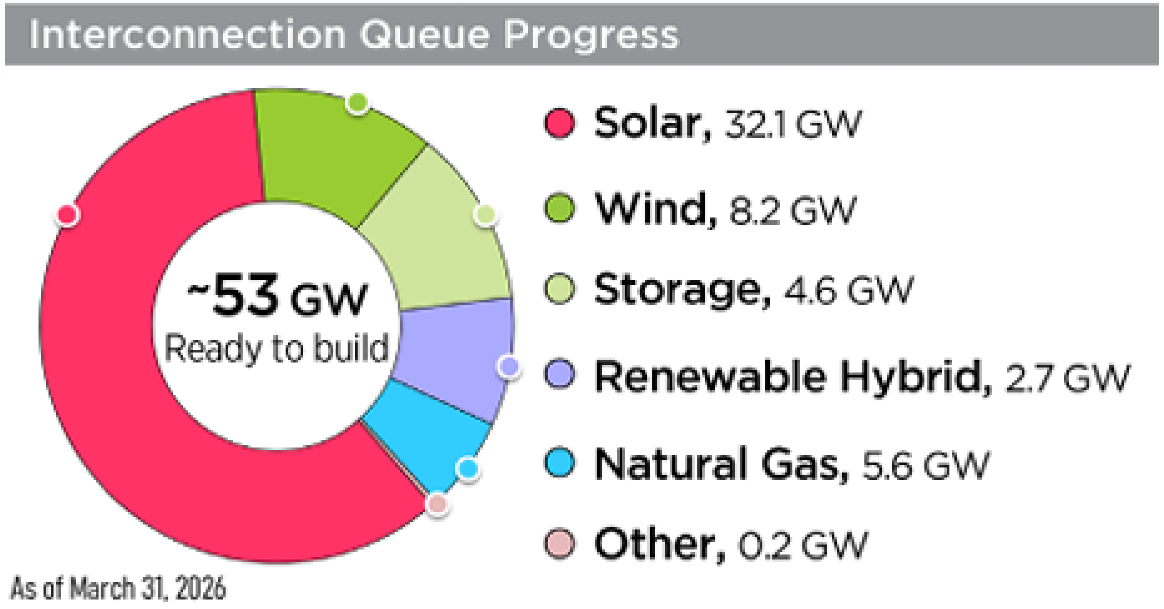
A one-time PJM program —— to pull priority capacity forward through Transition Cycle 2.

94	51	9,361	2030
applications received	projects selected	MW UCAP added	90% online by
26.6 GW nameplate	39 uprates + 12 new	≈ 11.7 GW nameplate	all online by 2031

UCAP – Unforced Capacity after accounting for historic forced outages.

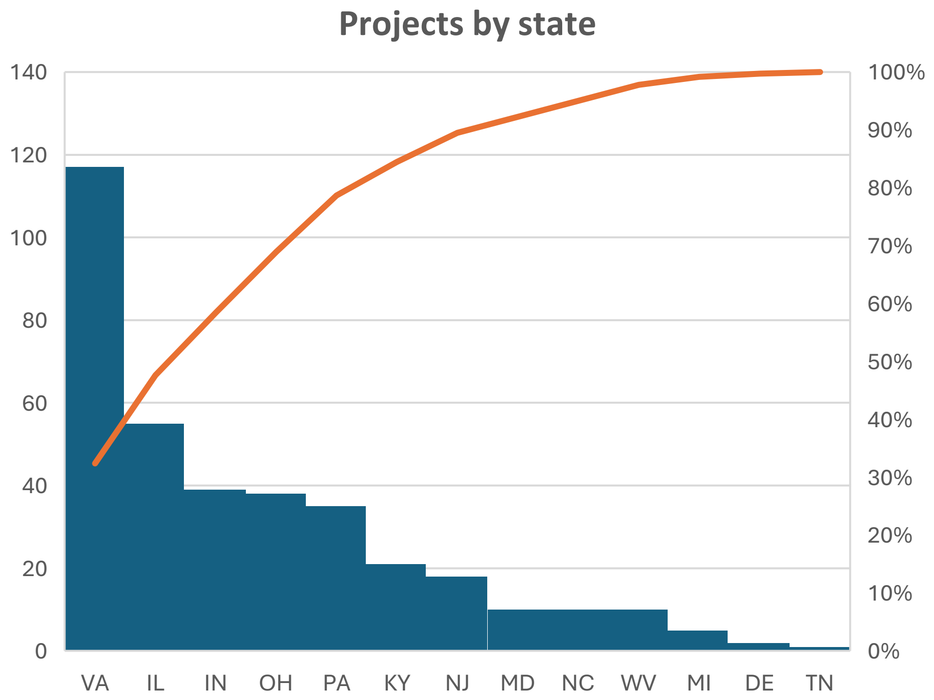
Current Queue Status



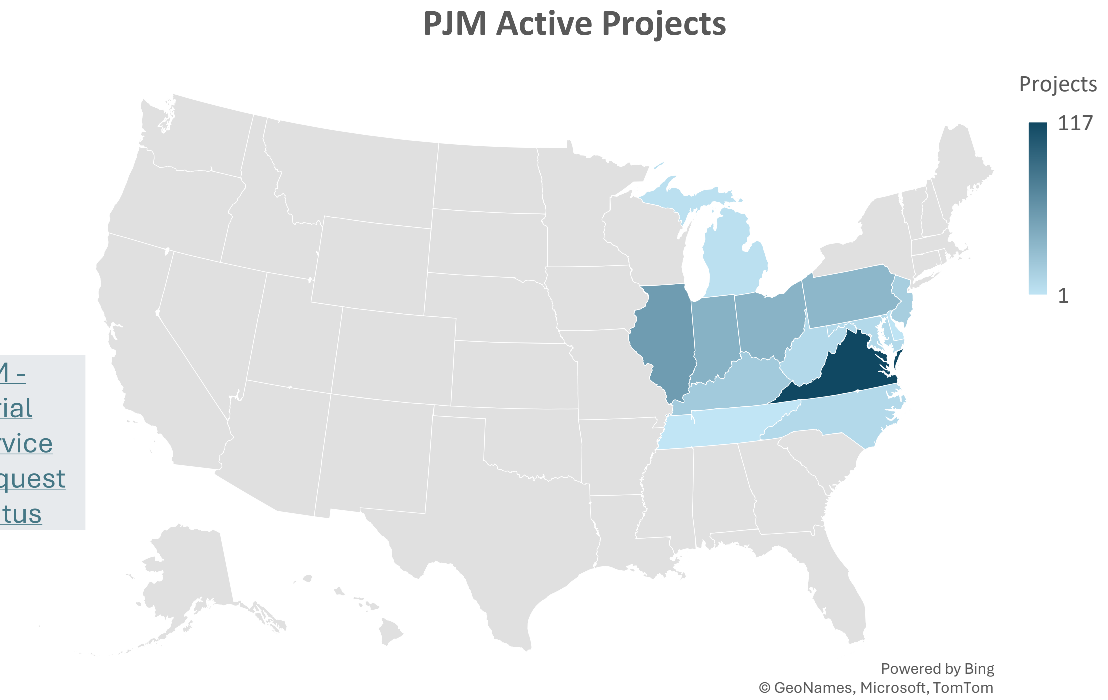


PJM cites many of these projects as delayed due to permitting, siting and supply chain issues.

