

Agenda

Board of Directors • Risk and Compliance Committee

August 27, 2025 • 12:30 PM – 3:00 PM (ET)

Nemacolin
1001 Lafayette Drive
Farmington, PA 15437

Room: Grand Ballroom
Attire: Business Casual

Closed Agenda • Grand Ballroom

1. **Confidential Compliance and Enforcement Matters** 12:30 pm
Presenter: Kristen Senk, Deputy General Counsel and Director, Legal and Enforcement, Matt Thomas, Director, Compliance and Monitoring, and Tom Scanlon, Senior Managing Counsel, Enforcement.
Description: Ms. Senk, Mr. Thomas, and Mr. Scanlon will present confidential matters and an overview of the confidential documents.
Reference: Confidential Documents
Action: Information and Discussion
2. **System Events Discussion** 1:00 pm
Presenter: Diane Holder, VP of Engineering & Strategic Engagement
3. **Adjourn** 1:20 pm

Open Agenda • Grand Ballroom

1. **Call to Order and Appoint Secretary to Record Minutes** 1:30 pm
Presenter: Ken Seiler, Chair
2. **Antitrust Statement** 1:32 pm
Presenter: Ken Seiler, Chair
3. **Consent Items** 1:35 pm
Presenter: Ken Seiler, Chair
Reference:
 - a) [Draft Minutes for the April 30, 2025 Risk and Compliance Committee Meeting](#)
 - b) [Enforcement Data \(Reference Materials\)](#)
Action: **Approve Consent Items**

- 4. Artificial Intelligence Evolution and Energy Trends** 1:40 pm
Presenter: Sudip Roy, Senior Director of Inference, Cohere
Description: Mr. Roy will discuss trends in AI, including capabilities and the evolving compute efficiency landscape and trends and use cases in the energy industry.
Reference: Presentation
Action: Information and Discussion
- 5. Iberian Peninsula and NERC State of Reliability Report** 2:00 pm
Presenter: Mark Lauby, Senior Vice President and Chief Engineer, NERC
Description: Mr. Lauby will provide an overview of the Iberian Peninsula blackout and NERC's observations and insights into what caused it and lessons learned from it. He will also discuss NERC's State of Reliability Report with a focus on the ReliabilityFirst Region.
Reference: a) [2025 State of Reliability Assessment Overview](#)
b) [NERC SOR 2025 Presentation](#)
c) [Iberian Peninsula Presentation](#)
Action: Information and Discussion
- 6. DTE Technology and Security Challenges and Updates** 2:30 pm
Presenter: Steve Ambrose, Vice President and CIO, and Jason Smith, Director of NERC Compliance, DTE Energy
Description: Mr. Ambrose and Mr. Smith will provide an overview and updates on trends and challenges industry is facing related to technology and security.
Reference: [Presentation](#)
Action: Information and Discussion
- 7. Next Meeting** 2:55 pm
• December 3, 2025 in Washington, DC • NERC Offices
- 8. Adjourn** 3:00 pm

Roster • Risk and Compliance Committee

Ken Seiler, **Chair** • Independent (2026)
Joanna Burkey • Lead Independent (2025)
Melika Carroll • Independent (2027)
Dr. Renuka Chatterjee • MISO (T • 2027)
Lesley Evancho • Independent (2025)
Craig Grooms • Buckeye Power (S-LSE • 2026)
Mark Mroczynski • FirstEnergy (T • 2027)

a) Draft Minutes for the April 30, 2025 Risk and Compliance Committee Meeting

DRAFT - Minutes

Board of Directors • Risk and Compliance Committee

April 30, 2025

ReliabilityFirst Corporation • Cleveland, OH

Closed Session

Confidential Compliance & Enforcement Matters – Kristen Senk, RF's Deputy General Counsel and Director of Legal & Enforcement, Matt Thomas, RF's Director of Compliance Monitoring, and Tom Scanlon, Senior Managing Counsel, Enforcement presented on confidential matters.

Adjourn – Chair Ken Seiler adjourned the Closed Committee meeting at 1:15 pm (ET).

Open Session

Call to Order – Chair Ken Seiler called to order a duly noticed open meeting of the Risk and Compliance Committee (Committee) on April 30, 2025, at 1:20 pm (ET). A quorum was present, consisting of the following members of the Committee: Ken Seiler, Chair; Joanna Burkey; Melika Carroll; Dr. Renuka Chatterjee; Lesley Evancho; Craig Grooms; and Robert Taylor. A list of others present during the Committee meeting is set forth in Attachment A.

Appoint Secretary to Record Minutes – Chair Seiler designated Niki Schaefer, ReliabilityFirst's (RF) Vice President and General Counsel, as the secretary to record the meeting minutes.

Antitrust Statement – Chair Seiler advised all present that this meeting is subject to, and all attendees must adhere to, RF's Antitrust Compliance Guidelines.

Approve Compliance Committee Meeting Minutes – Chair Seiler presented draft minutes for the December 4, 2024 Committee meeting and the Enforcement Data Reference Materials (both included in the agenda package). Upon a motion duly made and seconded, the Committee approved the minutes.

Keynote Speaker – Daniel Scripps, Chair of the Michigan Public Service Commission, provided keynote remarks. He began by giving an overview of Michigan's hybrid regulatory structure, which requires utilities to divest their transmission or join an RTO but does not require divestment of generation. Chair Scripps then discussed the state's integrated resource planning process that helps to ensure resource adequacy. He discussed what is

required to be in an integrated resource plan (IRP) and the standard for approval of an IRP, and also discussed an annual capacity demonstration requirement for utilities. Chair Scripps provided an overview of recent renewable energy legislation and requirements in Michigan, and how the laws are structured to help ensure reliability is maintained (such as defining renewables broadly and allowing compliance extensions to maintain resource adequacy or stability). Finally, he noted other significant initiatives in the areas of gas-electric coordination and planning, cybersecurity (including required annual cyber reports to the state), and energy waste reduction.

There was then open discussion with the Committee. Chair Seiler asked what the reaction has been to the recent state energy legislation, and Chair Scripps responded that it has been mixed, as the legislation did not fully address the needs of the Upper Peninsula. There was also discussion about the importance of gas-electric coordination to ensure reliability during extreme cold weather periods, and the state's efforts to speed transmission upgrades.

Standards Overview and Update – Soo Jin Kim, Vice President of Engineering, Standards, and PRISM at NERC, provided an update on recent Standards activity. She discussed revisions to the definitions of Generator Owner and Generator Operator to create a new category for Inverter-Based Resource registrations, corresponding revisions to certain Standards to reflect those definition changes, and the implementation plan for those changes. Ms. Kim also shared information about the IBR Registration Quick Reference Guide and the timeline for the definition and Standard revisions.

Ms. Kim also discussed Standards efforts related to cold weather actions and physical security. She shared that the Standards group and stakeholders are having many discussions on modeling, and encouraged participation in an upcoming workshop on the topic in June.

MISO Trends and Challenges – Dr. Renuka Chatterjee presented on MISO's initiatives related to resource adequacy and the reliability imperative. She shared that MISO is entering a different operating & risk paradigm with increasing extreme weather events and the transition to renewables. Dr. Chatterjee also discussed that due to data centers and industrial development, MISO's load is projected to grow approximately 60% through 2040. She discussed key reliability challenges, and corresponding MISO initiatives such as market redefinition, increased planning, transmission reforms, and advanced cybersecurity and data analytics.

Dr. Chatterjee provided information on how MISO's resource adequacy planning occurs over multiple time horizons, from real-time operations and the day-ahead market, to the one-year seasonal resource assessments, to the 2-5 year OMS-MISO study, and the 6-15 year member and state resource planning horizon. She also explained how MISO continues to evolve its resource adequacy construct and its probabilistic model to meet the needs of the changing operating paradigm. She concluded by discussing how MISO is

working on various reforms to reduce the processing time for its generation interconnection queue.

Mr. Gallagher encouraged the Committee to read MISO's Reliability Imperative document and praised the company for its groundbreaking work in this area.

Cybersecurity Risks Associated with Distributed Energy Resources (DER) – Lindsey Mannion, RF Principal Technical Auditor, provided an overview of DERs, which are generating resources located on the distribution system. She explained that DERs may or may not use inverter technology to interface with the grid, but they are different than bulk power system (BPS) connected inverter-based resources.

Ms. Mannion noted that DERs have traditionally been viewed as a relatively passive load resource on the BPS, but this will no longer be a valid assumption with the integration of more DERs on the electric system. She reported that DERs in the NERC have increased from 2.8% to 6.4%. She then discussed the increased attack surface stemming from the connection of numerous DERs with BPS assets or BPS connected devices. To address this risk, proper network segmentation and additional security controls should be implemented, and Ms. Mannion discussed methods to secure DERs.

Next Meeting – Chair Seiler noted that the next Committee meeting will occur on August 27, 2025, in Farmington, PA.

Adjourn - Chair Seiler adjourned the Committee meeting at 2:58 pm.

As approved on this 27th day of August, 2025 by
the Compliance Committee,

Niki Schaefer
*Vice President General Counsel & Corporate
Secretary*

Attachment A

Others Present During the Risk and Compliance Committee Meeting

Steve Ambrose • DTE
Jeff Craigo • ReliabilityFirst
Craig Creamean • Exelon
Beth Dowdell • ReliabilityFirst
Chelsey Eppich • ReliabilityFirst
Tim Foster • PJM
Tim Gallagher • ReliabilityFirst, President & CEO
Vinit Gupta • ITC Holdings
Scott Hipkins • First Energy
Diane Holder • ReliabilityFirst
Soo Jin Kim • NERC
Lindsey Mannion • ReliabilityFirst
Shawn McWilliams • Foxguard
Kamila Molda • PJM
Marcus Noel • ReliabilityFirst
Nelson Peeler • Duke Energy
Tom Scanlon • ReliabilityFirst
Niki Schaefer • ReliabilityFirst
Kristine Schmidt • NERC
Daniel Scripps • Michigan PUC
Kristen Senk • ReliabilityFirst
Joan Soller • Wabash
Brian Thiry • ReliabilityFirst
Matt Thomas • ReliabilityFirst
Jody Tortora • ReliabilityFirst
Joe Trentacosta • SMECO
Jim Uhrin • ReliabilityFirst
Hunter Walter • Foxguard
Becky Webb • Exelon

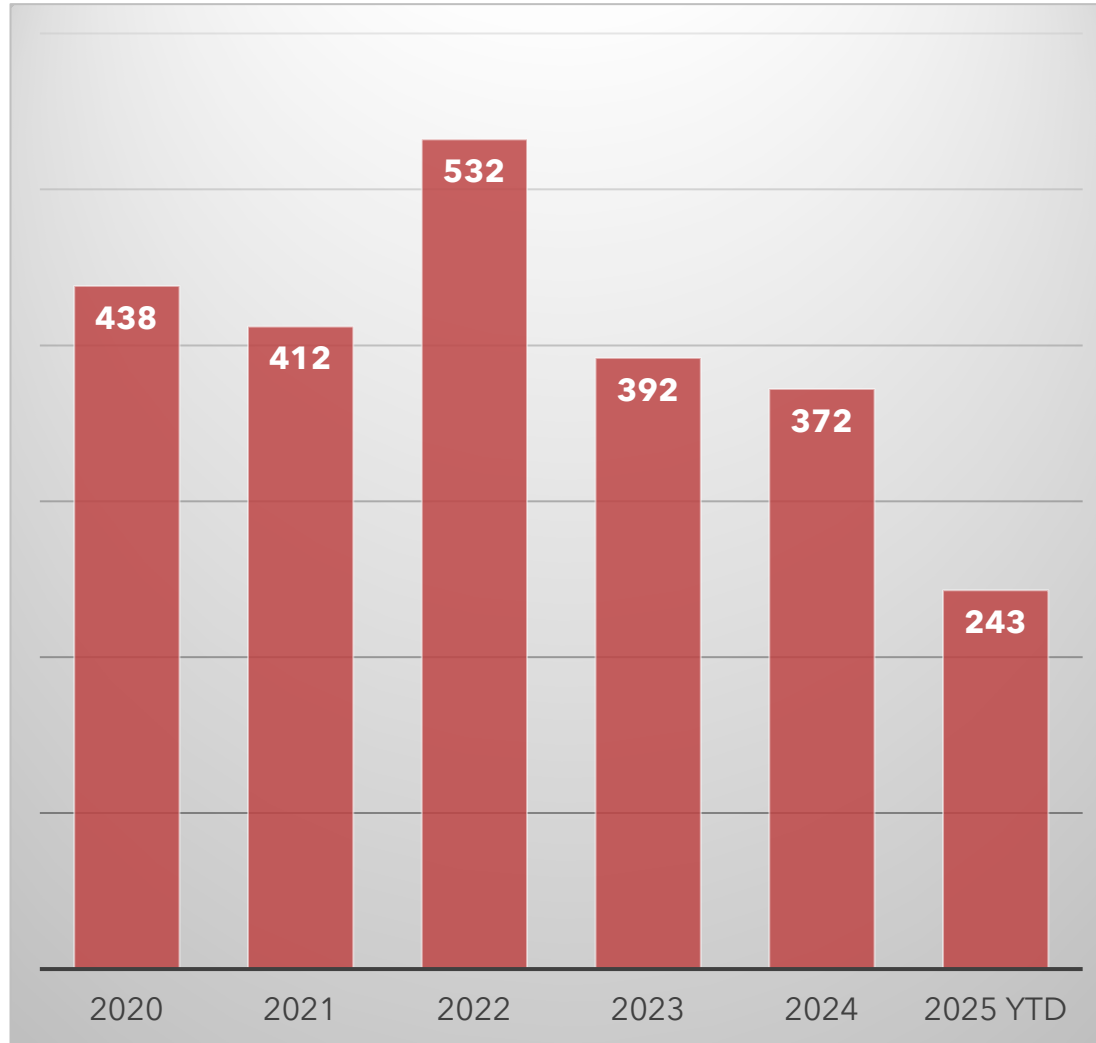
b) Enforcement Data (Reference Materials)

SUMMARY - ENFORCEMENT DATA

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

The data shows that violation intake remains high. At the current pace, ReliabilityFirst is on track to receive over 400 violations in 2025. A significant 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 July 31, 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 68% identified in 2024 and 2025, 25% identified in 2023, 6% identified in 2022, and less than 1% identified in 2021.

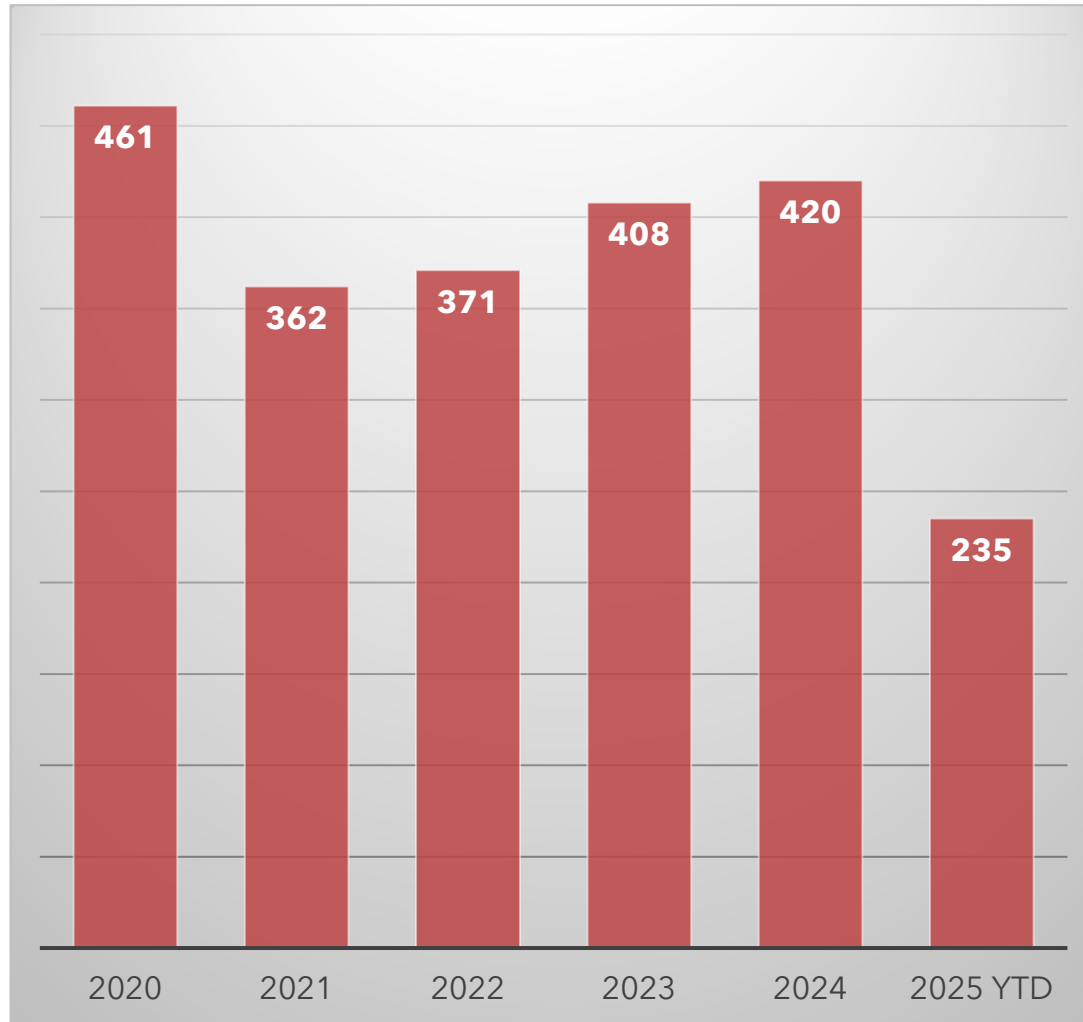
RF ANNUAL VIOLATION INTAKE



2025 Commentary:

- Year-to-date as of 7/31/2025; and
- Majority self-reported/self-logged (~72%).

