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TEXASRE

Ensuring electric reliability for Texans

2023 RELIABILITY PERFORMANCE AND REGIONAL RISK ASSESSMENT

JUNE 2024

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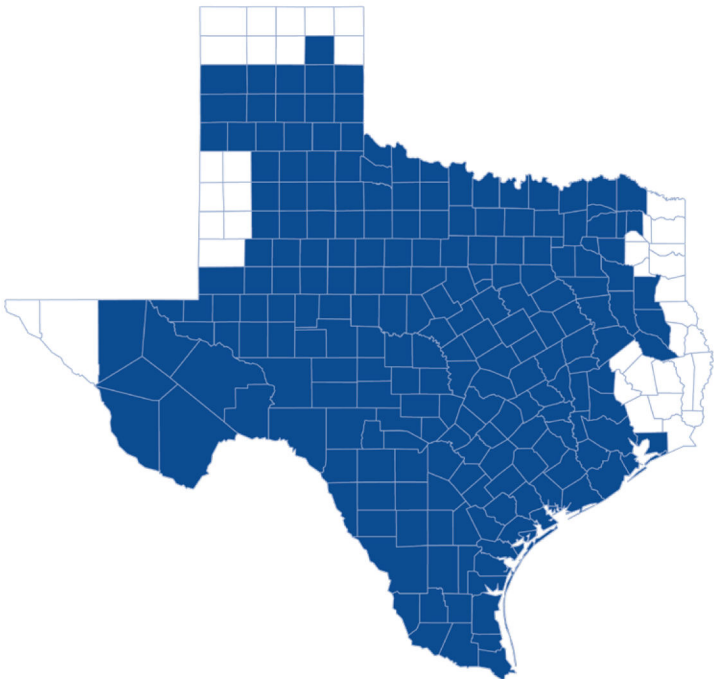


INTRODUCTION

Electricity is essential in our daily lives for the health and safety of our communities. As part of its mission, Texas Reliability Entity, Inc. (Texas RE) periodically assesses and reports on the reliability and adequacy of the Bulk Power System (BPS) within the Texas Interconnection (also known as the Electric Reliability Council of Texas [ERCOT] Interconnection). The Assessment of Reliability Performance annually compiles analyses for the previous year and this document is the 2023 report of that analysis.

The goals of this report are to paint the overall BPS reliability picture with historical context, identify current and future risk areas, and prioritize them to promote actionable results for reliability improvement.

This report provides insight into areas where reliability goals can be more effectively achieved by addressing key measurable components of BPS reliability. Additionally, it aligns data and facts reported from multiple sources with full information transparency. This report provides insight into the current state of reliability in the Texas RE Region. Its purpose is to inform policy makers and other stakeholders, elevate identified risks to grid reliability, and prioritize focus areas for future outreach by Texas RE.



TEXAS RE'S MISSION

To assure efficient and effective reduction of risks to the reliability and security of the Bulk Power System within the ERCOT Interconnection.

DATA SOURCES

TADS
Transmission Availability
Data System

GADS
Generation Availability
Data System

DADS
Demand Response
Availability Data System

MIDAS
Misoperation Information
Data Analysis System

EVENT REPORTS
OE-417,
NERC EOP-004,
& NERC Events Analysis

Frequency Control
Performance and
Primary Frequency
Response

ERCOT ISO Data
and Reports

2023 IN REVIEW

Society relies on electricity in every aspect of daily life and a reliable electric system can mean the difference between life and death. Across North America, future energy peak demand is rising faster than at any time in the past five or more years. Texas is no different. The Texas RE/ERCOT Region (hereafter “Region”) is experiencing significant load growth and demand expectations. Moreover, load patterns are no longer as predictable due to the integration of large flexible loads and distributed energy resources (DER).

As load increases, the Region’s generation and transmission topology is also undergoing important changes. The generation mix continues to evolve toward more variable resources utilizing power electronics and away from traditional dispatchable fossil-fueled machines. Annual energy production grew along with renewable generation output and penetration levels to meet projected peak loads. New energy storage resources (that act as both load and generation) are also increasingly being integrated into the ERCOT system. Climate extremes, such as prolonged heat and drought, severe cold weather, and increasingly frequent and more powerful storms continue to affect

generation availability, along with the availability of fuel supplies such as natural gas. The transmission system has operational limits that must be considered in order to maintain system reliability. ERCOT implemented Generic Transmission Constraints (GTCs) that are used to monitor and manage thermal and stability constraints to prevent widespread cascading and stability events. In addition, physical and cyber threats have been increasing due to both foreign and domestic actors.

Even with this array of dynamic challenges, the Region continues to demonstrate adequate reliability for normal operating conditions (and when subjected to contingencies within planned parameters). As in recent years, the Region handled extended high summer peak periods helped by new solar generation and storage resources. Policymakers have implemented an array of new requirements to increase generation extreme weather preparedness, support alternative fuel availability during peak natural gas demand periods, and enhance coordination across critical infrastructure sectors. Continued efforts at the state and national levels will be vital to ensuring that the Region continues to successfully meet the range of challenges facing the Bulk Power System (BPS) across North America.



INTERCONNECTION RISK FOCUS AREA HIGHLIGHTS

Texas RE continuously evaluates existing and emerging risks to the Texas Interconnection in developing its risk-based programs. Based on the review of significant risks in 2023, Texas RE focused on risk mitigation activities in three key reliability areas:

- Grid transformation and inverter-based resource (IBR) performance
- Extreme events resiliency and winterization
- Cyber and physical security



2023 IN REVIEW

GRID TRANSFORMATION AND IBR PERFORMANCE

In 2023, Texas RE supported activities to reduce risks for IBR performance, and monitored trends related to solar generation resource ramping and significant declines in wind generation. Key events included:

ONGOING EFFORTS TO REDUCE RISKS FROM INVERTER-BASED RESOURCES (IBRs)

The June 2022 Odessa Disturbance involved over 1,700 megawatts (MW) of reduced output from solar photovoltaic (PV) facilities that were up to several hundred miles away from the location of the initiating event—a single-line-to-ground fault at a 345 kilovolt (kV) substation near Odessa, Texas. In December 2022, Texas RE and North American Electric Reliability Corporation (NERC) staff prepared a [joint report on the 2022 Odessa Disturbance event](#), including recommendations to address IBR performance issues, mitigate abnormal performance, and perform comprehensive model quality reviews. Additional events with concurrent and unexpected IBR generation losses, such as the Southwest Utah disturbance in April 2023 and the California battery energy storage disturbances in April and May of 2023, continue to pose a significant risk to BPS reliability. Texas RE and

NERC staff noted in the 2022 Odessa Report that many of the underlying causes of abnormal performance are systemic in nature, but were not captured in system planning assessments or interconnection studies due to lack of comprehensive interconnection processes for IBR capability and performance requirements.

Since the June 2022 Odessa event and the publication of the 2022 Odessa Report, ERCOT has taken steps to implement recommendations in the report and reduce the IBR disturbances risk by initiating Nodal Operating Guide Revision Requests (NOGRR) 245 and 255, as well as Planning Guide Revision Requests (PGRR) 085 and 109. The two NOGRRs propose more stringent ride-through requirements as well as data recording and monitoring requirements. The two PGRRs seek to introduce new requirements for dynamic modeling of IBRs. These NOGRRs and PGRRs are currently working through the ERCOT stakeholder process.

ERCOT has conducted planning assessments to identify necessary transmission reliability improvements aimed at addressing operational challenges associated with IBRs. As a result of these assessments, ERCOT recommended six synchronous condensers with flywheels at six 345 kV substations in West Texas. This synchronous condenser project received the endorsement of the ERCOT Board in December 2023 and is projected to be in-service in 2027. ERCOT has also been working directly with IBR generator owners and operators to correct the specific issues identified in the Odessa report and has achieved some success, including settings changes related to phase-lock-loop loss of synchronism, voltage phase jump settings, overvoltage threshold changes, and firmware changes. However, getting updated IBR models continues to be a problem area. As the penetration of solar photovoltaic (PV) and other IBRs continues to grow rapidly in the ERCOT footprint, it is paramount that these performance



2023 IN REVIEW

issues are immediately addressed. ERCOT should be commended for the proactive approach it has taken to address these performance issues, including multiple outreach opportunities with Generator Owners and manufacturers, as well as drafting new performance requirements in the Nodal Operating Guides and Protocols and implementing a new Transient Security Assessment Tool (TSAT) for operations.

In March 2023, NERC issued a Level 2 Alert on [Inverter-based Resource Performance Issues](#). The purpose of the alert was to collect data and provide specific recommendations to industry to reduce the systemic performance issues identified in multiple disturbance reports. The data collection effort included responses from 521 generation facilities, fifteen different inverter manufacturers, and over 53,500 MW of solar capacity.

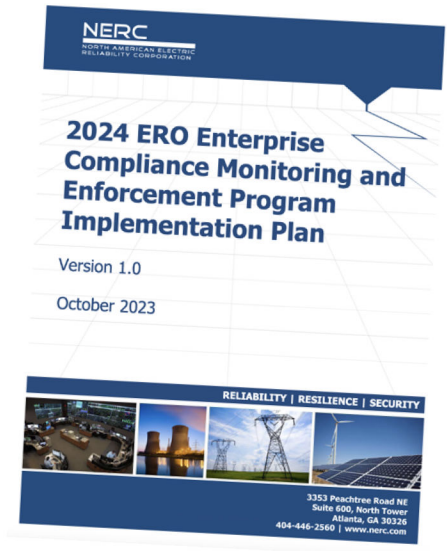
In October 2023, the Federal Energy Regulatory Commission (FERC) directed NERC to develop new or modified Reliability Standards that address reliability gaps related to inverter-based resources in the following areas: data sharing; model validation; planning and operational studies; and performance requirements.¹ In response to FERC Order No. 901, NERC filed its initial plan to implement new standards to address the order's directives in these areas. As part of this workplan, multiple IBR-related high priority standards projects are slated to be completed in 2024, including new IBR performance requirements. As these standards are being developed, Texas RE staff will emphasize the current IBR performance requirements, as well as modeling



and interconnection study requirements set forth in the [2024 Electric Reliability Organization \(ERO\) Enterprise Compliance Monitoring and Enforcement Program \(CMEP\) Implementation Plan \(IP\)](#).

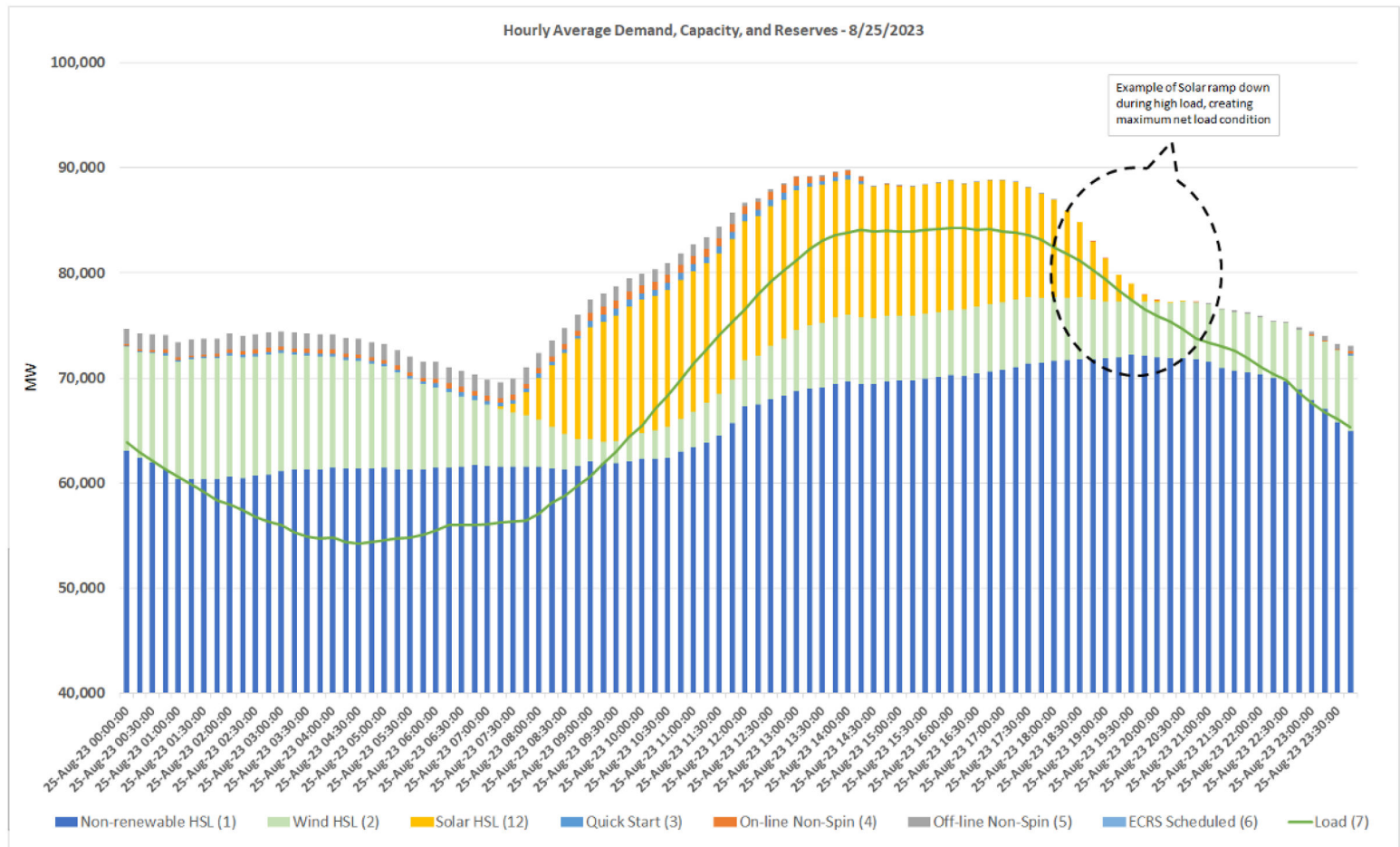
SUMMER SOLAR RAMP ISSUES

During the summer of 2023, ERCOT issued public appeals for energy conservation on eleven different dates, with the majority of these dates between August 17 and September 7. Evening down-ramps of solar generation between the hours of 1800 and 2000, combined with high summer evening loads were the primary cause of these public appeals. Solar generation down-ramps exceeded 7,000 MW per hour on several occasions. Maximum net-load up-ramps exceeded 10,000 MW per hour on multiple occasions, stressing the conventional generation fleet's ramping capability. ERCOT mitigated these issues through deployments of ancillary services, including ERCOT Contingency Reserve Service (ECRS), non-spinning, and quick start reserves. See the example at the top of the next page from August 25, 2023.



¹FERC Order No. 901: Final Rule; Reliability Standards to Address Inverter-Based Resources under RM22-12 (Oct. 19, 2023) ("FERC Order No. 901").

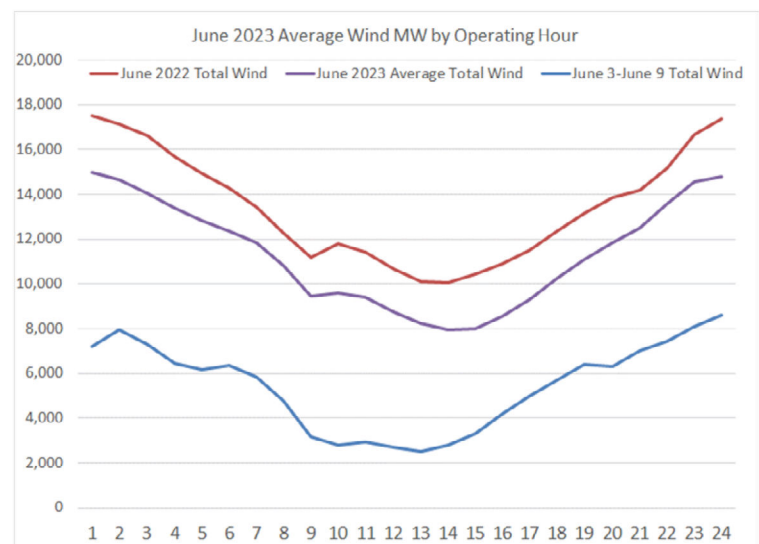
2023 IN REVIEW



JUNE 2023 "WIND DROUGHT"

Below-normal wind speeds prevailed both from the zonal and meridional wind directions across most of the wind power generation zones of the central U.S. during June 2023. Zonal (west-to-east/east-to-west) below normal wind speed anomalies occurred across most of the Northern U.S., especially the upper Midwest to Northeast sector due to high pressure centered in Canada and the arrival of an El Niño weather pattern. This extended across the northern states with some impact on North Texas and the Panhandle. Larger meridional (south-to-north/north-to-south) wind speed anomalies were also below normal from West Texas to the Northeast. As a composite, the central and Midwest experienced below normal wind speeds during June, which impacted wind generation.

In the first 15 days of June 2023, total ERCOT wind energy was down 45 percent from the same period in 2022. The two lowest actual values were 38 MW and 77 MW for Hour Ending (HE) 10 and HE11 on June 6, 2023.



2023 IN REVIEW

EXTREME EVENTS RESILIENCY AND WINTERIZATION

Texas RE continued to monitor and prioritize risk mitigation activities addressing extreme events resiliency and generator winter readiness. Of particular importance, Texas RE supported the ongoing activities to implement the recommendations from Winter Storms Elliott and Uri, and played a key role in the development of the December 2023 Blackstart Report. These efforts also include supporting activities to address critical infrastructure interdependencies, particularly between the electric generation and natural gas pipeline sectors.

WINTER STORM URI AND ELLIOTT RECOMMENDATION AND FOLLOW-UP ACTIVITIES

Between December 22 and December 25, 2022, much of the United States (including most of Texas) was impacted by Winter Storm Elliott's extreme cold temperatures. As with previous cold weather events, outages due to freeze-related issues and natural gas curtailments affected the generation fleet. ERCOT did not have any power capacity limitations that necessitated an energy emergency declaration, even as it set a new winter peak. In November 2023, FERC, NERC and Regional Entity staff (including Texas RE) issued the [Final Report on Lessons from Winter Storm Elliott](#). The Joint Elliott Report describes how the extreme cold weather event that occurred December 21 to 26, 2022, impacted the reliability of the BPS and the supporting natural gas infrastructure in the U.S. Eastern Interconnection. During the Event, 1,702 individual BPS generating units in the Eastern Interconnection experienced 3,565 unplanned outages, derates, or failures to start. Each individual unit could, and often did, have multiple outages from the same or different causes. At the worst point, the Event had 90,500 MW of coincident unplanned generating unit outages, derates, and failures to start (meaning they all occurred at the same time). Including generation already out

of service, a total of over 127,000 MW of generation was unavailable, representing 18 percent of the U.S. portion of total anticipated resources in the Eastern Interconnection. The findings and recommendations included in the report expand on the previous recommendations from Winter Storm Uri.

In May 2023, NERC issued a Level 3 Alert on [Cold Weather Preparations for Extreme Weather Events](#). The purpose of the alert was to collect data to increase readiness and enhance plans for the upcoming winter. The responses to the Cold Weather Alert were used to identify weak areas and formulate outreach to registered entities.



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In addition, EOP-011-2 requirements R7 and R8 became effective on April 1, 2023. These requirements are part of the 2024 ERO CMEP Implementation Plan. The NERC Board of Trustees has also approved enhanced cold weather winterization requirements under the new EOP-012 standard, which is scheduled to become effective on October 1, 2024. Texas RE staff will emphasize these requirements as part of its extreme weather response focus area for upcoming compliance engagements.

BLACKSTART AND NEXT-START RESOURCE REPORT

In December 2023, FERC, NERC, and Regional Entity staff (including Texas RE staff) jointly issued the [Blackstart and Next-Start Resource Availability Study in the Texas Interconnection](#) that originated from recommendations in The [February 2021 Cold Weather Outages in Texas and the South Central United States](#) report on Winter Storm Uri.

The study made several key findings, including that ERCOT has defined procurement procedures in place to secure Blackstart Resources and that ERCOT has verified the sufficiency of the Blackstart Resources in its blackstart system restoration plan through simulations and models. However, the mix of the Blackstart Resources available to ERCOT has limited fuel diversity as it relies heavily on natural gas as fuel for its Blackstart and next-start Resources. The study also observed that the electric and natural gas industries are heavily reliant on one another to maintain reliable operations. For this reason, the study concluded that having open lines of communication in place between the two industries in preparation for a blackstart system restoration scenario is necessary to facilitate timely restoration of the electric grid. To that end, the study highlighted the need for the

electric and natural gas industries to work together to develop a joint blackstart system restoration plan that considers extreme cold weather conditions and the mutual interdependence of these two complex and important industries.

Texas RE staff presented these findings both to FERC and the Public Utility Commission of Texas (PUCT) at their respective open meetings.

Blackstart and Next-Start Resource Availability in the Texas Interconnection

FERC, NERC and Regional Entity Staff Study
December 2023



NERC
NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Regional Entities:



2023 IN REVIEW

CYBER AND PHYSICAL SECURITY

Operational security is essential for a highly reliable and secure electric grid. Like the other regions of North America, the Region faces an array of security challenges associated with the convergence of information technology (IT) and operational technology (OT). At the same time, the BPS is integrating new types of facilities, services, and technologies. These include growing reliance on cloud-based technologies, the emergence of artificial intelligence, dispersed management systems, and the increased use of internet-protocol enabled devices to name just a few. These changes are occurring while global conflicts continue to threaten BPS cyber security and domestic terror threats aim to disrupt normal operations of the grid.

Despite these critical challenges, the Region experienced minimal impact from cyber security events affecting BPS facilities in 2023. However, security threats remain persistent and continual vigilance is required. Texas RE staff focused activities around remote connectivity controls, supply chain security, advanced persistent threats (such as ransomware), and incident response. These activities will continue in 2024.

Protecting physical infrastructure from a wide range of threats continued to be a top priority in 2023. Across North America, the Electricity Information Sharing & Analysis Center (E-ISAC) noted continued risks from ballistic damage, theft, and vandalism.² In the Region, Texas RE observed increases in reported physical security incidents. Consistent with this increased threat, the 2024 ERO CMEP IP included a new risk focus area around physical security for the first time. Texas RE compliance staff will continue to emphasize



physical security protections through its compliance monitoring and outreach activities in 2024.

FERC Order No. 887 directed NERC to conduct a study on the risks (or lack thereof) and challenges to implementing, internal network security monitoring for medium impact Bulk Electric System (BES) Cyber Systems without External Routable Connectivity and for all low impact BES Cyber Systems. In response, NERC issued a Section 1600 Data Request for internal network security monitoring on May 25, 2023.

Over the past year, NERC has identified instances of cross-border operation or control of bulk power system elements. Technological advancements have enabled dispersed management systems used by distributed energy resource aggregators, Internet-of-Things devices, and outage management systems, and have increased automation/integration of operational technology networks, increasing the opportunity for cross-border operations. In November 2023, NERC issued a Section 800 Data Request³ that will enable NERC to identify the extent to which non-U.S. entities have the ability to operate or control U.S. bulk power system assets.

SEPTEMBER 6, 2023, ENERGY EMERGENCY ALERT

Texas RE monitored and followed up on one Energy Emergency Alert (EEA) event in 2023. Specifically, on

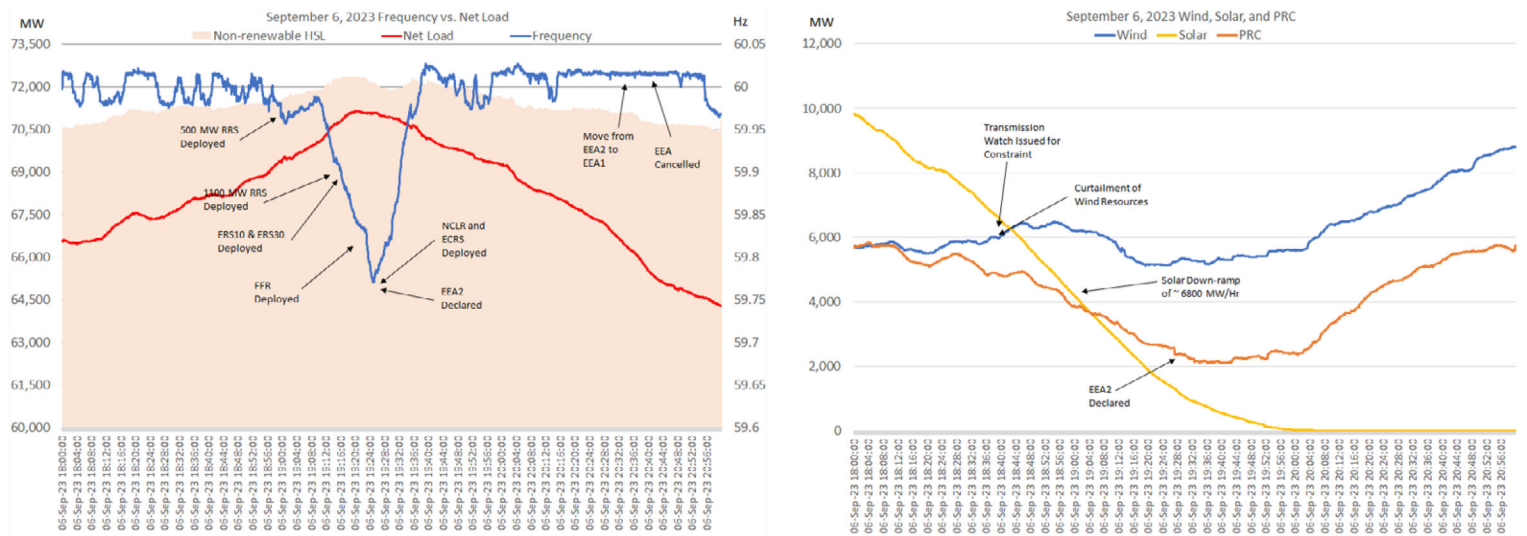


² 2023 E-ISAC End-of-Year Report, at 4 (Dec. 2023).