Breakdown by state



[PJM - Serial Service Request Status]()



Status options: Active, Engineering Procurement, Under Construction which comprise 37% of queue. Does not include 63% of projects which were withdrawn.

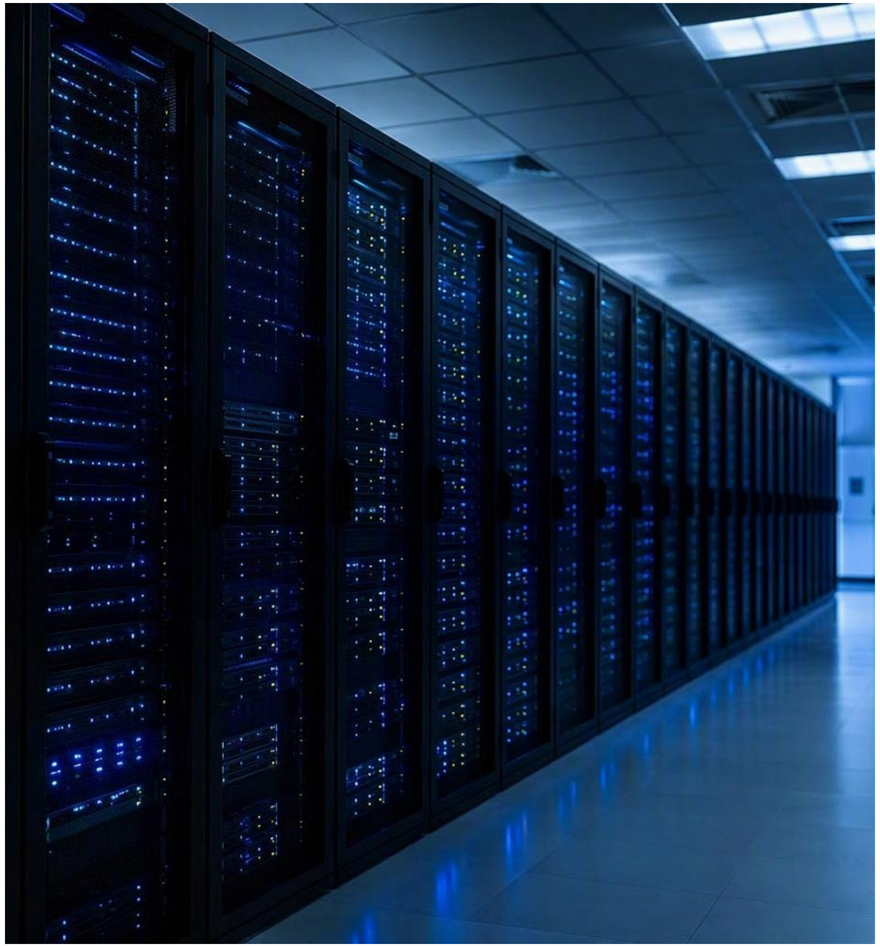
Reliability Backstop Procurement Bilateral RFP

- Submissions were solicited for load and resources
- Published June 2026
- Proposals received July 21, 2026
- Up to 15-year term
- From 2028/29 to 2042/43

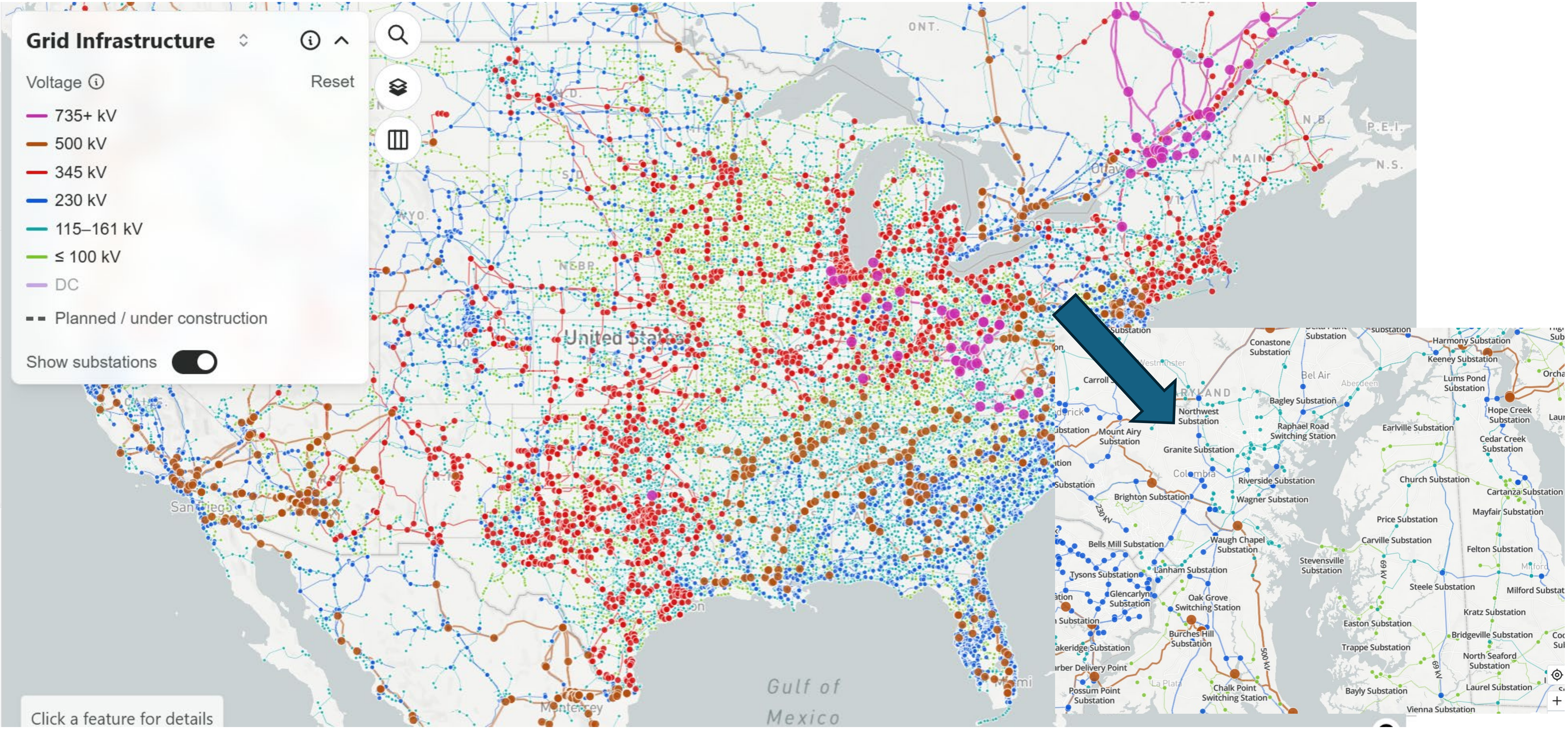
- PJM will administer
  - Central Procurement path for 2028 to 2030, and
  - Facilitated Bilateral Matchmaking path for longer term needs
- Initial results to be published December 2026.