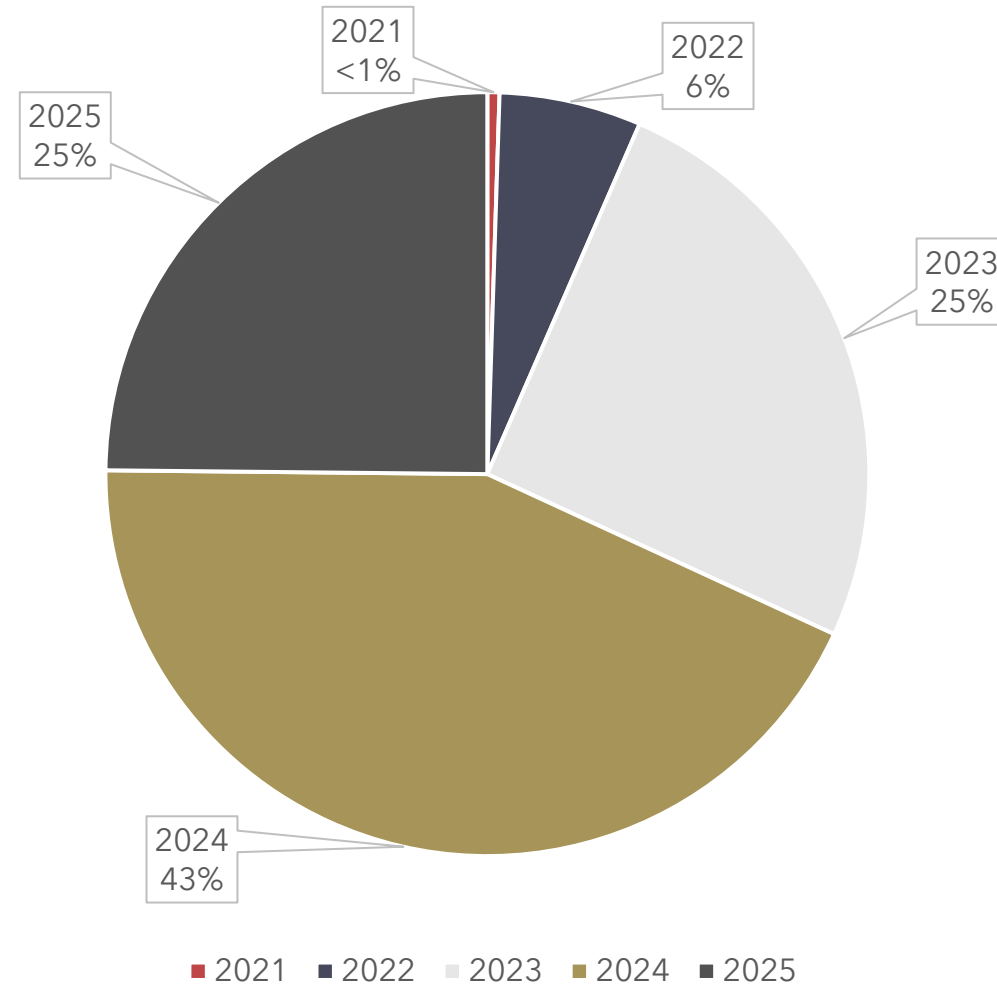
RF ANNUAL VIOLATIONS PROCESSED



2025 Commentary:

- Year-to-date as of 7/31/2025; and
- ~93% were processed as Compliance Exceptions or Find, Fix, and Track Report.

RF INVENTORY BY YEAR REPORTED



NERCNORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

2025 State of Reliability

Assessment Overview of 2024
Bulk Power System Performance

June 2025

[2025 SOR Infographic](#)

[2025 SOR Technical Assessment](#)

[2025 SOR Video](#)

RELIABILITY | RESILIENCE | SECURITY



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Table of Contents

Preface iii

About This Overview iv

 Development Process iv

 Considerations iv

Executive Summary..... 1

Severe Weather Responsible for the Most Severe Outages in 2024 3

 Related Actions 5

2024 Data Suggests that Generator Performance is Improving during Winter Storms 6

 Related Actions 7

Data Centers are Creating New Challenges for Reliability..... 8

 Related Actions 9

Initial Evidence Suggests Battery Energy Storage Systems Can Improve Primary Frequency Response 10

 Related Actions 12

Industry Continues to Address the Reliability Impacts of Inverter-Based Resources..... 13

 Related Actions 13

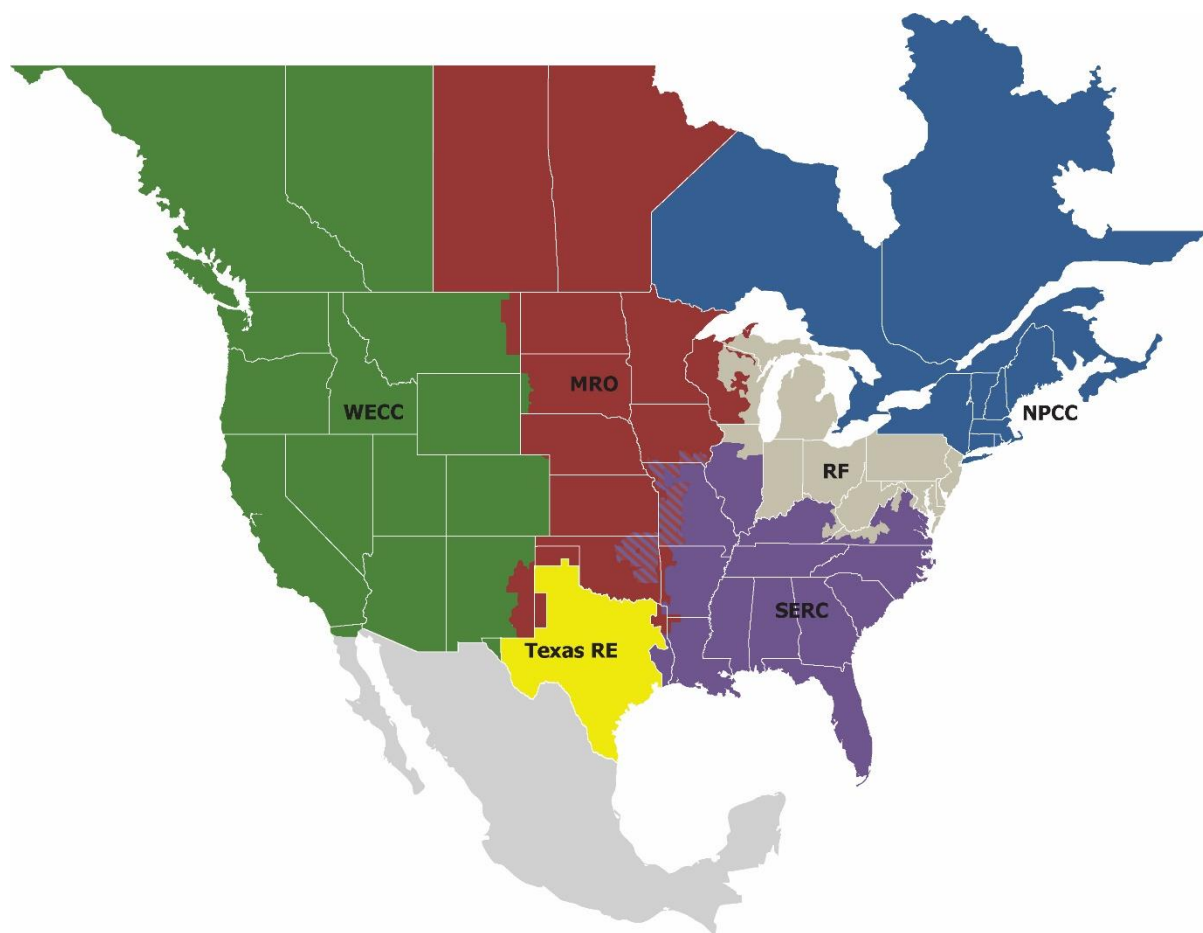
Preface

Electricity is a key component of the fabric of modern society and the Electric Reliability Organization (ERO) Enterprise serves to strengthen that fabric. The vision for the ERO Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable, resilient, and secure North American bulk power system (BPS). Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid.

Reliability | Resilience | Security

Because nearly 400 million citizens in North America are counting on us

The North American BPS is made up of six Regional Entities as shown on the map and in the corresponding table below. The multicolored area denotes overlap as some load-serving entities participate in one Regional Entity while associated Transmission Owners/Operators participate in another.



MRO	Midwest Reliability Organization
NPCC	Northeast Power Coordinating Council
RF	ReliabilityFirst
SERC	SERC Reliability Corporation
Texas RE	Texas Reliability Entity
WECC	WECC

About This Overview

This year's *State of Reliability (SOR)* is comprised of two publications: this *2025 SOR Overview*, which is a high-level summary of the most important topics impacting the BPS and how they are being addressed, and the *2025 SOR Technical Assessment*,¹ which provides NERC's comprehensive annual analytical review of BPS reliability for the 2024 calendar year. The analysis fulfills a key role in NERC's mission by providing an unbiased, data-driven look at BPS reliability, identifying ongoing challenges, and informing future-looking assessments. This overview seeks to inform regulators, policymakers, and industry leaders of the most significant reliability risks facing the BPS and describe the actions that the ERO Enterprise has taken, and will take, to address them.

Development Process

ERO staff developed this overview and the corresponding *2025 SOR Technical Assessment* with support from the Performance Analysis Subcommittee (PAS). Both documents draw conclusions from an established set of reliability indicators and mandatory information reported by industry to the Transmission Availability Data System (TADS), the Generating Availability Data System (GADS), the Misoperation Information Data Analysis System (MIDAS), voluntary reporting into the Event Analysis Management System (TEAMS), Bulk Power System Awareness monitoring and processes, and the Institute of Electrical and Electronics Engineers (IEEE) Distribution Reliability Working Group.

Considerations

- Data in the *SOR* represents the performance for the January–December 2024 operating year unless otherwise noted.
- Analysis in this report is based on data from 2020–2024 that was available in Spring 2025 and provides a basis to evaluate 2024 performance relative to performance from the last five years. All dates and times shown are in Coordinated Universal Time (UTC).
- The *SOR* is a review of industry-wide trends—not a review of the performance of individual entities.
- When analysis is presented by Interconnection, the Québec Interconnection is combined with the Eastern Interconnection unless specific analysis for the Québec Interconnection is shown.

¹ [NERC SOR 2025 Technical Assessment](#)

Executive Summary

NERC's 2025 *SOR* provides an in-depth analysis of the BPS, identifies system performance trends and emerging reliability risks, and reports on the relative health of the interconnected system. The BPS remains highly reliable and resilient, and underlying key performance metrics (e.g., frequency response and misoperation rates) continue to improve or remain stable. [Table 1](#) provides an overview of key performance measures of the BPS that compare 2024 performance to the previous four years.²

Severe weather remained responsible for the most severe outages in 2024, with two significant winter storms and five major hurricanes that made landfall. NERC saw an improvement in performance during the winter events, with no operator-initiated load shed, in part due to industry's efforts to improve generator performance during extreme cold weather following NERC and Federal Energy Regulatory Commission (FERC) recommendations and regulatory updates. Industry demonstrated the results of grid hardening, ever-improving coordination, and mutual aid agreements during hurricanes, resulting in rapid restoration of the Bulk Electric System (BES), although significant distribution outages remained.³

A significant near-term reliability challenge facing the ERO is the size and speed at which large data centers, typically developed to support the computing needs for AI and cryptocurrency mining, are expanding across the country. Data centers can be developed faster than the generation and transmission infrastructure needed in the area to support them, resulting in lower system stability. Additionally, the voltage sensitivity and rapidly changing, often unpredictable, power usage of these facilities creates new operating challenges. As such, more accurate models of the operational characteristics of these impactful loads are essential to reliability to prevent instability caused by these large changes in electricity demand.

Improvements in frequency response are being observed in areas of the country that have high concentrations of battery energy storage systems (BESS) and incentives in place to encourage or require participation.

Some inverter-based resources (IBR) continue to unexpectedly reduce output following disturbances that generators have historically been expected to ride through. These sudden, often widespread, reductions can exacerbate instability on the system following these disturbances. NERC, FERC, and industry are in the process of addressing these known issues through various reliability alerts, standards, and other regulatory means.

Each of these topics is covered in more detail in the sections that follow this summary.

² [Reliability metrics](#)

³ Distribution consists primarily of equipment below 100 kV, acting to get power from the BES to customers. This equipment is not in NERC's regulatory jurisdiction.

Executive Summary

Table 1: Reliability Indicators

Improving	Stable	Monitor	Actionable
Frequency Response: Texas and Western Interconnections	Transmission-Related Events Resulting in Loss of Load: Supported by Event Analysis Data	Winter Reserve Margin⁴	Transmission Outages Caused by Human Error: Transformers ⁵
Inertia and Rate-of-Change-of-Frequency: Texas Interconnection	Frequency Response: Eastern and Québec Interconnections	Inertia and Rate-of-Change-of-Frequency: Québec Interconnection	
Interconnection Reliability Operating Limit (IROL) Exceedance	Inertia and Rate-of-Change-of-Frequency: Eastern and Western Interconnections	Energy Emergency Alerts	
Protection System Misoperations Rate	Transmission Outages Caused by Failed Protection System Equipment: Transformers	Transmission Outages Caused by Failed AC Substation Equipment: Transformers	
Transmission Outages Caused by Failed Protection System Equipment: AC Circuits	Transmission Outages Caused by Human Error: AC Circuits	Transmission Outage Severity	
	Automatic AC Transmission Outages Caused by Failed AC Substation Equipment: AC Circuits		
	Transmission Outages Caused by Failed AC Circuit Equipment		
	Transmission Element Availability: AC Circuits and Transformers		
	Transmission Physical Security Metric		

⁴ Driven by NPCC-Maritimes.⁵ The number of human error events has remained stable; however, some of the events involved multiple transformers, which drove this indicator's actionable status.

Severe Weather Responsible for the Most Severe Outages in 2024

In 2024, NERC reliability metrics indicated that the BPS remained reliable but challenged by adverse weather conditions and transitions in resource mix and usage. Because of industry's continuous adaptation to these transitions, most related concerns were able to be mitigated before having catastrophic results. Despite the increasing frequency and severity of weather events, efforts to combat the more familiar challenges posed by weather have led to consistently reliable performance except in the most extreme circumstances.

Based on the severity risk index (SRI) (see [Figure 1](#)), transmission and generation measures, and external sources,⁶ severe weather continued to represent the greatest threat to the BPS. In 2024, 27 events occurred in the United States⁷ and 3 in Canada⁸ with losses exceeding \$1 billion within the BPS footprint; 10 of these events had notable impacts on the BES, based on the SRI.⁹

Severity Risk Index

The SRI is a quantitative measure that assesses the relative severity of the combined impact of load, generation, and transmission loss on the BPS daily. It offers a simple snapshot of the performance of the BPS, allowing NERC to assess year-on-year reliability trends.