³ [NERC to Issue Section 800 Data Request to Assess the Extent of Cross-Border Operation Control of Bulk Power System Elements](#)

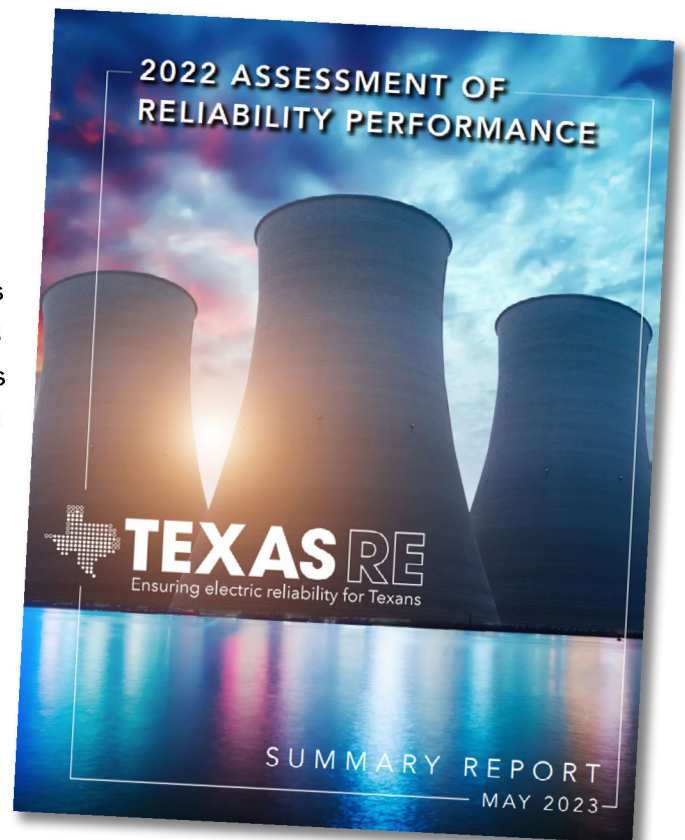
2023 IN REVIEW

September 6, 2023, ERCOT entered into an EEA level 2 between 19:25 and 20:37 due to low frequency conditions arising from a combination of unusually high September system loads, low wind output in the north, and the evening down-ramp in solar production. High wind generation in the south and coastal areas aggravated the issue, which caused a 345 kV line south of San Antonio to exceed its System Operating Limit (SOL). To mitigate this SOL exceedance, ERCOT issued curtailment signals to multiple wind generation resources for approximately 1,590 MW. Wind curtailment in turn led to a capacity shortage and frequency drop, which ERCOT resolved through demand response and ECRS ancillary service deployments after declaring EEA2.



REVIEW OF 2023 FOCUS AREAS FROM 2022 ASSESSMENT OF RELIABILITY PERFORMANCE

In the [2022 Assessment of Reliability Performance](#), Texas RE identified multiple focus areas to prioritize the mitigation of risks across its reliability and compliance programs. These focus areas aligned with the three high-level Texas Interconnection risk focus areas (grid transformation and IBR performance, extreme events resiliency and winterization, and cyber and physical security) and shape Texas RE's engagement and outreach activities. The following table summarizes significant 2023 activities related to these specific risk focus areas.

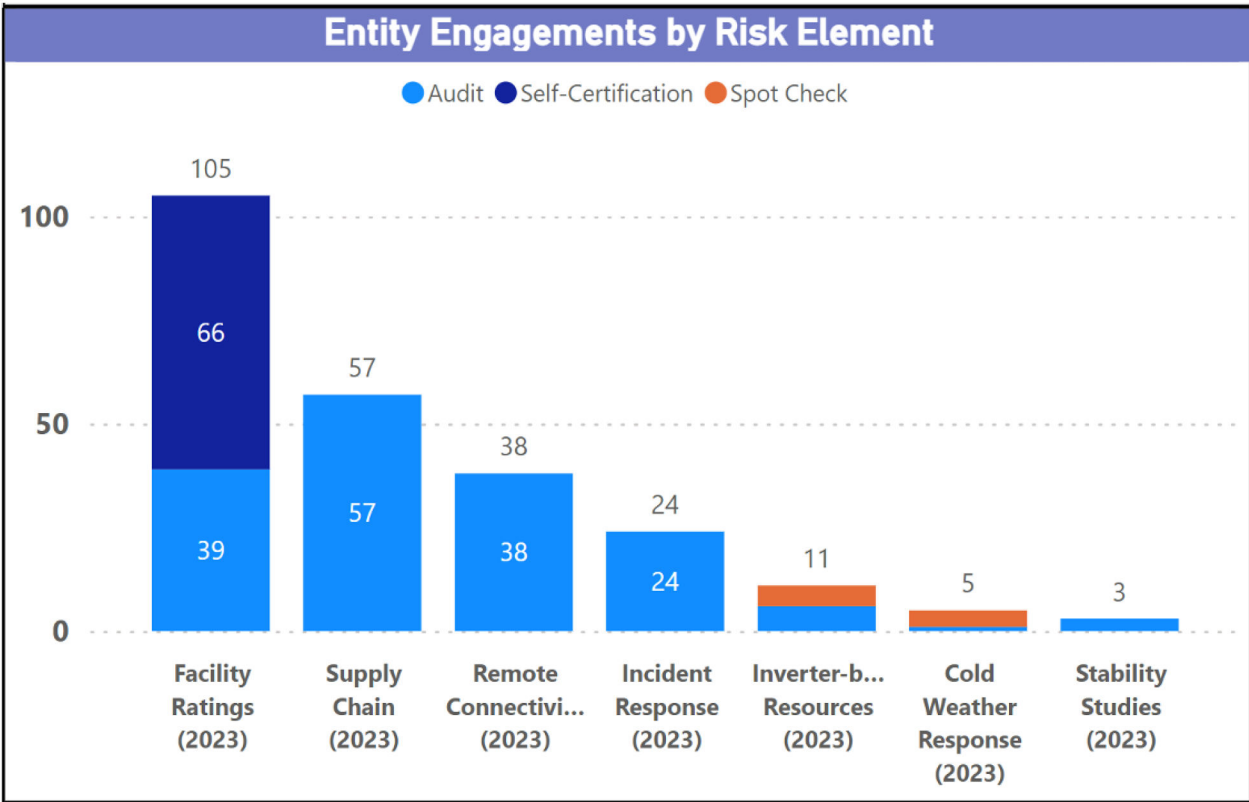
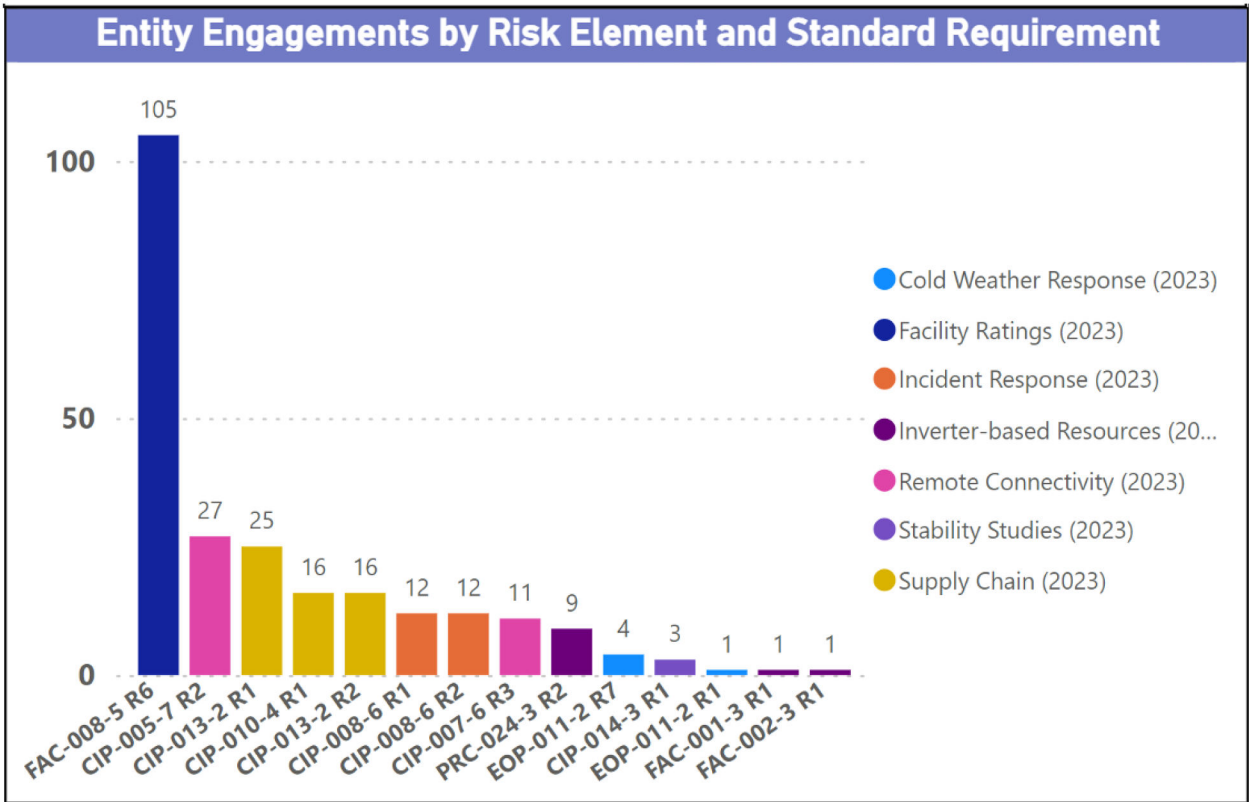


2023 IN REVIEW

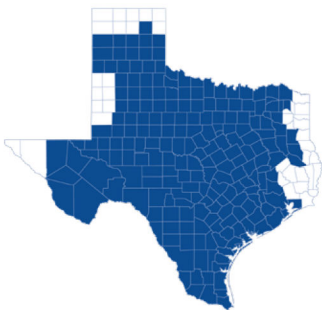
FOCUS AREA	SELECT OUTREACH HIGHLIGHTS	COMPLIANCE ENGAGEMENTS
Extreme Weather & Resource Weatherization	<ul style="list-style-type: none"> March 2023 Talk with Texas RE: Cold Weather Standards May 2023 Level 3 NERC Alert on Cold Weather Preparations for Extreme Weather Events September 2023: Winter Weatherization Workshop November 2023: ERO FERC Winter Storm Elliott report 	<ul style="list-style-type: none"> Engaged five entities that included cold weather Reliability Standards
IBR Ride-through	<ul style="list-style-type: none"> January 2023 Talk with Texas RE: June 2022 Odessa Disturbance Report March 2023 Level 2 NERC Alert on Inverter-Based Resource Performance Issues 	<ul style="list-style-type: none"> Engaged 11 entities that included modeling Standards and IBRs
Physical Security, Malware, Remote Access, and Supply Chain	<ul style="list-style-type: none"> February 2023 Talk with Texas RE: Cybersecurity Threats March 2023 Talk with Texas RE: Advanced Persistent Threat Cyber Tools April 2023 Talk with Texas RE: E-ISAC update December 2023 Talk with Texas RE: Cyber Asset Management August 2023 Talk with Texas RE: Cybersecurity for Distributed Energy Resources August 2023 Talk with Texas RE: Cybersecurity for Oil and Gas Industry 	<ul style="list-style-type: none"> Engaged 11 entities that included requirements associated with remote connectivity Engaged 11 entities that included a supply chain area of focus
Provision of Essential Reliability Services from a Changing Resource Mix	<ul style="list-style-type: none"> July 2023: Grid Transformation Workshop November 2023 Talk with Texas RE: Distributed Energy Resources December 2023: ERO FERC Blackstart Unit Availability report 	<ul style="list-style-type: none"> N/A
Energy Reliability Planning	<ul style="list-style-type: none"> January 2023 Talk with Texas RE: NERC and ERCOT Reliability Assessments May 2023 Talk with Texas RE: Summer Outlook 	<ul style="list-style-type: none"> N/A
Gas Supply Restrictions during Cold Weather	<ul style="list-style-type: none"> October 2023 Talk with Texas RE: Electric-Gas Coordination 	<ul style="list-style-type: none"> N/A
Inaccurate Resource Modeling	<ul style="list-style-type: none"> July 2023: Grid Transformation Workshop 	<ul style="list-style-type: none"> Engaged 11 entities that included modeling Standards and IBRs Engaged 105 entities that included the Facility Ratings Standard
Equipment Failures/ Misoperations, and Loss of Situational Awareness	<ul style="list-style-type: none"> May 2023 Talk with Texas RE: Assessment of Reliability Performance 	<ul style="list-style-type: none"> N/A



2023 IN REVIEW



TEXAS INTERCONNECTION AT A GLANCE



BY THE NUMBERS

REGISTERED ENTITIES 337

Distribution Providers 36

Generator Owners 261

Generator Operators 193

Transmission Owners 28

Transmission Operators 20

Transmission Planners 26

Generating Units > 1,100

Miles of Transmission > 52,000

Population Served > 26 Million

Percentage of Texas Load 90%

MW Peak Demand 85,508

Renewable Penetration Record 70.5%

CAPACITY AND GENERATION — FIVE YEAR CHANGE

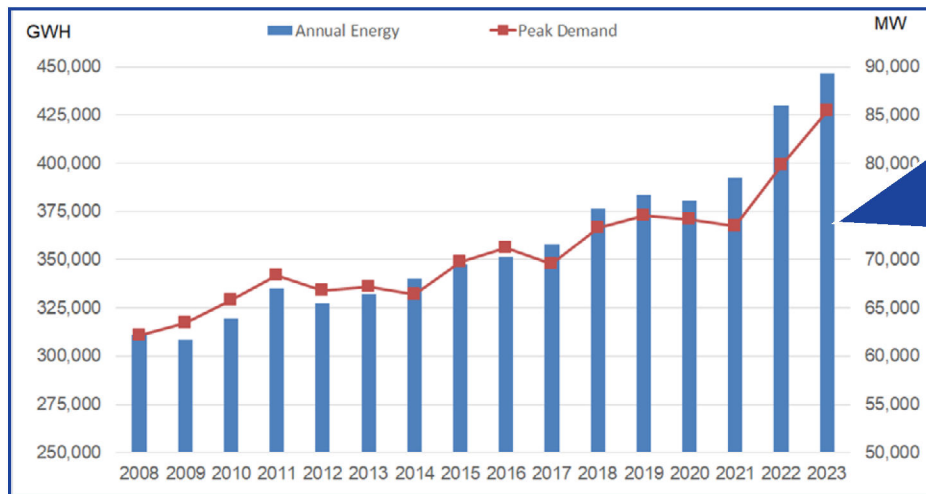
FUEL SOURCE	2018 (MW)	2023 (MW)	% Change	2018 (MWH)	2023 (MWH)	% Change
Coal	15,608	14,713	- 6%	93,249	61,734	- 34%
Natural Gas	52,262	69,185	+ 32%	167,206	200,419	+ 20%
Wind	22,633	38,694	+ 71%	69,796	107,995	+ 55%
Solar	1,909	22,258	+ 1,066%	3,240	32,400	+ 900%
Hydro	555	583	+ 5%	811	345	- 57%
Nuclear	4,960	5,268	+ 6%	41,125	40,746	- 1%
Storage	104	5,100	+ 4,804%			
Other	202	174	- 14%	957	1,031	+ 8%

TRANSMISSION — FIVE YEAR CHANGE (BASED ON TADS DATA)

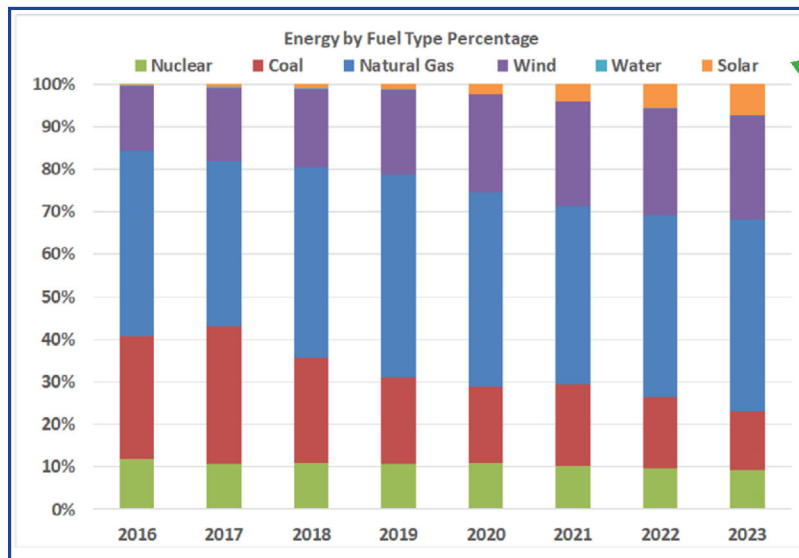
VOLTAGE	2018 (Circuit Miles)	2023 (Circuit Miles)	% Change
345 kV	16,334	20,943	+ 28%
138 kV	25,299	29,451	+ 16%

DEMAND AND ENERGY

2023 AT A GLANCE



**ALL-TIME SUMMER
PEAK DEMAND
RECORD:**
85,508 MW
on 8/10/2023



**PEAK HOURLY
RENEWABLE
GENERATION:**

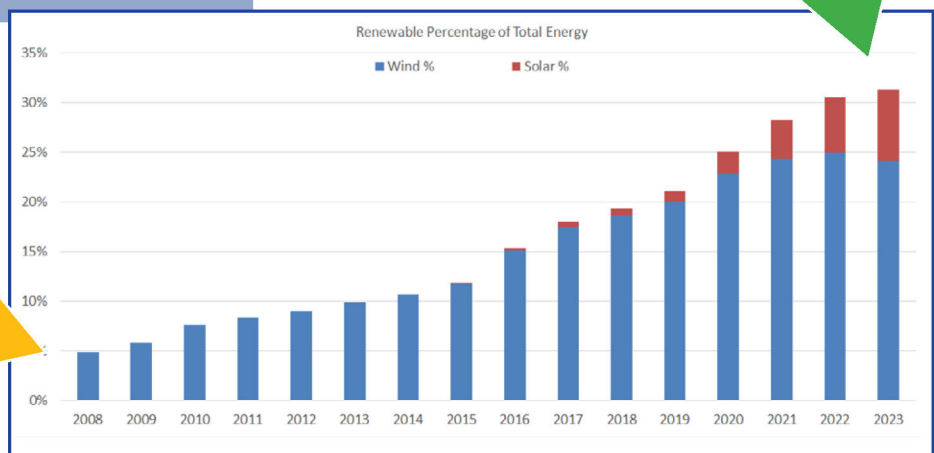
31,350 on
8/9/2023

**RENEWABLE
ENERGY SERVED:**

32.6% of total
energy in 2023

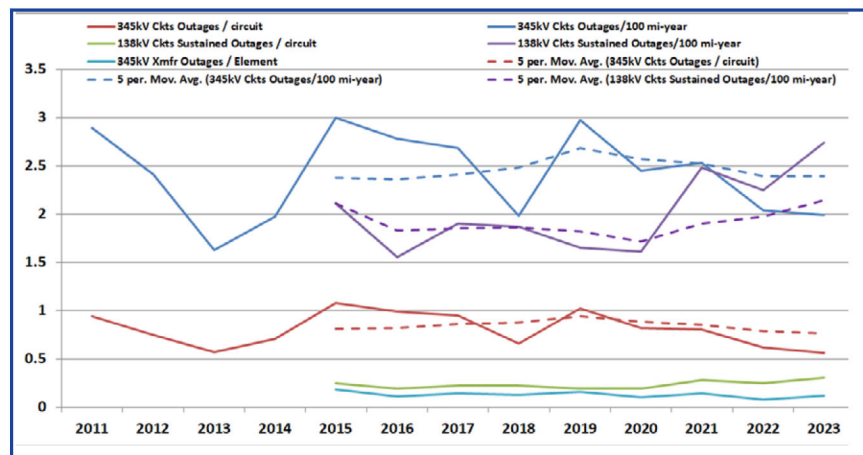
**PEAK HOURLY
RENEWABLE
PENERATION:**

68.1% on
4/29/2023

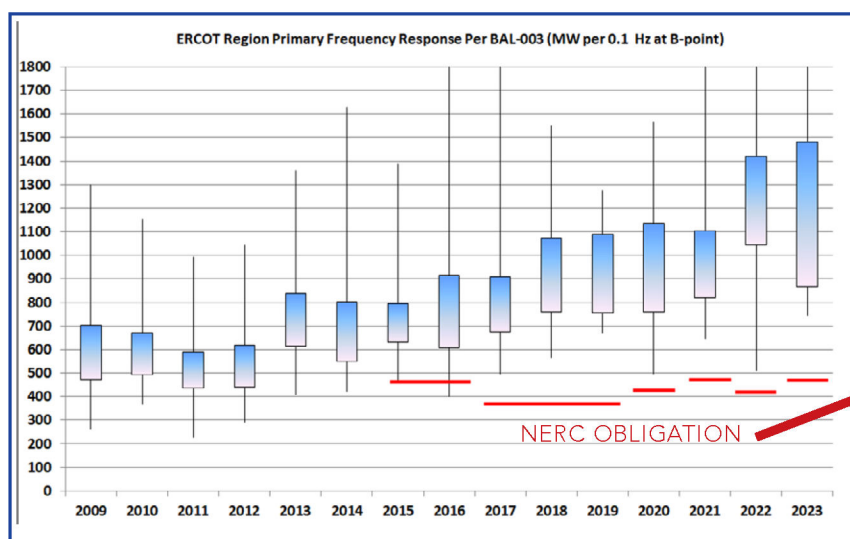


RELIABILITY

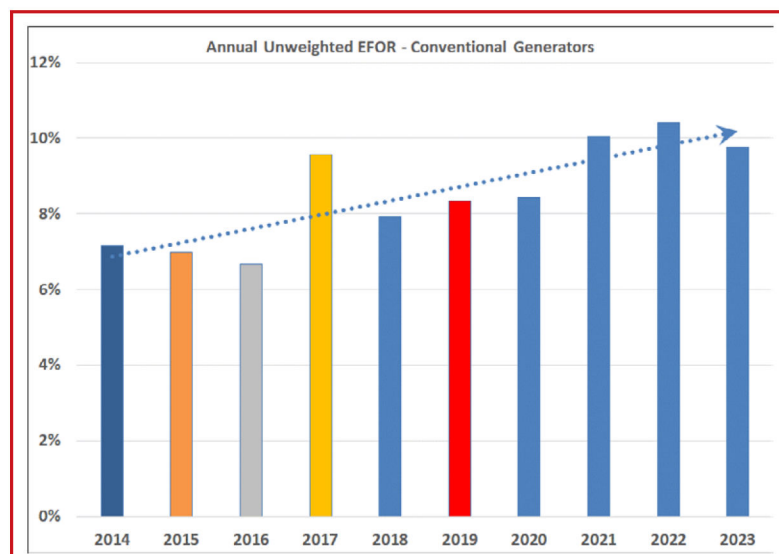
2023 AT A GLANCE



345 Transmission line outage rates remained stable in 2023, however, 138 kV Transmission line outage rates increased to its highest level in the last five years.



PRIMARY FREQUENCY RESPONSE:
1106 MW/0.1Hz for 2023 vs. NERC Obligation of 463 MW/0.1Hz



	2023	2022
CONTROL PERFORMANCE STANDARD 1 (CPS1)	173.4	173.4
TADS 345kV CIRCUIT AUTOMATIC OUTAGE RATE PER 100 MILES	2.00	2.04
PROTECTION SYSTEM MISOPERATION RATE	4.6%	7.3%
GENERATION AVAILABILITY DATA SYSTEM (GADS) EQUIVALENT FORCED OUTAGE RATE (EFOR) UNWEIGHTED	9.8%	10.4%

2023 PERFORMANCE METRICS

Texas RE utilizes key performance indicators to evaluate how effectively the Region is meeting targeted electric reliability objectives. The table below describes these indicators and event performance, how they are measured, the target values, and an assessment of the current state of each.