Large loads and data centers

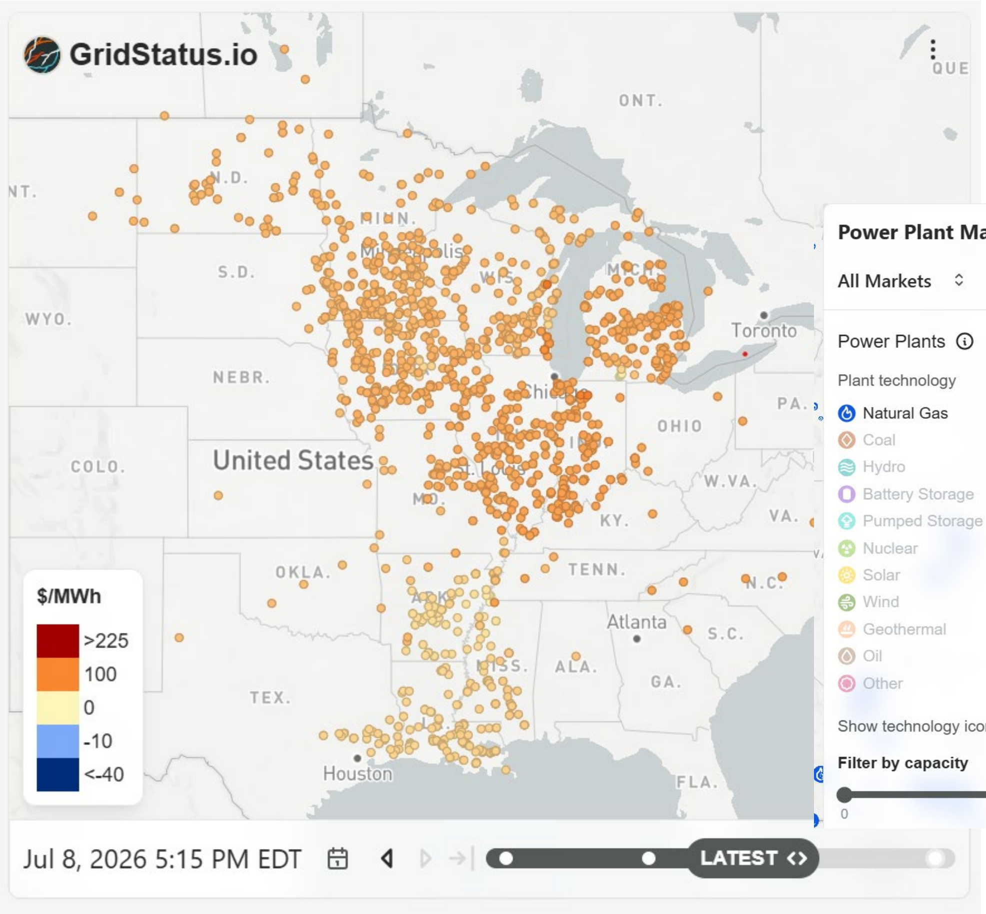
- AI and data-center demand causing concerns.
- June 18, 2026 (Docket RM26-4) — FERC issued Section 206 show-cause orders to all six jurisdictional RTOs, giving them 60 days to justify or reform large-load tariffs.
- The order sets a 20 MW large-load threshold.
- NERC formed Large Load Working Group (LLWG) to discuss reliability issues and propose requirements
- MISO and PJM stakeholder groups are working in parallel to identify ways to improve situational awareness
- Engage with RF and follow developments here