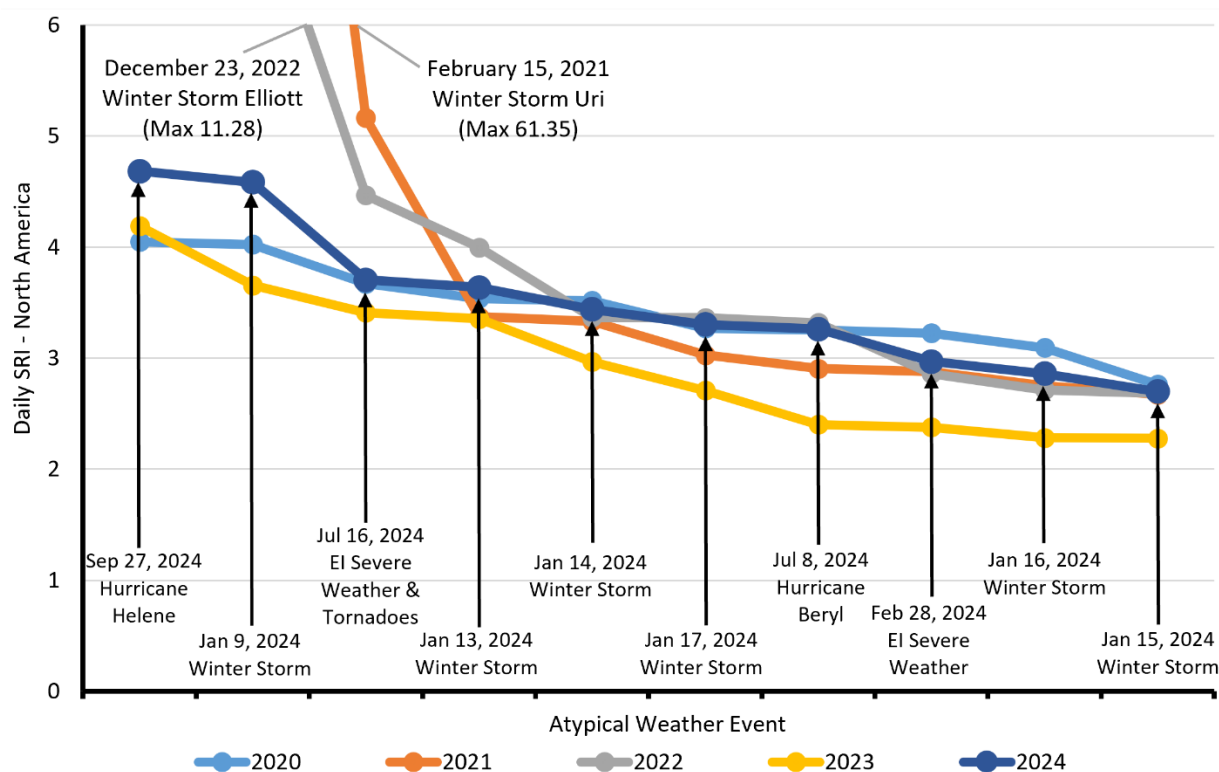


Figure 1: Top Annual Daily SRI Days Sorted Descending

The most severe single day was September 27, after Hurricane Helene made landfall as a Category 4 storm causing catastrophic damage that resulted in more than 4.7 million customers losing power.¹⁰ The storm caused

⁶ [Weather-related Power Outages Rising | Climate Central](#)

⁷ [Billion-Dollar Weather and Climate Disasters | National Centers for Environmental Information \(NCEI\)](#)

⁸ [Canada Insured Catastrophic Losses in 2024 | Insurance Beau of Canada \(IBC\)](#)

⁹ Notability is determined based on comparison to seasonal control limits described in Chapter 2 of the SOR Technical Document. Days include all those in [Figure 1](#), except January 9. Additional days include: April 2–4 (tornadoes and severe weather), April 9 (severe weather), May 16 (southern derecho), and May 20 and 22 (severe storm).

¹⁰ [SERC - Hurricanes Helene and Milton Impact](#)

Severe Weather Responsible for the Most Severe Outages in 2024

approximately 431 transmission element outages, the highest recorded for a single event as well as extensive, ongoing damage to the distribution system. Functional transmission restoration¹¹ was achieved 7.6 days after the first outage, significantly faster than the 15-day average of previous years' Category 4 hurricanes (see [Figure 2](#)) and 9-day average of all hurricanes in the past five years. Load loss attributed to transmission equipment outages was in line with previous Category 3 and 4 hurricanes.

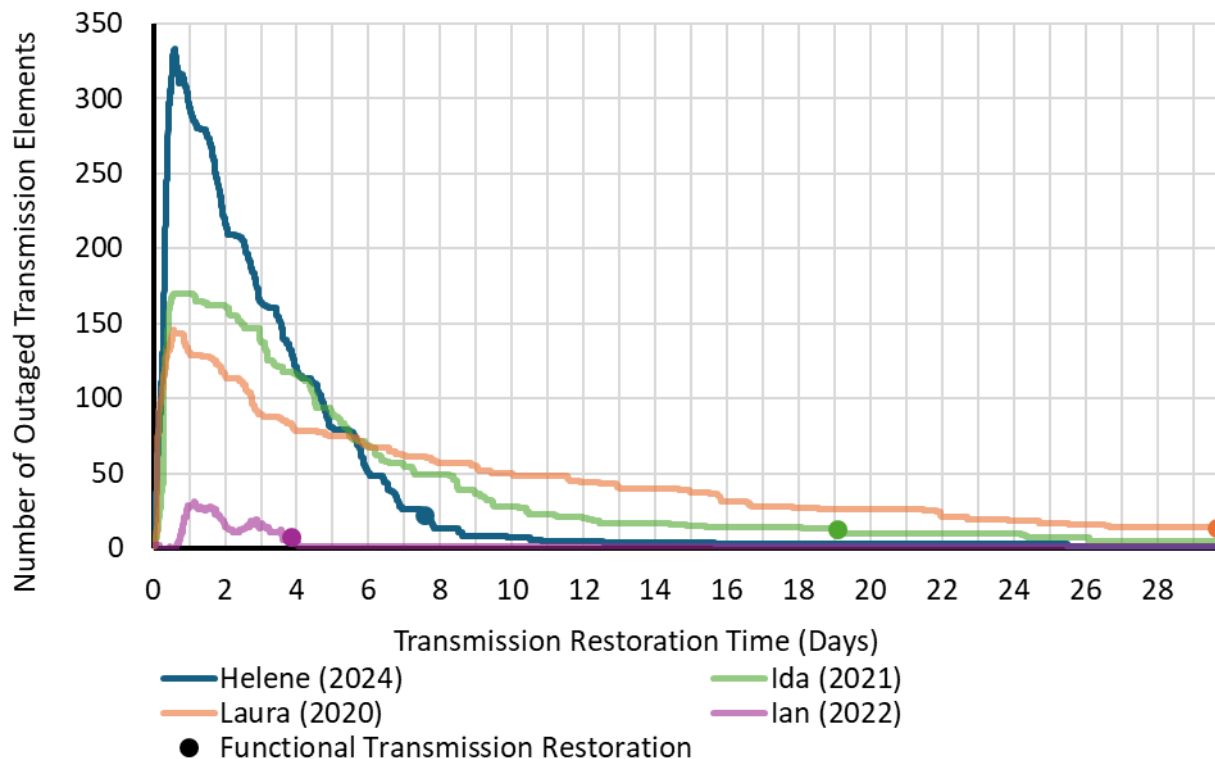


Figure 2: Category 4 Hurricane Transmission Restorations

Also of note were winter storms Gerri and Heather, which traveled back-to-back from the Northwest to the Southeast. While no single day's severity during these storms was as severe as Hurricane Helene, the duration of their impact caused an accumulation of generation outages that left the BPS in a higher risk state than normal even though fewer customers lost power. Further details are provided in the section titled, [2024 Data Suggests that Generator Performance is Improving during Winter Storms](#).

¹¹ Functional transmission restoration: Functionality was restored to the BPS. It is important to recognize that end-use customers may remain without power following transmission restoration due to other factors.

Severe Weather Responsible for the Most Severe Outages in 2024

Although severe storm events remained the largest events impacting the BPS, they did not cause any operator-initiated load shed.¹² The only instance of operator-initiated load shed in 2024 was the result of a failed dispatch following an unplanned generator outage in Wisconsin. Load was restored in half an hour, representing approximately 0.005% of the year (see [Table 2](#)).

Lastly, there were no physical security outages on conventional generation, a stable number of physical security transmission outages, and no outages due to cyber security reported on BES equipment in 2024.

Table 2: Hours with Operator-Initiated Firm Load Shed (Hours/Year)			
Year	Event	Event Hours	Total Annual Hours
2020	California Heat Wave	7.4	22.4
	California Wildfires	4.1	
	Hurricane Laura	10.9	
2021	Winter Storm Uri	70.5	70.5
2022	June Heat Wave	21.0	56.5
	Winter Storm Elliott	35.5	
2023	N/A	0.0	0.0
2024	WI: Generator Trip, Subsequent Failure of Dispatched Units	0.4	0.4

Related Actions

Recommendations

- NERC recommends that industry and state legislatures continue to implement grid-hardening efforts as geographically and economically appropriate.
- NERC recommends that industry continue to leverage mutual aid agreements and coordination process improvements to maintain exceptional restoration times.

ERO Existing and Ongoing Efforts

- The ERO Enterprise continues to do the following:
 - Monitor BES performance during adverse weather conditions
 - Further analyze notable trends and then communicate them with industry and legislators
 - Issue lessons learned,¹³ reliability guidelines,¹⁴ or standards¹⁵ as necessary
 - Collaborate with industry subject matter experts to identify new and relevant methods to measure BES reliability

¹² Operator-initiated load shed is when customers' power is intentionally disconnected to prevent a larger-scale blackout from occurring. Frequent or major operator-initiated load shed can be indicative of an unreliable BPS for a number of reasons, such as: lack of available generation or transmission capacity, poor operator practices, or a lack of voltage or frequency stability.

¹³ [Lessons Learned](#)

¹⁴ [Reliability Guidelines, Security Guidelines, Technical Reference Documents, and White Papers](#)

¹⁵ [Reliability Standards](#)

2024 Data Suggests that Generator Performance is Improving during Winter Storms

Over the past decade, many of the largest reliability events recorded by NERC have been due to severe winter storms that resulted in extensive generator outages and derates. In extreme events, such as the Texas-South Central United States event in February 2021,¹⁶ significant operator-initiated firm load shedding has been required to maintain reliability in the area (see [Table 3](#)).

Table 3: Winter Storm Generation Outages¹⁷

Winter Storm Dates	Unique Units That Experienced Outages or Derates (U1, SF, D1)	Cumulative Megawatts (MW) Net Maximum Capacity Lost ¹⁸	Cumulative MW Hours (MWhrs) of Potential Generation Lost	Average Outage Duration per Unit (Hours)	Maximum Units Lost in a Single Day	Operator-Initiated Firm Load Shed (MW)	Approximate Area of Storm (Sq. Miles)	Degrees Fahrenheit Below Normal
Jan 6–8, 2014 ¹⁹	1,435	184,124	13,969,932	81	746	<300	1,923,000 ²¹	20–30 ²¹
Jan 15–19, 2018 ²⁰	793	118,765	13,201,903	131	256	0	418,000 ²¹	12–28 ²¹
Feb 8–20, 2021 ¹²	1,656	259,088	113,382,224	554	502	23,418	869,600 ²¹	40–50 ²¹
Dec 21–26, 2022 ²¹	1,633	233,277	59,231,859	205	666	5,400	1,517,000 ²¹	20–30 ²¹
Jan 10–17, 2024 ²²	1,182	169,682	35,555,786	263	305	0	1,396,553 ²³	20–35 ²²

Due to their outsized impacts on reliability, NERC has always reviewed the largest events to assess causes, share lessons learned, and initiate corrective actions to better prepare for future events. While winter storms can differ dramatically in scope and severity, the January 2024 storms featured weather conditions that were similar enough to those experienced in January 2014 and December 2022 that some comparisons can be made.²⁴

Based on the similarities and differences, NERC has determined that there have been improvements in generator performance and system reliability during winter storms. Most importantly, where both prior storms required some amount of operator-initiated load shed, none was required in 2024. In addition, there were significantly fewer generator outages that were more geographically dispersed, indicating that the issues were not as localized as in the past, helping to alleviate potential operator-initiated load shedding. Furthermore, natural gas production losses declined.

¹⁶ [The February 2021 Cold Weather Outages in Texas and the South Central United States](#)

¹⁷ All generation data is from conventional GADS as of April 29, 2025.

¹⁸ Limited to the highest single loss per unit over the event duration.

¹⁹ [2014 Polar Vortex Report](#)

²⁰ [The South Central United States Cold Weather Bulk Electric System Event of January 17, 2018](#)

²¹ [Winter Storm Elliott Report: Inquiry into Bulk-Power System Operations During December 2022](#)

²² [System Performance Review of the January 2024 Arctic Storms](#)

²³ [Regional Snowfall Index \(RSI\) | RSI and Societal Impacts | Historic Storms | National Centers for Environmental Information \(NCEI\)](#)

²⁴ While similar, there were some important differences. The 2014 winter storm lasted only three days yet affected a larger geographic area. It also involved a generation resource mix that had more coal and less natural gas. The 2022 winter storm was also shorter in duration and less severe in the range of below-normal temperature. Still, the 2022 winter storm also recorded more freezing precipitation (as measured by the National Oceanic and Atmospheric Administration (NOAA) regional snowfall index (RSI)) and sudden temperature drops.

Related Actions

Recommendations

- Further analysis by NERC and the PAS of the meteorological characteristics of the 2024 event is recommended to support a more thorough comparison with past events. More analysis will also help establish a consistent methodology for future winter weather-related comparative analysis.

ERO Existing and Ongoing Efforts

- Multiple NERC reliability alerts^{25, 26, 27} and webinars were issued and hosted.
- Regional Entities performed generator site visits to review cold weather preparedness and freezing protection vulnerabilities and to evaluate both current design thresholds and impacts based on preparedness for the future.
- NERC and FERC issued reports and recommendations for each winter storm.^{19, 20, 21, 22, 28}
- The Extreme Cold Weather Preparedness and Operations Standard was issued (EOP-012-2) and is now subject to enforcement.^{29, 30}
- NERC intends to continue monitoring to determine any reliability gaps.

²⁵ [Cold Weather Preparations for Extreme Weather Events](#)

²⁶ [Cold Weather Preparations for Extreme Weather Events II](#)

²⁷ [Cold Weather Preparations for Extreme Weather Events III](#)

²⁸ [Reliability Spotlight: Cold Weather Preparedness | Federal Energy Regulatory Commission](#)

²⁹ [EOP-012-2](#)

³⁰ [EOP-012-3](#) – Pending approval

Large Loads are Creating New Challenges for Reliability

The size and speed at which data centers are being connected to and operated on the BES is creating one of the greatest near-term reliability challenges. Recent events have demonstrated the importance of improving industry's understanding of data center collective behavior during times when the BPS is under stress.

For example, approximately 1,500 MW of data centers disconnected simultaneously and unexpectedly from the BES due to a transmission line fault in 2024.³¹ A loss of load of this size is comparable to a large nuclear power plant coming on-line immediately and unexpectedly, creating an imbalance due to too much generation on the system. In this instance, while system voltages and frequency rose rapidly, the overall impact on the BES was limited. ERCOT has also reported experiencing several similar events on a smaller scale (100–400 MW).³² Improving the ability to model the behavior of data centers when events such as transmission faults occur is key to reliability planning.

Another emerging reliability challenge is positioning resources so that the system can rebalance itself quickly in response to rapidly changing loads caused by the increased use of data centers supporting AI and cryptocurrency-mining facilities. Such rapid changes in load are part of normal operations for these facilities, which raises concerns for balancing, frequency stability, and voltage stability. Current models do not accurately portray these data center loads. Model analysis tools are used when planning to identify things like worst-case scenarios and how to deal with them. Poor models can result in sub-optimal planning and operator practices being implemented. Better models³³ of data center loads are needed to improve planning and preparations for operating with these large loads in the mix.

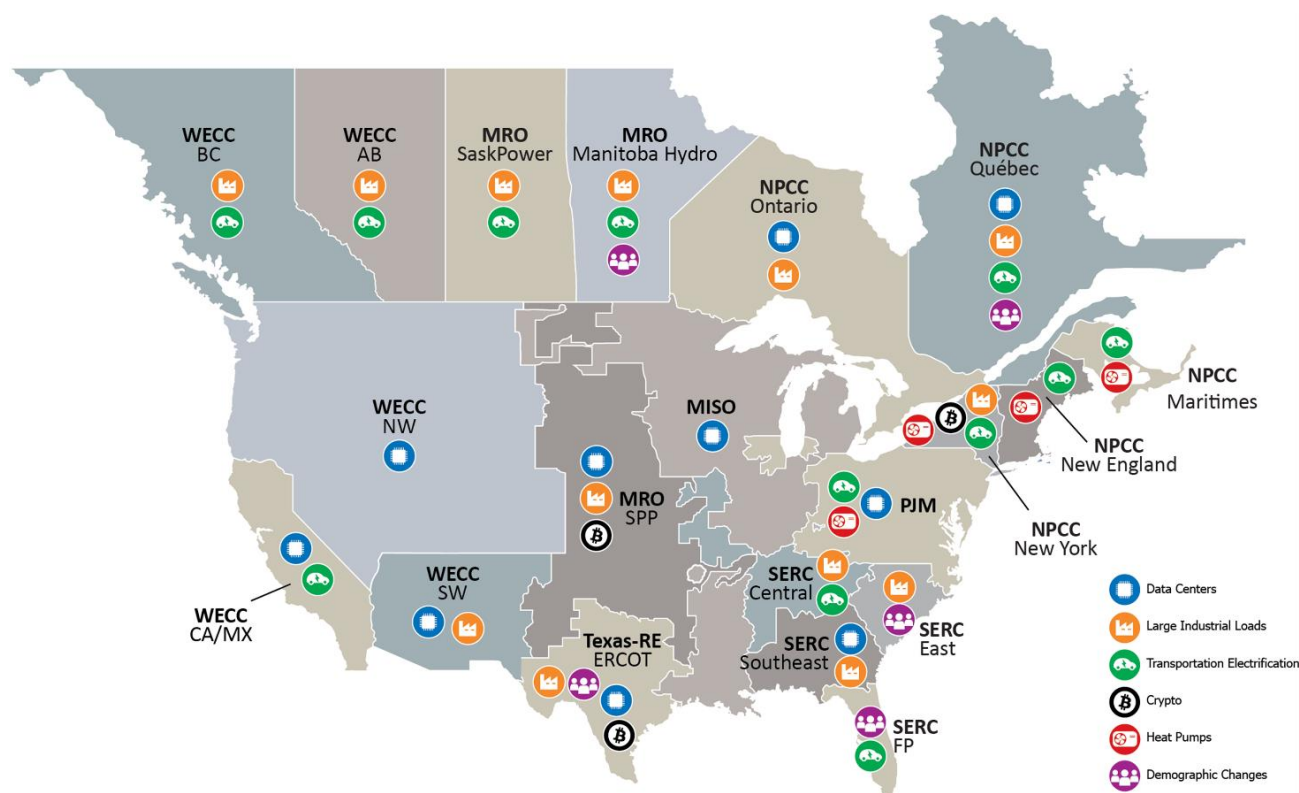


Figure 3: Data Centers Driving Load Growth in the United States³⁴

³¹ [Incident Review – Considering Simultaneous Voltage-Sensitive Load Reductions](#)

³² https://www.nerc.com/comm/RSTC/LLTF/LLTF_Presentations_December_12_2024.pdf

³³ Modeling tools are used when planning to identify things like worst-case scenarios and how to deal with them. Poor models can result in sub-optimal operator practices being implemented.

