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NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

talk with
TEXASRE

FERC-ERO Enterprise Report on the February 2021 Cold Weather Outages

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The February 2021 Cold Weather Outages in Texas and the South Central United States

FERC, NERC and Regional Entity Joint Staff Report
November 2021

This report was prepared by the staff of the Federal Energy Regulatory Commission in consultation with staff from the North American Electric Reliability Corporation and its Regional Entities. This report does not necessarily reflect the views of the Commission.



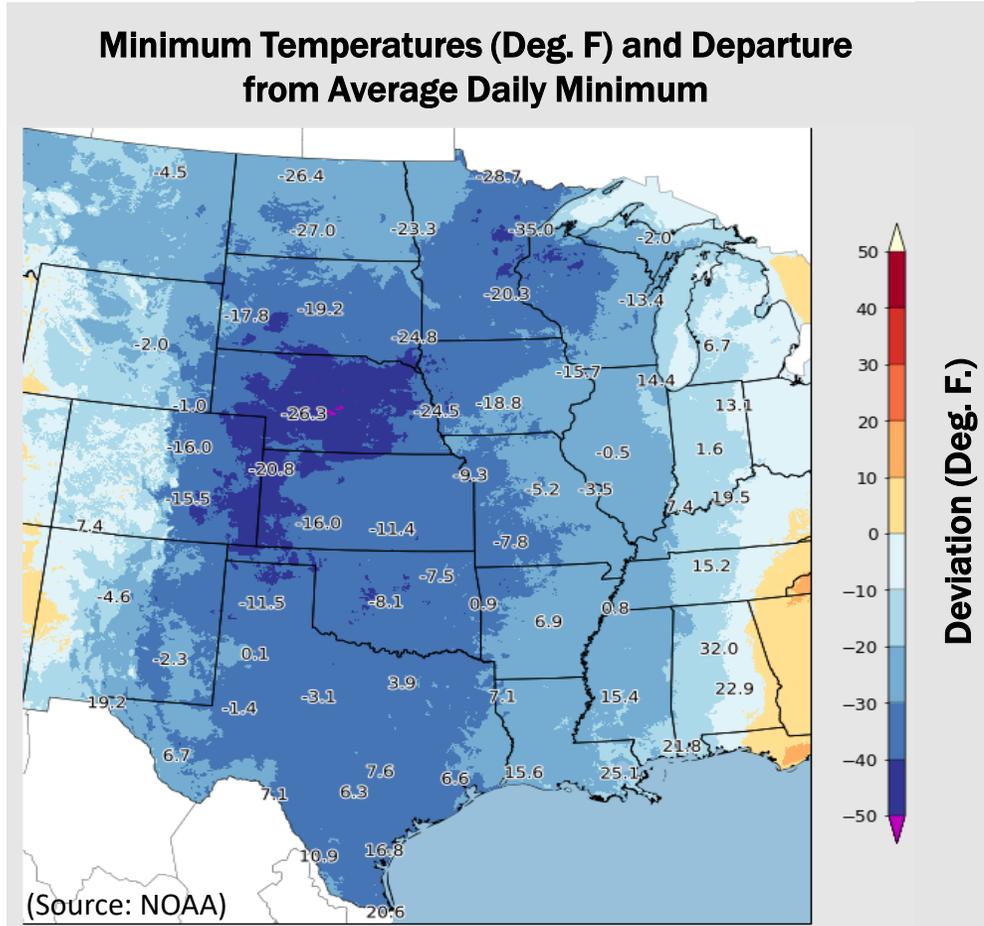
Extreme Cold Weather - February 2021

Bottom Line

- During the week of February 14, 2021, for over two consecutive days, ERCOT averaged 34,000 megawatts (MW) of generation outages, nearly half of ERCOT's 2021 all-time winter peak load of 69,871 MW.
- Largest firm load shed event in U.S. history (23,418 MW), third largest in quantity of outaged MW of load (August '03 and August '96 blackouts).
- Fourth event in the past 10 years which jeopardized bulk-power system reliability due to unplanned generating unit outages which escalated due to cold weather.



Severe Cold and Freezing Precipitation Have Happened Before in Texas and South Central U.S.