IMPROVING

Improving trend compared to previous four years or improved event performance or observed conditions.

STABLE OR NO CHANGE

Minimal or no change compared to previous four years.

MONITORING

Declining trend compared to previous four years or specific negative event performance issues.

ACTIONABLE

Declining trend for two or more consecutive years or significant negative event performance.

Key Performance Indicator with Description

2023 Performance & Trend Results

Resource Adequacy

Measures potential resource adequacy issues by analysis of planning reserve margin and energy emergency alerts.

- Reserve margins show sufficient resource capacity
- Extreme event scenarios highlight risk areas

- Resource weatherization

Transmission Performance

Measures transmission performance by analysis of transmission outage rates and Interconnection Reliability Operating Limits (IROL) exceedances.

- 345 kV & 138 kV transmission outage rates are stable

- IROL Exceedances

Resource Performance

Measures generation performance by analysis of generator outage rates, primary frequency response, and balancing contingency events.

- Resource outages/gas restrictions during cold weather
- Long-term continued increase in EFOR rates

- Primary frequency response
- No balancing contingency event failures

Grid Transformation

Measures potential issues related to grid transformation by analysis of system inertia and ramping.

- Solar ramp magnitudes continue to increase
- Synchronous generator retirements

- Voltage ride through for inverter-based resources
- Decrease in average system inertia levels

Protection System Performance

Measures Protection System Performance by analysis of Protection System Misoperations.

- Misoperations due to incorrect settings decreased in 2023
- Misoperation rate decreased in 2023, remains less than overall NERC Misoperation rate

Human Performance

Measures transmission outages, generation outages, and Protection System Misoperations caused by human error.

- Reduction in transmission and generation outage rates from human error

- Human error primary causal factor in Misoperations and events

Situational Awareness

Measures situational awareness by analysis of state estimator convergence rates, event analysis, and telemetry performance.

- Four loss of situational awareness events
- State estimator convergence rate

2023 KEY FINDINGS

Texas RE continually evaluates risks to grid reliability in its Region through long-term and seasonal reliability assessments, event analyses, situational awareness, tracking reliability indicators, real-time performance monitoring, and planning observations. The 2023 Reliability Performance and Regional Risk Assessment report provides a high-level overview of the data collected in 2023. It includes:

- Overview of 2023's numbers
- Associated historical data
- The current state of the Interconnection
- Observations for the future of Texas RE's Region

To gauge reliability of the Region and turn that data into actionable information, Texas RE assessed data and historical trends in these areas:

GRID TRANSFORMATION

Bulk Power System Planning
Resource Adequacy and Performance
Protection and Control Systems
Situational Awareness Challenges
Human Performance
Changing Resource Mix

RESILIENCE TO EXTREME EVENTS

CYBER AND PHYSICAL SECURITY

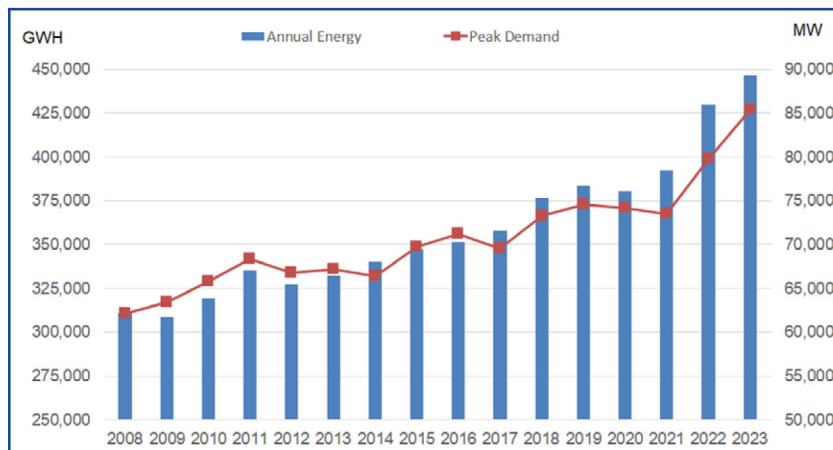
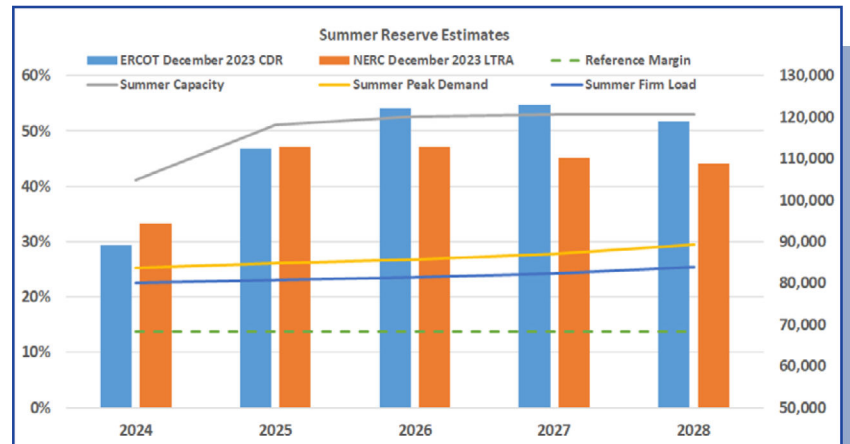
CRITICAL INFRASTRUCTURE INTERDEPENDENCIES

KEY FINDINGS - GRID TRANSFORMATION

BULK POWER SYSTEM PLANNING

The [2023 NERC Long-Term Reliability Assessment \(LTRA\)](#) shows a planning reserve margin above the 13.75 percent reference margin for the next five years in the Region. [ERCOT's 2024-2033 Capacity, Demand and Reserves \(CDR\)](#) report also shows a planning reserve margin above 13.75 percent for the next five years. While both of these reports are focused on the long-term planning reserve margins, the results will differ due to multiple factors such as data collection dates and forecasting of load.

ERCOT had 2,020 MW of non-modeled generation capacity and 2,511 MW of unregistered distributed generation resources (DGR) at the end of 2023.

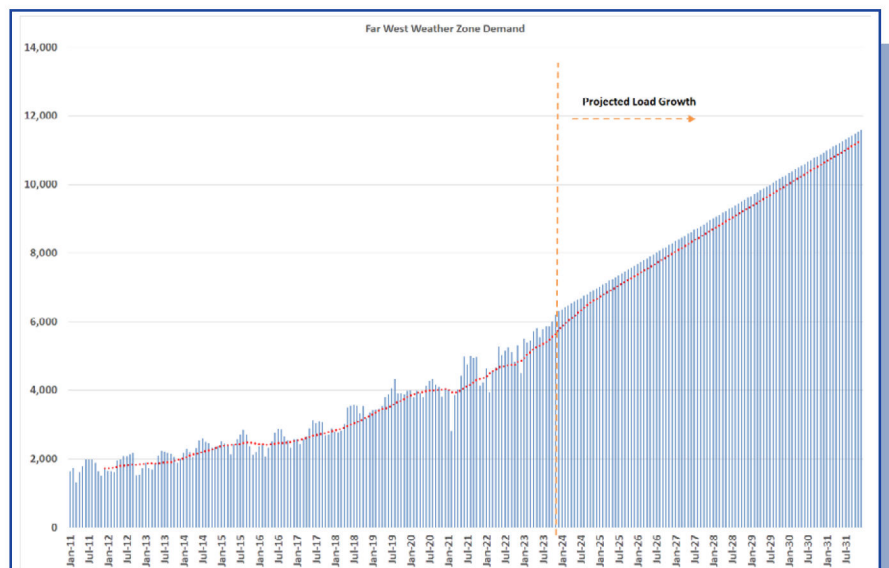


WEST TEXAS LOAD GROWTH

ERCOT studies project the load growth in the Permian Basin to be 11.9 GW by 2030. An additional 14.7 GW of forecasted load is expected to peak in 2039. ERCOT is working with the Transmission Distribution Service Providers (TDSPs) serving the Permian Basin to develop transmission plans to interconnect the forecasted load in the area as required by House Bill 5066 (88th Legislature). In addition to the rapid oil and gas demand growth in the Permian Basin, significant amounts of large flexible loads (typically cryptocurrency data centers) are also seeking interconnection in the area. In the 2023 Regional

Transmission Plan, the 2029 Far West weather zone load forecast is close to 15 GW. ERCOT has performed independent review and approval of multiple transmission projects in the past three years to reliably interconnect the forecasted load in the area.

Since 2014, there have been \$4.3 billion of approved projects in the Permian Basin and \$1.12 billion of projects are currently under review. 630 miles of 345-kV lines were completed with another 330 miles approved for construction and over 430 miles currently under ERCOT review. Additionally, 2,500 miles of 138-kV upgrades are either already built, upgraded, or converted.



BULK POWER SYSTEM PLANNING

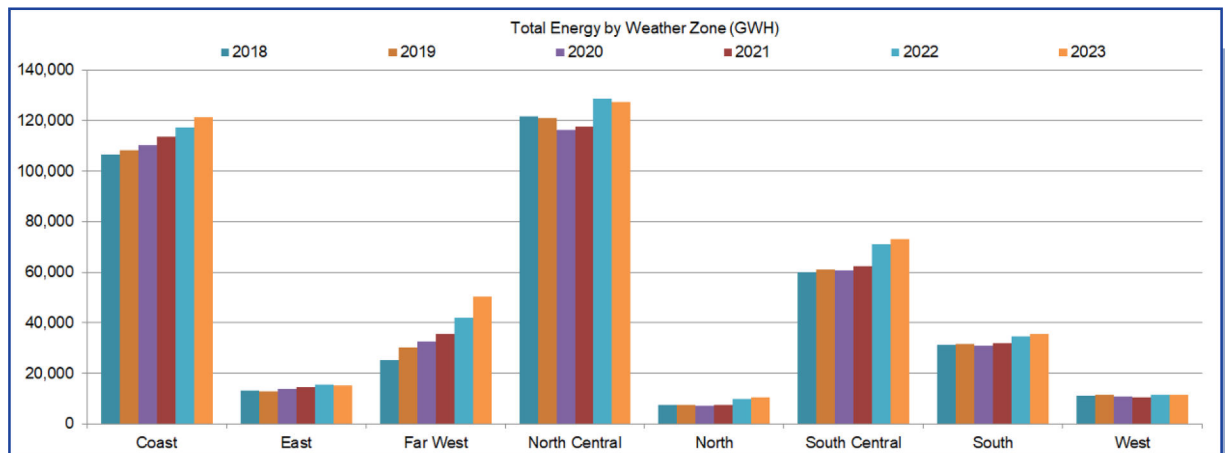
SOUTHERN SPIRIT AND PECOS WEST PROPOSED DC TIES

ERCOT currently has four asynchronous ties to other grids: two connections to the Eastern Interconnection with a total capacity of 820 MW, and two ties to the Mexican system with a total capacity of 400 MW. These ties allow ERCOT and the connecting grids to exchange power in emergencies and for entities to trade power between grids on a commercial basis.

Southern Spirit Transmission has proposed building a 3,000 MW merchant tie between ERCOT and the Eastern Interconnection via a 320-mile high-voltage direct current (HVDC) line. This was formerly the 2,000 MW Southern Cross Transmission Project. ERCOT has begun its work on the directives assigned to ERCOT by the PUCT in Project No. 46304. A new project filing, Project No. 41155, is open for completion of the remaining directives and issues. These include reviewing any needed transmission upgrades and a determination regarding primary frequency response and voltage support. Pattern Energy has requested ERCOT conduct a transmission interconnection study of the revised Southern Spirit Transmission project. The project has not reached sufficient levels of development to be formally included in ERCOT's system models, but it does signify the heightened interest in providing additional interconnections outside the ERCOT grid.

In 2022, Grid United Texas submitted an application in PUCT Docket No. 53758 seeking PUCT approval of the Pecos West Intertie (a proposed 280-mile, 1,500-MW HVDC transmission line, with potential for expansion up to 3,000 MW) that would connect ERCOT to the

Western Interconnection at El Paso by 2029. However, the Certificate of Convenience and Necessity (CCN) for the proposed Grid United DC tie was rejected by the Public Utility Commission of Texas.



2023 highlights from the analysis of bulk power system planning include:

- **SUMMER PEAK:** Actual 85,508 MW versus projected 83,412 MW
- **WINTER PEAK:** Actual 65,632 MW versus projected 67,423 MW
- **RENEWABLE PERCENTAGE OF TOTAL LOAD AT SUMMER PEAK:** 23.4 percent
- **PEAK HOURLY WIND GENERATION:** 26,268 MW on March 16, 2023
- **PEAK HOURLY SOLAR GENERATION:** 13,742 MW on October 16, 2023
- **PEAK HOURLY RENEWABLE PENETRATION:** 68.1 percent on April 29, 2023

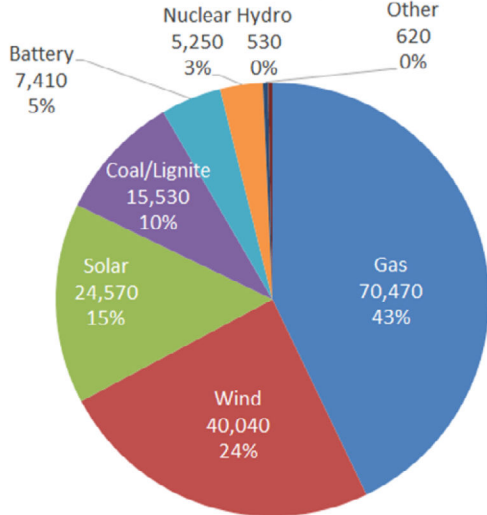
AREAS TO MONITOR INCLUDE:

- As of December 2023, ERCOT projections indicate utility-scale solar generation will increase 190 percent to over 42,473 MW, wind generation will increase five percent to more than 40,485 MW, and storage resources will increase 310 percent to over 15,932 MW during the next two years (based on current signed generation interconnect agreements with financial security).
- Projected growth of distributed generation continues a steady increase, and only part of it is modelled in the grid. 2023 estimates of growth just for unregistered rooftop PV in ERCOT's [December 2023 Capacity, Demand and Reserves](#) report project growth from 1,058 MW in 2024 up to 2,652 MW by 2028. Other types of distributed energy resources will add to this.
- Load growth rates in the Coastal, South Central, and Far West weather zones continue to drive the overall ERCOT demand, increasing by 6.3 percent in the last year.

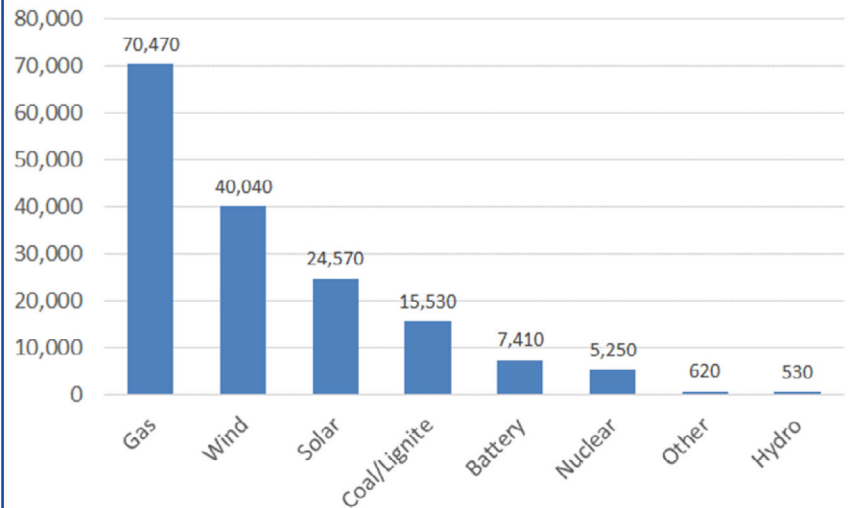
KEY FINDINGS - GRID TRANSFORMATION

BULK POWER SYSTEM PLANNING

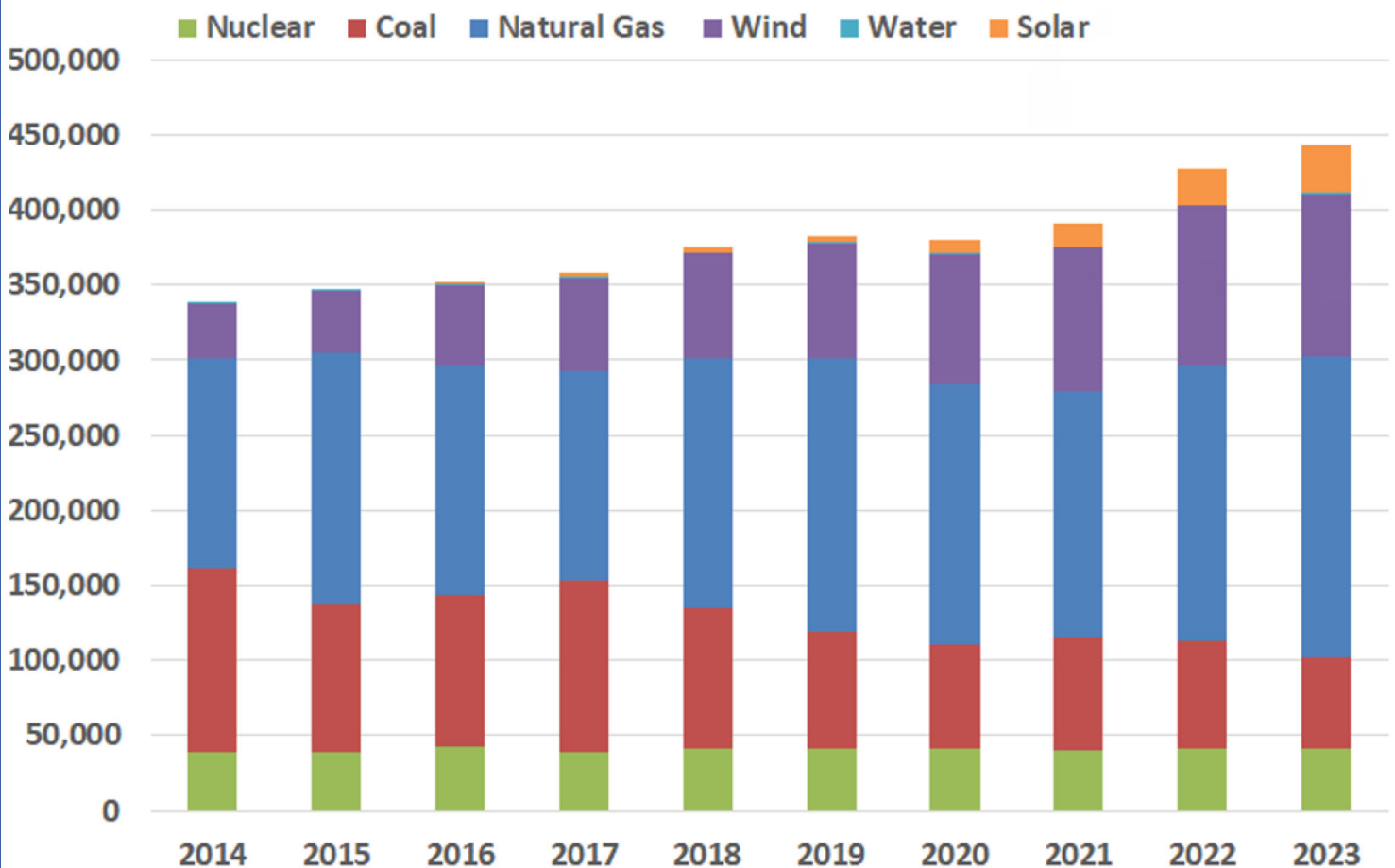
2023 Generation Nameplate Capacity (MW) (Modeled Units)



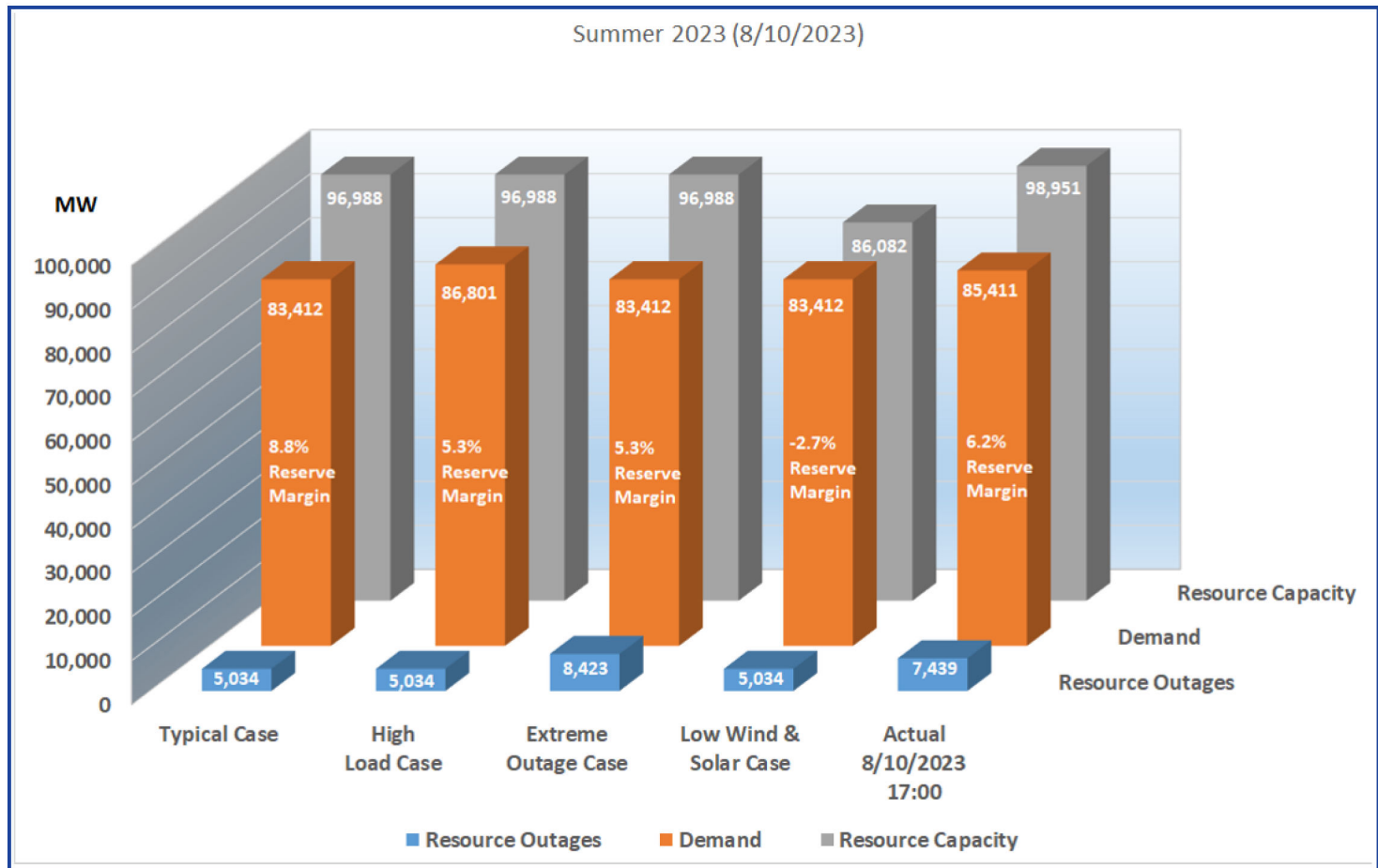
2023 Generation Capacity by Fuel Type (MW)



Net Generation MWH



RESOURCE ADEQUACY & PERFORMANCE



Projected Peak: 83,412 MW

Actual Peak: 85,508 MW

Renewable % at Peak: 22.8%

Max Hourly Wind: 26,268 MW

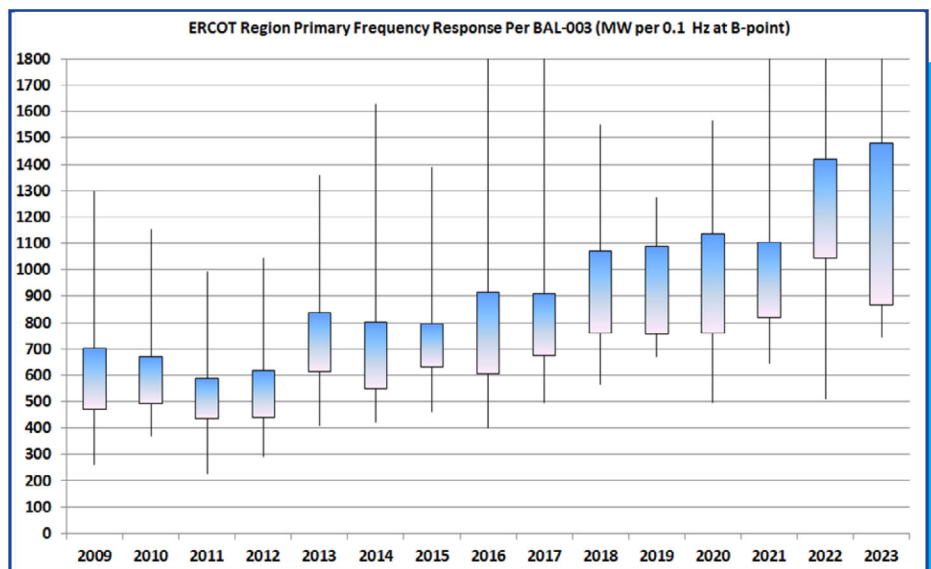
Max Hourly Solar: 13,742 MW

Max Hour Renewable%: 68.1%

Advisories (PRC <3000): 3

Watches (PRC <2500): 0

EEA (PRC <2300): 1

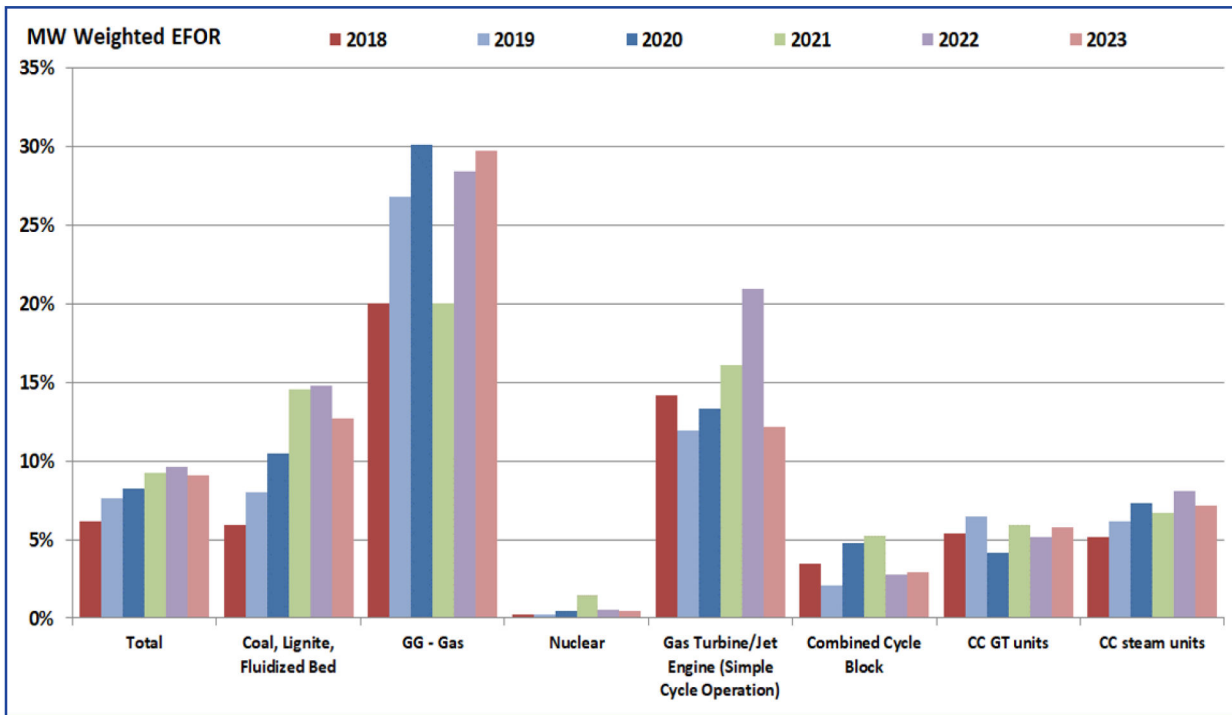


Primary frequency response continues to far exceed NERC minimums.