³⁴ [NERC Long-Term Reliability Assessment](#)

A final challenge is adapting load forecasting, system planning, and interconnection procedures to accommodate the speed with which these large loads can and are being built and the uncertainty that announcements of new data centers create for planners (see [Figure 3](#)). The size of individual facilities often represents a step-change increase in the load forecast for a geographic area, often within a two-year timeframe. This is in sharp contrast to the more gradual increase in load due to traditional sources of load growth or more traditional large loads, such as industrial loads, which can take several more years to plan and construct. Planning generation and transmission to accommodate such large step-changes in load is made even more complicated by the speculative nature of where and if these new facilities will be built.

Related Actions

Existing and Ongoing Efforts

- NERC initiated the Large Loads Task Force (LLTF)³⁵ to better understand the reliability impacts of emerging large loads on the BPS³⁶ and the Load Modeling Working Group (LMWG)³⁷ to drive Interconnection-wide advancement and the use of dynamic load modeling.
- NERC presented activities and plans to address reliability impacts from large load integration to FERC.³⁸
- The LLTF is expected to publish a white paper covering characteristics and risks later this year.
- The frequency response metric will continue to be monitored to measure the response to frequency events during large load tripping events.

Recommendations

- The System Protection and Control Working Group (SPCWG) should assess possible protection system impacts to the BPS from emerging large loads.
- The Energy Assessment Working Group (EAWG) and Probabilistic Assessments Working Group (PAWG) should investigate methods for grid operators and planners to assess the risks potentially posed by emerging large loads to resource adequacy.
- Grid operators and planners should collect data from load developers, owners, and operators to help understand the unique risks associated with each emerging large load connecting to their system.
- Communication and coordination with the Electric Power Research Institution (EPRI), the Energy Systems Integration Group (ESIG), large load industry groups, and the electric industry at large should be continued.
- NERC should continue incident analysis and lessons learned and share findings with industry.

³⁵ [Large Loads Task Force \(LLTF\)](#)

³⁶ [LLTF Work Plan](#)

³⁷ [Load Modeling Working Group \(LMWG\)](#)

³⁸ [NERC Seeks to Address Reliability Impacts from Large Load Integration | Federal Energy Regulatory Commission](#)

Initial Evidence Suggests Battery Energy Storage Systems Can Improve Primary Frequency Response

BESS in the Texas and the Western Interconnections are contributing to improvements in frequency control and frequency response.

Primary Frequency Response

The North American BES operates at a nominal frequency of 60 Hz. This is maintained by balancing the amount of generation with the amount of load. In instances where a sudden, unexpected imbalance between these occurs, the system frequency will deviate. If the frequency changes too much, it can damage equipment, cause instability that trips equipment, and eventually cause blackouts. To address this, many generators are equipped with governors that will increase or decrease output in response, restoring the frequency; this is called **primary frequency response** (see [Figure 4](#)).

The effectiveness can be most simply evaluated by assessing the low (or high) point of the frequency, known as the **C-Point** or **Nadir**.

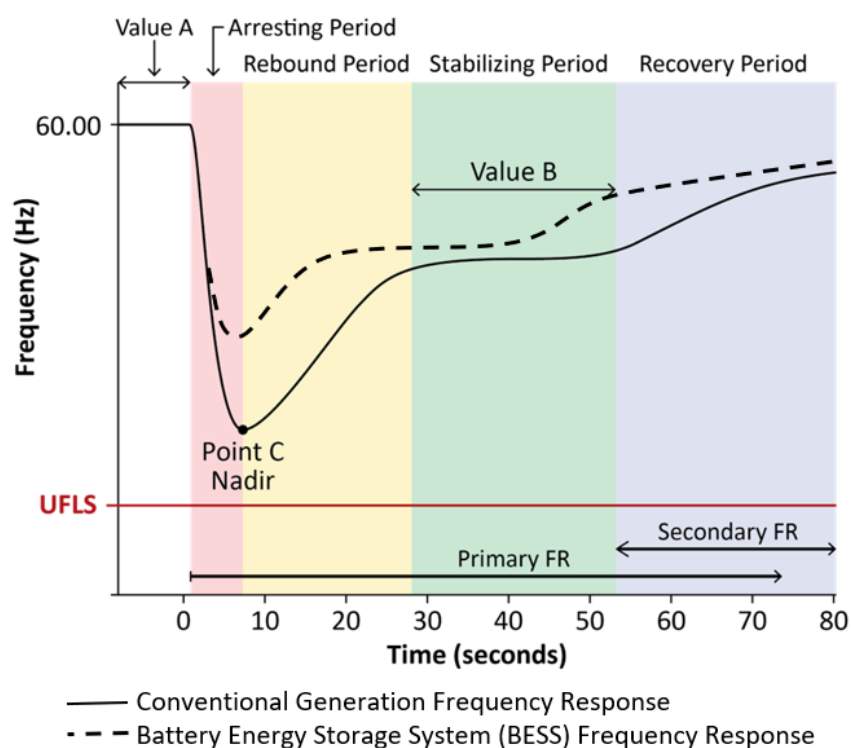


Figure 4: Frequency Response Comparison Example

Initial Evidence Suggests Battery Energy Storage Systems Can Improve Primary Frequency Response

BESS installations in Texas increased to 10,027 MW in December 2024 from 1,307 MW in January 2022, with significant additions planned (see [Figure 5](#)), approaching 19,000 MW by the end of 2025. While all industrial battery installations can provide frequency support, in Texas RE, the provision of frequency support (when available) is mandated through Reliability Standard BAL-001-TRE-2 BESS. This requirement combined with the increasing amount of installed capacity, quick response times, and BESS often being in a state of partial charge has positioned these installations as a key part of the Texas Interconnection's frequency response. BESS is an ever-increasing portion of ERCOT's ancillary service market, primarily for frequency regulation services, responsive reserve services,³⁹ fast frequency response,⁴⁰ contingency reserve⁴¹ services, and non-spinning reserves.⁴² For example, in 2024, ERCOT experienced several instances where batteries provided up to 100% of the total capacity for frequency regulation services. All of these services act cohesively to ensure that additional generation, also known as reserves, is available to compensate for major generator outages, which also enables rapid frequency recovery.

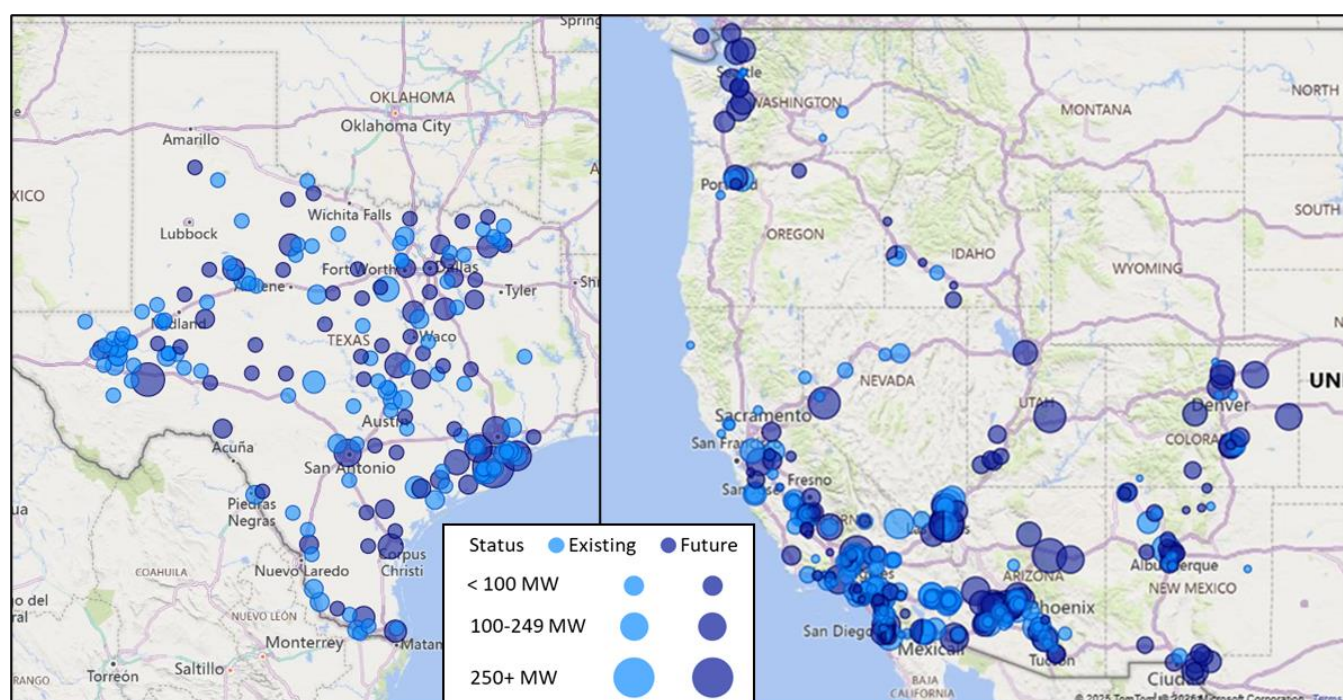


Figure 5: Texas RE and WECC Existing and Planned BESS Installations⁴³

There was an upward trend in frequency responsive capacity for the total generation fleet from 2021 to 2024, as more generators had extra capacity to respond to a frequency event. Conversely, over the same period, this extra capacity decreased for conventional generation with the difference primarily being BESS. This has had the additional and positive effect of arresting the frequency nadir faster and at higher levels than were historically seen for the same size MW loss under similar inertia conditions. By arresting the frequency decline at higher levels, the potential for under-frequency load shedding is reduced.

When looking at individual frequency disturbances and analyzing the response by different unit types, BESS have been noted as providing greater than 70% of the overall MW response for individual disturbances. Additionally, a

³⁹ [Ancillary Service](#): Services necessary to support the transmission system's ability to get energy from resources to loads.

⁴⁰ [Fast Frequency Response](#): Full, automatic self-deployment of resources within 30 cycles of a frequency event for at least 15 minutes.

⁴¹ [Contingency Reserve](#): Resources that can be rapidly dispatched to the grid to mitigate sudden loss of resource.

⁴² [Non-Spinning Reserve](#): Generating reserve not connected to the system but capable of serving demand within a specified time.

⁴³ Texas RE BESS map background obtained from TomTom.com

large portion of the BESS resources have a 1% droop setting⁴⁴ (compared to a 5% droop for conventional units), which is partially responsible for the excellent governor response from the BESS fleet.

Related Actions

ERO Existing and Ongoing Efforts

- NERC, Texas RE, and WECC will continue monitoring the impacts of greater BESS penetration as inertia on the respective Interconnections decreases.
- NERC, Texas RE, and WECC will continue monitoring the reduced number of measurable frequency events per the criteria set forth by the NERC Resource Subcommittee in its procedures for calculating the frequency response obligations for these Interconnections.

⁴⁴ Droop setting: The governor setting that dictates the rate of power change from a generator based upon the amount of frequency change that occurs. A smaller number indicates a larger response to a frequency deviation.

Industry Continues to Address the Reliability Impacts of Inverter-Based Resources

IBRs are wind power plants, solar photovoltaic (PV) devices, and BESS, and these generation sources are rapidly growing throughout the North American BPS. In 2024, 45,037 MW of new IBR capacity became operational on the BPS.

As these resources expand, coordinated failures in response to modest system disturbances continue to be observed with four exceeding 500 MW reported to NERC's Event Analysis team in 2024 for a total of 16 since 2020. These events have identified that, during normally occurring faults on the power system (e.g., generator trip, loss of a transmission line), IBRs automatically cease their output and stop injecting power into the system. Generally, within several minutes, they resume injecting power into the system. Both the sudden drop and equally sudden resumption of IBR output pose challenges for reliability.

NERC's Engineering and Security Integration and Situation Awareness teams have analyzed 10 large-scale disturbances since 2016. In total, the 10 disturbances involved nearly 15,000 MW in unexpected reductions in output. Moreover, this trend is increasing with approximately 10,000 MW of these reductions taking place between 2020 and 2024.⁴⁵ The analysis also identified that poor modeling and study practices did not accurately reflect the poor performance.

As a result, industry remains focused on improving the ride-through capability of IBRs and more accurate modeling of the behavior of IBRs during grid disturbances.⁴⁶

The ability of generating units and other grid-connected devices to stay connected and synchronized with the grid during and after such voltage or frequency disturbances is known as ride-through capability. Ride-through capability is essential for preventing cascading outages and maintaining the overall stability of the power grid.

The IBR Mitigation Strategy outlines NERC's approach for mitigating the IBR reliability risks.⁴⁷ The strategy outlines NERC's recommendations, created in collaboration with industry and regulatory authorities, to improve interconnection processes, develop new reliability guidelines and standards, and implement new registration requirements for IBRs. These and related activities are summarized below.

Related Actions

Existing and Ongoing Efforts

Regulatory Activities

- FERC order in Docket RD22-4,⁴⁸ Registration of Inverter-Based Resources.
- FERC Notice of Proposed Rulemaking issued November 17, 2022,⁴⁹ to address concerns regarding reliability impacts on IBRs.
- FERC Order 2023⁵⁰ required interconnection asynchronous generating facility customers to do the following:

⁴⁵ Links to individual disturbance events are available in the [NERC Quick Reference Guide: Inverter-Based Resource Activities](#)

⁴⁶ [Findings from Inverter-Based Resource Model Quality Deficiencies Alert](#)

⁴⁷ [Inverter-Based Resource Strategy](#)

⁴⁸ [FERC Docket RD22-4-000](#) (Docket No. RM22-12-000), Registration of Inverter-Based Resources, November 17, 2022.

⁴⁹ [Notice of Proposed Rulemaking re: Reliability Standards to Address Inverter-Based Resources under RM22-12](#)

⁵⁰ [FERC Order No. 2023](#), Improvements to Generator Interconnection Procedures and Agreements, July 28, 2023.

Industry Continues to Address the Reliability Impacts of Inverter-Based Resources

- Provide models needed for accurate interconnection studies
- Maintain power production at pre-disturbance levels
- Provide dynamic reactive power to support system voltage during transmission system disturbances
- FERC Order 901⁵¹ directed NERC to develop Reliability Standards that address reliability gaps related to IBRs.
 - IBR facilities are required to provide ride-through capability consistent with standards and guidelines applied to other generating facilities in the Balancing Authority area.

Reliability Standards

- Reliability Standard⁵² modifications are in progress for PRC-024, MOD-025, MOD-026, MOD-027, FAC-001, FAC-002, PRC-002, PRC-019, and EOP-004.

Reliability Alerts and Guidelines

- March 14, 2023, NERC Level 2 Alert on IBR performance issues⁵³
- March 2023 NERC Reliability Guideline: *Electromagnetic Transient Modeling for BPS-Connected Inverter-Based Resources*⁵⁴
- June 2023 NERC Reliability Guideline: *Performance, Modeling, and Simulation of BPS – Connected Battery Energy Storage Systems and Hybrid Power Plants*⁵⁵
- June 4, 2024, NERC Level 2 Alert on IBR modeling issues⁵⁶
- May 20, 2025, NERC Level 3 Alert on Essential Actions to Industry for Inverter-Based Resource Performance and Modelling⁵⁷

Other NERC and Industry Activities

- 2025: IBR Registration Initiative⁵⁸
- 2023: Quick Reference Guide: Inverter-Based Resource Activities⁵⁹
- Started in 2024: New reporting requirements for performance and event data from wind and solar generating facilities, including hybrid plants with BESS resources.⁶⁰
- ERCOT stakeholders approved two changes to their Nodal Operating Guides in 2024 specific to IBRs, Nodal Operating Guide Revision Requests (NOGRR) 245 and NOGRR 255.^{61,62}

⁵¹ [FERC Order No. 901](#), Final Rule Reliability Standards to Address Inverter-Based Resources, October 19, 2023.

⁵² [Reliability Standards](#)

⁵³ [March 14, 2023, Level 2 Alert: Industry Recommendation: Inverter-Based Resource Performance Issues.](#)

⁵⁴ [2023 Reliability Guideline: Electromagnetic Transient Modeling for BPS-Connected Inverter-Based Resources: Recommended Model Requirements and Verification Practices](#), March 2023.

⁵⁵ [2023 Reliability Guideline: Performance, Modeling, and Simulation of BPS – Connected Battery Energy Storage Systems and Hybrid Power Plants](#), June 2023.