- Comparing 1983, 1989, 2011, 2018 and 2021 cold weather conditions
- In every event, average daily temperatures fell below freezing in Dallas, Houston, and Jackson, for at least 3 days.
- 1983 was colder than 2021 on multiple days in Dallas, Houston and Jackson, MS, and 1989 was still coldest recorded winter for Houston and Galveston; 14 days below freezing over 2-3 weeks.
- 1983, 2011 and 2018 events all had significant freezing precipitation, like 2021.



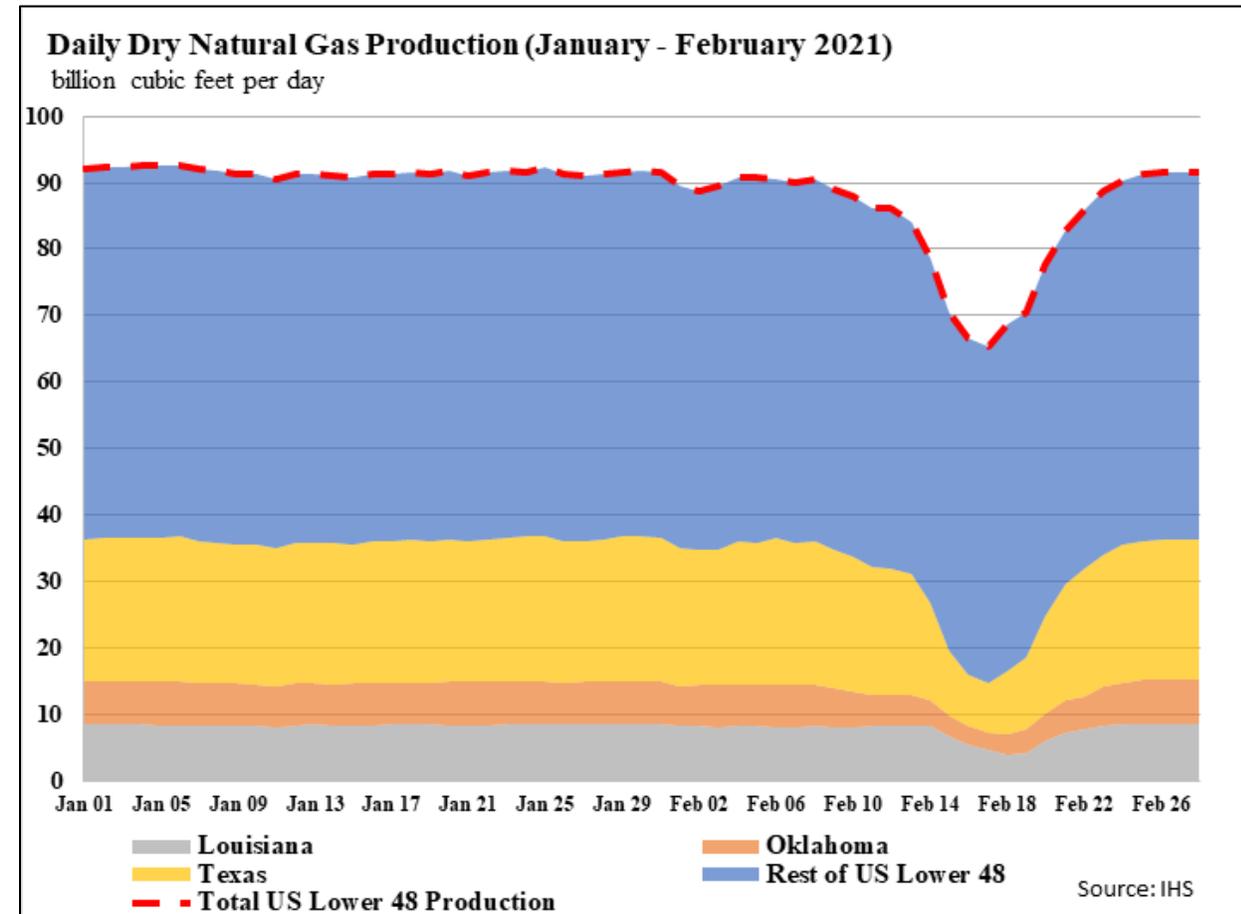
Fourth Cold Weather Event in the Past 10 Years Which Jeopardized BES Reliability