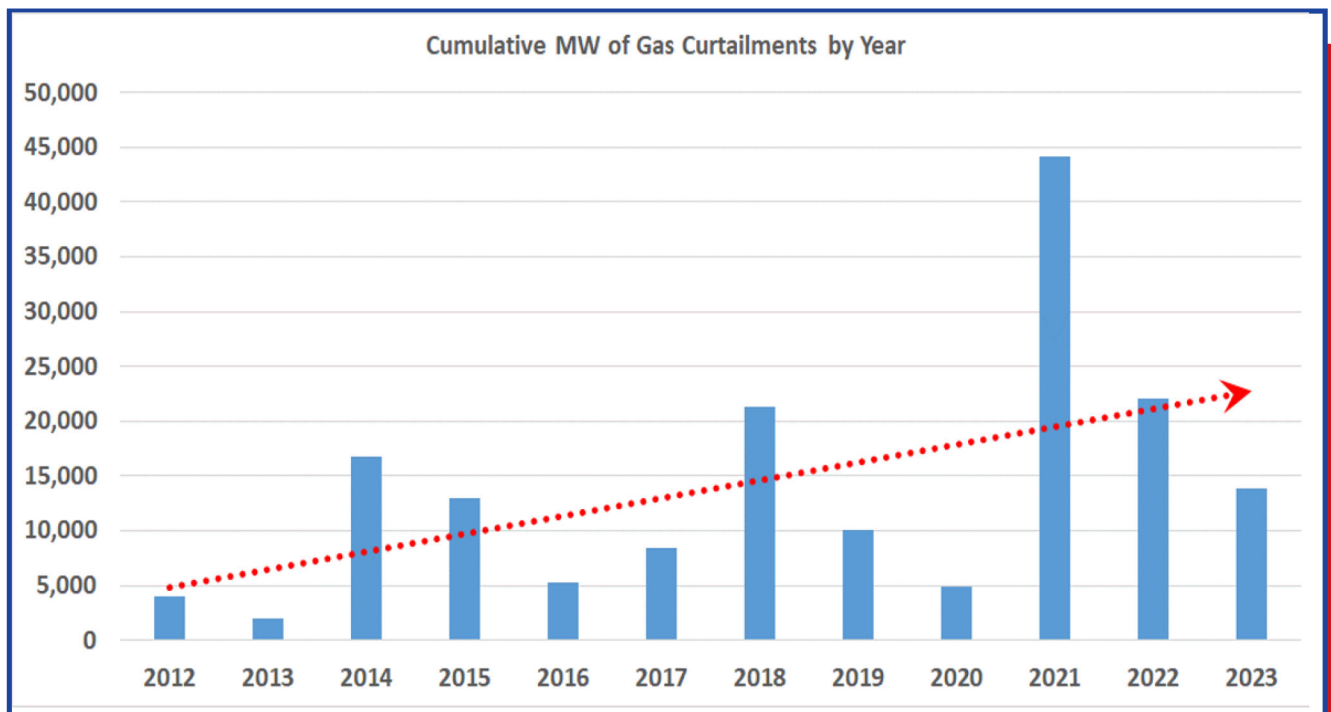
KEY FINDINGS - GRID TRANSFORMATION

RESOURCE ADEQUACY

EFOR (forced outage) rates for the coal fleet declined in 2023 compared to 2022 while gas unit EFOR rates increased. Long-term trend for overall fleet is also increasing.



Gas curtailments declined in 2023 compared to 2022.



RESOURCE ADEQUACY

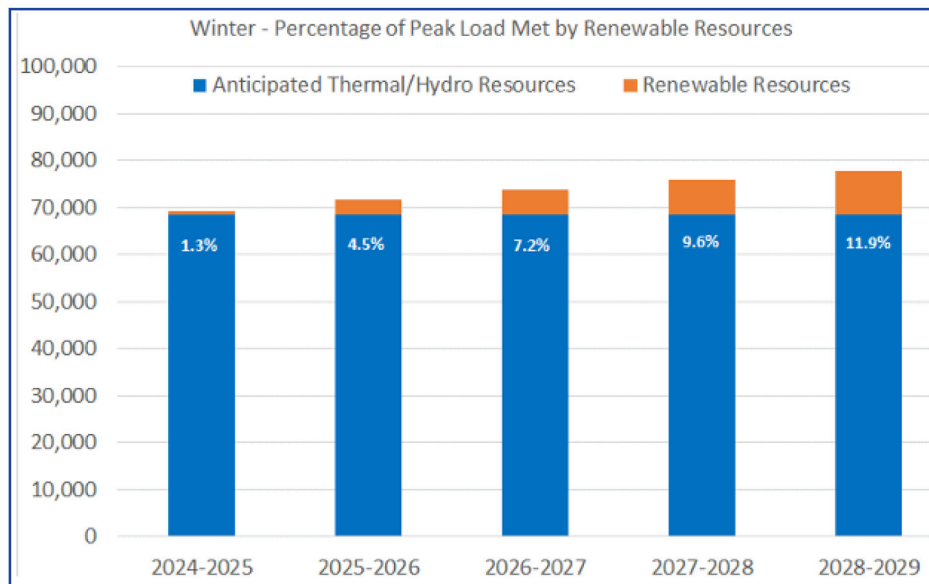
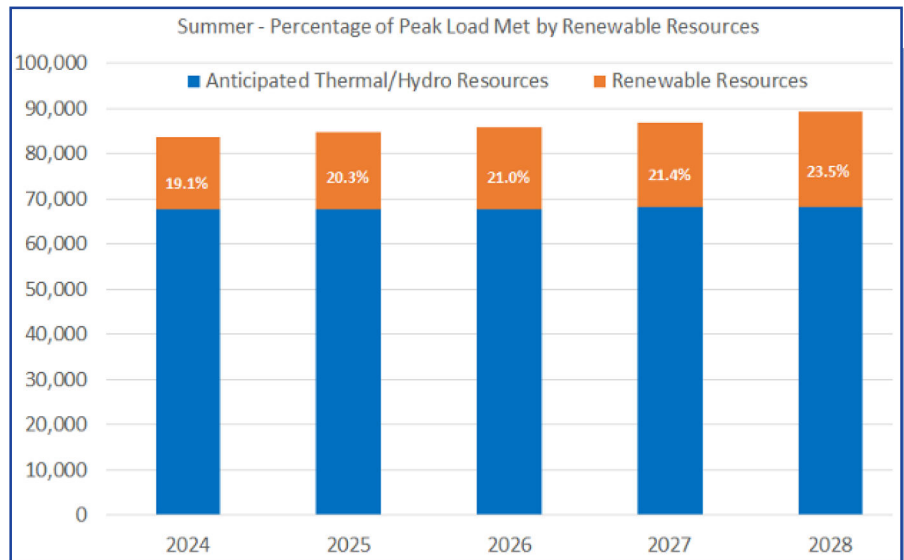
ERCOT no longer has sufficient dispatchable resources to meet its projected 50/50 peak and extreme peak loads. The balance of energy not provided by dispatchable thermal resources must be provided by renewable and energy storage resources, both at peak and during other periods with limited thermal resource availability. The percentage of peak load provided by renewable resources has shown an increase over the last few years, a trend that is expected to continue. The increased level of

variable renewable generation results in a growing need to have flexible resources and demand response available that can be reliably called upon—at times with minimal notice or for short periods across multiple days to balance electricity supply and demand as conditions occur. Flexible resources and demand response are necessary during some periods to ensure resource adequacy and meet ramping needs. Batteries and other energy storage options play a key role, especially for shorter duration needs. Should solar and wind output

fall below expectations during peak conditions, ERCOT will need to draw on such flexible resources and/or demand response to maintain balance between load and generation. Imports from outside of the Interconnection are often fully utilized. Additionally, the high levels of solar resources generate a need for more flexible resources to match steep ramping conditions during times when wind or solar output changes rapidly.

Sufficient operating reserves were maintained during the all-time summer peak day in August 2023.

On September 6, 2023, however, ERCOT entered into an EEA level 2 between 19:25 and 20:37 due to low frequency conditions arising from a combination of unusually high September system loads, low wind output in the north, the evening down-ramp in solar production, and transmission congestion in South Texas.



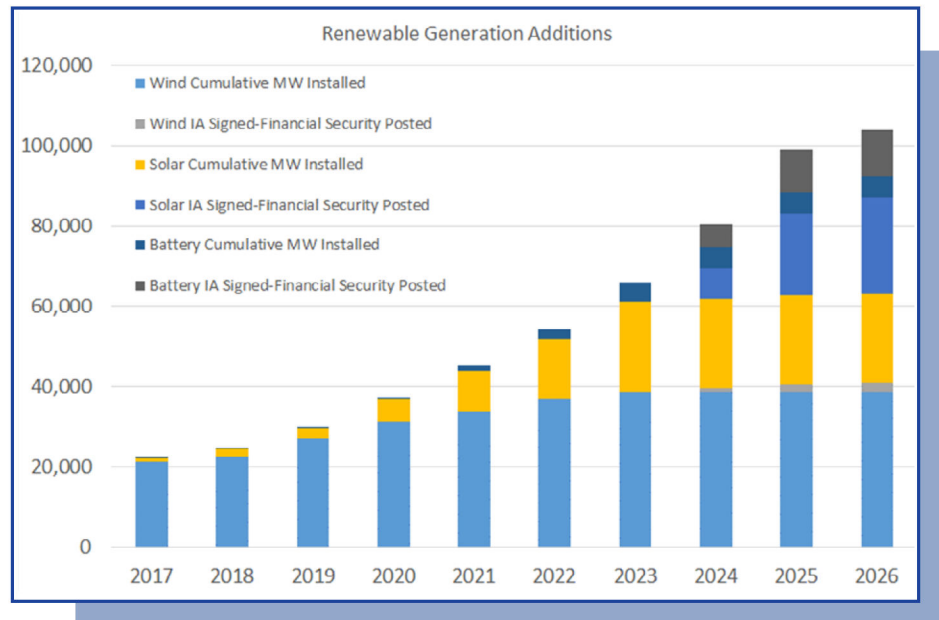
KEY FINDINGS - GRID TRANSFORMATION

RESOURCE ADEQUACY

Gas curtailments decreased in 2023 compared to 2022 and were comparable to a similar polar vortex event in 2015. Natural gas supply and delivery, and alternative fuel capability and availability for gas generation (including blackstart units) was one of the main focus areas of the FERC inquiry report of Winter Storm Elliott.

Approximately 38,000 MW of additional renewable and storage resources are expected by the end of 2026. These additions will continue to drive changes in how ERCOT manages generation. Combined wind and solar generation curtailments exceeded 8,606 gigawatt-hours (GWh) in 2023.

Hourly Reliability Unit Commitments (HRUC) decreased dramatically in 2023 compared to 2022. HRUC totaled 81 units for 2,636 commitment hours. The primary reason for the commitments was capacity shortage, accounting for approximately 81 percent of all HRUC hours.



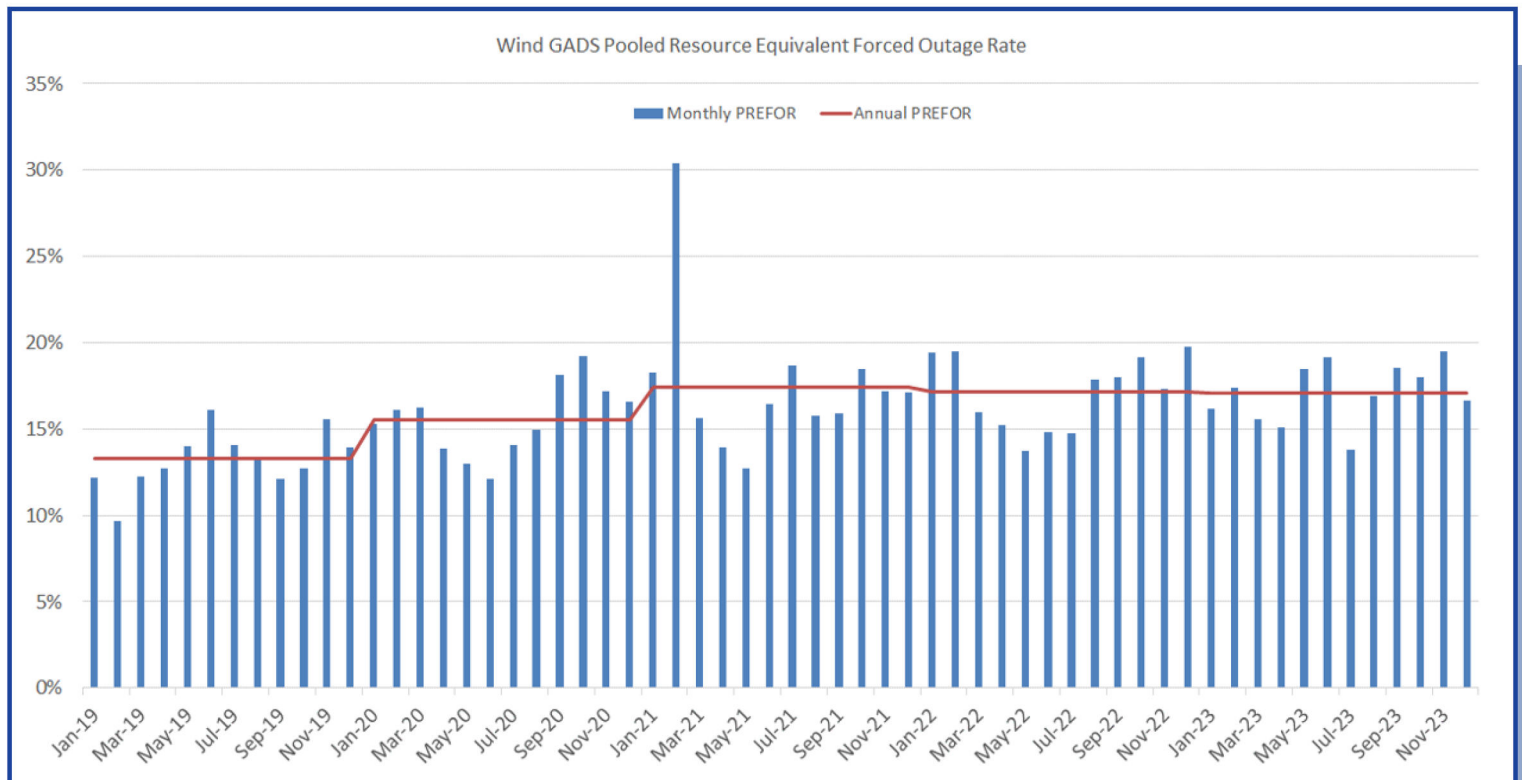
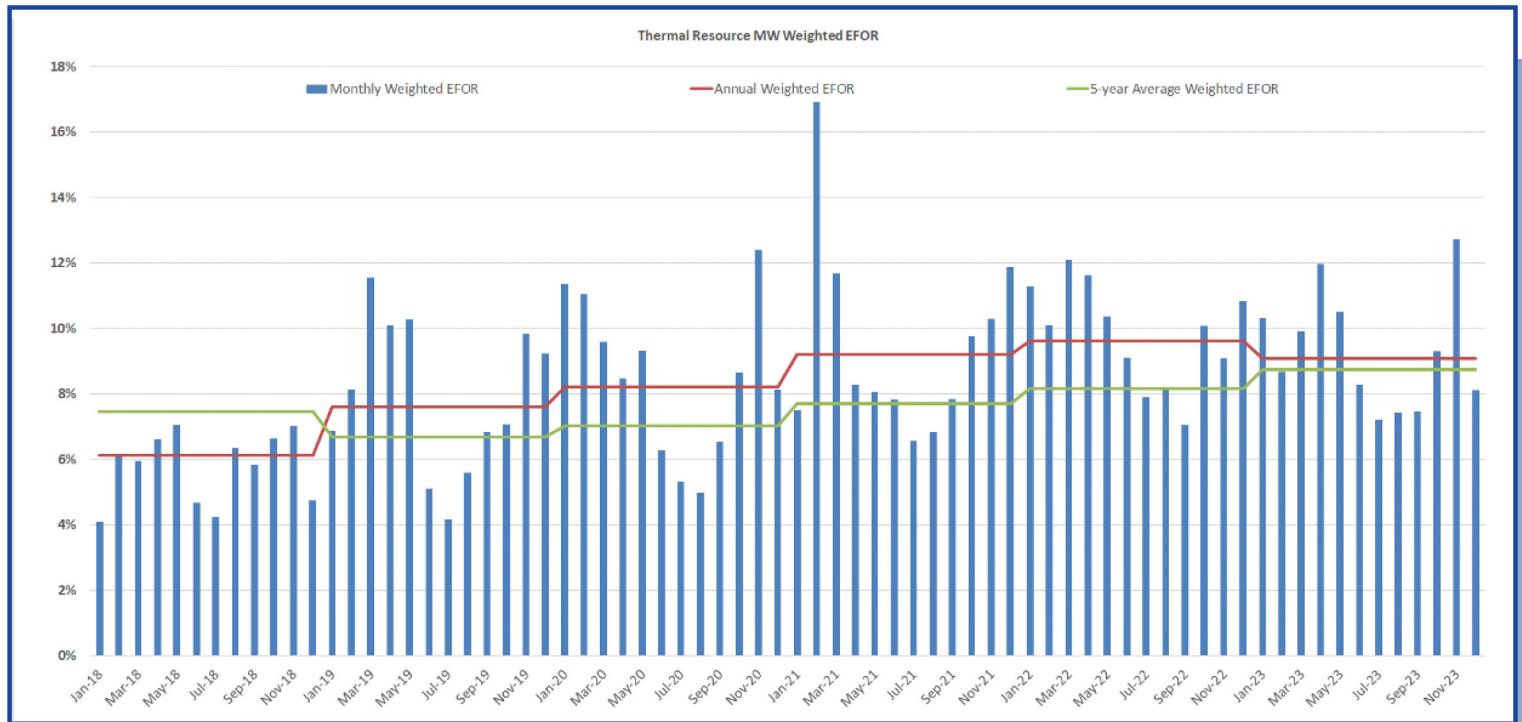
2023 HIGHLIGHTS FROM THE ANALYSIS OF RESOURCE ADEQUACY AND PERFORMANCE INCLUDE:

- Primary Frequency Response achieved a median value of 1,106 MW/0.1 Hz versus the NERC obligation of 463 MW/0.1 Hz.
- No Reportable Balancing Contingency Event Recovery Period failures occurred in 2023.
- No Reportable Balancing Contingency Events greater than the Most Severe Single Contingency (MSSC) occurred in 2023.
- An IROL was exceeded two times (totaling eight minutes) in 2023.

AREAS TO MONITOR INCLUDE:

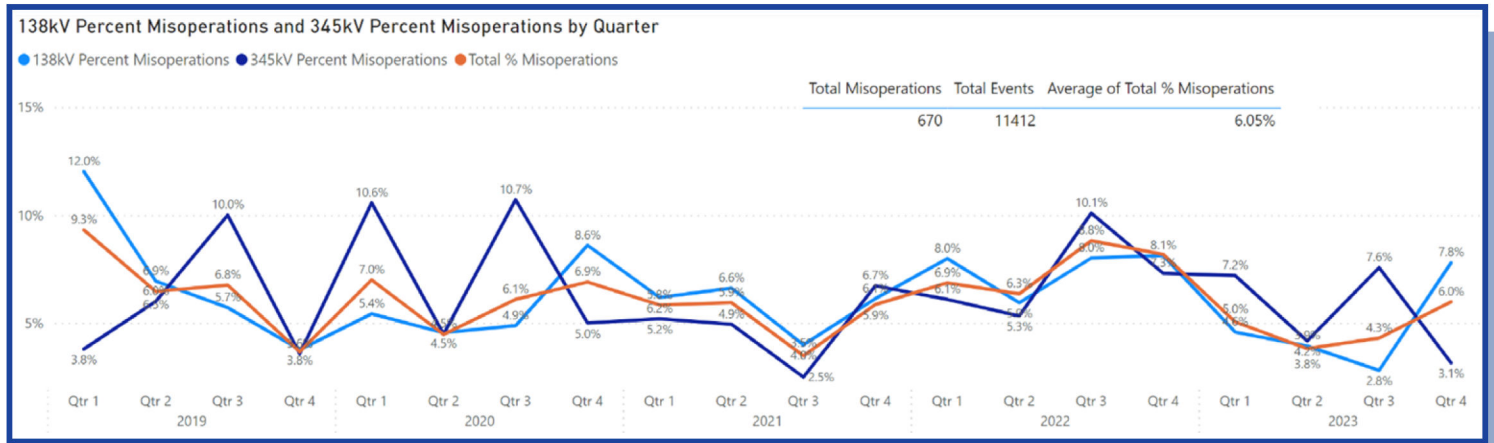
- Weatherization of generation resources will continue to be a primary focus for the foreseeable future.
- Additional follow-up and potential NERC Standard requirement changes to improve voltage ride-through for IBRs is a primary focus in 2024.
- GADS EFOR (unweighted) for thermal resources was 9.8 percent for 2023, which was a small decrease from 10.4 percent in 2022. Long-term trends continue to show an increasing rate.
- GADS Wind Resource EFOR was 17.1 percent in 2023, approximately the same as in 2022.
- Natural gas supply and delivery, and alternative fuel capability and availability for gas generation (including blackstart units), will be a focus in 2024 as a result of follow-up recommendations from Winter Storm Uri.
- Monitor potential NERC Standard development to assess the risks associated with energy emergencies – Energy Reliability Assessment Standards.