⁵⁶ [June 4, 2024, Level 2 Alert: Industry Recommendation: Inverter-Based Resource Model Quality Deficiencies](#)

⁵⁷ [IBR Performance & Modelling Alert](#)

⁵⁸ [IBR Registration Initiative](#)

⁵⁹ [Quick Reference Guide: Inverter-Based Resource Activities](#)

⁶⁰ [GADS Section 1600 Data Request](#)

⁶¹ [NOGRR245 Issue](#)

⁶² [NOGRR255 Issue](#)

The NERC logo consists of the letters "NERC" in a bold, black, sans-serif font. A horizontal blue bar is positioned directly beneath the letters.

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

2025 State of Reliability

Overview Summary

Mark Lauby, Senior Vice President and Chief Engineer
RF Board

RELIABILITY | RESILIENCE | SECURITY

Severe Weather Remained Responsible for the Most Severe Outages in 2024

U.S. 2024 Billion-Dollar Weather and Climate Disasters

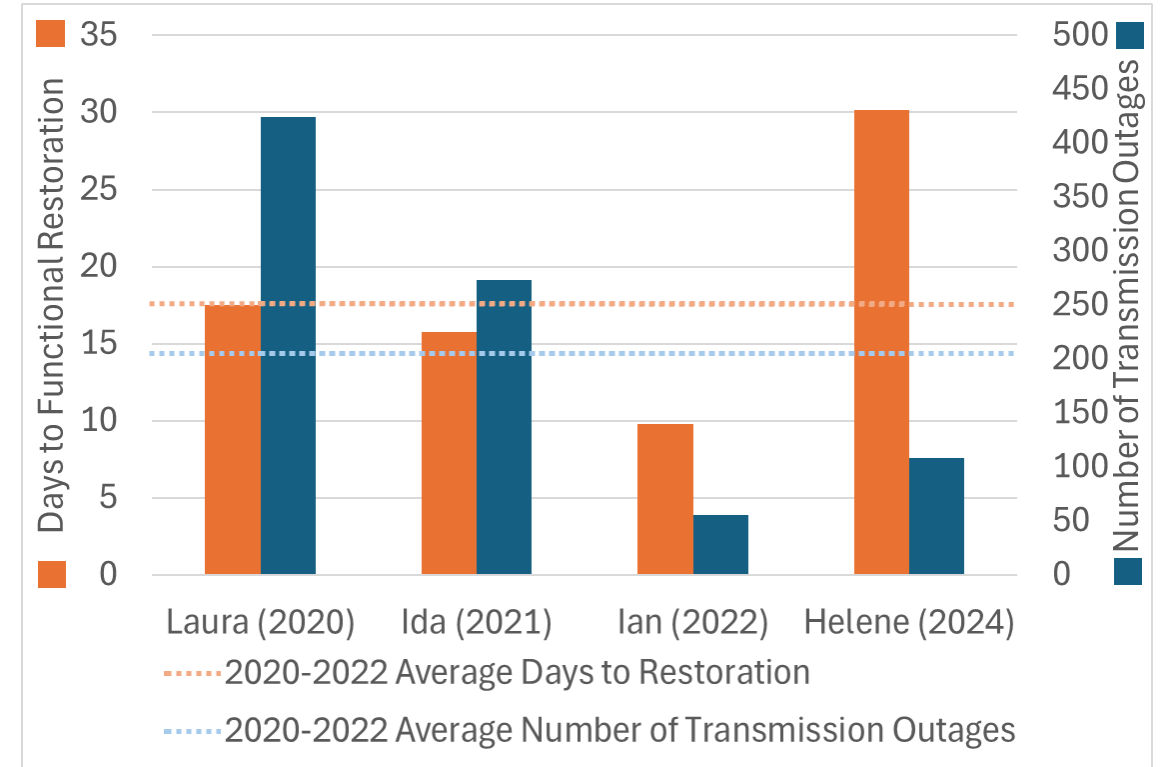
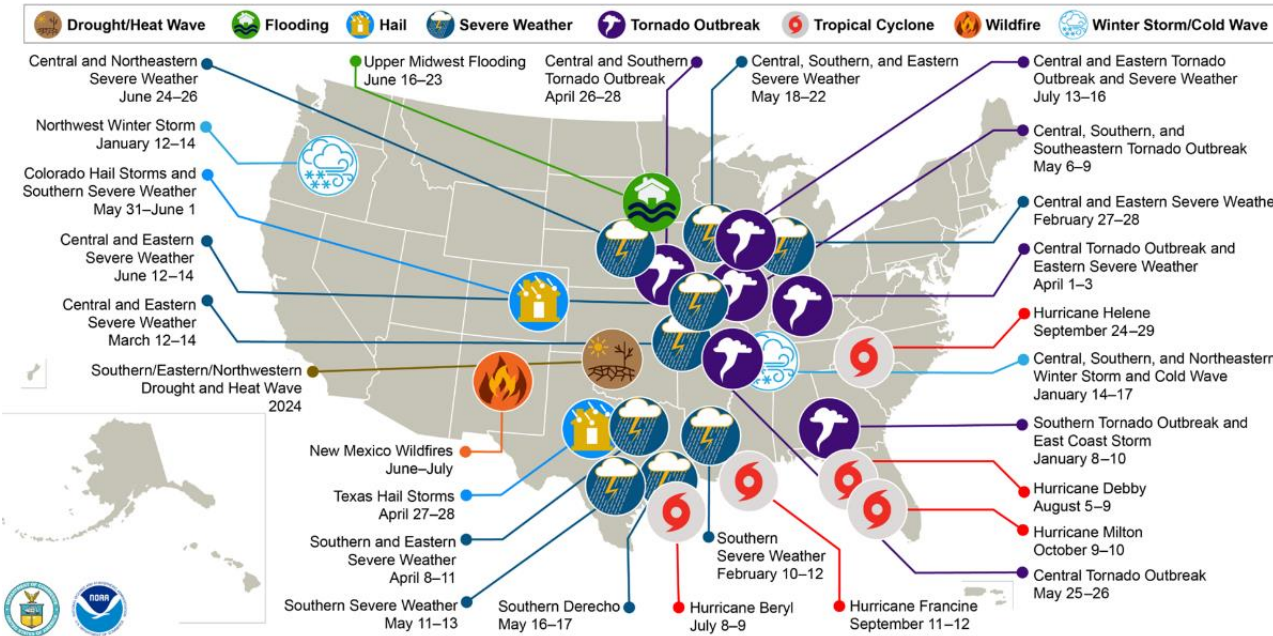


Table 2.2: 2024 Top 10 SRI Days							
Rank	Date	SRI and Weighted Components 2024				Atypical Weather Conditions	Regional Entities
		SRI	Weighted Generation	Weighted Transmission	Weighted Load Loss		
1	27-Sep	4.68	1.42	2.41	0.85	Hurricane Helene	RF, SERC
2	9-Jan	4.58	1.56	0.68	2.35	Northwestern Winter Storm, Eastern Tornadoes & Severe Storms	RF, SERC, Texas RE, WECC
3	16-Jul	3.71	1.80	0.38	1.52	Central & Eastern Tornadoes & Severe Weather	NPCC, RF, SERC
4	13-Jan	3.64	2.47	0.48	0.68	Winter Storm	MRO, RF, SERC, WECC
5	14-Jan	3.44	3.09	0.27	0.08	Winter Storm	MRO, RF, SERC, Texas RE
6	17-Jan	3.30	2.87	0.29	0.14	Winter Storm	MRO, RF, SERC
7	8-Jul	3.26	2.04	0.92	0.30	Hurricane Beryl	MRO, SERC
8	28-Feb	2.97	1.46	0.37	1.13	Central & Eastern Severe Storms	NPCC, RF WECC
9	16-Jan	2.86	2.41	0.38	0.07	Winter Storm	MRO, SERC, Texas RE, WECC
10	15-Jan	2.70	2.27	0.37	0.06	Winter Storm	MRO, RF, SERC, Texas RE, WECC

Preliminary Evidence Suggests that Generator Performance during Winter Storms is Improving

2022 vs 2024

- Winter Storms Comparison
 - Similar area impacted
 - Similar temperature deviations
 - Less frozen precipitation
 - More gradual temperature changes
- Generator Performance
 - 27.6% decrease in generator outages
 - 27.2% decrease in capacity loss
 - 54.2% decrease in maximum single day outages
 - Zero operator-initiated firm load shed
 - 22.6% increase in average outage duration



- Voltage Sensitivity

- Sudden, unexpected loss of load due to normal transmission faults
- Rapid voltage and frequency increases
 - Potential damage to generators
 - Potential reactional transmission operations

- Highly Variable

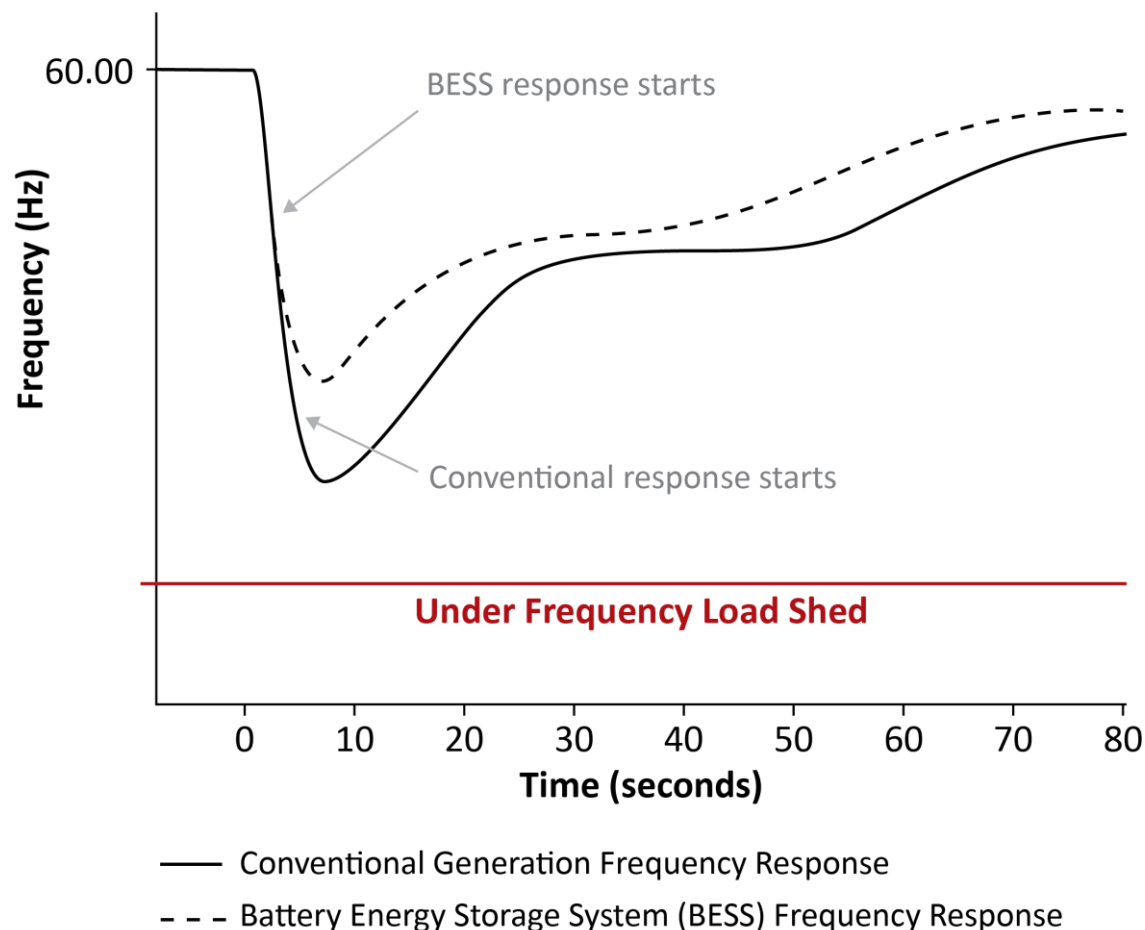
- Quick demand fluctuations during normal operations
- Generally, not communicated in advance
- Exciting oscillation modes
- Lack of accurate modelling

- Forecasting Challenges

- Rapid construction
- Uncertainty in long-term projects
- Balancing and adequacy concerns



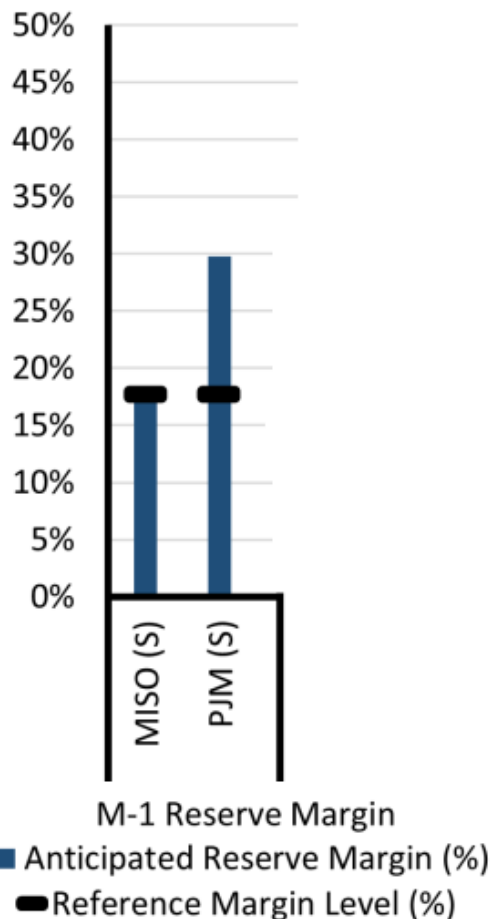
Integration of Battery Energy Storage Systems (BESS) shows a positive impact on Primary Frequency Response



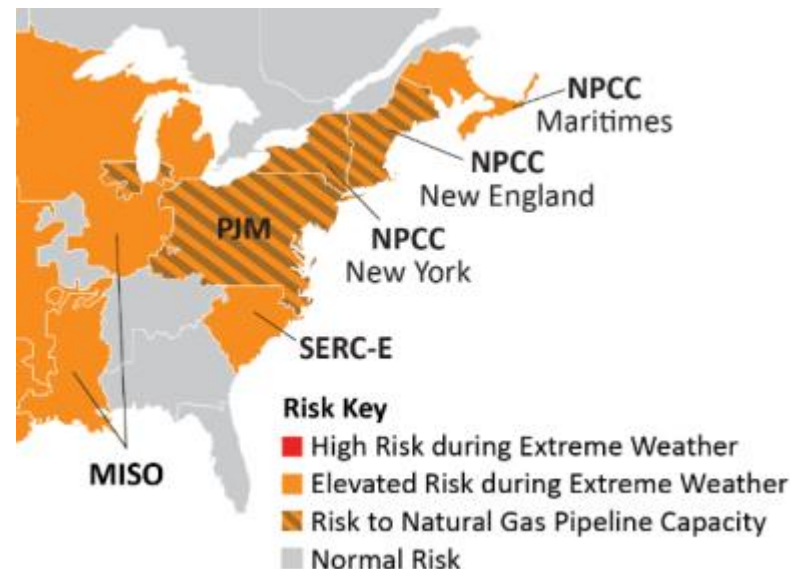
The Texas and Western Interconnections are seeing frequency response improvements and attributes a portion of this improvement to increasing BESS penetration.