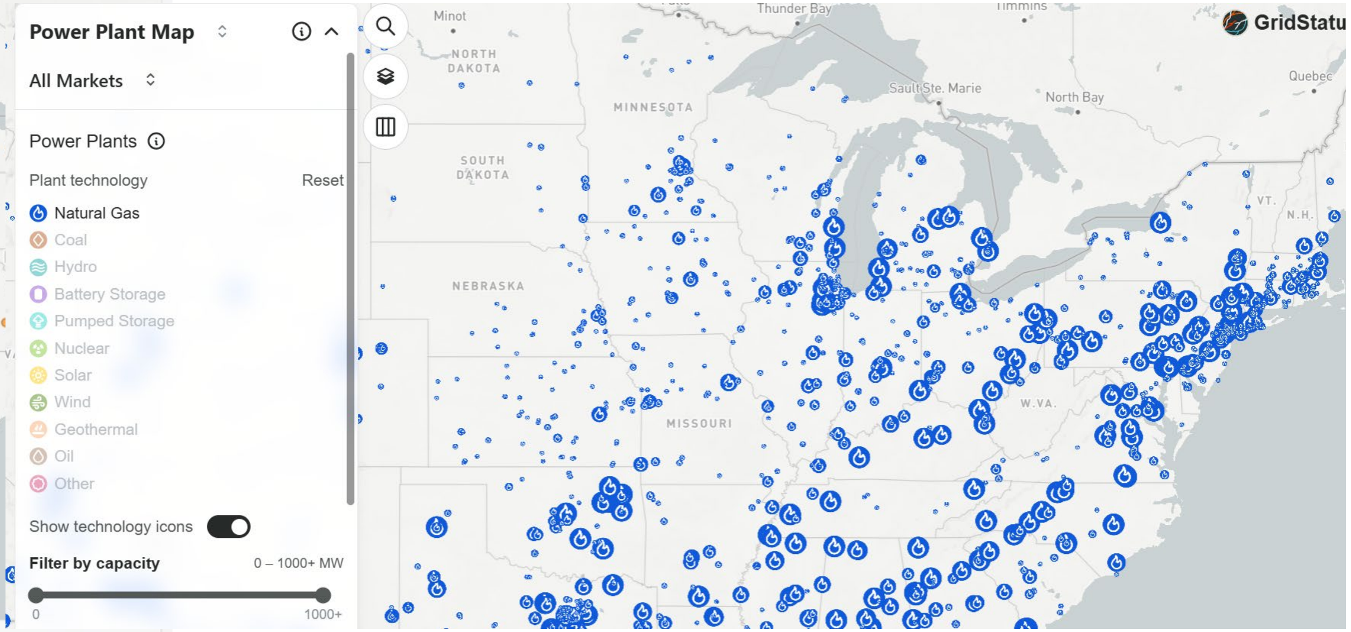


Datasets from [Home | Grid Status]