	Feb. 1-5, 2011	Polar Vortex Jan. 6-8, 2014	2018 Event Jan. 15-19, 2018	2021 Event Feb. 8-20, 2021
	17 to 36 deg F below average	20 to 30 deg F below average	12 to 28 deg F below average	40 to 50 deg F below average
Unavailable Generation Due to Cold Weather, at Worst Point (MW)	14,702	9,800	15,600	65,622
Energy Emergencies Declared / Highest Level	Yes / EEA 3	Yes / EEA 3	Yes / EEA 2	Yes / EEA 3
Maximum Firm Load Shed (MW)	5,411	300	---	23,418



Effect on Natural Gas System

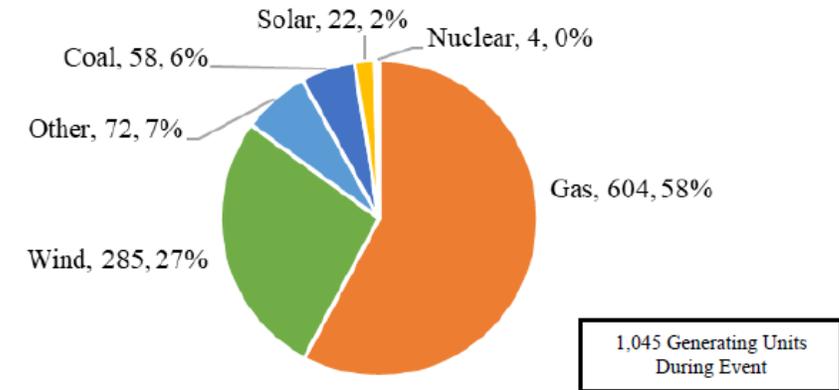
- Largest U.S. monthly decline of natural gas production on record.
- Between February 8 and 17, the total natural gas production in the U.S. Lower 48 fell by **28 percent**, while Texas production declined **70.1 percent** (as compared to January average).
- Most producing regions of the U.S. saw a sharp decline and recovery.



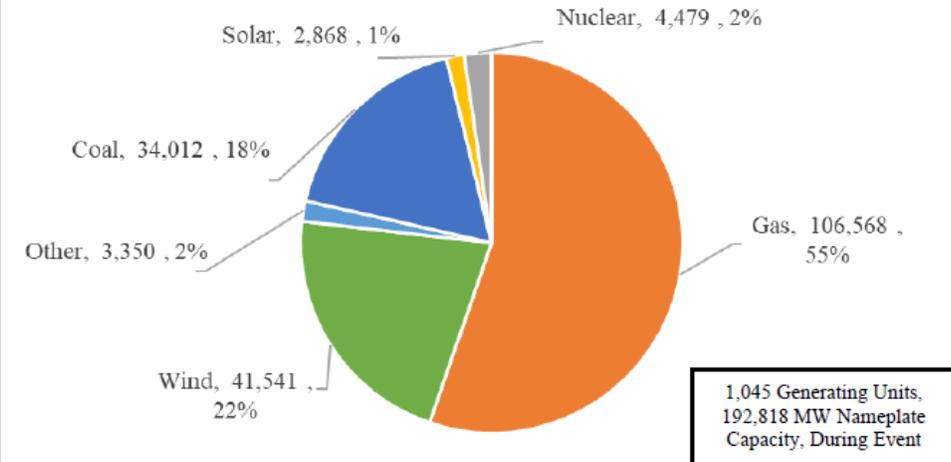
Unprecedented Electric Generation Shortfalls Due to Cold Weather Conditions

- **1,045** individual generating units experienced **4,124** outages, derates or failures to start, of which **604 (58 percent of all units)** were natural gas-fired generators.