- Rapid penetration continues
- Momentary cessation persists at some plants
- IBR Mitigation Strategy

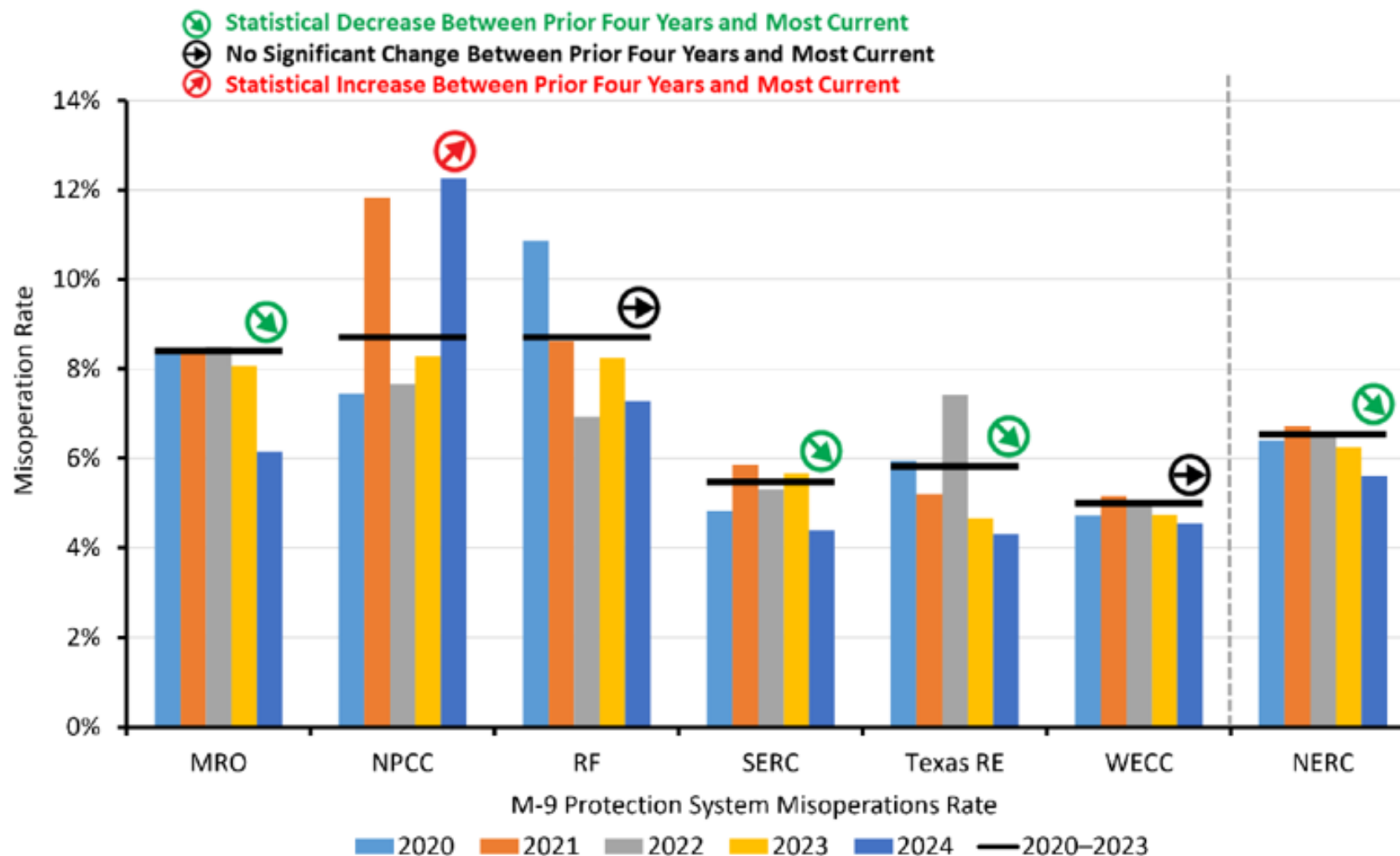




2024 Summer Reliability Assessment Risk Areas



2024-2025 Winter Reliability Assessment Risk Areas



A map of North America, including the United States, Canada, and Mexico. A horizontal band of varying shades of blue and grey stretches across the middle of the map, passing through the United States. The text "Questions and Answers" is centered within this band.

Questions and Answers

The NERC logo consists of the letters "NERC" in a bold, black, sans-serif font. A horizontal blue bar is positioned directly beneath the letters.

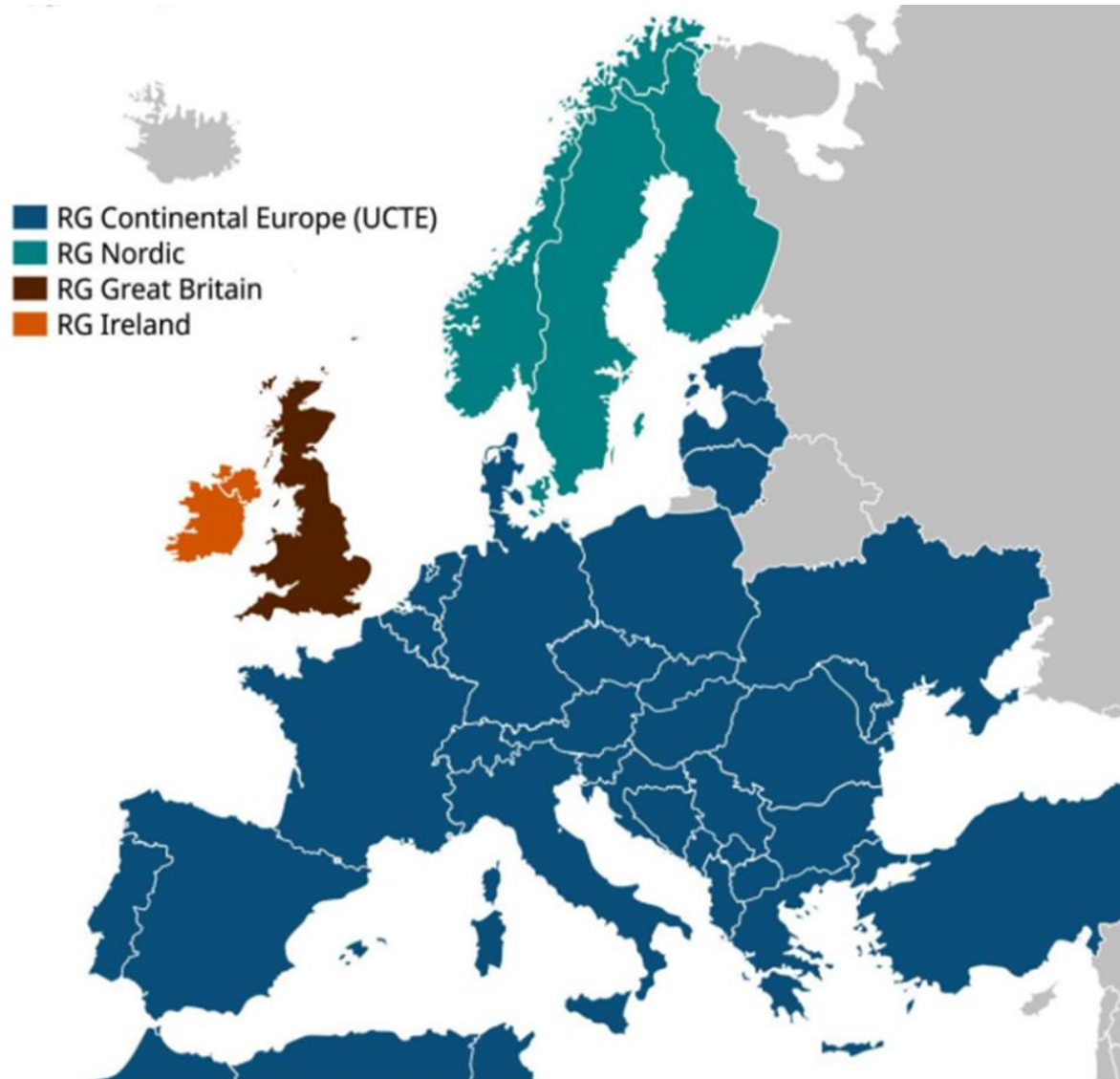
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Iberian Peninsula Blackout

Contextual Comparison with North American BPS Reliability Safeguards

Mark Lauby, SVP, Chief Engineer

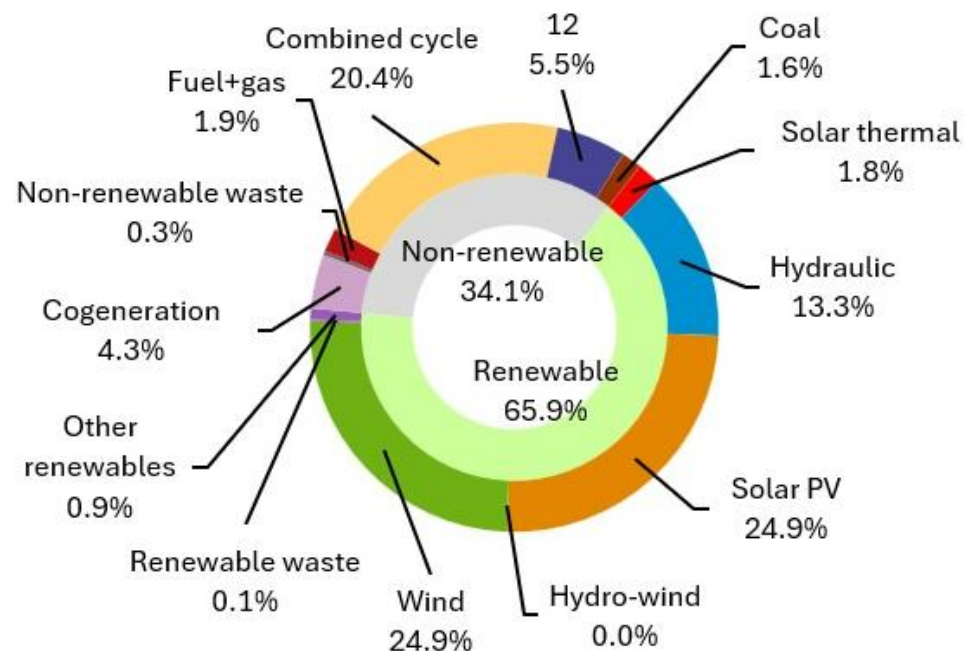
RELIABILITY | RESILIENCE | SECURITY



- European Network of Transmission System Operators for Electricity
 - 40 Transmission System Operations (TSOs)
 - 36 countries across Europe, beyond EU borders
 - + 500 millions people served
 - Nearly 300K miles of transmission lines
 - + 1TW net generation capacity
 - Consumption of 3,600 TWh

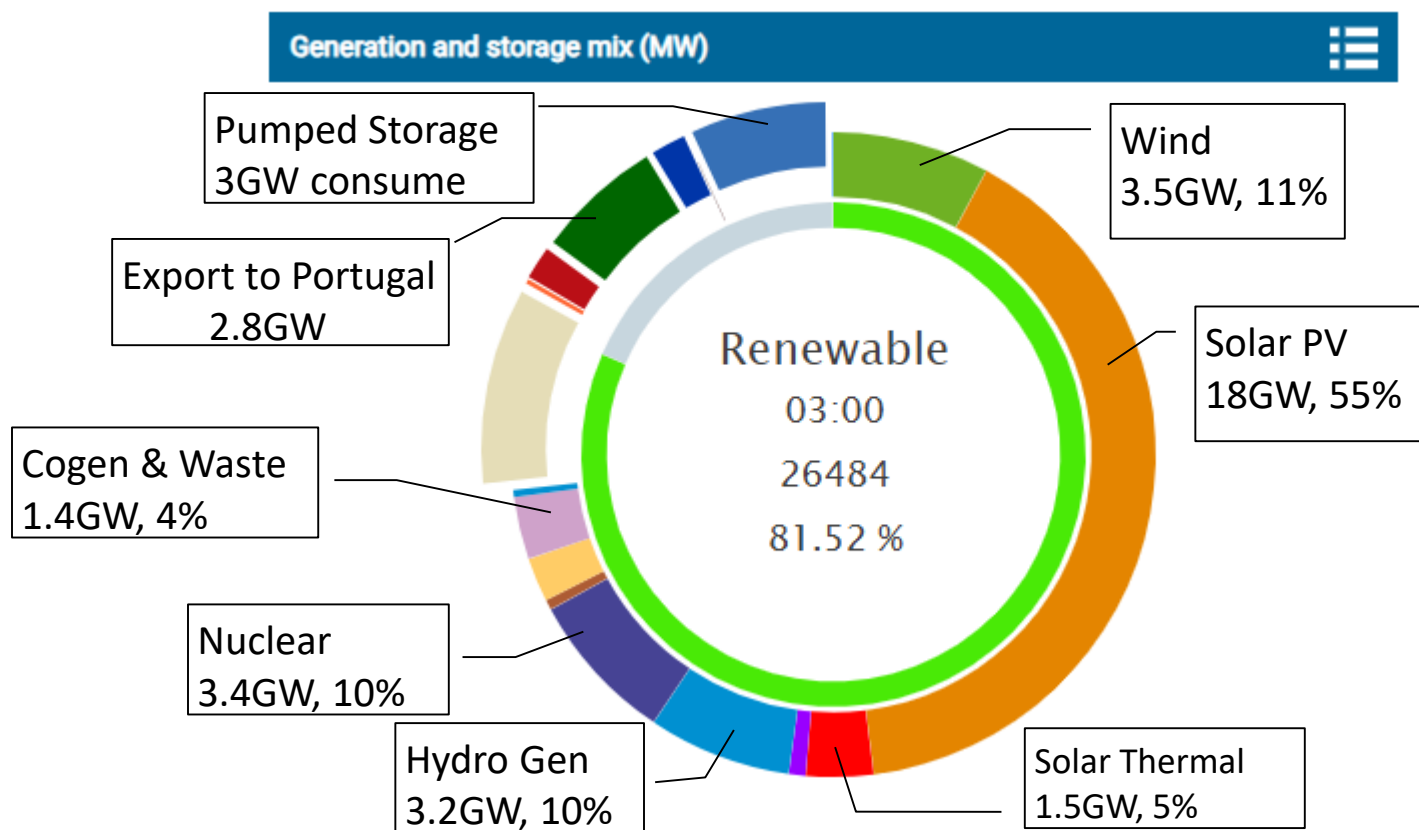
Source: <https://annualreport2017.entsoe.eu/about-entso-e/>
RELIABILITY | RESILIENCE | SECURITY

- 
- A map of Spain, colored in dark blue, with the word "Spain" written in white text across its center. The map shows the Iberian Peninsula and surrounding islands.

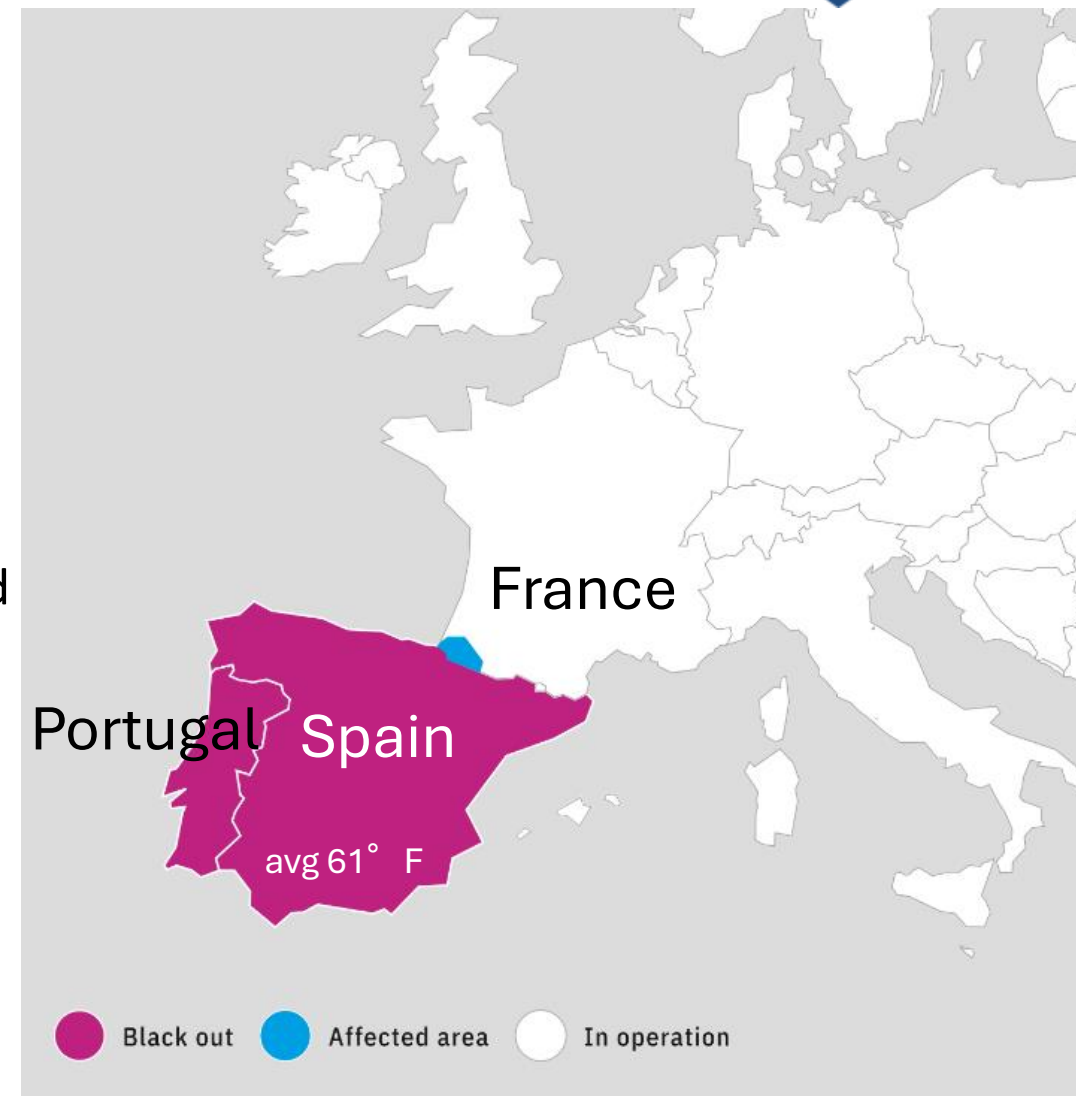


3

- **System Strength:** Weak grid conditions - higher voltage sensitivity to network changes
- **Total load pre-event:** 27 GW
- **Export pre-event:** 1 GW to France, 2.8GW to Portugal, 800MW to Morocco



- Affected: Portugal & Spain
 - Small part of south France
- April 28, 2025
- 12:33 CET – Black Out
- 12:35 CET – Black-Start began
- 13:04 CET – Morocco-Spain interconnector reenergized
- 13:35 CET – Eastern France-Spain interconnector re-energized
- 18:36 CET – Tie-line between Portugal and Spain re-energized
- 21:35 CET – 400kV tie-line Portugal and Spain re-energized
- April 29
- 00:22 CET – Portugal transmission system restored
- 04:00 CET – Spain transmission system restored



- 12:03 – 12:07 Local oscillation between Spanish and Portuguese systems (0.6 Hz)
- 12:16 – 12:22 Inter-area oscillation (0.2 Hz), followed by rising voltage due to DER tripping

16 mins ↓

● 12:32:57

Generation loss in Spain (355 MW, unknown type)
- Collector substation tripped due to overvoltage
- Some generators responsible for voltage regulation failed to perform

19 sec ↓

○ 12:33:16

Generation loss in Spain (727 MW, 1 PV, 1 unknown type)

1 sec ↓

○ 12:33:17

Generation loss in Spain (834 MW, 4 wind farms, 4 PV)
Sharp voltage increase, triggering a cascade of additional generation losses

} = total 2GW generation loss

2 sec ↓

○ 12:33:19

Import from France reached 4,609 MW through AC ties. Iberian Peninsular system began to lose synchronism with the European system. Automatic load shedding began.