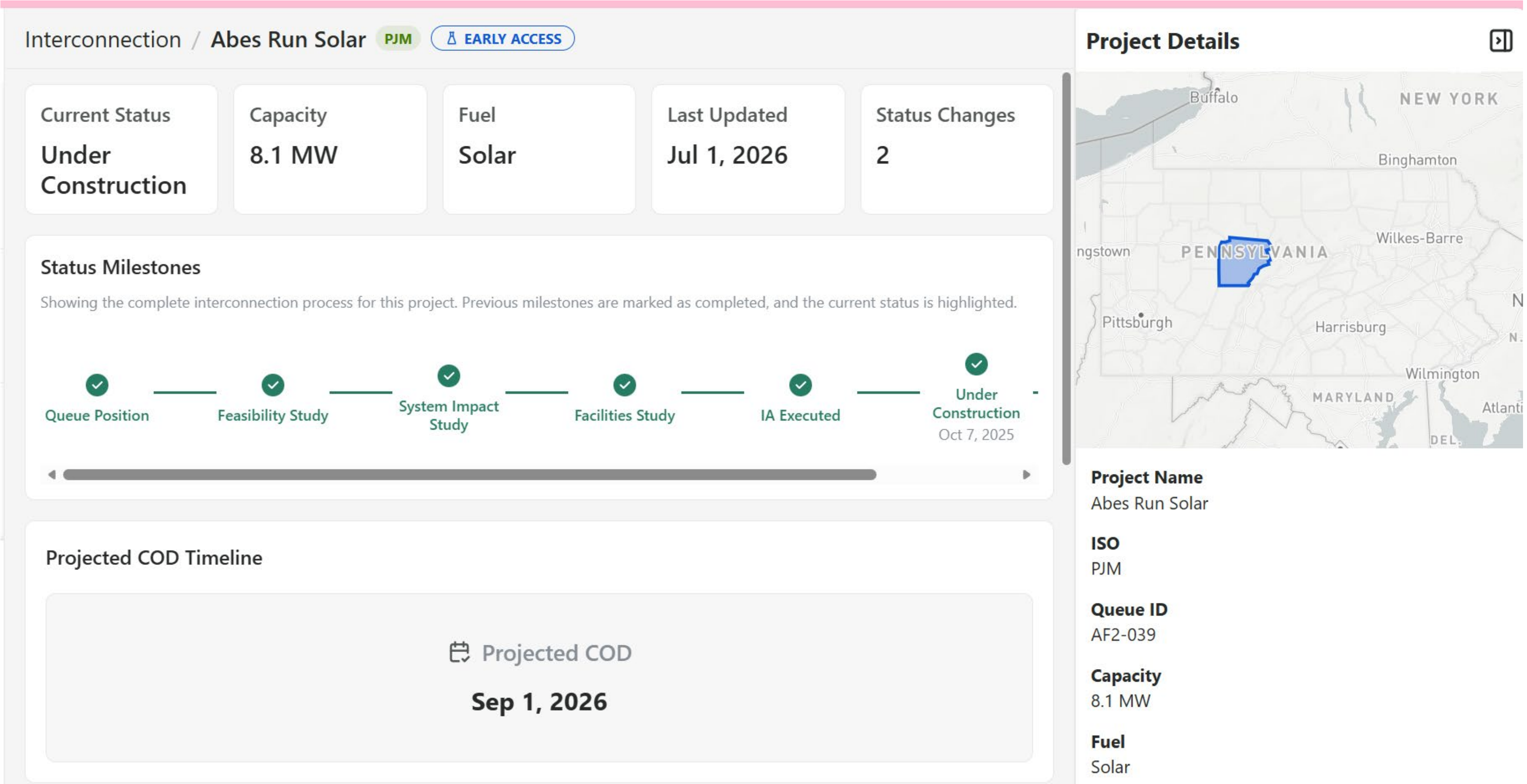


Pricing and power plant information



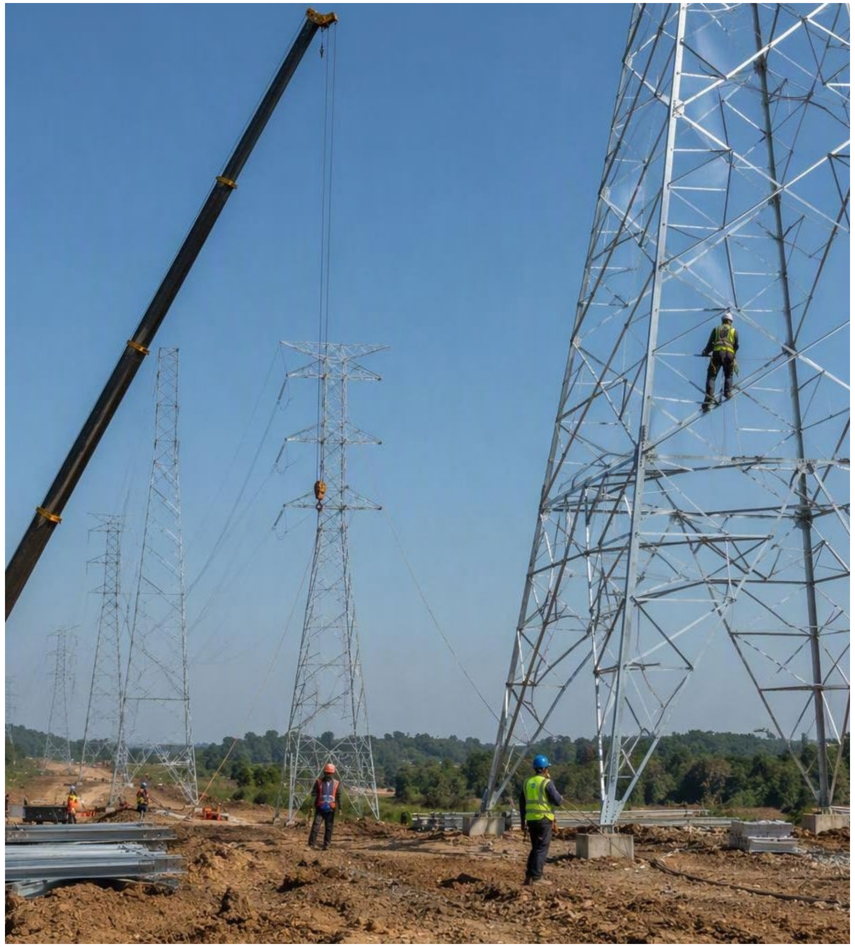


Project details are available



THE LONG VIEW

Transmission planning & FERC Order 1920



- Plan for the long term - 20 year horizon
- Measure what matters - Minimum of seven scenario factors and benefits
- Allocate the cost - set defaults with state input
- Build smarter - alternative technologies and local planning transparency

KEY TAKEAWAYS

Scale	RTOs coordinate roughly two-thirds of U.S. electricity demand under FERC — MISO and PJM both sit within ReliabilityFirst.
Pressure	Resource adequacy is the significant challenge: retirements and data-center load growth are outpacing new supply.
Fast tracks	PJM's RRI and CIFP and MISO's ERAS are purpose-built tools to add priority capacity faster.
Reform	FERC Order 1920 reshapes long-term regional transmission planning and cost allocation.
Watch	Interconnection queues and large-load tariffs are the live fronts to track through 2026.

How to learn more…

- Create account on website
- Select alerts, mailing list subscriptions, calendar sync
- Utilize help center knowledge articles, training courses and BPMs
- Review materials and attend RASC, IPWG, Advisory Committee sessions with Board
- Follow items on MISO Dashboard

- Create account on website and coordinate with your organization admin
- Sign up for alerts, committee updates, etc.
- Access library, training materials and Manuals
- Review materials and attend Members and Markets & Reliability Committee meetings
- Issue Tracking page

Business Practice Manuals (BPMs), Resource Adequacy Subcommittee (RASC), Interconnection Process Working Group (IPWG)

Questions?

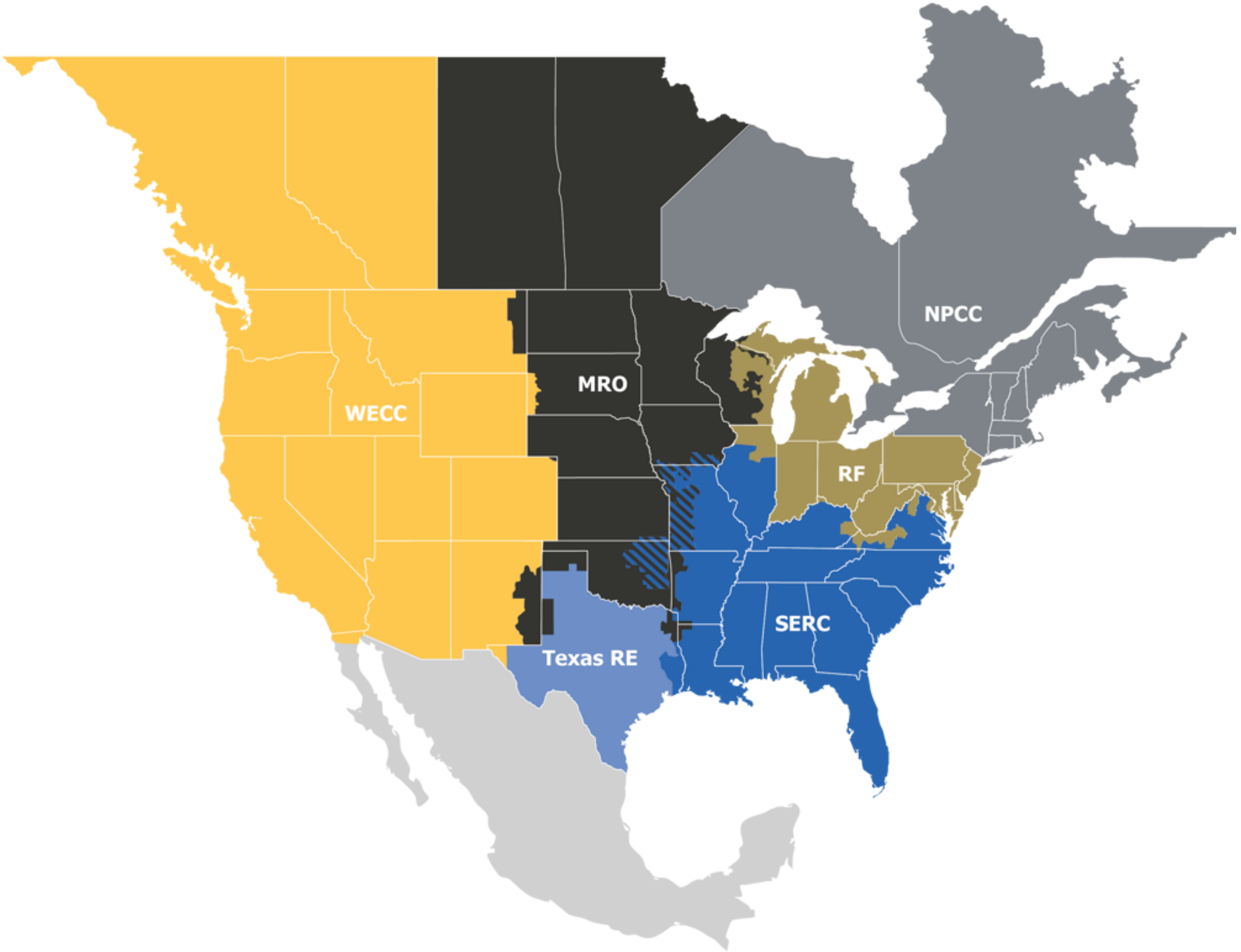
Joan M Soller, PE
sollerjmarie@gmail.com

Pareto Advisors

Focusing on What Matters

Appendix

NERC Electric Reliability Organizations (EROs)