Fuel Type of Generating Units That Experienced Incremental Unplanned Outages and Derates (by Number of Generators), Total Event Area

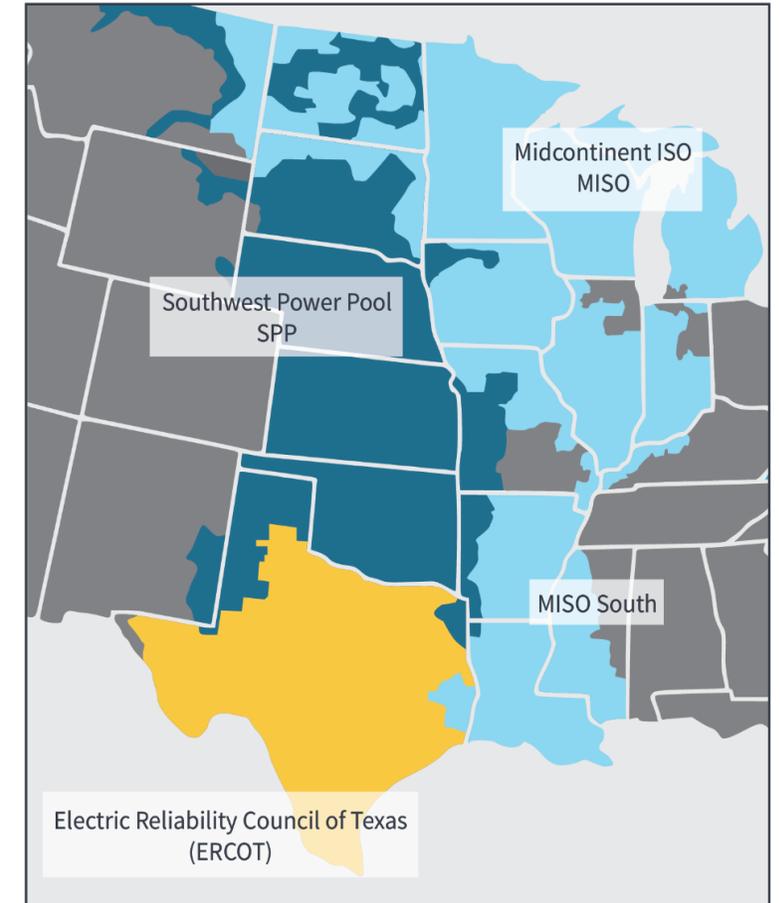


Fuel Type of Generating Units That Experienced Unplanned Outages and Derates (by MW of Nameplate Capacity), Total Event Area



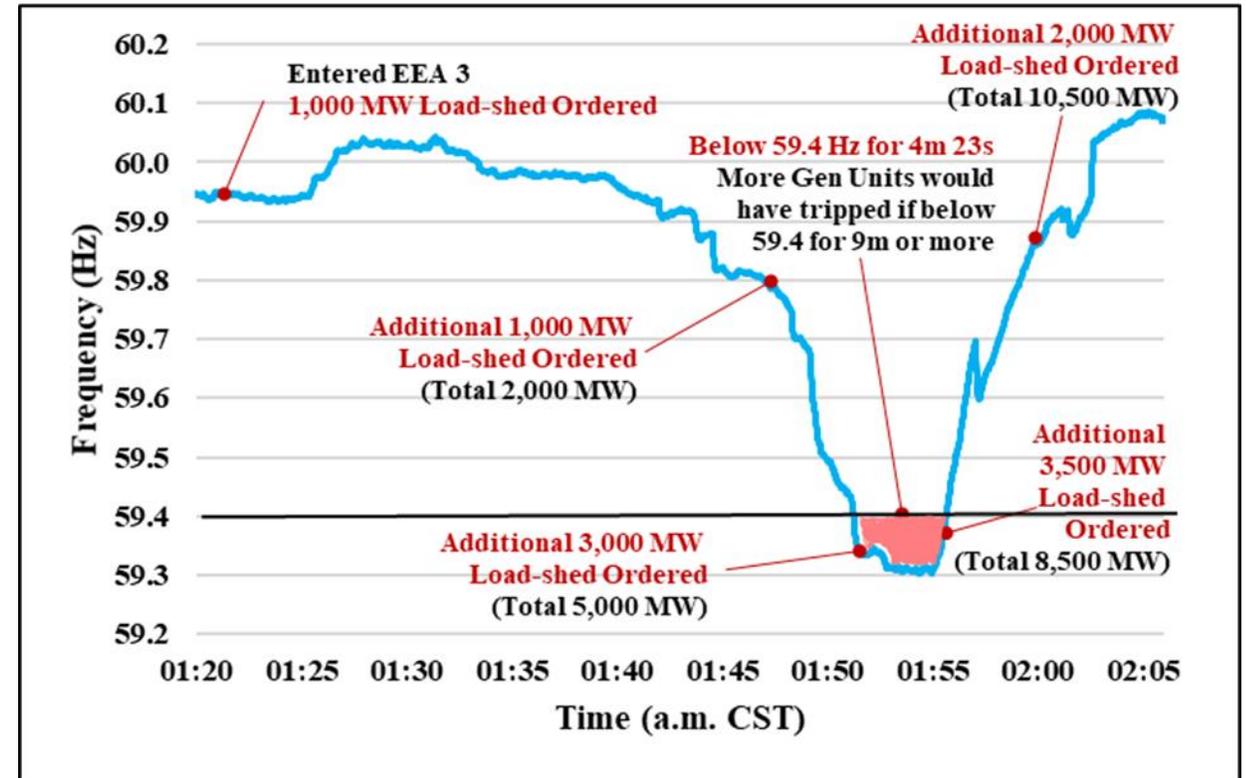
Generation Shortfalls Led to Energy Emergency Firm Load Shed in ERCOT, SPP, and MISO