2 sec ↓

○ 12:33:21

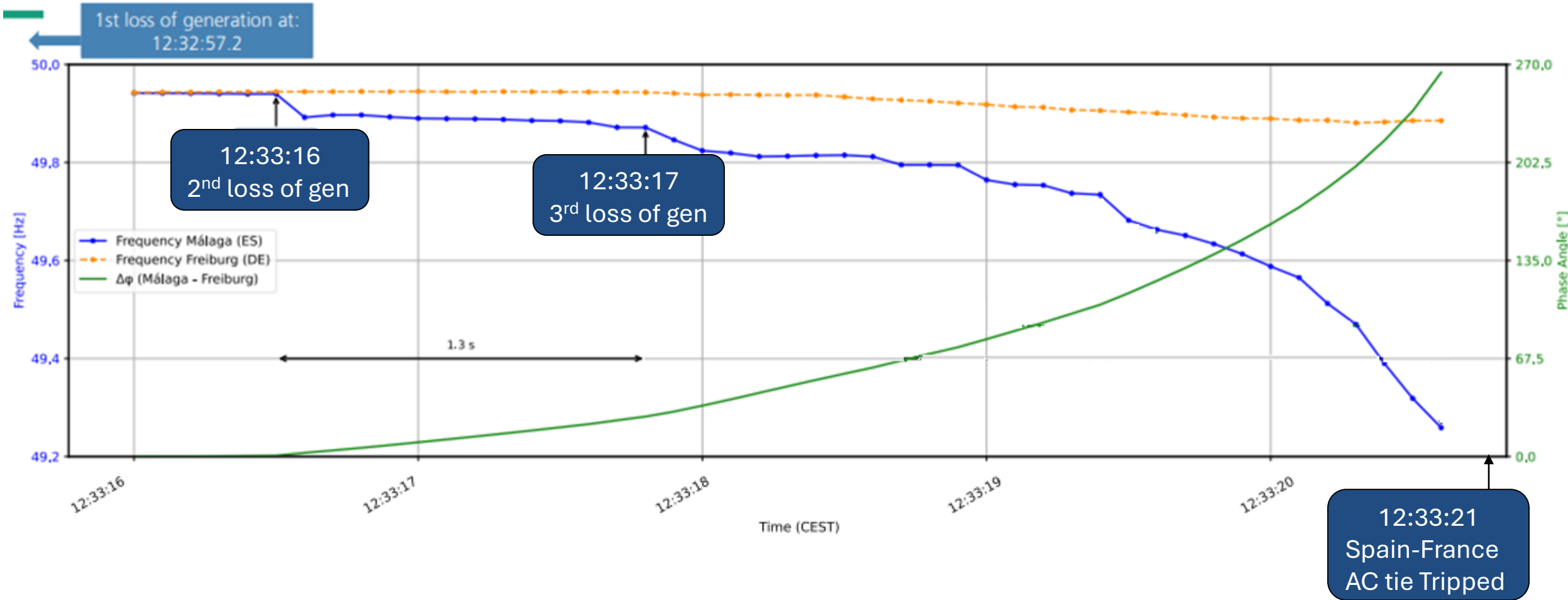
AC lines between France and Spain were disconnected by loss of synchronism protection

3 sec ↓

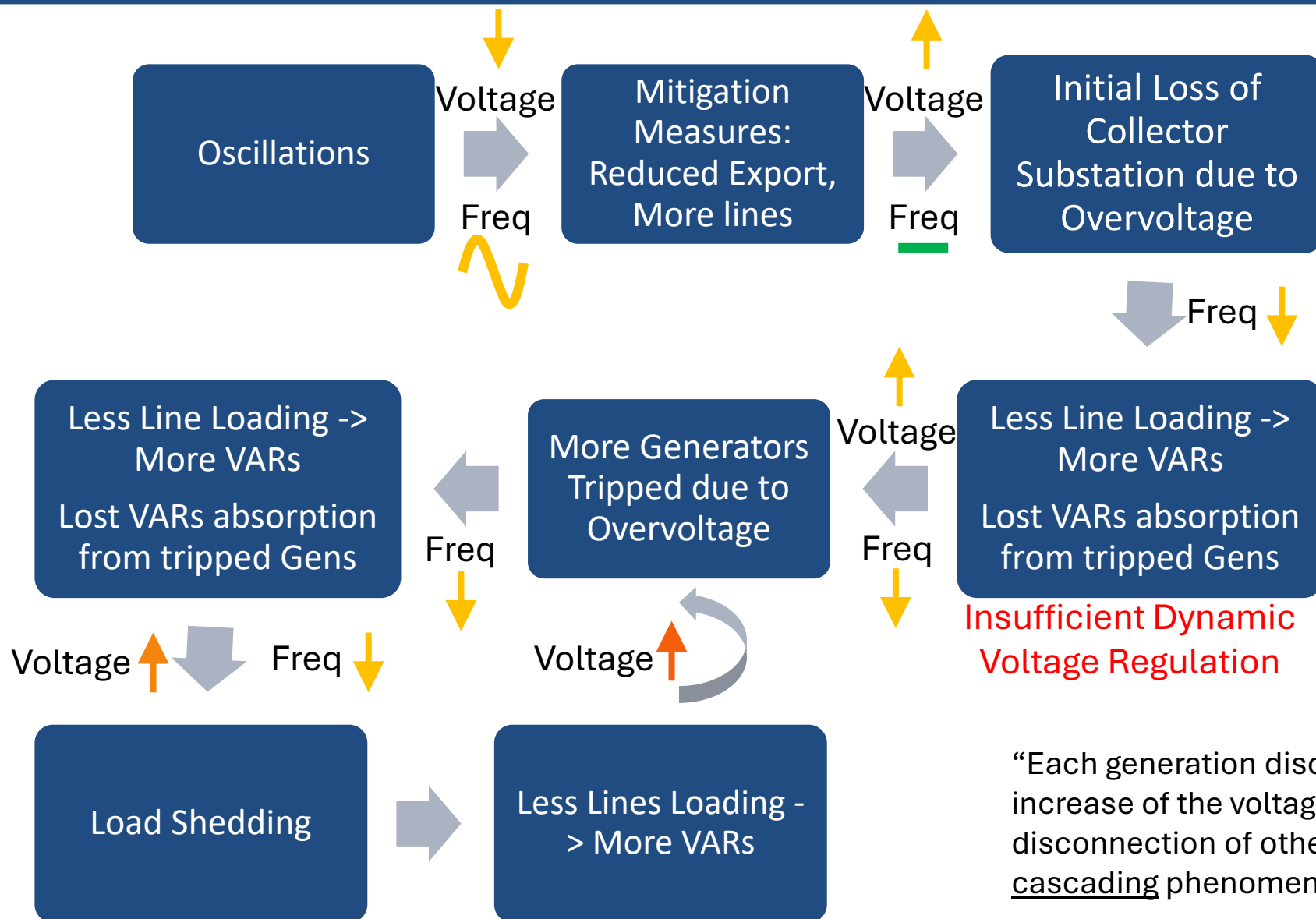
○ 12:33:24

Spanish and Portuguese systems collapsed. HVDC lines stopped.

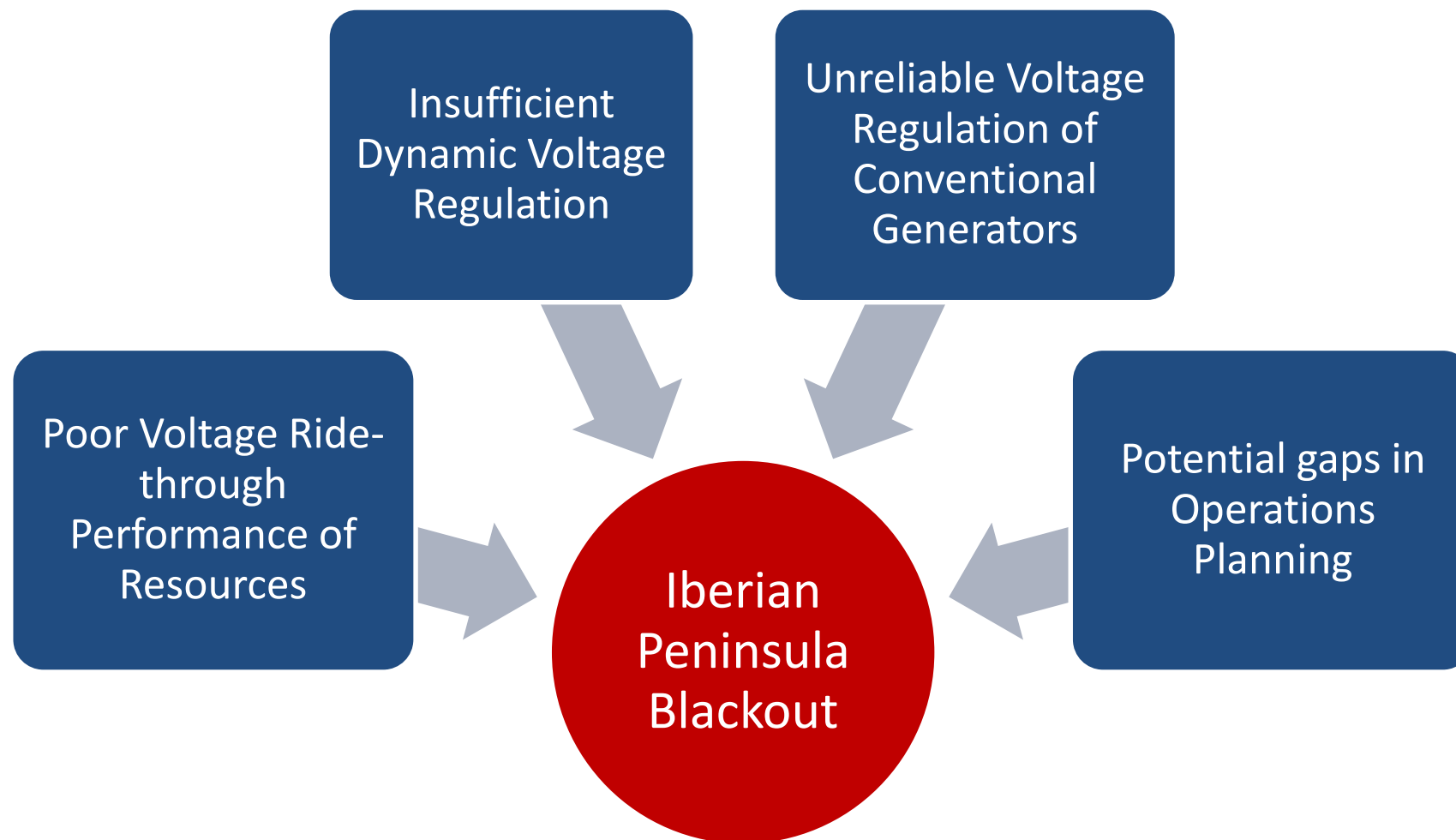
27 sec



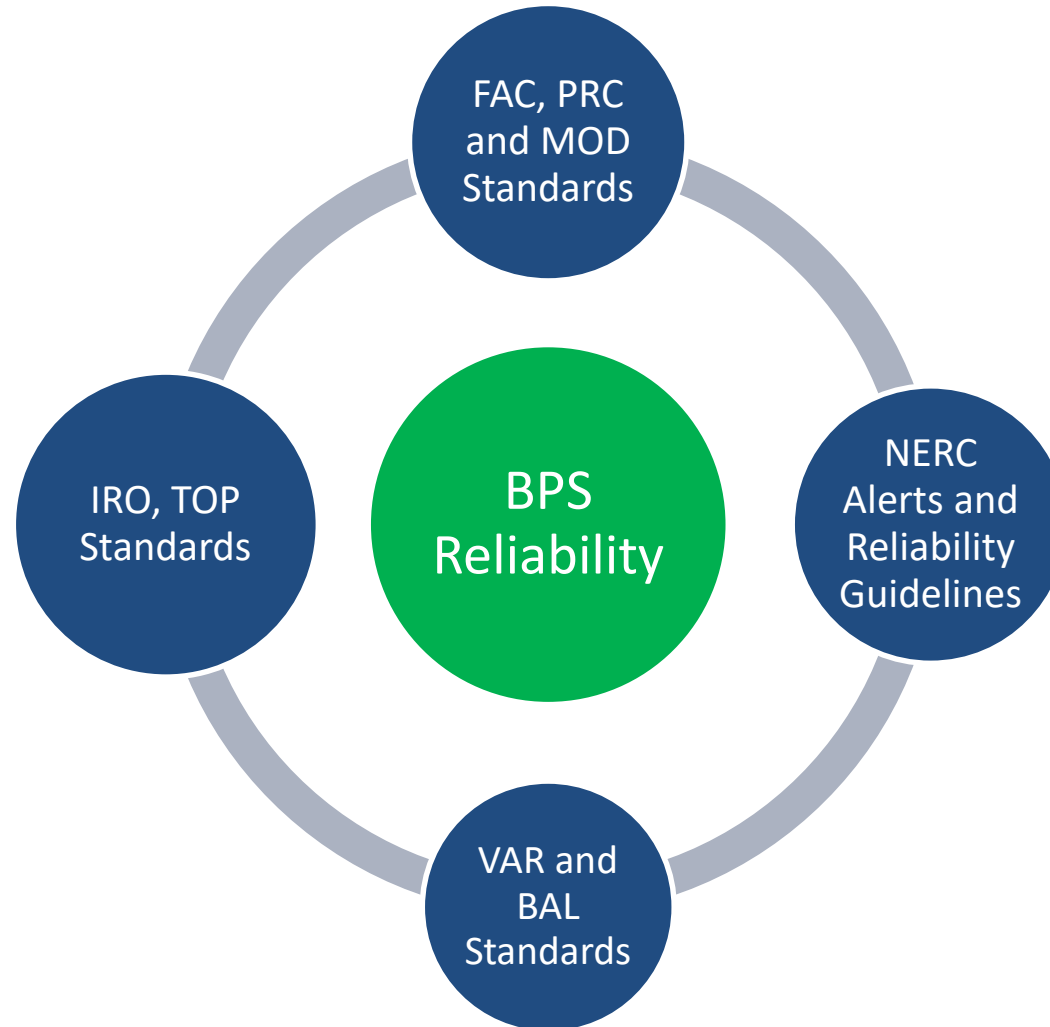
Graph Source: Leonhard Probst, Scientist at the Fraunhofer Institute for Solar Energy Systems ISE



“Each generation disconnection causes a slight increase of the voltage, which in turn causes the disconnection of other generators, producing a cascading phenomenon.” - REE



Lesson Learned for North America: If resource tripping is caused by overvoltage and results in underfrequency condition, UFLS will result in higher voltage in the absence of sufficient voltage regulation.



Mandate all generation units, including IBRs capable of voltage regulation perform such control

- We already do this!
- NERC VAR-002-4 and FERC Order No. 827

Review of overvoltage protection settings

- NERC Level 2 and Level 3 Alerts on IBR Performance Issues and Modeling Deficiencies

Enhancement of voltage control resources

- Synchronous condensers and SVC/STATCOMs are already leveraged in North American BPS.