Helpful links

- FERC RTO page
- PJM Interconnection reform update
- Grid Status service https://www.gridstatus.io/interconnection-queue?ref=blog.gridstatus.io
- NREL Data center map

FORWARD TOGETHER RELIABILITYFIRST

GENERATE:
THE GAME OF ENERGY CHOICES

August 18, 2026

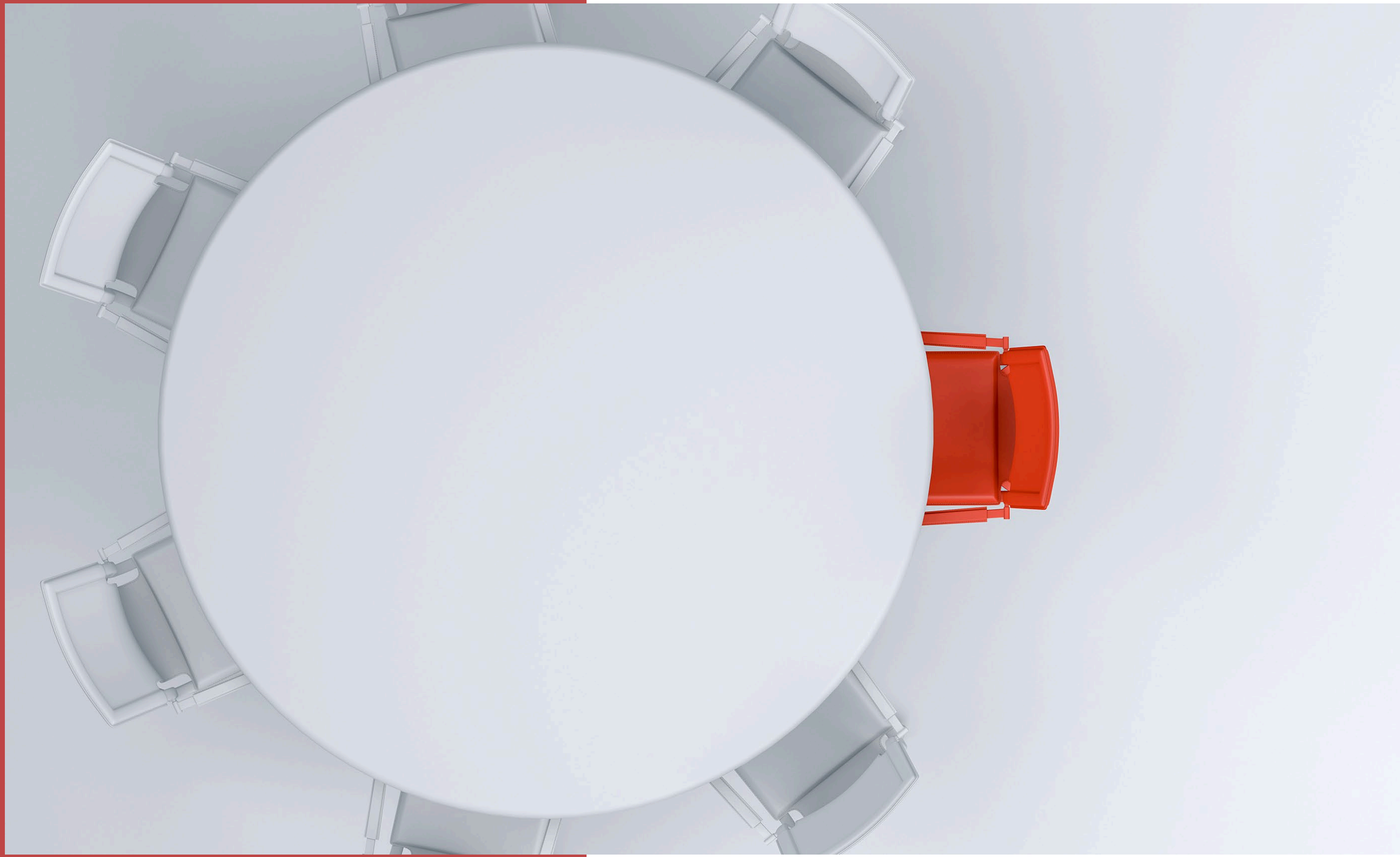
RELIABILITY FIRST

Public

FORWARD TOGETHER RELIABILITYFIRST

For our Virtual Players, please join Slido!
#RFBootcamp

FIRST THINGS FIRST– ESTABLISH YOUR TEAM!



Cost Control

Time-Keeper

Recorder

Spokesperson

FORWARD TOGETHER RELIABILITYFIRST

OVERVIEW

Teams will each be responsible for a grid and will have a unique mix of energy pieces

You will need to design your grid with your choice of resources from your listed energy pieces. No trading and no cheating!

Each piece has associated costs and emissions

They are an approximation for the fun of the game, designed by the EPA in 2021

Teams compete to get the total lowest cost

Hopefully you have someone good at math on your team

Each round will present new challenges and opportunities

Carbon pricing, more renewables, efficiency options, a spinning wheel of chance, the ability to broker deals with other teams for different energy pieces…