- Affected grid operators, known as Balancing Authorities (BAs) declared Energy Emergencies and ordered firm load shed at different points of time, in total **23,418** MW during severely cold weather to avoid entire system blackouts:
 - ERCOT BA: nearly three consecutive days and at its worst point, **20,000** MW,
 - SPP BA: over four hours total and at its worst point, **2,718** MW, and
 - MISO BA (MISO South): over two hours and at its worst point, **700** MW.



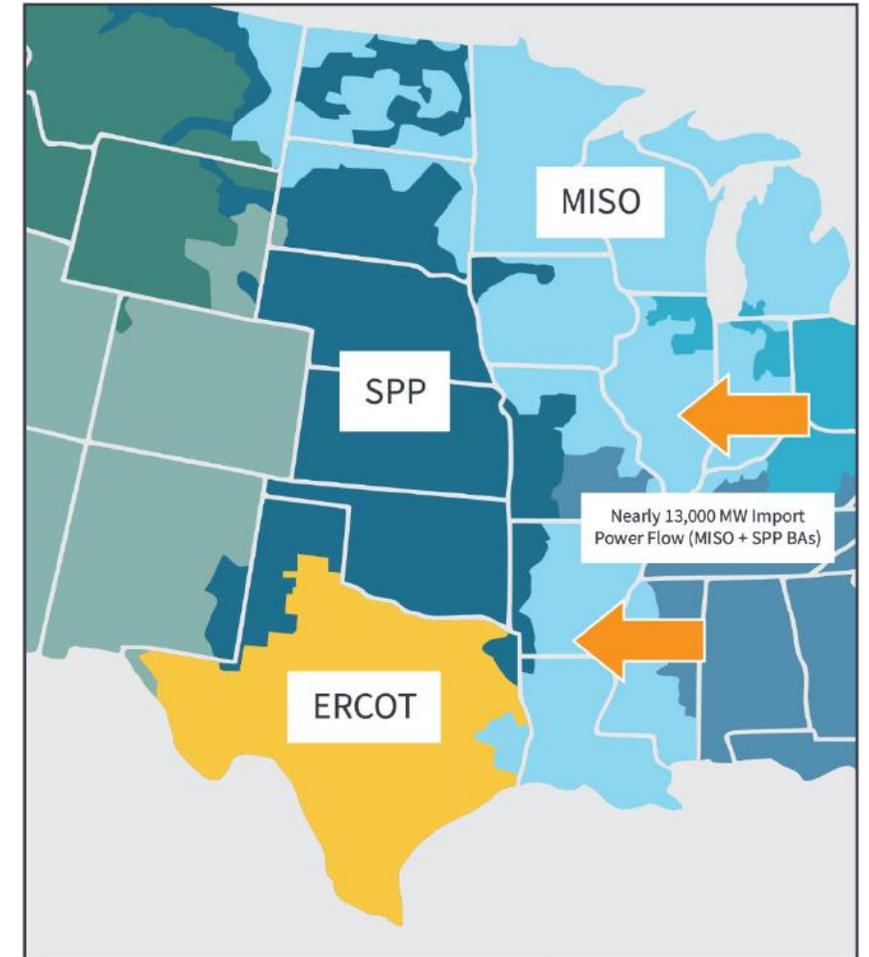
ERCOT Frequency Excursion

- Over 2 hour period generating units tripped/ran back at rapid pace
- Operators struggled to keep up, kept shedding more load
- Frequency dropped to the point of triggering a nine-minute time delay on generator underfrequency relays
- Had remained below 59.4 Hz for 4 more minutes, underfrequency relays would have tripped additional 17,000 MW of generation