RESOURCE ADEQUACY



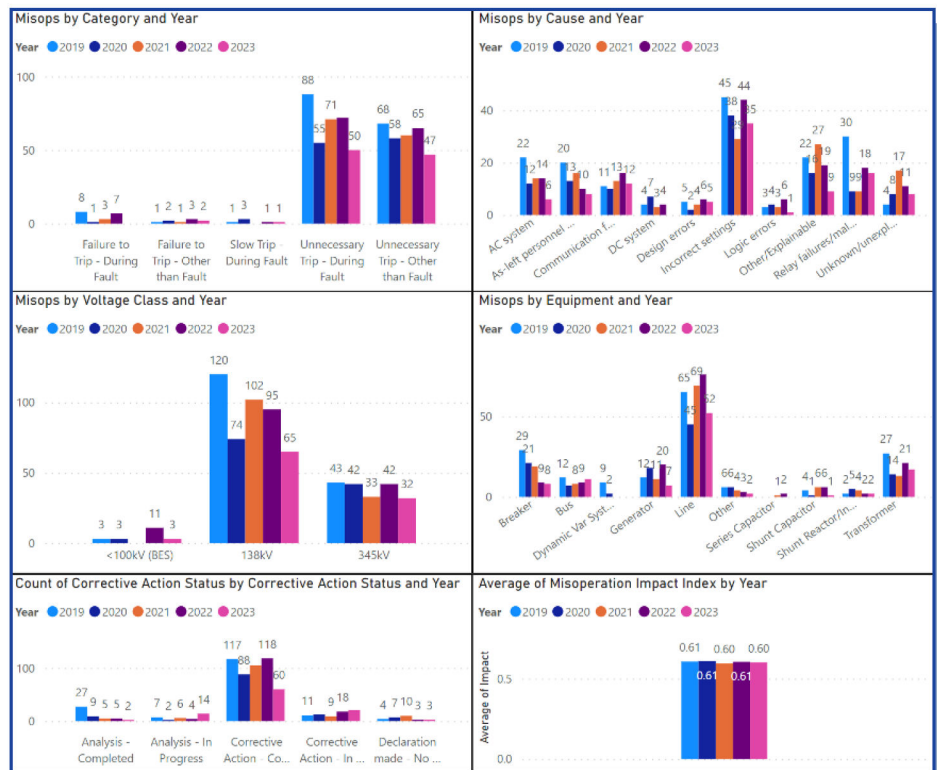
KEY FINDINGS - GRID TRANSFORMATION

PROTECTION & CONTROL SYSTEMS



2023 HIGHLIGHTS FROM THE ANALYSIS OF PROTECTION SYSTEM MISOPERATIONS INCLUDE:

- Since January 2019, the overall transmission system Protection System Misoperation rate has gradually declined, from 6.4 percent in 2019 to 4.6 percent in 2023. The five-year Misoperation rate from 2019-2023 was 6.1 percent.
- In 2023, three main categories account for 69 percent of the total Misoperations: incorrect settings/logic/design (41 percent), relay failures (16 percent), and communication failures (12 percent). Incorrect settings continue to be the largest category of misoperations over the past five years.
- Misoperations due to AC systems, incorrect settings, and other explainable causes decreased in 2023 compared to 2022.
- Misoperations due to AC systems and as-left personnel error continue to show a positive downward trend.
- Corrective actions were completed or are in-progress for approximately 60 percent of Misoperations that occurred in 2023.



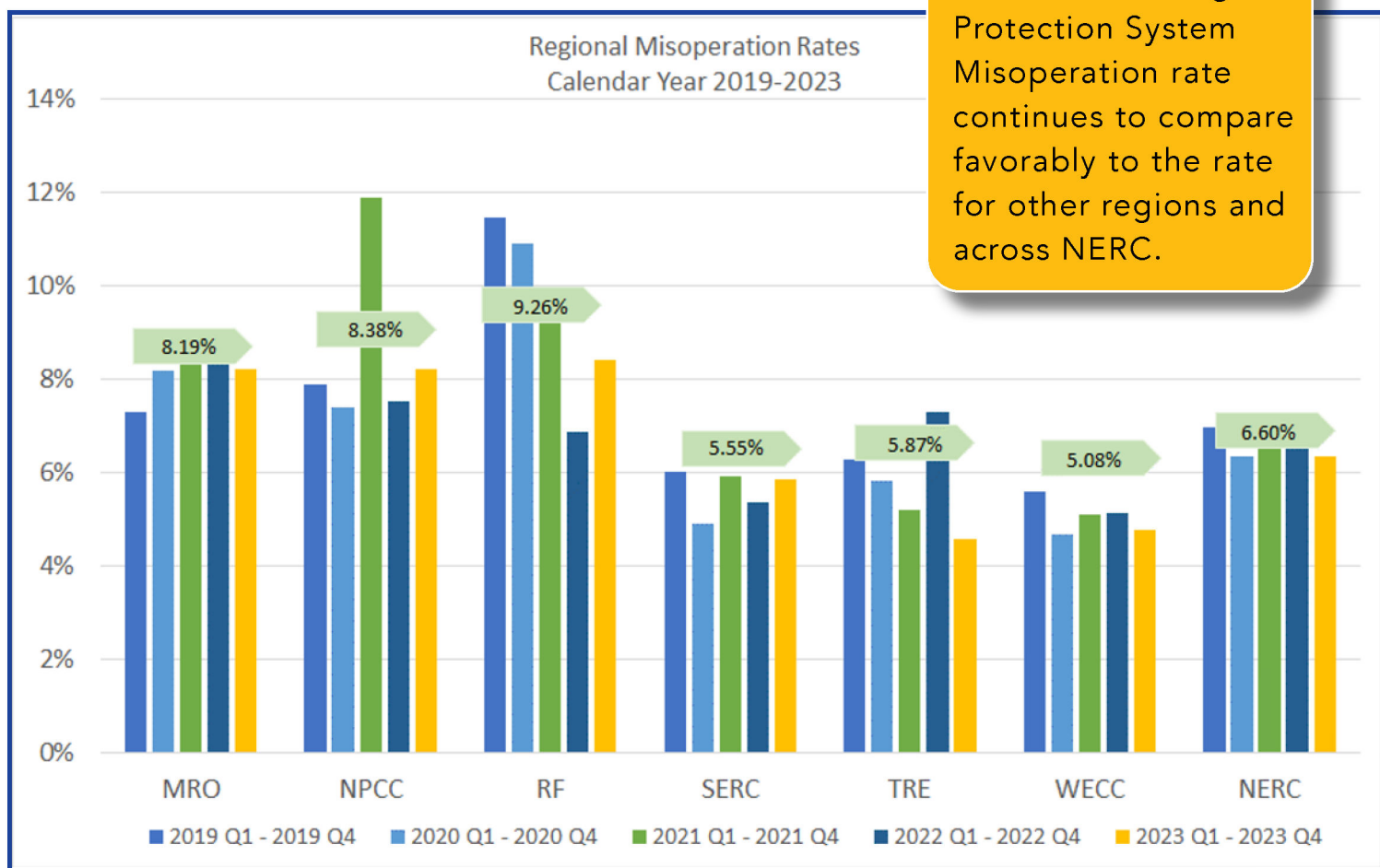
AREAS TO MONITOR INCLUDE:

- Incorrect settings, logic, and design errors remained the largest cause of Misoperations, accounting for 41 percent of Misoperations in 2023.
- Multiple system events continue to occur where Protection System Misoperations expanded the magnitude of the transmission elements outaged or caused loss of generation or load.

PROTECTION & CONTROL SYSTEMS

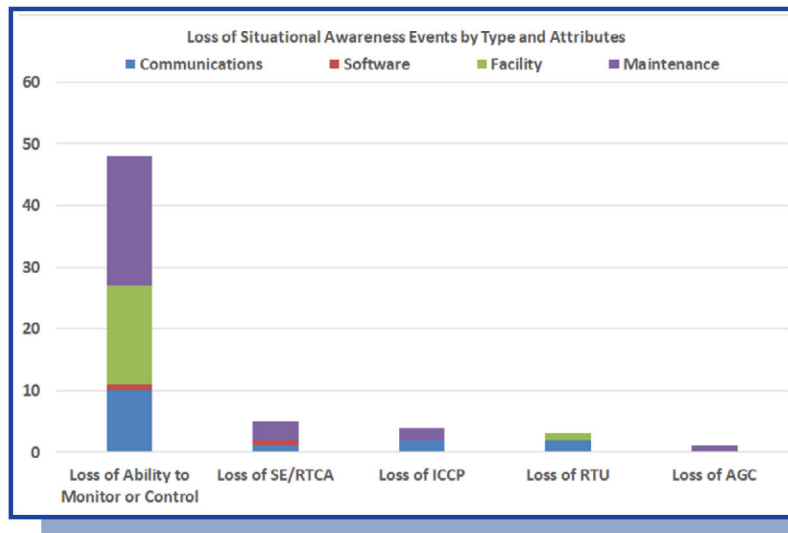
Despite an overall downward trend in the annual Misoperation rate, Protection System Misoperations were a contributing factor in several system events in 2023. In all of these events, the Misoperations expanded the magnitude of transmission elements outaged or caused loss of generation or load. Loss of multiple elements resulted from Protection System Misoperations after faults on the following dates:

- Loss of multiple elements on June 3, 2023: A 138 kV bus fault resulted in loss of multiple 138 kV lines due to protection system misoperations.
- Loss of multiple elements on June 9, 2023: A 345 kV line fault resulted in a 345 kV breaker failure clearing of a 345 kV bus and loss of one generator.
- Loss of multiple elements on July 21, 2023: A 345 kV bus fault occurred due to contaminated insulators, resulting in loss of three generators due to a single protection system misoperation.



KEY FINDINGS - GRID TRANSFORMATION

SITUATIONAL AWARENESS CHALLENGES

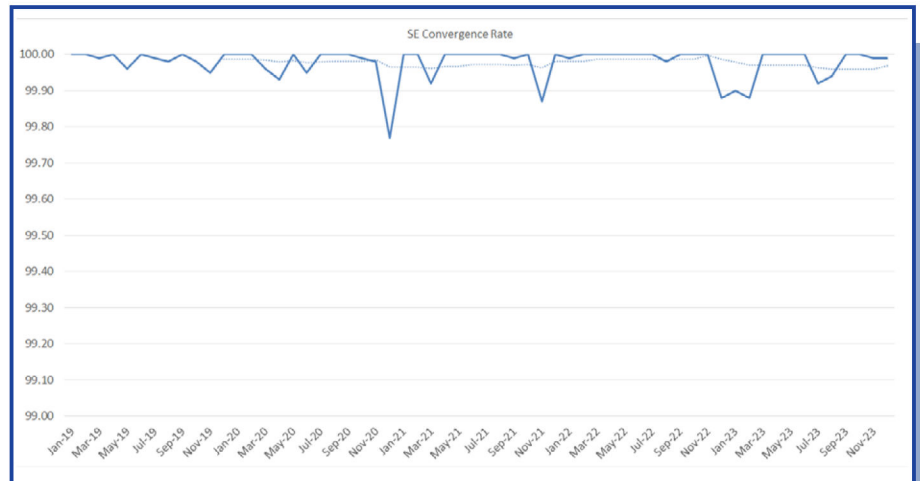


LOSS OF SITUATIONAL AWARENESS EVENTS ARE BROKEN DOWN INTO SEVERAL CATEGORIES BY THE CAUSE OF THE EVENT. THESE ARE:

- Loss of ability to monitor or control
- Loss of State Estimator (SE) or Real-time Contingency Analysis (RTCA)
- Loss of Inter-Control Center Communication Protocol (ICCP) links
- Loss of remote terminal units (RTUs)
- Loss of Automatic Generation Control (AGC)

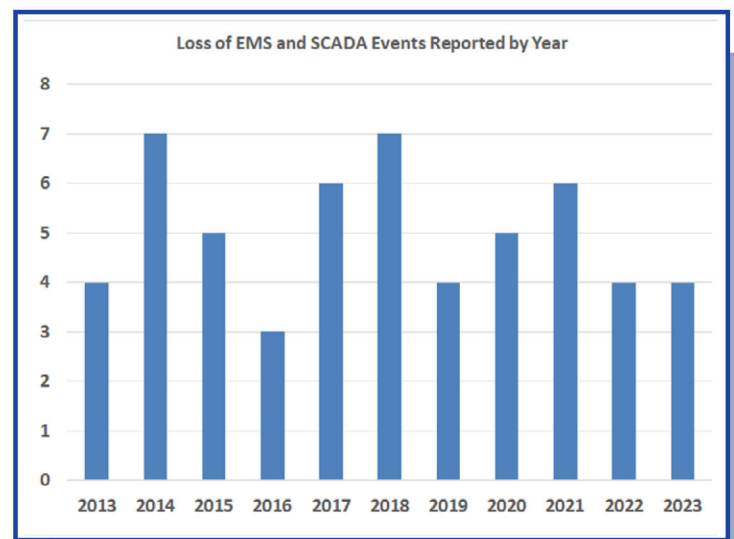
2023 HIGHLIGHTS FROM THE ANALYSIS OF LOSS OF SITUATIONAL AWARENESS INCLUDE:

- Convergence rates for ERCOT's state estimator continue to surpass the goal of 97 percent, exceeding 99.97 percent in 2023.
- Telemetry availability rates remain stable at approximately 96.4 percent overall.



AREAS TO MONITOR INCLUDE:

- A total of four Category 1 loss of System Control and Data Acquisition (SCADA) or Energy Management System (EMS) events were reviewed in 2023 at Transmission Operators' control facilities. Average duration was approximately 85 minutes. Two events were caused by Internet Service Provider (ISP) outages.



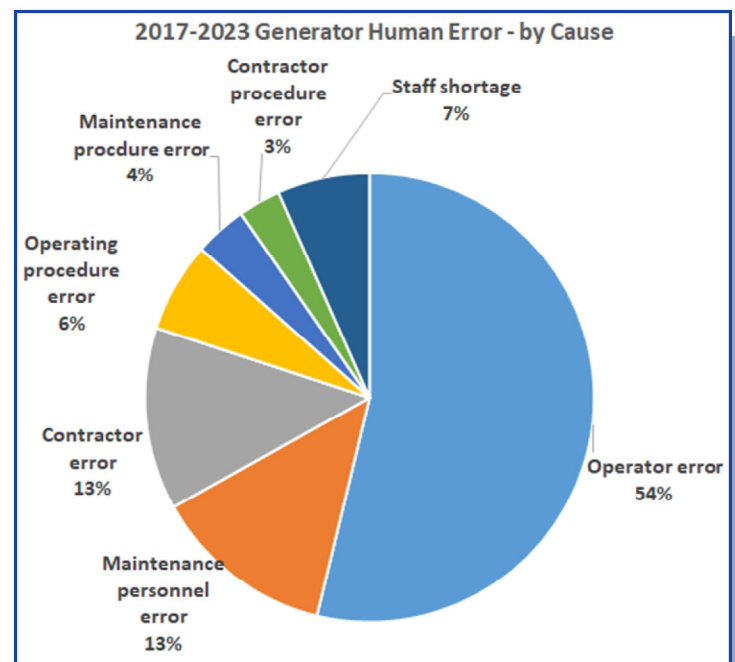
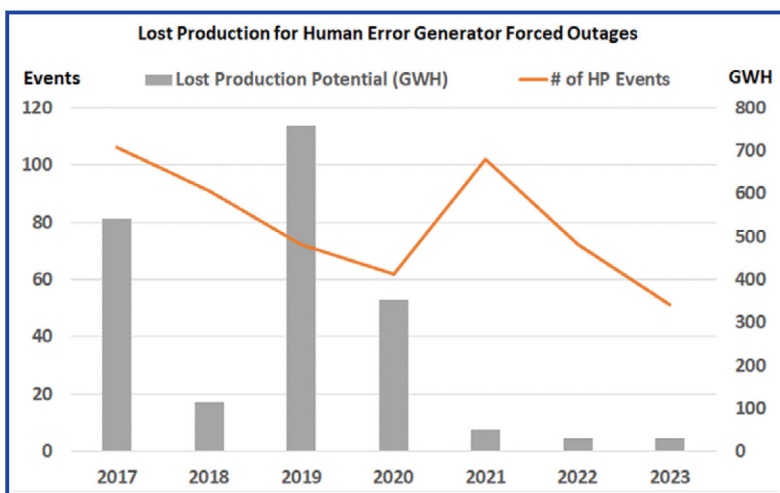
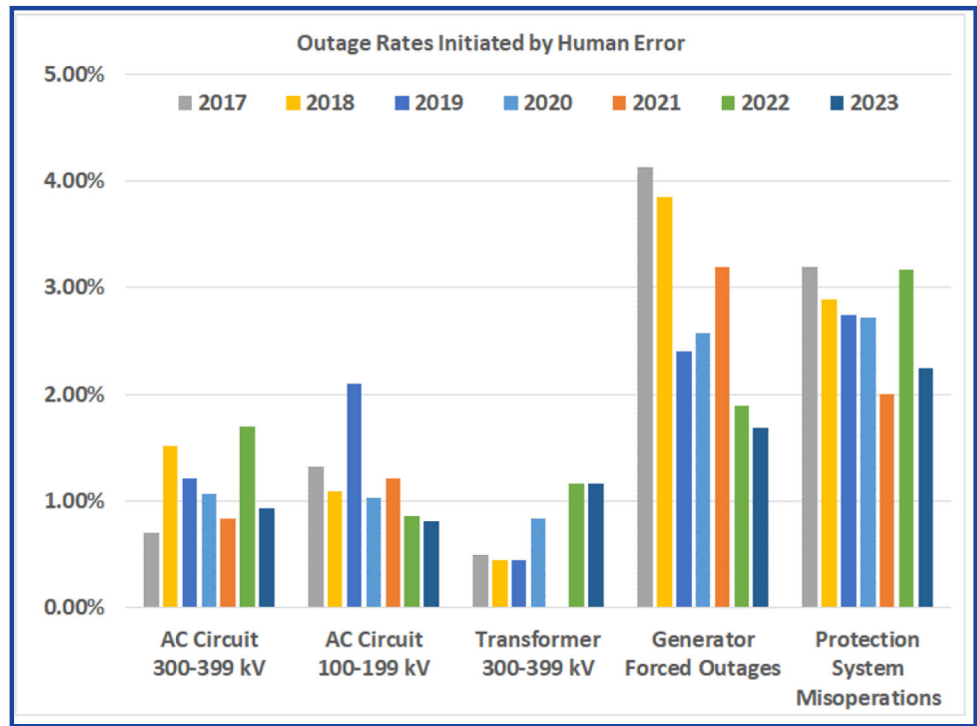
HUMAN PERFORMANCE

2023 HIGHLIGHTS FROM THE ANALYSIS OF HUMAN PERFORMANCE INCLUDE:

- Outage rates in GADS data caused by human error continued to show an improving, downward trend.
- TADS human error outage rates for 138 kV circuits decreased slightly in 2023 compared to prior years.
- TADS human error outage rates for 345 kV circuits decreased significantly compared to 2022.

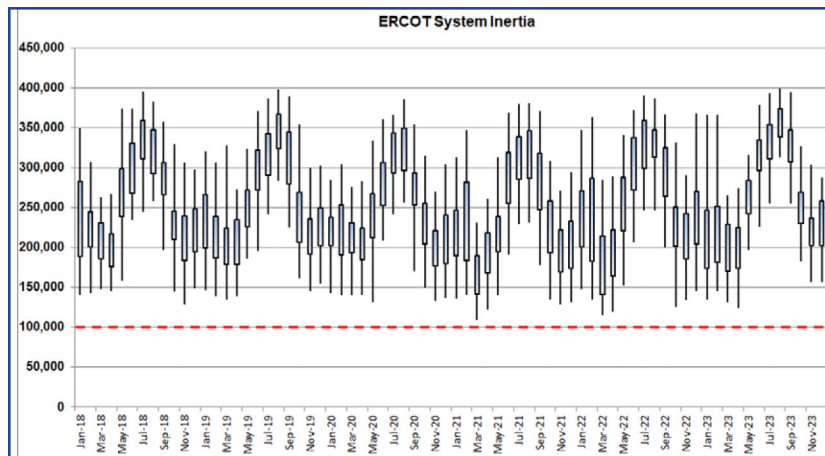
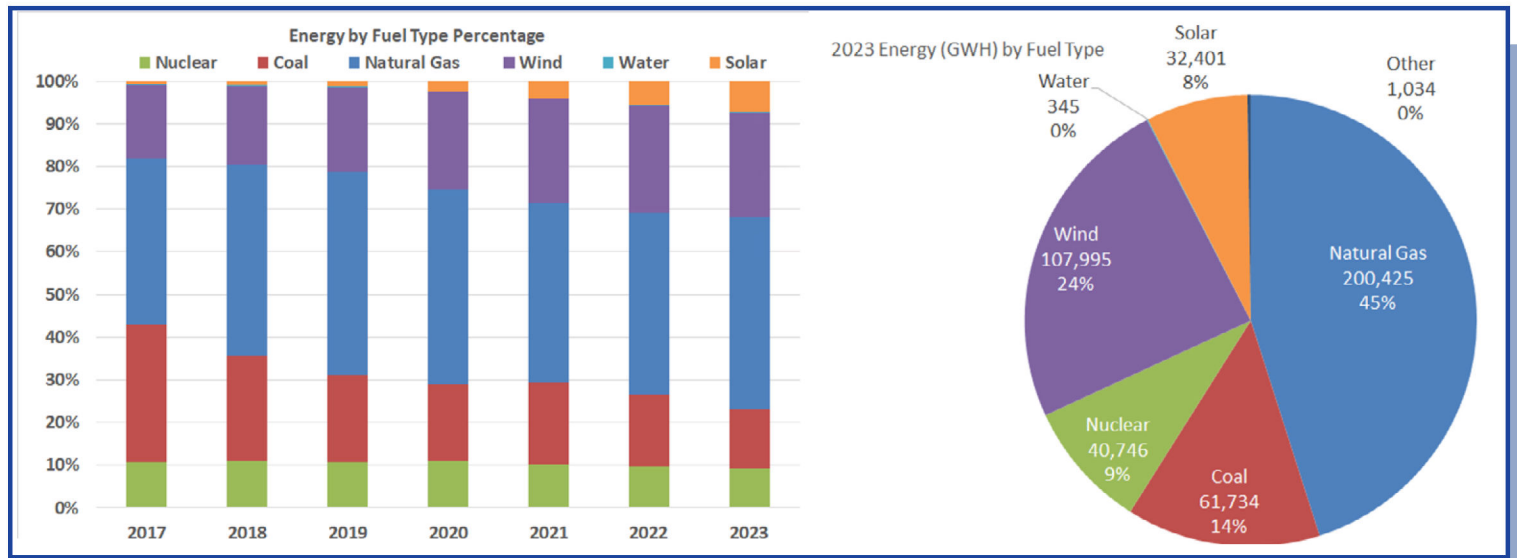
AREAS TO MONITOR INCLUDE:

- Causal analysis of human errors in events and Protection System Misoperations continue to show repeated issues due to lack of adequate error-checking processes and procedures.



KEY FINDINGS - GRID TRANSFORMATION

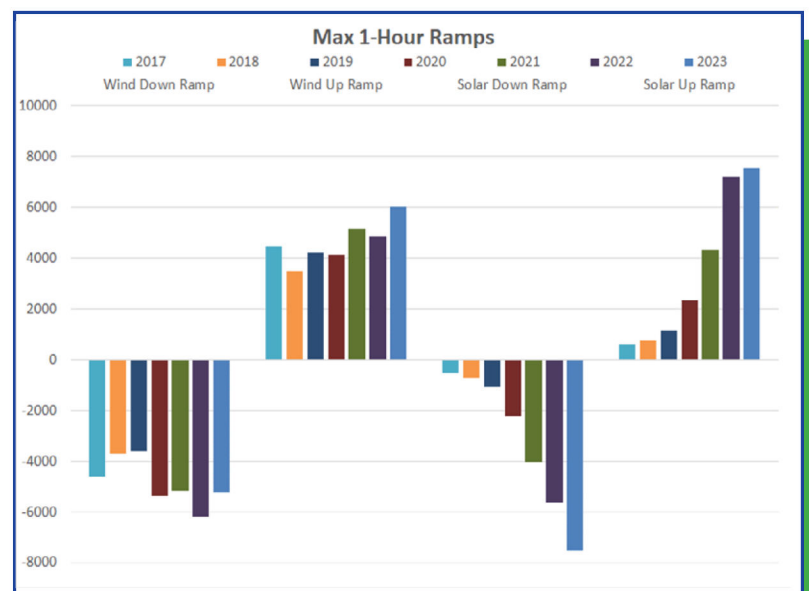
CHANGING RESOURCE MIX



In 2023, 1,514 MW of fossil generation was retired or mothballed and 1,398 MW of gas generation was added. Simultaneously, over 5,633 MW of renewable generation was approved for commercial operation. Inertia levels during the highest penetration hours were higher than 2022. The margin between minimum inertia conditions and critical inertia levels remains well within adequate safety margins.

Since 2017, renewable generation has increased from 18% to 33% of energy while coal has decreased from 32% to 14%.