For our Virtual Players, please join Slido! #RFBootcamp

GENERATE: THE GAME OF ENERGY CHOICES

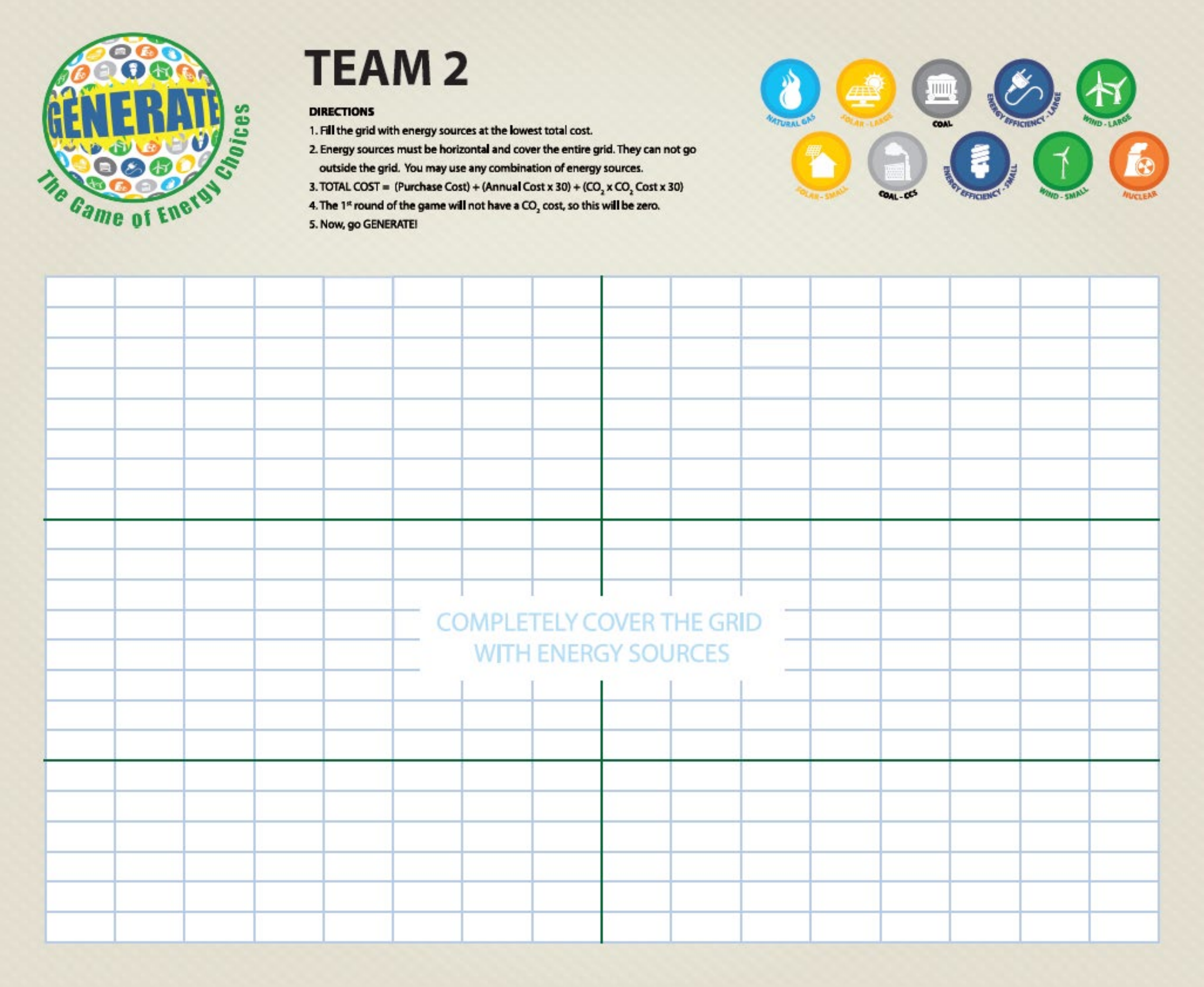
The game board = the "grid"

This board will be used for multiple rounds

Each team can be thought of as a region, state, or country

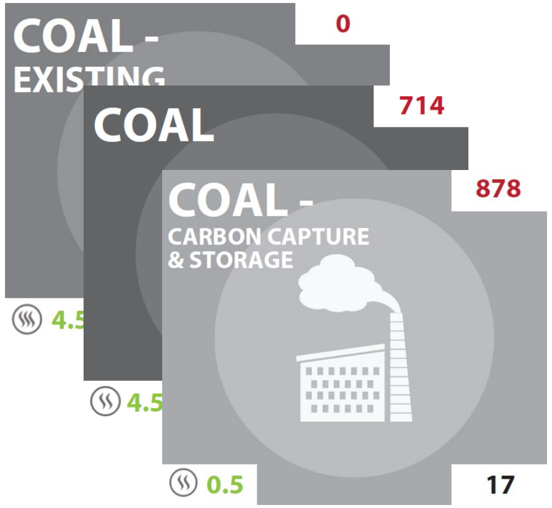
Goal is to completely fill the grid with energy pieces to achieve lowest total cost

Pieces may not overlap, extend past the grid, or be placed sideways



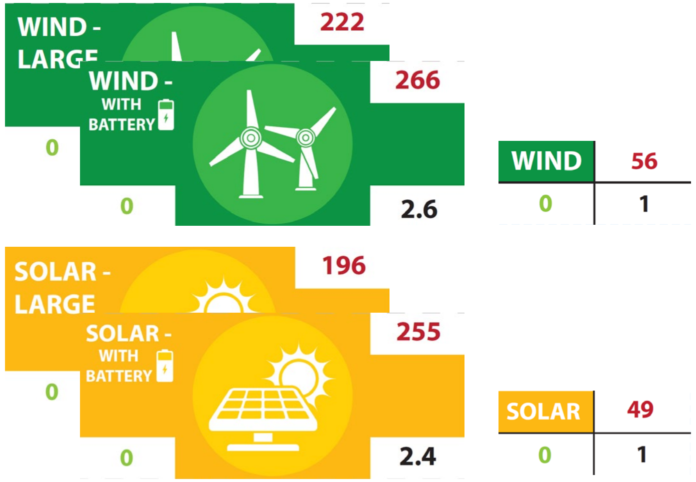
TYPES OF PIECES

FOSSIL ENERGY



NUCLEAR ENERGY

RENEWABLE ENERGY

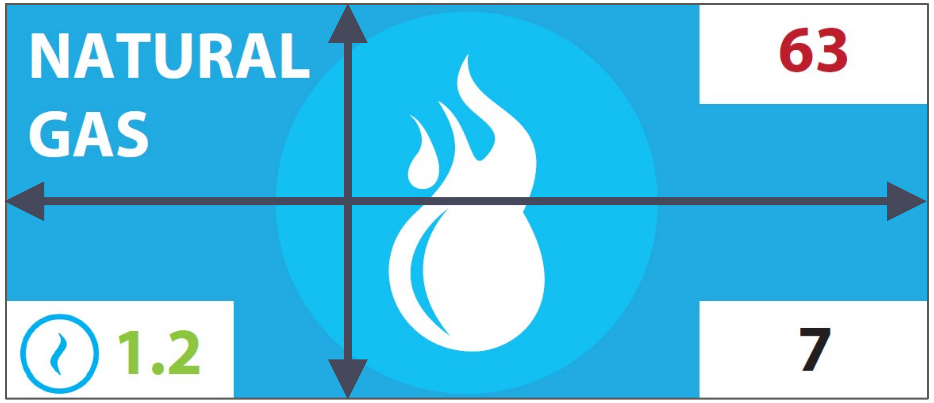


BIO-BASED ENERGY

PIECES AND PARTS

Size:
How much energy does it produce?

Type:
What primary energy resource does it use?



Purchase Cost:
How much does it cost up front to build/purchase?

AQ Impacts:
How much air pollution is produced?
Scale is 0-3 waveforms

CO_2 emissions:
How much CO_2 does it produce *each year*?

Annual Cost:
How much does it cost *each year* to run/operate?