Define minimum monitoring requirements for incident analysis

- New PRC-028: Disturbance Monitoring

Source: “Blackout in Spanish Peninsular Electrical System the 28th of April 2025” by the Spanish Transmission System Operator (TSO), Red Eléctrica

Recommendations in Spanish Government Report

Strengthen oversight and verification of regulatory compliance

Improve voltage control capabilities and oscillation damping

Increase interconnection with the European system

Review of services framework

Update system restoration procedures

Analyze and update operating procedures

Boost demand

Increase strength and flexibility

Source: “Report from the Committee for the analysis of the electricity crisis of April 28th 2025”, published by the Spanish government

- FERC Order 901 Milestone 3 and 4 standard development projects
- NERC work plan priority to develop a comprehensive framework to identify risks resulting from the transforming grid (e.g., inverter-based resources, large loads, essential reliability services)
- Relevant essential reliability services include
 - Inertia,
 - Rate of Change of Frequency (RoCof),
 - Frequency Response Measurement – ERO-wide performance assessment of BAL-003,
 - Reactive Capability,
 - Voltage Performance,
 - System Strength (sensitivity to voltage magnitude and phase)



Questions and Answers

Backup Slides with Additional Info

Insufficient Voltage Regulation

- NERC VAR-001-5: Voltage and Reactive Control
- NERC VAR-002-4 requires ALL generators to operate in automatic voltage control mode (unless otherwise instructed by TOP)
- FERC Order No. 827: Mandatory Automatic Voltage regulation
- [NERC Level 2 Alert IBR Performance Issues](#), Recommendation 6
- [NERC Level 3 Alert](#), Essential Action #4 (for GOs)

Unreliable Voltage Regulation

- PRC-019-2: Coordination of Generating Unit or Plant Capabilities, Voltage Regulating Controls and Protection
- MOD-026: Periodic model verification against plant performance
- NERC Level 3 Alert, Essential Action #3 (for TOs, TPs, PCs), #4 (for GOs)

Poor Voltage Ride-through Performance of IBRs

- PRC-024-4: Synchronous machine voltage and frequency trip settings
- PRC-029-1: IBR Ride-through performance
- PRC-030-1: Unexpected IBR Event Mitigation
- FAC-008-5: Facility ratings
- NERC Level 2 Alert IBR Performance Issues, Recommendation 1, 2, 3, 4
- NERC Level 3 Alert Essential Actions #1

Active Power Frequency Control

- Primary Frequency Response (FERC Order No. 842)
- Fast Frequency Response (in select region)
- BAL-002-3: Identify and have reserve for most severe single contingency
- BAL-003-2: Maintain Interconnection frequency within predefined bounds
- NERC Level 3 Alert Essential Actions #1

Reliability Operations

- FAC-011-4: System Operating Limits Methodology for Operations Horizon
- IRO-008-3: Reliability Coordinator Operational Analyses and Real-time Assessment
- IRO-009-2: RC Actions to operate within Interconnection Reliability Operating Limit

Operations Planning

- TOP-002: Analysis to identify and avoid unstable operating conditions
- TOP-003: Maintain situation awareness for real-time operation
- TOP-010 and IRO-018: Quality of analysis for real-time assessment
- FERC Order No. 901 – Directive to study more variety of contingencies and operating conditions

System Restoration

- EOP-005-3: System Restoration from Blackstart Resources
- EOP-006-3: System Restoration Coordination

Effective UFLS Operation

- PRC-006-5: Automatic UFLS
- PRC-008-0: UFLS Equipment Maintenance Programs
- PRC-012-2 & PRC-017-1: Remedial Action Scheme

DTE Technology and Security Challenges and Updates



Security and Technology

Risk and Compliance Committee
Reliability First

August 27, 2025

Discussion Topics

Introduction and DTE's culture of compliance
overview – Steve Ambrose

Driving accountability and rigor to the point of
activity – Jason Smith

Jason Smith

Director – NERC Compliance **DTE Energy**

Jason Smith is DTE Energy's director of NERC compliance. He is responsible for the oversight of DTE's NERC programs and activities.

Jason joined DTE Energy in 2012. Prior to joining DTE, he worked in various finance, compliance and consulting roles at General Motors, Fiat Chrysler and Deloitte.

He holds a Bachelor's degree in Accounting from Oakland University, and an MBA from Wayne State University. He is also a licensed CPA.



DTE is a predominantly pure-play utility

DTE Electric

- ✓ 2.3 million customers
- ✓ ~11GW electric generation capacity (11,084MW)
- ✓ Largest electric utility in Michigan and one of the largest in the nation
- ✓ Electric generation and distribution

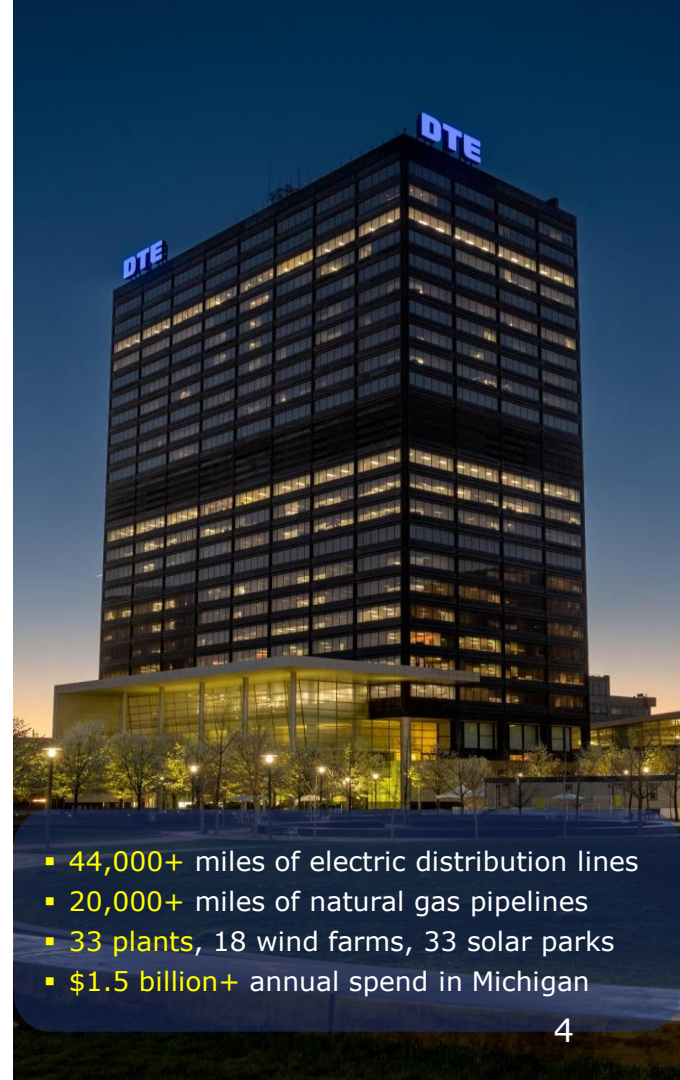
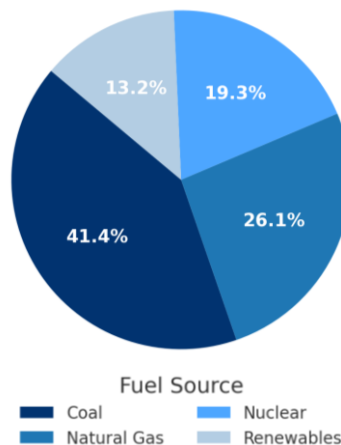
DTE Gas

- ✓ 1.3 million customers
- ✓ ~140BCF underground gas storage capacity
- ✓ One of the nation's largest natural gas utilities
- ✓ Natural gas transmission, storage and distribution

Non-Utility

- ✓ DTE Vantage – leading developer of energy-related projects including RNG and cogeneration
- ✓ Energy Trading – gas, power and renewables marketing

DTE Generation Mix



- 44,000+ miles of electric distribution lines
- 20,000+ miles of natural gas pipelines
- 33 plants, 18 wind farms, 33 solar parks
- \$1.5 billion+ annual spend in Michigan

DTE's grid modernization investment journey



Strategic Investment and Reliability Goals

- DTE has committed \$9 billion over five years (2024–2029) to upgrade its electric grid
- The company is focused on reducing outage duration by 50% and outage frequency by 30% by end of 2029
- In 2024 alone, DTE invested \$1.5 billion; customer downtime has improved nearly 70% when compared to 2023



DTE's Four-Point Modernization Plan

- Smart device deployment (e.g., reclosers)
- Infrastructure rebuild (e.g., voltage upgrades)
- Grid automation
- Tree and vegetation trimming, on an accelerated cadence



Smart Grid Technology Rollout

- Over 220 smart grid devices (e.g., automated reclosers) installed; 230 miles of pole maintenance completed in early 2025, cutting outage duration by 75% since 2023
- Reclosers, smart meters, and automation allow DTE to isolate damage quickly and restore power faster to unaffected areas



Regulatory and Pilot Innovation Framework

- DTE Electric's grid modernization rate case (u-21534) under Michigan Public Service Commission approval provides funding mechanism via an Infrastructure Recovery mechanism through 2026
- DTE filed its Distribution Grid Plan (U-20147) in September 2023, outlining the next 10-15 years of grid investments strategy, with a new Distribution System Plan(DSP) due in 2026

Our culture-deliberate company unifies with Service Keys



"As part of our operating model, our stated purpose is to 'improve lives with our energy.' We fulfill this purpose by driving a culture of service excellence, creating distinctive customer experiences, and living our service keys."

- Jerry Norcia, CEO, DTE Energy

- **Employee Engagement (Gallup)** – Employees' high engagement has earned the company 13 straight Gallup Exceptional Workplace awards and a spot in the top 6% worldwide for employee engagement
- **Enterprise Safety** – With an OSHA rate of 0.57, DTE is approaching the top 10% of utilities for safety performance – a testament to our strong accountability, active safety councils and committees, and rigorous training across the enterprise; this ensures safety is everyone's responsibility, every day
- **Customer Experience** – DTE's commitment to customer satisfaction is reflected in our five-year partnership with the Disney Institute, a 2025 YTD Net Promoter Score of +33 for electric service, and a #1 Midwest ranking in the latest J.D. Power business natural gas study – underscoring our dedication to service excellence and a truly customer-centric culture
- **Continuous Improvement** – Our continuous improvement culture empowers employees and teams across the company to systematically refine operations, eliminate inefficiencies, and elevate safety and reliability through disciplined, data-driven innovation
- **Quality Management** – The Enterprise is on a march to ISO 9000 accreditation, with IT in final preparations for 2025; this ensures clarity in process, consistency in execution, and collaboration across teams
- **Force for Good** – Participants in DTE's flagship volunteer program, which mobilizes employees (including retirees) across hundreds of nonprofits in Michigan, contribute both time and specialized skills to support local missions

A strong internal control focus helps prioritize governance activities and leads to stronger protection of the Bulk Electric System



Benefits of an internal control program:

- ✓ Improves annual risk assessment
- ✓ Establishes an accountable owner for the control
- ✓ Streamlines governance work by risk ranking controls/requirements
- ✓ Earlier identification of gaps

We are seeing positive results from some of our recent key initiatives

Initiative	Benefits
Driving rigor and accountability to the point of activity (mostly complete)	<ul style="list-style-type: none">✓ Collaborative approach allows for a more thorough compliance framework✓ Enabler for ownership and robust problem solving
Moving governance activities “upstream” and focusing on internal controls (underway)	<ul style="list-style-type: none">✓ Identifies small problems before they become big problems
Investing in governance activities that enable NCO to be in the “right place at the right time” (underway)	<ul style="list-style-type: none">✓ Risk based focus✓ Streamlines communication between NCO and internal business partners✓ Helps drive consistency across all NERC programs and activities

Prioritizing consistency and visibility drives accountability and rigor, creating a solid foundation for the development of a real-time heat map

Consistency Enablers

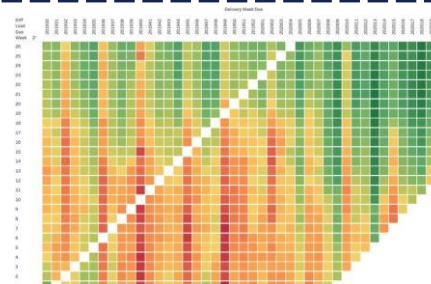
- Commitment to a single platform for all compliance activities
 - Risk Assessment
 - Task tracking
 - PNC investigations and related activities
 - Standards development
 - Control testing
 - Regulatory reporting and audits
- Ensure all activities are associated with a single authoritative source (NERC standard)
- Establish regular cadence and consistent look for huddles and NCO processes

Visibility Enablers

- Use graphics (charts, trendlines, etc.) to show status of compliance activities
- Identify and highlight cross process and business unit relationships for improved “big picture” analysis and proper thorough collaboration
- Use of a multi-function GRC tool allows clear visibility of workload assignments and associated risk

True-North

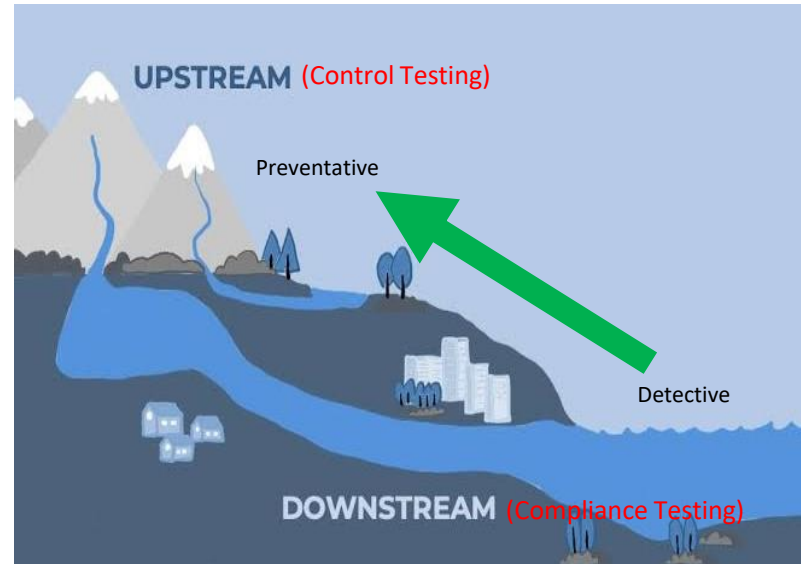
One real-time heat map showing risk aggregated across all inputs accessible to all stakeholders



Moving governance activities “upstream” and focusing on internal controls will strengthen compliance through earlier detection of gaps

A Control-centric approach provides the following advantages:

- ✓ Continuous review of the processes that could lead to a compliance issue
- ✓ Personnel change impacts are more transparent and less impactful to compliance outcomes
- ✓ Preventative in nature
- ✓ Moves the learnings to the point of activity
- ✓ Provides an opportunity to correct potential problems prior to becoming a compliance violation



Compliance and Control testing serve distinctly different yet complimentary purposes within an overall risk-reducing Control Program

Compliance Testing is evaluating our current/past position against a known standard or requirement.

"Are we compliant now?"



Control Testing is evaluating the process(s) used by control owners to determine if they are effectively designed to protect the BES and mitigate compliance risks.

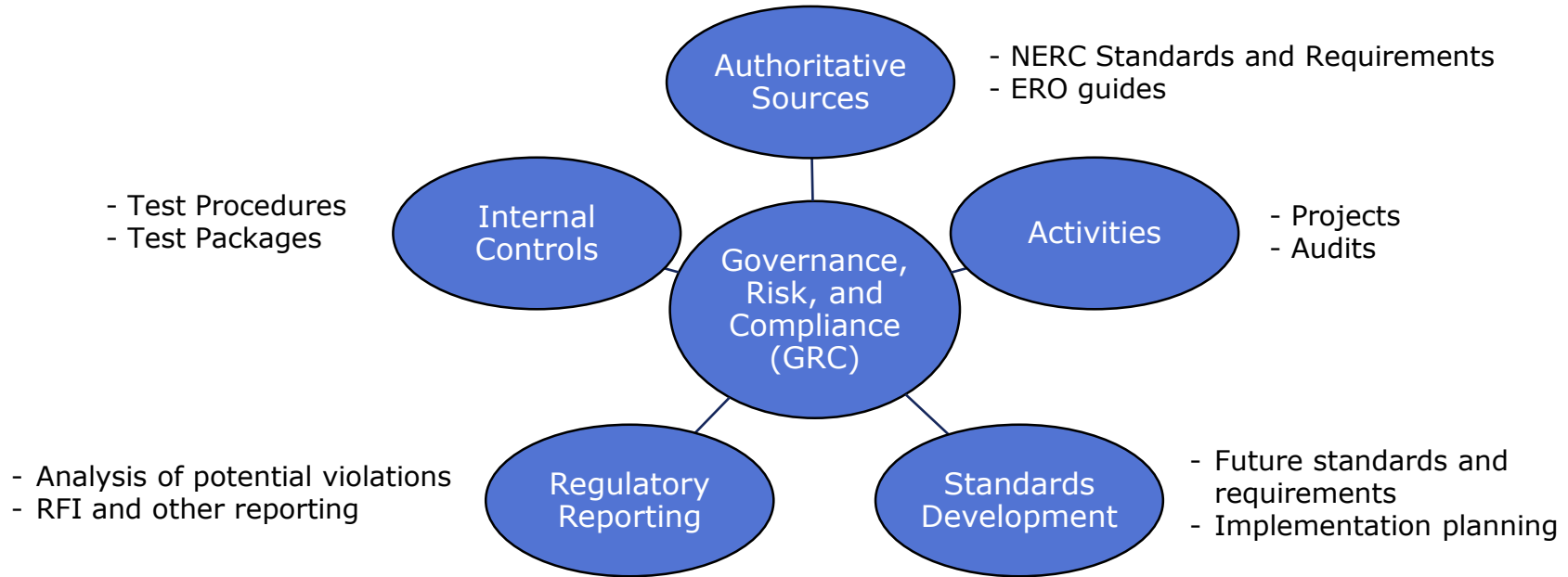
"How do we ensure that we are/remain compliant?"



"Even effectively designed and implemented internal controls cannot provide absolute assurance of compliance with NERC Reliability Standards"

– NERC ERO Enterprise Guide for Internal Controls

We are establishing our Governance, Risk, and Compliance (GRC) tool to be at the center of our NERC compliance activities



- Our GRC tool will centralize and automate our NERC compliance activities, improving efficiency and visibility while reducing manual effort and risk
- It will streamline evidence collection, standardize processes, and enhance audit readiness, making it easier to manage regulatory changes and ensure consistent compliance across the organization