Maximum up and down ramp magnitudes continue to increase as solar generation increases. Maximum solar up and down ramps exceeded 7,500 MW per hour.



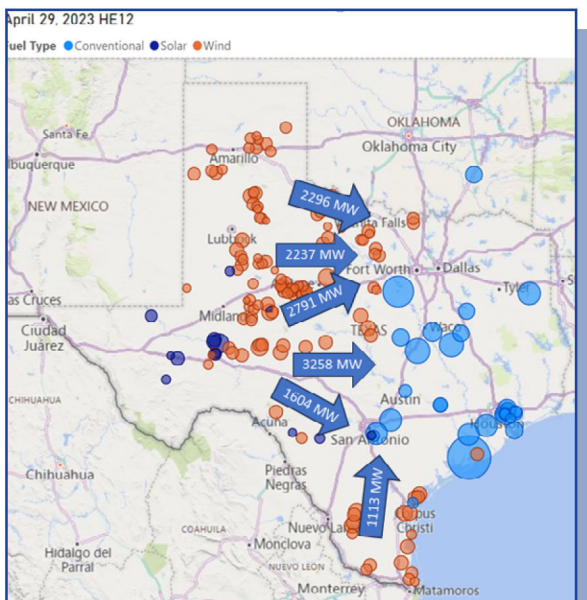
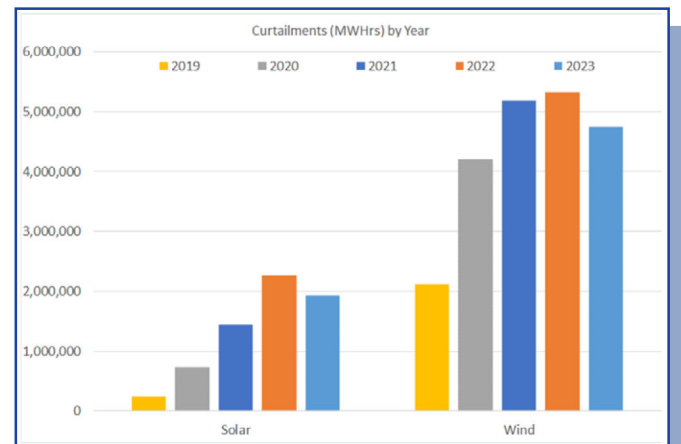
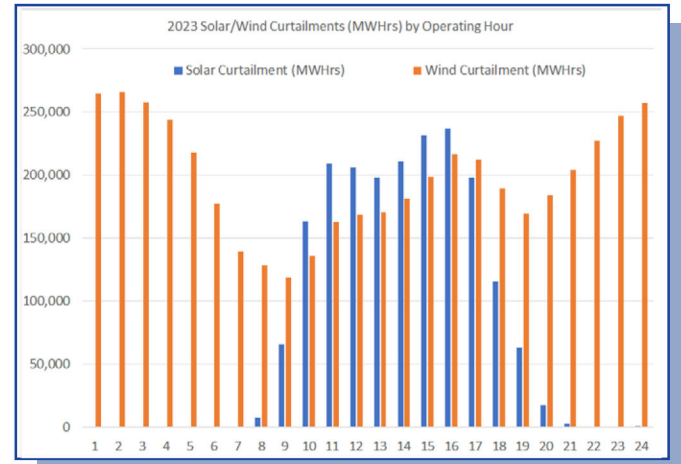
KEY FINDINGS - GRID TRANSFORMATION TEXAS

SYSTEM RESILIENCE

Today's resource mix continues to evolve with the addition of inverter-based generation resources and energy storage, driven by declining costs of IBRs and government policies that encourage renewable generation. While the growth in wind resources in the Region slowed, both solar and storage resources increased exponentially. Stability challenges and large solar ramp periods are anticipated to continue being significant issues, along with voltage and dynamic stability constraints associated with large-scale power transfers from West Texas to the east and from South Texas to the north. Management of stability constraints through generic transmission constraints (GTCs) in West and South Texas will continue to result in curtailments of wind and solar energy in order to manage power transfers within stability limits. Combined wind and solar generation curtailments decreased by 12 percent in 2023, from 7,600 GWh in 2022 to 6,700 GWh in 2023.

Evening solar down ramps were a common problem during the year, especially during the summer months. During July, August, and September, the evening solar down ramps reached a maximum of over 6,500 MW per hour. With the typical maximum solar generation value between 13,000 and 14,000 MW over these months, this equates to an approximate down ramp of 50 percent of the solar generation per hour between 1800 and 2000. In 2024, the solar down ramps could exceed 11,000 to 12,000 MW per hour since solar capacity is expected to increase above 25,000 MW by next year. This will increase the need for flexible resources, demand response, and battery storage resources to ensure resource adequacy and meet ramping needs.

High wind with low load periods (and low system inertia) occurred within the year when little or no synchronous generation was on-line in large areas of the Texas Interconnection. Large power transfers from west-to-east and south-to-north can occur under these high wind conditions. This creates risk conditions for voltage stability, in addition to issues caused by low inertia levels. These risks are monitored and managed through GTCs, several of which are also IROLs.



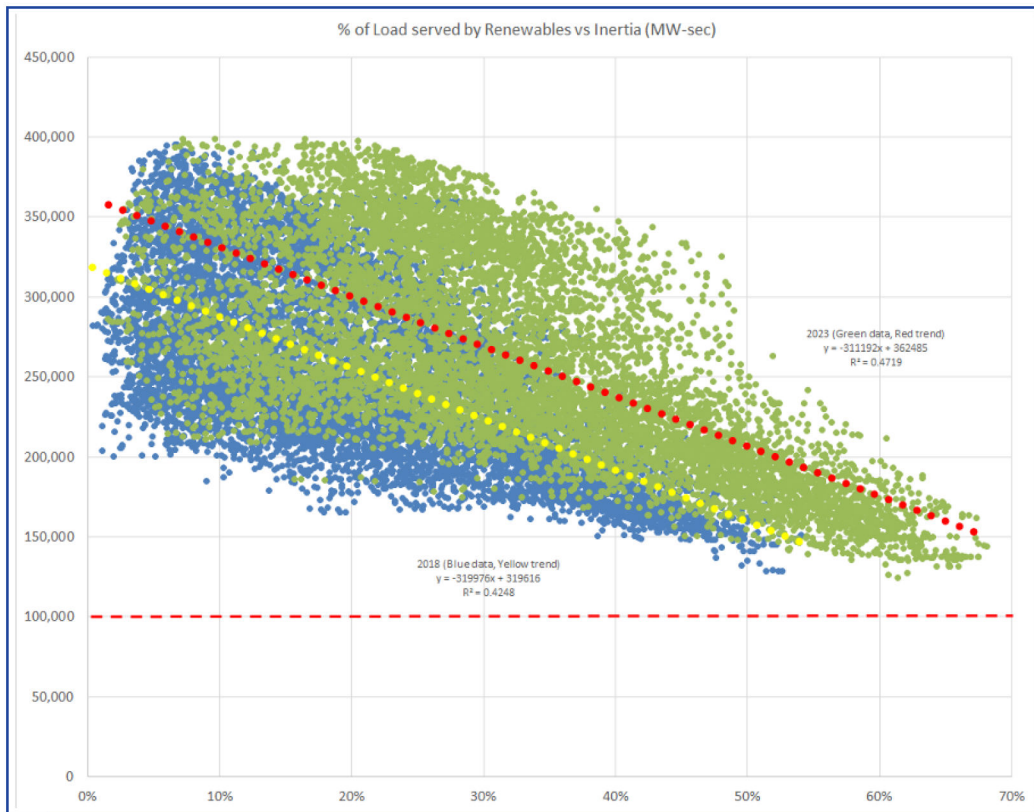
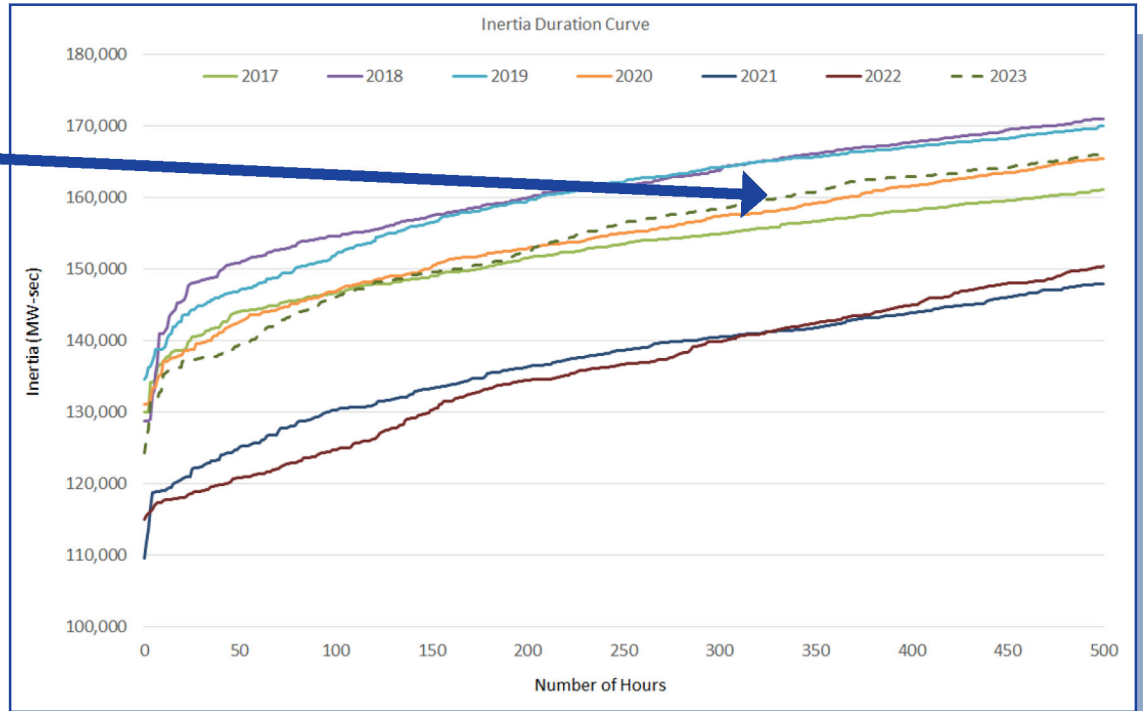
Snapshot of highest renewable penetration period 4/29/2023 HE12:

- No synchronous generation online in West Texas, Panhandle, or Lower Rio Grande Valley
- ERCOT LOAD: 40,227 MW
- NET LOAD: 12,823 MW
- INERTIA LEVEL: 144,227 MW-sec
- WIND GENERATION: 21,104 MW
- SOLAR GENERATION: 6,300 MW
- RENEWABLE PENETRATION: 68.1%
- TOTAL CURTAILMENTS: 8,320 MW
- SYSTEM LAMBDA: -\$1

KEY FINDINGS - GRID TRANSFORMATION

GRID TRANSFORMATION

Overall system inertia increased in 2023 (dashed line) compared to 2022 and returned to historic norms. The minimum hourly inertia level in 2023 was 124.3 GW-s on April 18, 2023, at HE03 when the intermittent renewable resource (IRR- i.e. solar and wind generation) penetration level was 61.4 percent and system load was 35,799 MW (net load of 13,817 MW). The chart at right shows a comparison of inertia levels during the lowest inertia hours.



This chart shows the relationship between the percentage of load served by renewables and system inertia levels. It compares 2018 (blue data, yellow trend line) versus 2023 (green data, red trend line). Notice how 2023 has shifted significantly to the right as renewable penetration levels increased.

GRID TRANSFORMATION

2023 HIGHLIGHTS FROM THE ANALYSIS OF CHANGING RESOURCE MIX INCLUDE:

- Overall inertia levels showed an increase in 2023 and were in-line with historical norms from the 2017-2020 timeframe. This may be due to the increased capacity factors from combined cycle facilities as base load units that typically have higher inertia constants for the machines than coal units.
- Wind and solar curtailments decreased in 2023 compared to 2022 but long-term curtailment trends continue to show an increasing rate.

AREAS TO MONITOR INCLUDE:

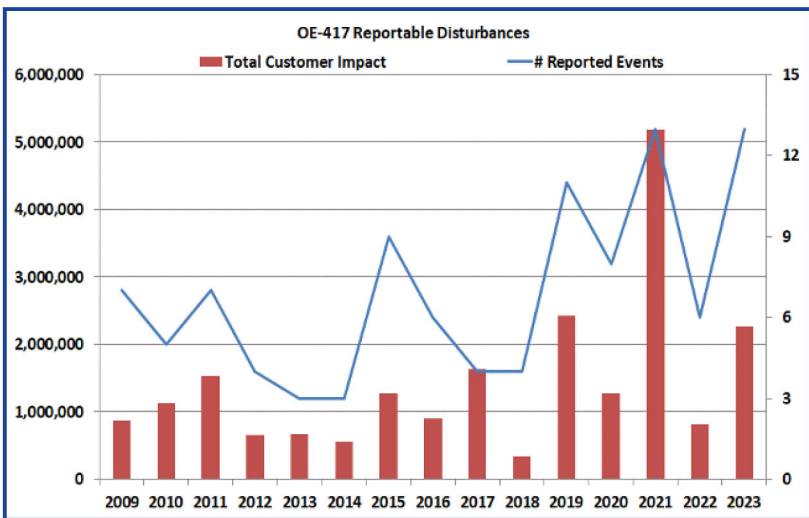
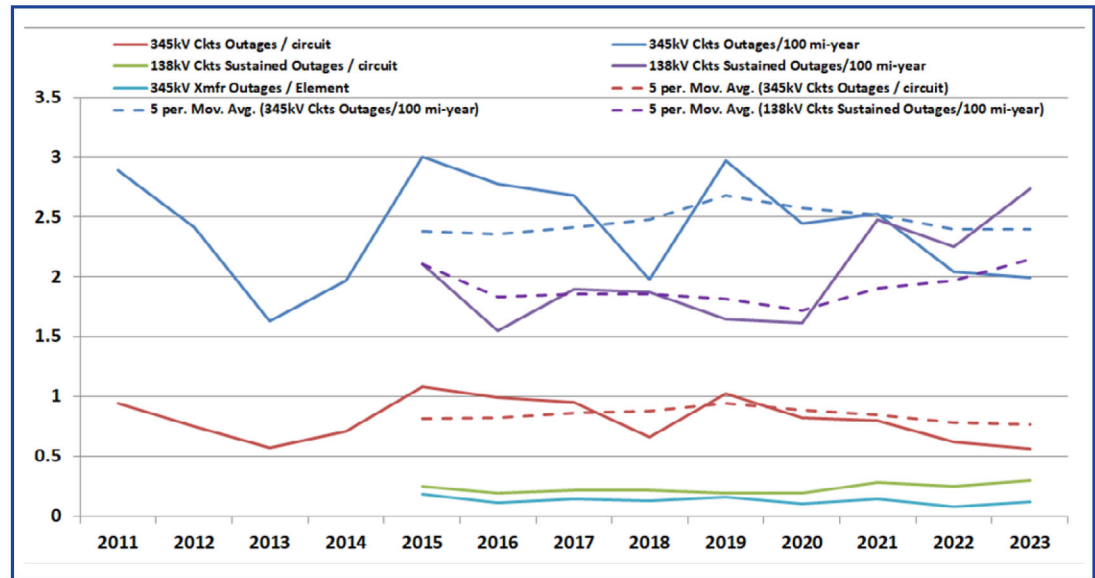
- Ratio of dispatchable generation to renewable generation continues to change rapidly. In 2023, 1,514 MW of fossil generation was retired or mothballed and 1,398 MW of gas generation was added. Concurrently, over 5,633 MW of renewable generation was approved for commercial operation.
- Maximum one-hour ramp magnitudes for solar generation continue to increase. Increased solar penetration will continue to stress the system during solar down-ramp periods and may require more flexible resource capability and ancillary services.
- Low voltage ride-through issues for wind and solar inverters continue to occur during transient voltage disturbances on the transmission system, although many facilities have implemented (or are planning to implement) improvements based on recommendations from the Odessa disturbance reports.
- Average synchronous inertia across most operating hours was comparable to 2021, which was a significant decrease from 2020.
- Low voltage ride-through issues for wind and solar inverters continue to occur during transient voltage disturbances on the transmission system.



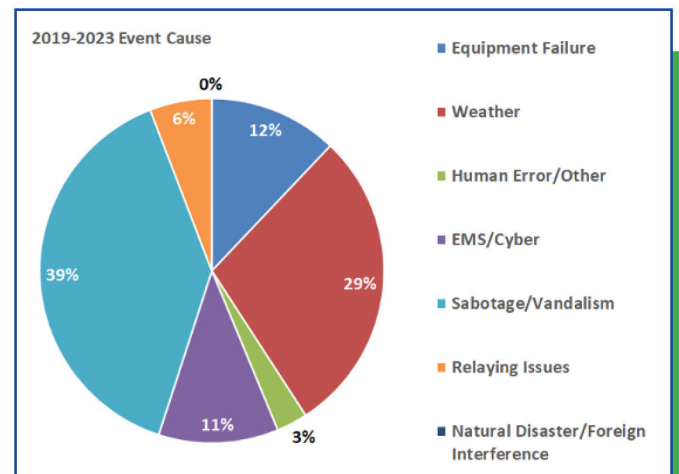
KEY FINDINGS - RESILIENCE TO EXTREME EVENTS

RESILIENCE TO EXTREME EVENTS

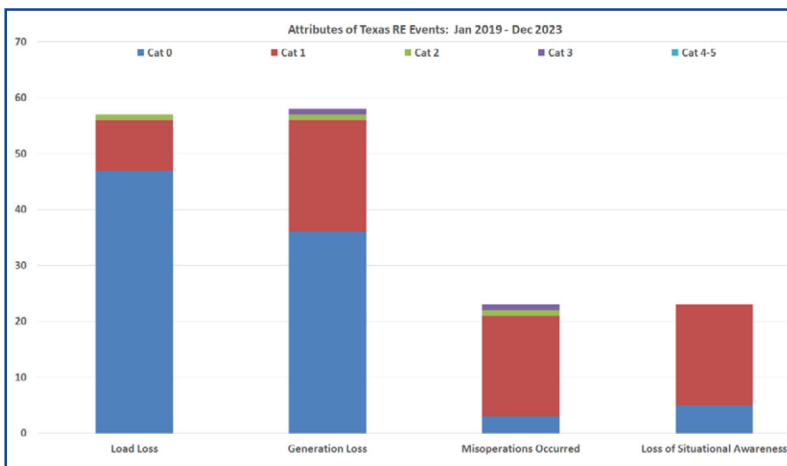
345 kV circuit automatic outage rates remained flat and near the five-year moving average. 138 kV circuit outage rates increased in 2023 to its highest level in the last five years. As in prior years, duration of sustained outages was primarily due to failed substation or circuit equipment.



2023 customer outages were within historical norms.



Equipment failure and weather continue to drive major events. Physical intrusions and damage reports have increased significantly.

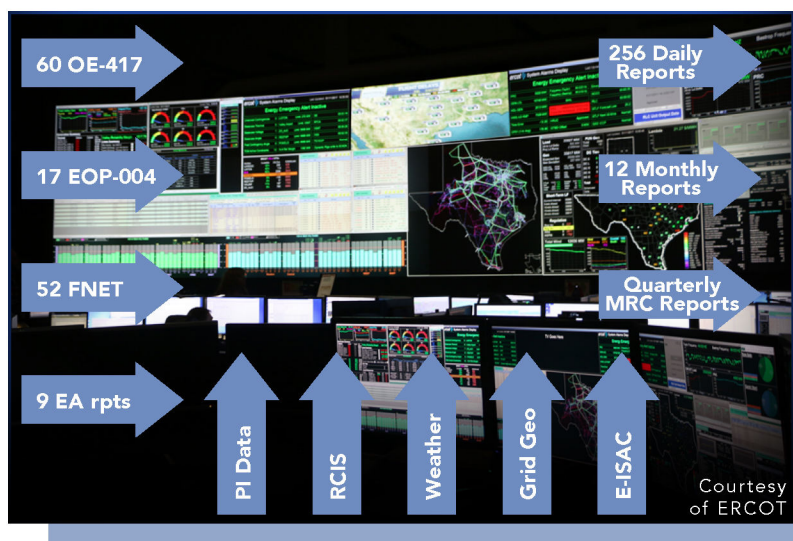


RESILIENCE TO EXTREME EVENTS

Multiple extreme events in recent years have tested the transmission grid's ability to maintain the reliability levels expected by Texans. These include Hurricane Harvey in August 2017, the cold weather event of January 2018, the Panhandle ice storm of October 2020, Winter Storm Uri in February 2021, and Winter Storm Elliott in December 2022. Generation system outage performance on extreme days in 2018, 2021, and 2022 have been related to cold weather events. The Odessa disturbances in May 2021 and June 2022, and the Panhandle wind disturbance in March 2022, all highlighted voltage ride-through issues with wind and solar units.

Date	Number of Generation Outage Events on Extreme Day	Leading Causes for Extreme Day	Cumulative Outage Duration on Extreme Day	Cumulative MW Impact on Extreme Day	Cumulative GWh Impact on Extreme Day
8/27/2017	41	Weather	22,798 Hours	10,107 MW	2,917.5 GWh
1/16/2018	84	Balance of Plant/Fuel	2,891 Hours	11,893 MW	517.8 GWh
5/11/2019	36	Turbine Generator	1,626 Hours	6,449 MW	282.5 GWh
7/1/2020	44	Auxiliary Systems	3,352 Hours	8,251 MW	247.9 GWh
2/15/2021	187	Weather	6,937 Hours	35,241 MW	1,204.1 GWh
12/23/2022	164	Weather	2,180 Hours	23,163 MW	321.8 GWh
1/30/2023	65	Turbine Generator/Fuel	2,745 Hours	9,327 MW	332.4 GWh

Despite the higher number of affected circuits and equipment associated with major events, examination of reported transmission outage data over time shows that rates trend in a consistent range and the relative order of causes have not changed significantly for both 345 kV and 138 kV systems. Failed transmission circuit and substation equipment accounted for 79 percent of the 345 kV and 64 percent of the 138 kV sustained outages' duration, respectively, from 2019 through 2023.



In 2023, Texas RE analyzed 124 BPS events, which was a significant increase from the number of events reported per year during the preceding four years. In total, 485 events were reviewed between 2019 and 2023. Of the 418 root and contributing causes identified, the "Equipment/ Material" category occurred most frequently with 38 percent of all identified causes. "Design/ Engineering" was second with 14 percent, followed closely by "Management/ Organization" with 12 percent. The number of Category 1 events has been stable over the last five years.