Cost per piece = **63** + (**7** x 30)
= 273

Assumed Lifetime:
All energy pieces will last 30 years

Round 1: Cost per piece = Purchase cost + (Annual Cost x 30)

ROUND ONE: LEAST COST

Goal is to completely fill the grid with energy pieces to achieve lowest total cost

Pieces may not overlap, extend past the grid, or be place sideways

Cost per piece =
Purchase cost + (**Annual Cost** x 30)

Cost per piece = **63** + (**7** x 30)
= 273

Cost per piece = **222** + (**2.6** x 30)
= 300

BREAK FOR SCORING

ENERGY TRADERS & THE WHEEL OF CHANCE

Players may swap pieces between their teams.

Players can trade any number or types of pieces, so long as both teams agree to the trade.

Teams will have a limited time to trade before Round 2 begins.

https://spinthewheel.io/wheels/pifOJYFjXW81LJ0OdgXocz0xJmU9MQ==

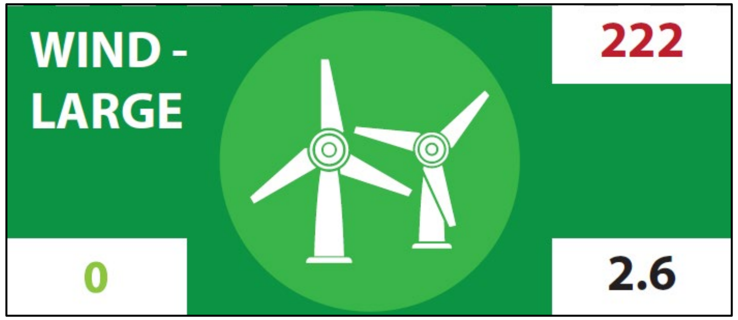
ROUND TWO: CO_2 PRICE & RENEWABLES

Must <u>completely fill</u> the grid with energy pieces to achieve lowest total cost

Pieces may not overlap, extend past the grid, or be place sideways

Cost per piece =
Purchase cost + (**Annual Cost** x 30)
+ ***(CO_2 emissions x CO_2 price x 30)***

CO_2 price = 1



Cost per piece = **63** + (**7** x 30)
+ (**1.2** x 1 x 30)
= 309

Cost per piece = **222** + (**2.6** x 30)
+ (**0** x 1 x 30)
= 300

Public

FORWARD TOGETHER RELIABILITYFIRST

BREAK FOR SCORING

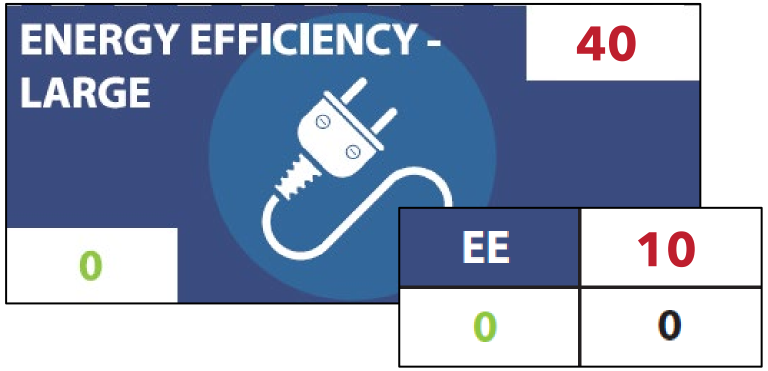
ROUND 3: IT ALL COMES TOGETHER

Cost per piece =
Purchase cost + (**Annual Cost** x 30)
+ ***(CO_2 emissions x CO_2 price x 30)***

CO_2 price = 4
AQ total ≤ 10

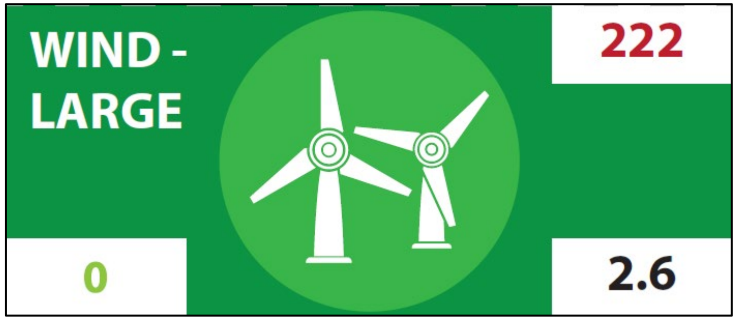
Cost per piece = **63** + (**7** x 30)
+ (**1.2** x 4 x 30)
= 417

AQ = +1



Cost per piece = **40** + (**0** x 30)
+ (**0** x 4 x 30)
= 40

AQ = +0



Cost per piece = **222** + (**2.6** x 30)
+ (**0** x 4 x 30)
= 300

AQ = +0

FORWARD TOGETHER RELIABILITYFIRST

BREAK FOR SCORING

THE SHORT COMINGS:

- This doesn't capture everything:
  - Resource issues
  - Environmental concerns
  - Any severe weather
  - Weather in general
  - Essential reliability resources
  - Ramping, min/max runtime, voltage or frequency control
  - Demand Response
  - Large loads and changing demand

Water, water, every where
And all the boards did shrink;
Water, water, every where
Nor any drop to drink

Water Use per Piece

Nuclear **74**

Coal with CCS **43**

Coal **16**

Biomass **8**

Natural Gas **4**

The Rime of the Ancient Mariner (text of 1834)
By Samuel Taylor Coleridge

Join us for our Fall Reliability & Security Summit

9:30 – 10:30 AM	State energy leadership outlook fireside chat: Policy reliability, and the future of the grid	• Suzanne Jaworowski, Secretary of Energy and Natural Resources, State of Indiana • Tim Gallagher, President & CEO, RF
10:30 – 11:00 AM	Networking break	
11:00 AM – 12:00 PM	Managing the AI era: Reliability challenges and opportunities related to large computational loads	• Stacey Burbure, Senior Vice President of Transmission Regulatory Engagement & Compliance, AEP • Dennis Deters, Commissioner, Public Utilities Commission of Ohio • Julie LaBella, Vice President – Regulatory & External Affairs, Talen Energy • Craig Sundstrom, Head of Energy and Sustainability Public Policy, Americas, Amazon Web Services
12:00 – 1:00 PM	Lunch	
1:00 – 2:00 PM	The evolving threat landscape: Protecting critical energy	Garris Ference, Intel Analyst, FBI

THANK YOU FOR JOINING US

Please complete our event survey

#RFBootcamp