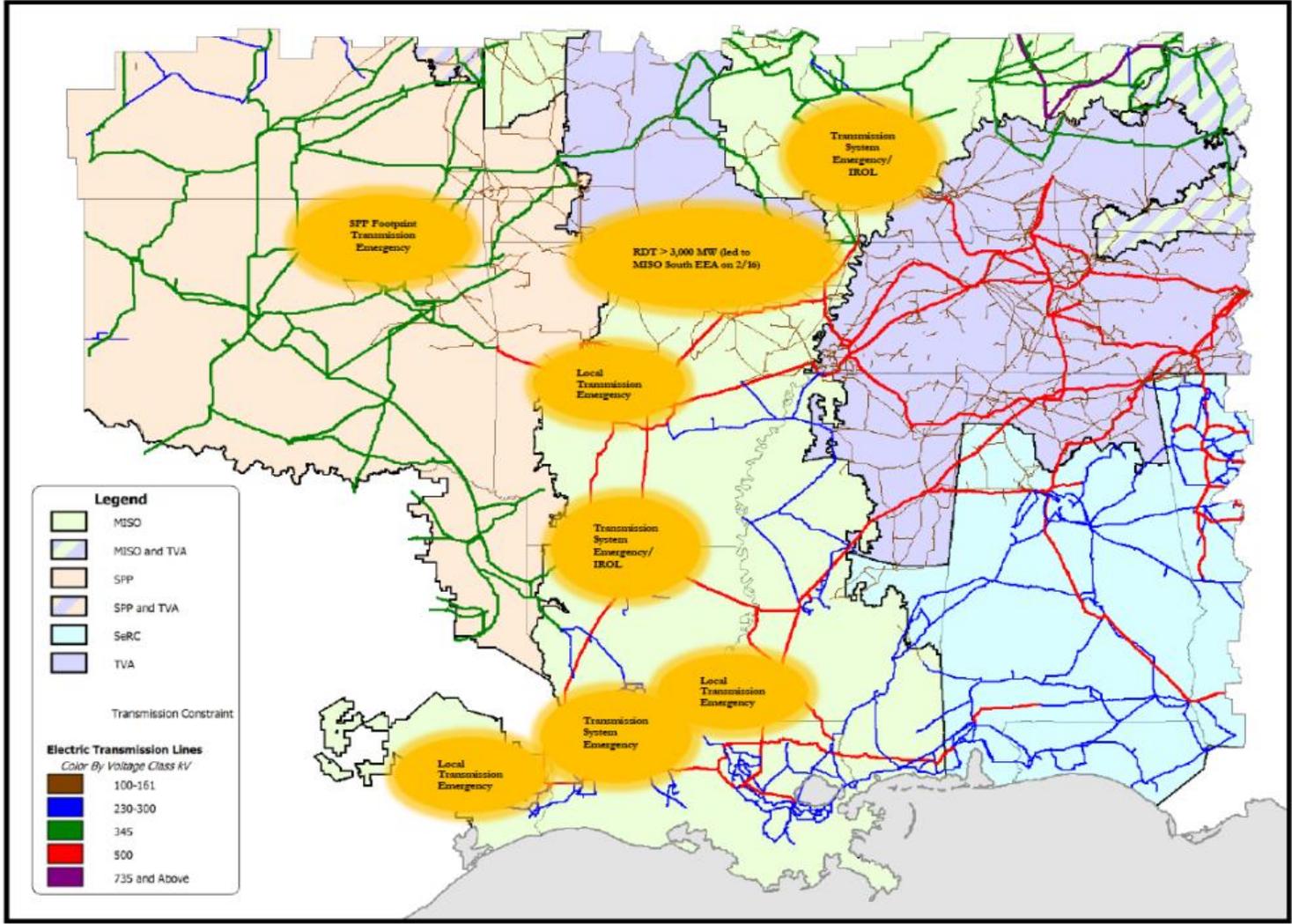


Generation Shortfalls Led To Transmission Emergencies in MISO and SPP

- SPP and MISO imported 13,000 MW of power from grid entities east of their footprints to make up for generation shortfalls.
- The heavy power transfers, combined with the widespread generation outages, created transmission emergencies in MISO and SPP on February 15 and 16 which, in the MISO footprint, required system operators to order a combined **2,000 MW** of firm load shed at different points in time.