KEY FINDINGS - RESILIENCE TO EXTREME EVENTS

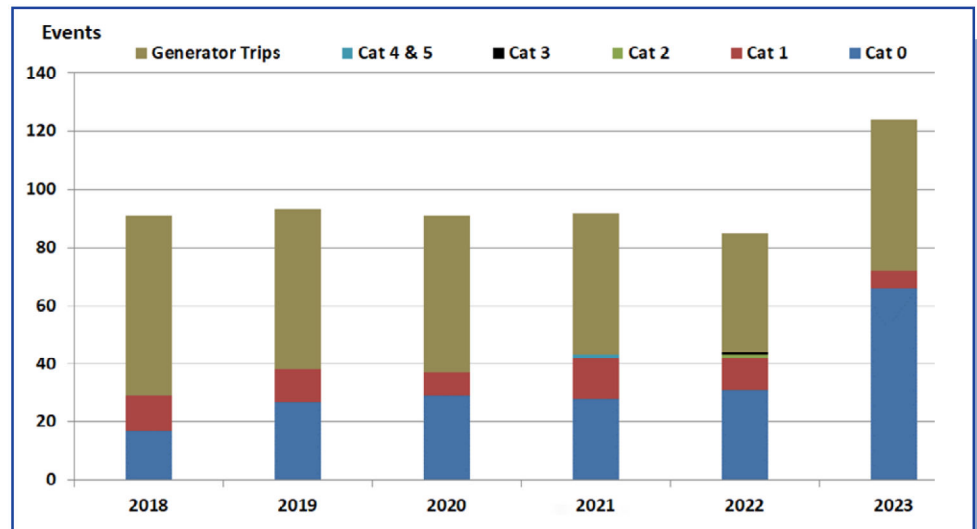
RESILIENCE TO EXTREME EVENTS

485 Events Analyzed

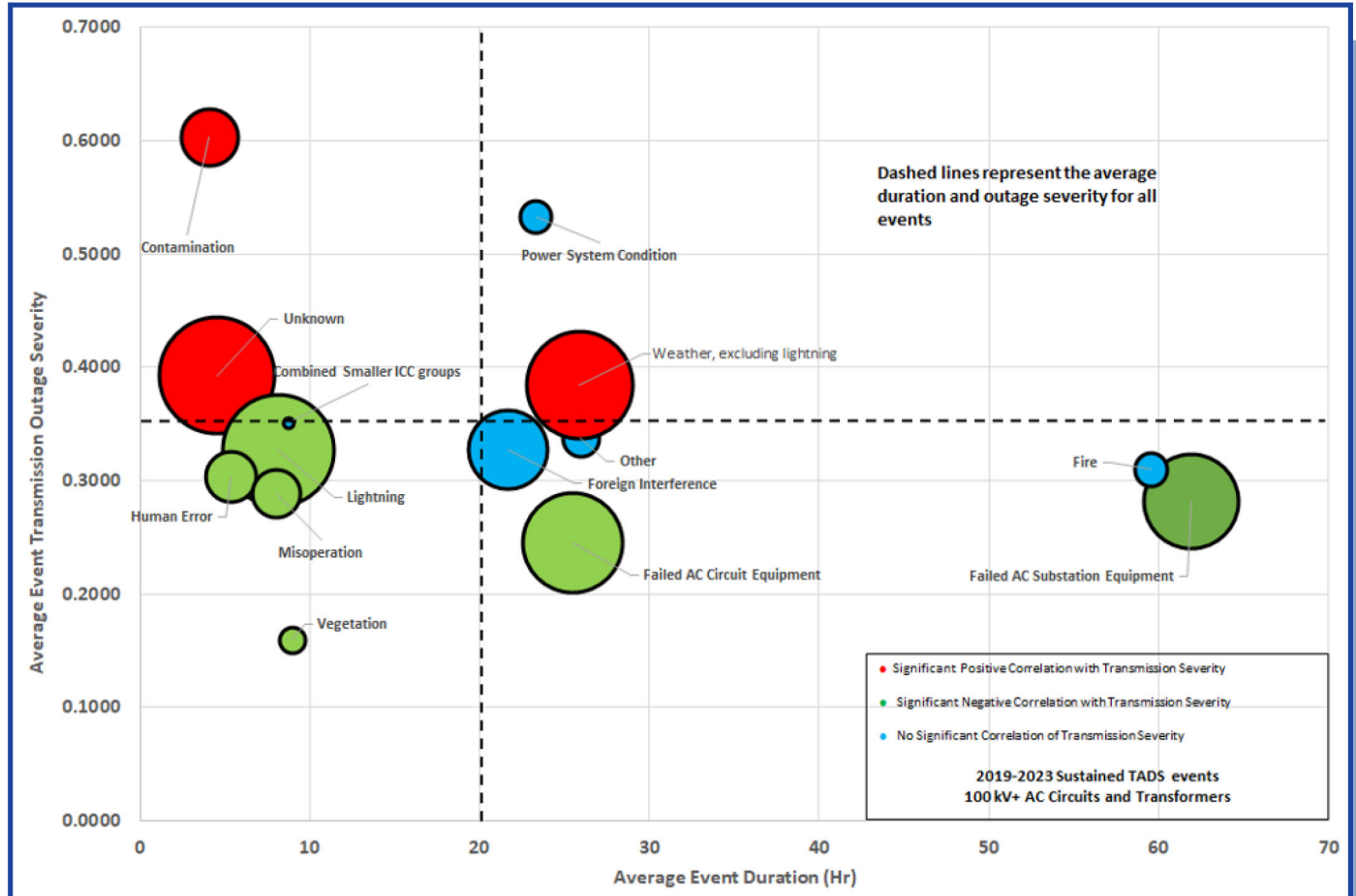
418 Root and Contributing Causes Identified

Qualified event attributes dominated by:

- Load Loss
- Generation Loss
- Physical Security Events



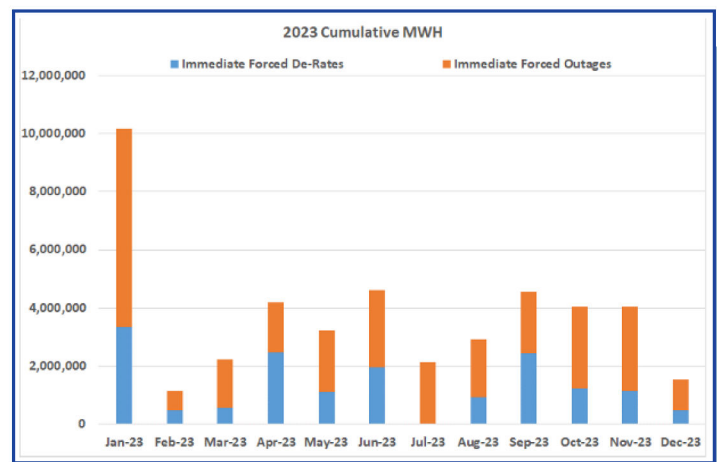
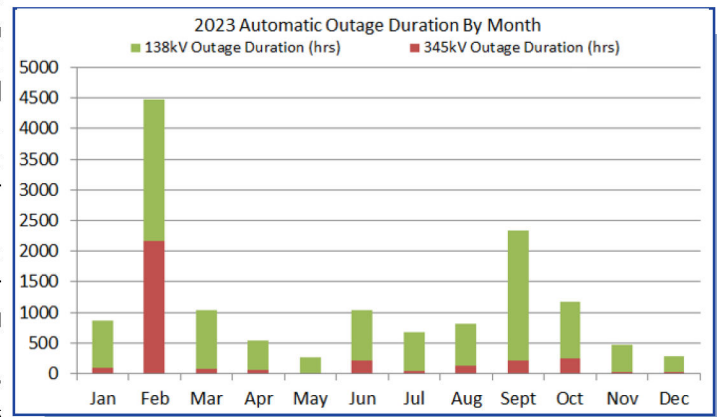
Transmission outage severity, as measured by the cumulative unavailable ratings of the circuit(s) outaged (expressed in megavolt-amperes (MVA)) and duration of the outage, is one measure of transmission system resilience. Outage severity can be further broken down by the causes of the sustained outages.



RESILIENCE TO EXTREME EVENTS

2023 HIGHLIGHTS FROM THE ANALYSIS OF RESILIENCE INCLUDE:

- Long-term trends are indicating stable outage rates per circuit and per 100 miles of line for the 345 kV and 138 kV systems, although the 138 kV circuit outage rates did increase in 2023 to its highest level in the last five years.
- For 345 kV transmission circuits, 65 percent of the total sustained outages in 2023 were: weather (excluding lightning), lightning, unknown, and failed substation equipment. Failed transmission circuit equipment accounted for just 12 percent of the outage count but 73 percent of the outage duration.
- For 138 kV transmission circuits, 77 percent of the total sustained outages in 2023 were: weather (excluding lightning), lightning, foreign interference, failed substation equipment, and failed circuit equipment. Failed transmission circuit equipment and foreign interference accounted for 68 percent of the outage duration.
- Generator winter preparedness has made significant improvements since 2021.
 - **Weatherization and Inspections.** ERCOT's third season of winter weatherization inspections included enhanced requirements for generation and transmission facilities compared to the 2022 winter season.
 - **Firm Fuel Supply Service (FFSS) Phase 2.** An additional source of onsite fuel for generators benefits the grid by providing a redundant (or additional) fuel source should there be a natural gas scarcity. FFSS Phase 1 created the FFSS service (deployed for the first time during Winter Storm Elliott in December 2022). Phase 2 expanded Resources that can qualify. Resources with firm fuel service and not subject to lower curtailment priority for a curtailment event can now qualify.
 - **Scheduled Maintenance Period.** ERCOT has worked with generators and transmission operators to schedule their maintenance to prepare their equipment for winter after running hard this past summer.
 - **Forecasting Improvements.** ERCOT has worked to reduce weather forecast error by procuring additional weather forecasts and developing load forecast models tuned for extreme cold weather. ERCOT has also improved the forecasting software testing process related to holidays and other outlier scenarios.
 - **ERCOT Contingency Reserve Service (ECRS).** Added in June 2023, ECRS takes advantage of Resources that can start within 10 minutes to address unexpected or rapid changes in supply or demand. ECRS was used several times throughout the summer.
 - **Fast Frequency Response Service.** Added in 2022, this addition to Ancillary Services takes advantage of the capability of faster-responding Resources to respond to events.
 - **Improved, Transparent Communications.** The Texas Advisory and Notification System (TXANS) was launched in May 2023. TXANS is a communications tool to keep Texans updated on grid conditions.
 - **Critical Supply Chain and Critical Infrastructure Map.** This map was created in 2022 to share the locations and connectivity of all the critical parts of the Texas power infrastructure, with a focus on natural gas facilities needed to operate generation.
 - **Improved Inter-Agency Communications.** Agencies are seeing improved, ongoing communications through both the Texas Department of Emergency Management and Texas Energy Reliability Council.



AREAS TO MONITOR:

- Weatherization of generation and transmission resources will continue to be a primary focus for the foreseeable future.
- Additional follow-up and potential requirement changes to improve voltage ride-through for IBRs will also be a primary focus.
- Physical security events, particularly gunfire damage, increased significantly in 2023.
- Protection System Misoperations continue to be an important causal factor in reported system events.

2023 CYBER AND PHYSICAL SECURITY INITIATIVES AND SECURITY RISKS INCLUDED:

- February 2023 – The Office of the Director of National Intelligence (DNI) released the Annual Threat Assessment of the U.S. Intelligence Community highlighting continued cyber espionage and cyberattack concerns from foreign nations including Iran, North Korea, Russia, and China.
 - March 2023 – President Biden released the National Cybersecurity Strategy aimed at strengthening cybersecurity for critical infrastructure and collaboration between public and private sectors.
 - October 2023 – President Biden issued an Executive Order on safe, secure, and trustworthy artificial intelligence.
 - The Department of Homeland Security (DHS) Cybersecurity and Infrastructure Agency (CISA) continues to urge organizations to prepare, respond, and mitigate the impact of cyberattacks through CISA's Shields Up campaign.
 - The Department of Energy (DOE), along with CISA, the National Security Agency (NSA), and the Federal Bureau of Investigation (FBI), issued numerous joint cybersecurity advisories including:
 - Joint Cybersecurity Advisory – AA22-061A: Royal Ransomware Update
 - Joint Cybersecurity Advisory – AA22-075A: LockBit 3.0
 - Joint Cybersecurity Advisory – AA23-144A: People's Republic of China State-Sponsored Cyber Actor Living off the Land to Evade Detection
 - Joint Cybersecurity Advisory – AA23-158A: CL0P Ransomware Gang Exploits CVE-2023-34362 MOVEit Vulnerability
 - Joint Cybersecurity Advisory – AA23-270A: People's Republic of China-Linked Cyber Actors Hide in Router Firmware
 - Joint Cybersecurity Advisory – AA23-325A: LockBit 3.0 Ransomware Affiliates Exploit CVE 2023-4966 Citrix Bleed Vulnerability
 - Joint Cybersecurity Advisory – AA23-335A: IRGC-Affiliated Cyber Actors Exploit PLCs in Multiple Sectors, Including U.S. Water and Wastewater Systems Facilities
 - May 2023 – NERC issued a Section 1600 Data Request for internal network security monitoring.
 - November 2023 – NERC issued a Section 800 Data Request to assess the extent of cross-border operation control of Bulk Power System elements.
 - September 2023 – Texas Legislature Senate Bill 947 became effective, making it a criminal offense to damage certain critical infrastructure facilities and providing for the prosecution of that conduct as manslaughter in certain circumstances, increasing the criminal penalty.
 - September 2023 – Texas Legislature House Bill 1833 became effective, increasing the penalty for the offense of criminal mischief involving a public power supply.



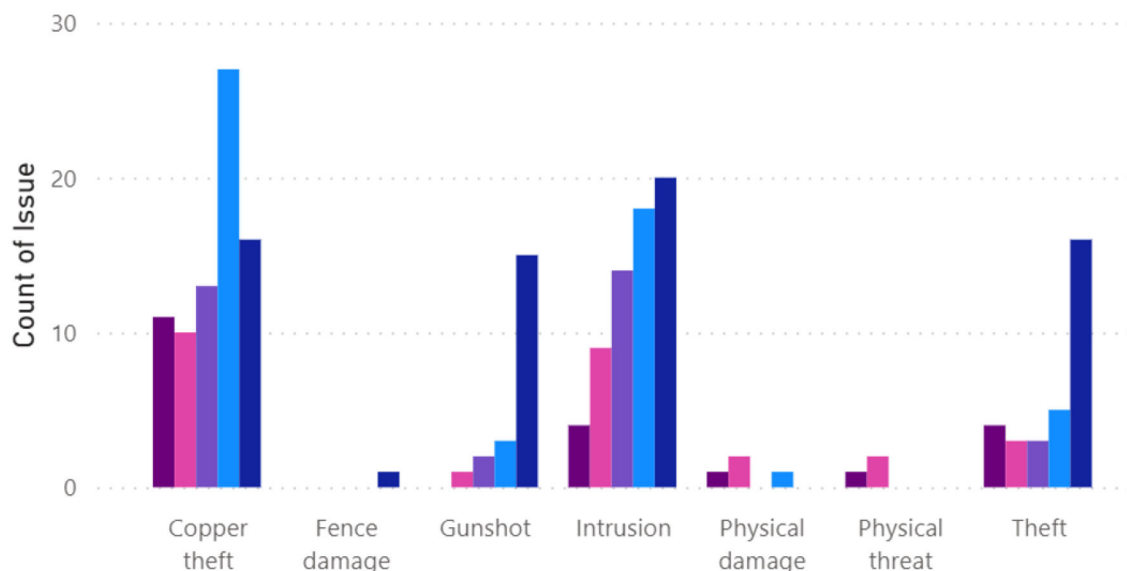
CYBER AND PHYSICAL SECURITY

2023 PHYSICAL SECURITY EVENTS AFFECTING BPS FACILITIES:

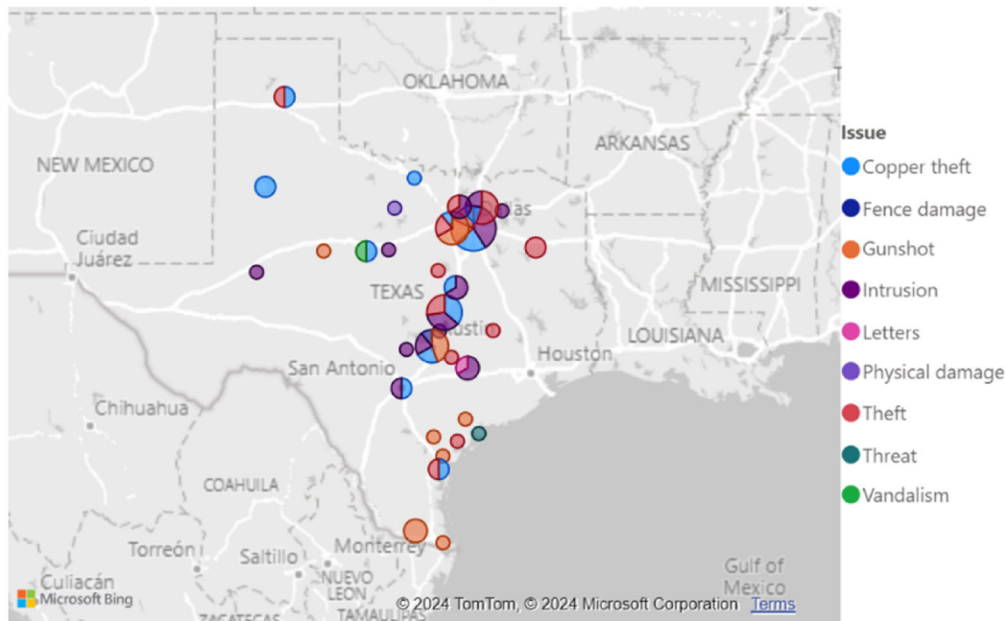
- Individual drove a car into a generator step-up (GSU) transformer oil containment pit and set fire to the vehicle
- Seventeen reported incidents of gunfire damage to transmission lines or substation equipment
- Substation batteries stolen at one substation
- Rolls of aluminum foil thrown at high voltage equipment
- Substation lost connectivity to SCADA after network firewall was removed
- Transformer damaged when oil valves were opened and smashed

Count of Physical Security Events by Issue and Year

Year ● 2019 ● 2020 ● 2021 ● 2022 ● 2023



Count of Physical Security Events by Location



AREAS TO MONITOR INCLUDE:

- Physical security events, particularly gunfire damage, increased significantly in 2023
- Incident increases in the Region were similar to industry-wide trends noted by the E-ISAC

KEY FINDINGS - CYBER AND PHYSICAL SECURITY

CRITICAL INFRASTRUCTURE INTERDEPENDENCIES

Two key reports from FERC were issued in 2023 that continued to highlight the critical interdependency between the natural gas and electric industries. These were the [FERC, NERC, and Regional Entity Staff Inquiry into Bulk Power System Operations during December 2022 Winter Storm Elliott](#), released in October 2023, and [FERC, NERC, and Regional Entity Staff Study on Blackstart and Next-Start Resource Availability in the Texas Interconnection](#), released in December 2023.

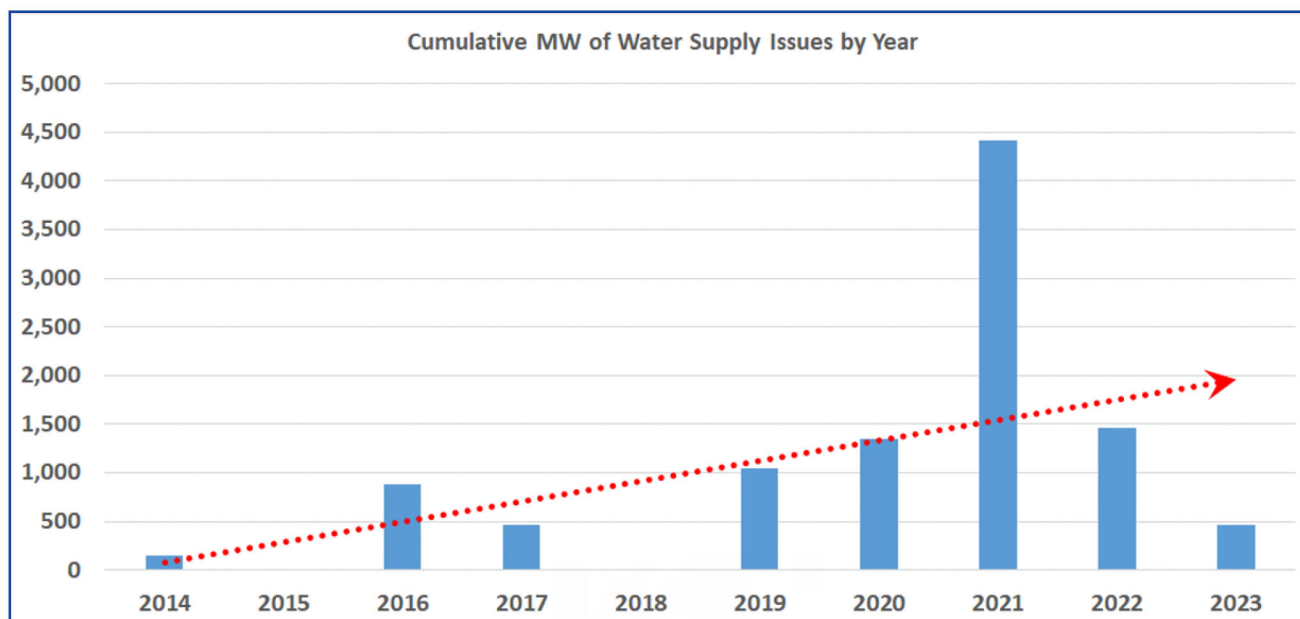
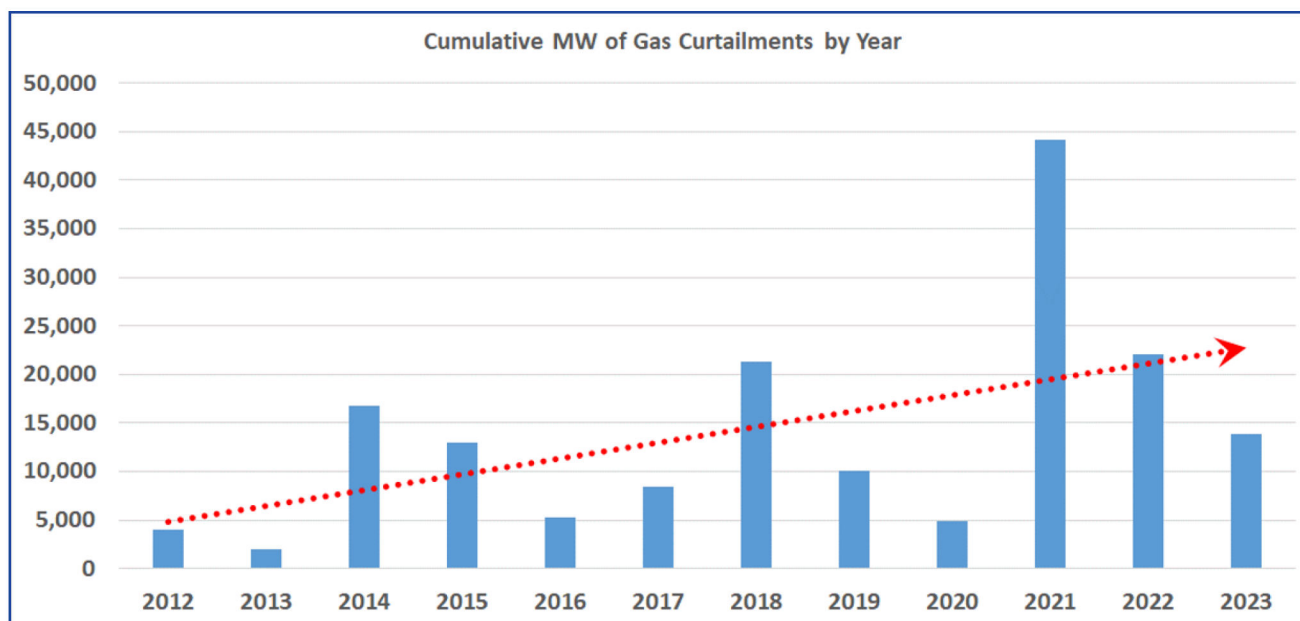
THE KEY RECOMMENDATIONS FROM THESE TWO REPORTS INCLUDE THE FOLLOWING:

1. Extreme cold weather events have repeatedly impaired the production, gathering, processing, and transportation of natural gas, therefore the need for natural gas infrastructure reliability rules should be addressed (from wellhead through pipeline requiring cold weather preparedness plans, freeze protection measures, and operating measures for when extreme cold weather periods are forecast and occur).
2. Reliability rules should address the need for regional natural gas communications coordinators (with situational awareness of the natural gas infrastructure similar to the grid's Reliability Coordinators) which can share timely operational information throughout the natural gas infrastructure chain and communicate potential issues to, and receive grid reliability information from, grid reliability entities.
3. Reliability rules should require natural gas infrastructure entities to identify those natural gas infrastructure loads that should be designated as critical for priority treatment during load shed and provide criteria for identifying such critical loads.
4. An independent research group (e.g., selected National Laboratories from the Department of Energy), should perform one or more studies to analyze whether additional natural gas infrastructure, including interstate pipelines and storage, is needed to support the reliability of the electric grid and meet the needs of natural gas Local Distribution Companies. The study should include information about the cost of the infrastructure buildout.
5. Authorities should assess the impact of a blackout on the natural gas supply chain with a focus on natural gas availability to Blackstart and next-start Resources. This assessment could help the electric and natural gas industries better understand what action is required in a blackout and which electric and natural gas entities are vital for blackstart system restoration.
6. Entities necessary for blackstart system restoration should develop a coordinated restoration plan that incorporates the needs of both the electric and natural gas industries. The entities should work collaboratively to develop this plan and should prioritize the infrastructure required to supply natural gas to the Blackstart, next-start, and other essential Resources. This plan could help ensure a more coordinated blackstart system restoration between the electric and natural gas industries.



2023 HIGHLIGHTS FROM THE ANALYSIS OF CRITICAL INFRASTRUCTURE INTERDEPENDENCIES INCLUDE:

- Gas curtailments decreased in 2023 compared to 2022 and were comparable to 2015.
- Two generation sites reported immediate de-rates in 2023 due to water supply issues. Both were due to leaks in the pipeline on the supplier side. Total derate capacity was 462 MW for 69 hours.
- Two entities experienced a loss of control and monitoring due to issues with external communications or internet service providers. Total downtime was 97 minutes.



KNOWN AND EMERGING RISKS FOR 2024

KNOWN & EMERGING RISKS FOR 2024

Texas RE continuously evaluates existing and emerging risks to the interconnection. The risk priorities and focus areas for 2024 are summarized by likelihood and impact in the risk matrix and discussion below.

OVERALL RISK IDENTIFICATION

Risk areas were identified based on the North American-wide risks identified in the August 2023 NERC Reliability Issues Steering Committee (RISC) [ERO Reliability Risk Priorities](#) report. Additional risk areas were identified based on review of geographical, regional, and entity-specific exposure (e.g. severe weather and high concentrations of variable generation).

IMPACT OR CONSEQUENCE

Was assessed by evaluating the potential for widespread or localized effects on the operation of the BPS.

How could a typical event affect BPS reliability?

SEVERE	Widespread effects across North America
MAJOR	Widespread effects across an RC area
MODERATE	Widespread effects across multiple entities or a portion of an RC area
MINOR	Effects on one entity
NEGLECTIBLE	Small or non-existent effects

OVERALL SCORE

Based on the likelihood and impact, each risk was assigned an overall score.

LOW	Low risk area
MEDIUM	Medium or moderate risk area
HIGH	High risk area
SEVERE	Severe risk area

LIKELIHOOD

Was assessed by evaluating three criteria:

- Are mandatory controls in place to mitigate the risk?
- Are there occurrences, or the likelihood of an occurrence, increasing?
- Are there any documented cases of the risk?

What is the reasonable probability that the event will occur?

	MANDATORY CONTROLS	EMERGING TRENDS	EVENT HISTORY
ALMOST CERTAIN	No NERC Reliability Standards in place for mitigation	Increasing trends have been identified	Widely publicized and documented events have been recorded
LIKELY	No NERC Reliability Standards in place for mitigation	Some trends have been identified	Generally publicized events have been recorded
POSSIBLE	NERC Reliability Standards in place for limited mitigation	Some trends have been identified	Moderate or no documented events have been recorded
UNLIKELY	NERC Reliability Standards in place for mitigation	Some trends have been identified	Minimal or no documented events have been recorded
VERY UNLIKELY	NERC Reliability Standards in place for mitigation	No trends have been identified	No documented events have been recorded

RISK LEVEL			
LOW	MODERATE	HIGH	VERY HIGH

CONSEQUENCE/ IMPACT		LIKELIHOOD (L)				
		L1	L2	L3	L4	L5
		VERY LIKELY	UNLIKELY	POSSIBLE	LIKELY	ALMOST CERTAIN
C5	SEVERE					
C4	MAJOR			Extreme Weather & Resource Weatherization		
				Supply Chain		
				Energy Availability		
				Gas Supply Restrictions During Cold Weather	IBR Ride-Through	
C3	MODERATE		Provision of Essential Reliability Services from a Changing Resource Mix			
			Facility Ratings	Remote Access		
				Inaccurate Resource Modeling		
			Disorganized Integration of Large Flexible Loads		Physical Security	
C2	MINOR					
C1	NEGLIGIBLE					

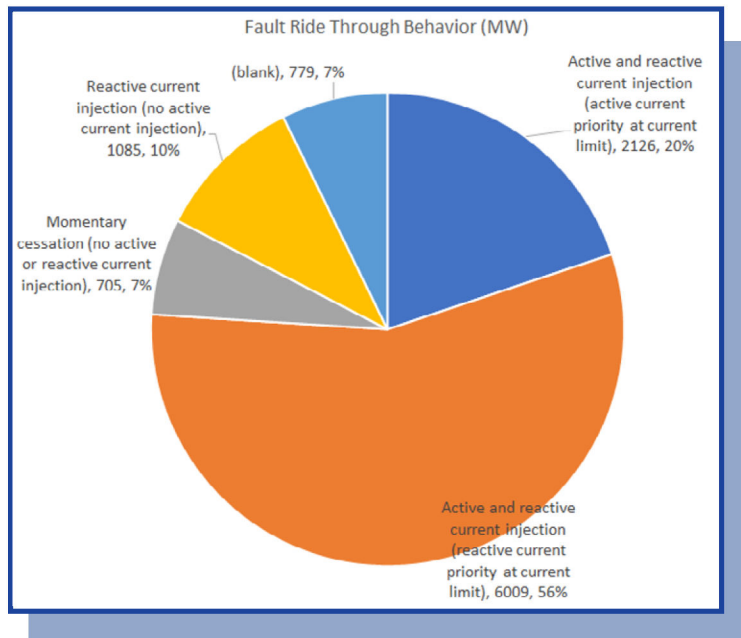
KNOWN AND EMERGING RISKS FOR 2024

GRID TRANSFORMATION

INVERTER-BASED RESOURCE RIDE-THROUGH

Likelihood: *LIKELY* // **Impact:** *MAJOR*

NERC has released multiple detailed disturbance reports from 2021 to 2023. The reports identified that IBR facilities lack sufficient ride-through capability to support the BPS for normal BPS fault events. In addition, the reports also discussed that system planning assessments need to accurately capture these types of systemic performance issues. Analysis of ERCOT units from the March 2023 NERC Level 2 Alert on [Inverter-based Resource Performance Issues](#) continues to show a risk to the Texas Interconnection for facilities that have not fully implemented the voltage and frequency ride-through recommendations from the NERC disturbance reports and guidelines.



Fault Ride-Through Behavior Enabled at the Facility	# of Facilities	Sum of Nameplate MW
Active and reactive current injection (active current priority at current limit)	9	2,126
Active and reactive current injection (reactive current priority at current limit)	32	6,009
Momentary cessation (no active or reactive current injection)	5	705
Reactive current injection (no active current injection)	5	1,085
No response	4	779
Grand Total	55	10,703

As noted above, ERCOT projects significant increases in utility scale solar generation (190 percent) and storage resources (310 percent) over the next two years. It is paramount that IBR ride-through performance issues are immediately addressed with the penetration of solar PV and other IBRs continuing to grow rapidly in the ERCOT footprint.

ERCOT should be commended for the proactive approach it has taken to address these performance issues. Nevertheless, continued low-level disturbance events are occurring in the Texas Interconnection. Beyond ERCOT, the Southwest Utah disturbance in April 2023 and the California battery energy storage disturbances in April and May of 2023 also demonstrate continued issues with concurrent and unexpected IBR generation losses. Given the increase in IBRs on the system and the continued risks associated with IBR ride-through issues to BPS reliability, Texas RE has increased the impact factor in the risk assessment of IBR ride-through from “Moderate” to “Major.”

GRID TRANSFORMATION

Based on the continued events and the increase in penetration and overall importance of IBRs to the Region's energy adequacy, Texas RE has increased the impact factor of the assessed risk in this area from "Moderate" to "Major." Texas RE is involved in Standards projects that address IBR performance and overall inclusion in Reliability Standards and will continue to conduct monitoring engagements that are focused on IBRs staying online when needed. Texas RE plans to conduct sixteen engagements in 2024 which include ride-through capability Standards. Texas RE's [Resource Hub](#) will continue to be updated with relevant materials to help address this risk.

PROVISION OF ESSENTIAL RELIABILITY SERVICES FROM A CHANGING RESOURCE MIX

Likelihood: **UNLIKELY** // **Impact:** **MODERATE**

The changing composition of the Region's resource mix from dispatchable to variable generation resources requires attention to the procurement of sufficient essential reliability services to maintain reliable grid operations. As the penetration of variable resources increases, merely having available generation capacity

does not equate to having the necessary reliability services (such as ramping capability) to balance generation and load. Summer 2023 was record-setting in terms of load at peak (generally HE17) but there were more concerns after the peak. Specifically, solar generation records were repeatedly broken, resulting in significant and rapid solar generation down ramps after the peak. Texas RE continues to monitor key indicators such as primary frequency response, ramping capabilities, and system inertia. In 2023, primary frequency response continued to exceed NERC's requirements. The



maximum hourly ramp rate for solar resources increased by 33 percent in 2023 compared to 2022. ERCOT has implemented enhancements to better manage frequency variations during these ramp periods but will continue to be challenged as solar penetration grows. Lastly, average synchronous inertia showed an increase in 2023 and was in-line with historical norms from the 2017-2020 timeframe.

ENERGY AVAILABILITY

Likelihood: **POSSIBLE** // **Impact:** **MAJOR**

ERCOT continues to not have sufficient dispatchable resources to meet its projected 50/50 peak and extreme peak loads. Increasingly, variable resources such as wind and solar must be counted on to provide

GRID TRANSFORMATION

the necessary energy to meet demand and the percentage of peak load provided by variable resources is expected to further increase in the coming years.

Federal energy policies are accelerating the shift to variable generation and retirements of conventional generation. The Environmental Protection Agency (EPA) issued a number of proposed rules in 2022 and 2023 that heighten the risk of thermal unit retirements occurring after 2023, including:

- Federal Implementation Plan (FIP) for interstate transport of ozone-forming emissions (“Good Neighbor Plan”)
- Coal Combustion Residuals Standards
- Mercury and Air Toxics Standards
- SO₂ Best Available Retrofit Technology (BART) requirements for certain Texas generation units under the Regional Haze rule
- Changes to New Source Performance Standards and emission guidelines for existing generation units

The implications for the Texas Interconnection are potentially enormous. For example, initial estimates regarding the EPA’s proposed Good Neighbor Plan note that greater than 10,000 MW of thermal units will be required to install Selective Catalytic Reduction (SCR) for NO_x emission reduction. Increased costs associated with these environmental mitigation activities could further accelerate the retirement of these resources. Conversely, in 2023 Texas voters approved a new low interest loan program for dispatchable generation. A new Dispatchable Reserve Service is also under development to secure availability of thermal and energy storage resources to offset variability in renewable generation. Additionally, ERCOT is developing a reliability standard that will identify minimum reserve levels, along with the performance credit mechanism selected by the PUCT for encouraging generator availability during stressed periods.

Regardless of the ultimate impact of various energy policies, variable generation will continue to grow. As the penetration of wind and solar resources increases, the risk of tight operating reserves during hours other than the daily peak load will also continue to increase. The traditional question of whether enough resources will be available at system peak has therefore become more complex and perhaps has transitioned to, “are there enough resources to manage the system effectively for every hour of the day?” The assessment of resource adequacy requires considering all times of day and all times of the year and not simply during peak hours.

ERCOT is continuing to update processes, tools, and techniques to better model the contribution of variable resources to meet demand. NERC and Texas RE are also enhancing their reliability assessments to incorporate probabilistic energy assessment analyses into their performance assessment products. Further, flexible resources such as batteries and demand response are being modeled and incorporated into the planning process to balance demand and load.

GRID TRANSFORMATION

INACCURATE RESOURCE MODELING

Likelihood: **POSSIBLE** // **Impact:** **MODERATE**

As previously noted, multiple event reports have reflected the abnormal performance of IBRs. These types of concurrent and unexpected losses in generation pose a significant risk to BPS reliability because many of the underlying causes of abnormal performance are systemic in nature. As discussed in the 2022 Odessa Disturbance report, system planning assessments need to accurately capture these types of systemic performance issues. As part of this process, a comprehensive review is needed to ensure that IBR models are accurate, have passed rigorous quality checks, and that sufficient documentation is in place for transmission planners to assess and verify model quality and fidelity. Improvements to the resource commissioning processes to ensure the “as built” plant condition matches what was studied during the interconnection process (with gaps or discrepancies clearly documented, understood, and corrected as needed) should occur. ERCOT protocol and operating guide revisions for modeling and performance of IBRs are being reviewed through ERCOT stakeholder processes. Ongoing delays in implementing these modeling and performance requirements will continue to be a risk as more IBR units are integrated into the electrical grid. The delay will ensure that Texas RE continues to monitor this risk in upcoming years. ERCOT is developing enhancements to its model review and verification process through work at the Inverter-Based Resource Task Force, which Texas RE will monitor closely.

DISORGANIZED INTEGRATION OF LARGE FLEXIBLE LOADS

Likelihood: **UNLIKELY** // **Impact:** **MODERATE**

Texas RE has added a new risk focusing on the disorganized integration of large flexible loads. Timely integration of large flexible loads into reliable BPS operations will be challenging and important. ERCOT has experienced continued rapid load growth in industries associated with interruptible data center operations



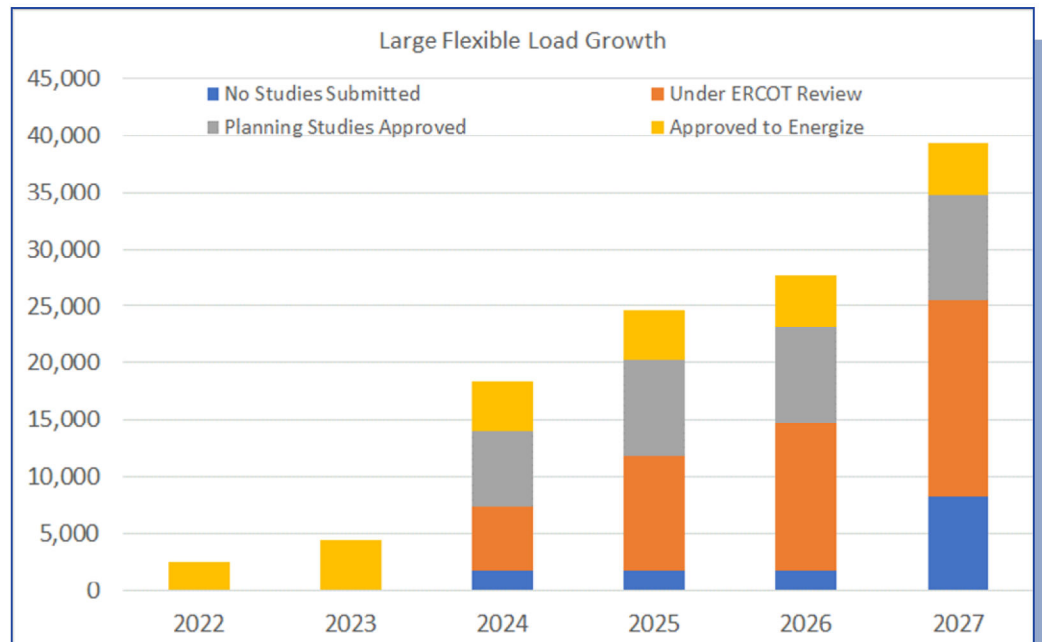
such as bitcoin mining. Interconnection request queues indicate large load totals could reach up to 41,000 MW by the end of 2027. However, it is thought that a significant portion of the 41,000 MW is made up of speculative interconnection requests. Of that 2027 total, only 9,087 MW have had their planning studies approved by ERCOT, and of that only 2,620 MW have been approved to energize.

KNOWN AND EMERGING RISKS FOR 2024

GRID TRANSFORMATION

The nature of this new load category has called for modifications to existing methodologies, such as that of the load forecasts, to capture aspects of flexibility and price responsiveness more accurately. This is demonstrated by a new assumption in the long-term load forecast that accredits large flexible loads at 10 percent of their maximum consumption during on-peak hours. This is an interim assumption based on observed operations of these sites during both summer and winter peaks. Continuous efforts are being made to further improve the accuracy of these forecasts and incorporate bitcoin mining economic models to better predict load ramps due to price response. This is already being incorporated into ERCOT's Monthly Outlook for Resource Adequacy (MORA) in the form of a *Large Flexible Load Adjustment* to the peak load forecast.

ERCOT's Large Flexible Load Task Force (LFLTF) has identified several potential solutions to issues pertaining to interconnection, operations, markets, and grid planning topics. One of the key reliability issues being evaluated is the extent to which these loads will impact system frequency in the event of rapid and unpredictable load ramping, or a failure to ride through a voltage event. Proposed solutions have included additional modeling requirements for loads 25 MW or greater including large load interconnection and stability studies, classification of the end-use of the load, and additional requirements for large loads that are co-located with existing or proposed generation resources.



CYBER AND PHYSICAL SECURITY

REMOTE ACCESS

Likelihood: **POSSIBLE** // **Impact:** **MODERATE**

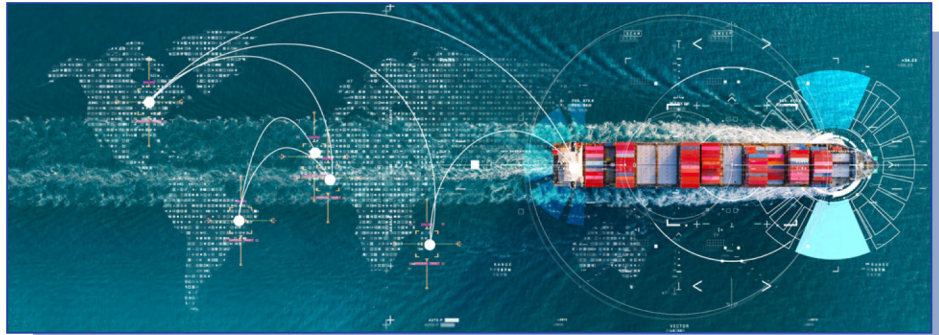
The 2023 RISC report recommends that to mitigate the risk of poor cyber hygiene, the industry must continue to focus on early detection and response to cyberattacks and adopt controls that can be executed to protect critical systems. This risk applies to both generation and transmission entities. As part of monitoring engagements, Texas RE is addressing this risk by assessing if entities are protecting data used for Real-time Assessment and Real-time monitoring while such data is being transmitted between Control Centers. Texas RE's outreach will highlight internal controls around remote connectivity.

CYBER AND PHYSICAL SECURITY

SUPPLY CHAIN

Likelihood: **POSSIBLE** // **Impact:** **MAJOR**

In 2021 FERC and NERC released the [Joint Report on SolarWinds and Related Supply Chain Compromise](#) that provided non-invasive techniques that registered entities may use to identify a vendor of network interfaces deployed on their network. Grid transformation has resulted in a large number of new entities (and their associated equipment) to be added to the Texas Interconnection, exacerbating the supply chain risk. As such, Texas RE assesses the risk associated with supply chain policies and procedures during monitoring engagements. Texas RE will continue to work with the Critical Infrastructure Protection Working Group (CIPWG) to mitigate this risk and CIP risks in general. In addition, Texas RE's outreach will highlight internal controls around using vendors.

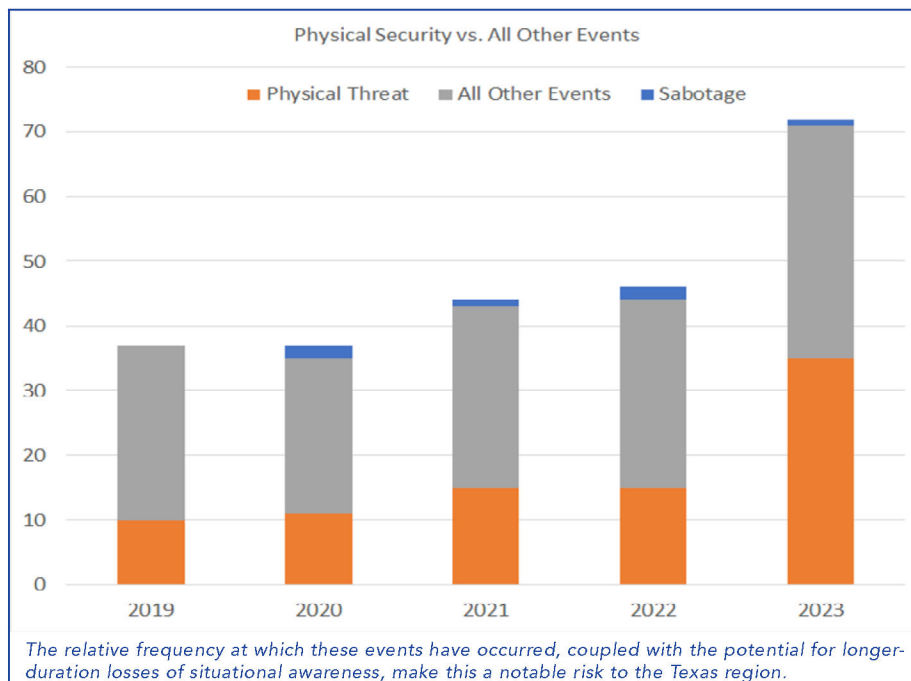


PHYSICAL SECURITY

Likelihood: **LIKELY** // **Impact:** **MODERATE**

In 2023, FERC issued an order that directed NERC to assess the effectiveness of Reliability Standard CIP-014-3. NERC subsequently filed a report evaluating CIP-014-3 and the risk of physical security attacks to the BPS. The E-ISAC monitored drone activity data gathered in late 2022 and is currently conducting a 12-month pilot

to provide asset owners and operators with a baseline understanding of the level of drone activity around electric infrastructure. A CIP-014 SAR was proposed in 2023 and will be monitored by Texas RE as it develops.



There have been noted increases in physical security events in the Region. Based on this trend, Texas RE has increased the likelihood factor of the assessed risk in this area from "Possible" to "Likely." Texas RE will continue to facilitate conversations involving physical risks during workshops, targeted outreach, and other means as needed.

KNOWN AND EMERGING RISKS FOR 2024



RESILIENCY

EXTREME WEATHER & RESOURCE WEATHERIZATION

Likelihood: **POSSIBLE** // **Impact:** **MAJOR**

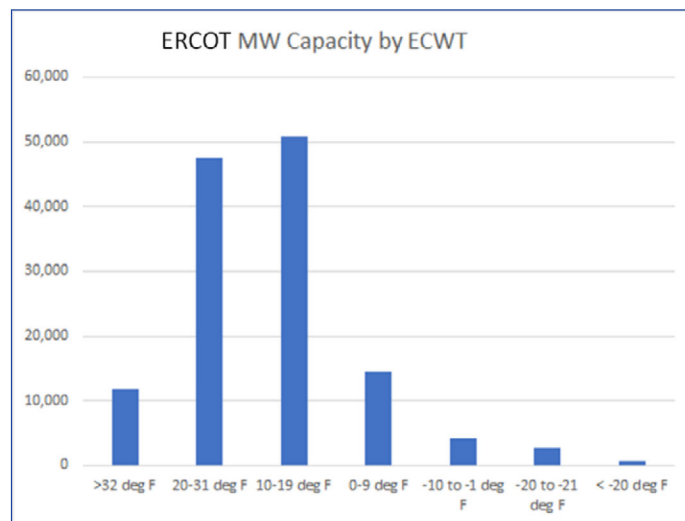
Review of data collected from the May 2023 NERC Level 3 Alert on [Cold Weather Preparations for Extreme Weather Events](#) show improvements in the winterization plans and preparations from generation entities. Approximately 88 percent of facilities have calculated the Extreme Cold Weather Temperature (ECWT) based on the proposed NERC standards for their units and approximately 85 percent of the

entities (95 percent of the MW capacity) reported that their units were capable of operating at the ECWT. Approximately 60 percent of the entities (75 percent of the MW capacity) have identified critical components. Finally, approximately 84 percent of the entities (91 percent of the MW capacity) have completed the essential actions recommended by NERC in the Alert.

Texas RE will continue to approach the risk associated with this focus area by various outreach activities throughout the year. Texas RE will facilitate a Winter Weatherization Workshop that allows industry to discuss winterization preparedness. In addition, Texas RE's online Resource Hub will continue to be updated with relevant materials. The Resource Hub helps ensure entities are prepared and ready to respond in the event of a major storm.

The ERO Enterprise considers Requirements associated with cold weather to be an area of focus. The FERC/NERC/Regional Entity Winter Storm Elliot [presentation](#) and subsequent report explicitly called out a need for, "robust ERO monitoring of implementation of currently-effective and approved cold weather Reliability Standards to determine if reliability gaps exist."

Texas RE will include monitoring engagements of Generation Owners and Generator Operators that focus on the Cold Weather Reliability Standards and the controls around implementing cold weather preparedness plan(s).



FACILITY RATINGS

Likelihood: **UNLIKELY** // **Impact:** **MODERATE**

The accuracy of Facility Ratings is related to other focus areas and remains critically important to reliable operations. For example, it is important that Facility Ratings are accurate so that in extreme weather

events, as well as normal conditions, entities making operational decisions are relying on accurate equipment information. Texas RE initiated a comprehensive compliance review of Facility Ratings in 2022 and will continue the efforts in 2024. As part of monitoring engagements, Texas RE assesses if entities are maintaining accurate Facility Ratings as well as the controls that an entity has around developing accurate Facility Ratings. Outreach, targeted and broad coverage, will continue as needed including monitoring changes to the FAC-008 Standard being considered. In addition, Texas RE's online Resource Hub will continue to be updated with relevant materials.

GAS SUPPLY CHAIN RESTRICTIONS DURING COLD WEATHER

Likelihood: *POSSIBLE* // **Impact:** *MAJOR*

Natural gas represents the largest fuel source in the Region and serves as an essential fuel to meet demand and balance variable resources on the system. Given this critical role, vulnerabilities associated with natural gas delivery to generators can result in generator outages. This is particularly true during cold weather conditions. During Winter Storm Uri, natural gas fuel supply issues accounted for 87 percent of all fuel-related outages and derates, resulting in over a quarter of all generation outages observed during the event. Natural gas fuel supply issues included declines in natural gas production, unplanned outages of natural gas wellheads due to freeze related issues, loss of power supply to natural gas infrastructure, facility shut-ins to prevent freezing, and unplanned outages of gathering and processing facilities. Texas regulators have implemented a range of measures to address gas supply and gas-electric coordination issues, including developing critical infrastructure mapping to prevent reduction in power to critical gas infrastructure during manual load shedding, winterization requirements for certain natural gas facilities, and flexible fuel market products. Gas curtailments decreased in 2023 compared to 2022 and were comparable to 2015. Natural gas supply and delivery, and alternative fuel capability and availability for gas generation (including blackstart units) will be the focus of follow-up recommendations from Winter Storm Uri and Winter Storm Elliott in 2024.





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