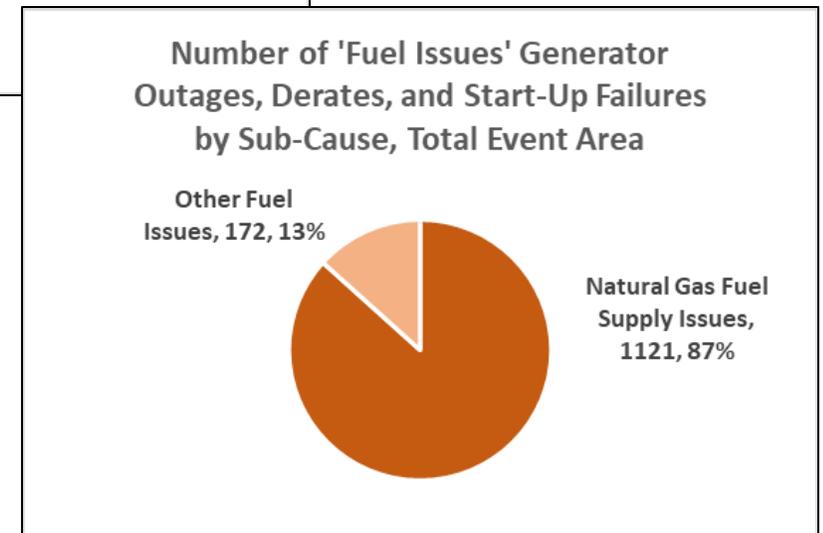
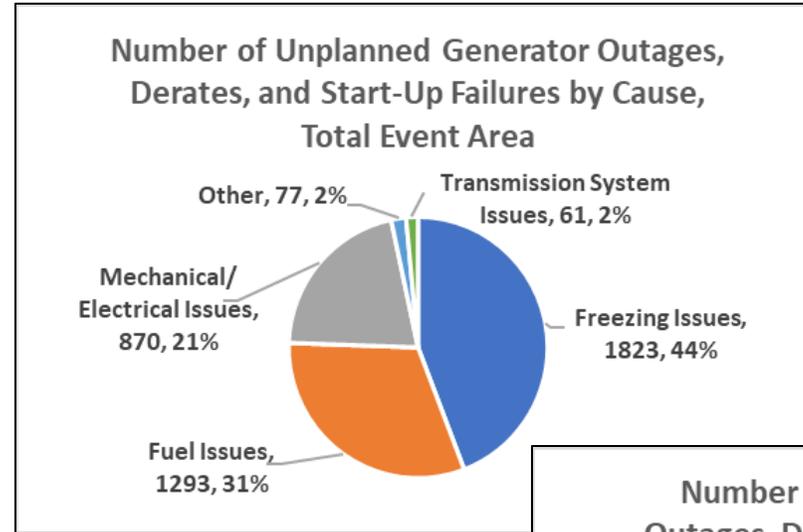


Generation Shortfalls Led To Transmission Emergencies in MISO and SPP



Causes of Generation Shortfalls

- **75 percent** of the generating unit outages, derates, and failures to start, were caused by:
 - **Freezing Issues (44 percent)**
 - **Fuel Issues (31 percent)**.
- Out of all outages and derates caused by Fuel Issues, **87 percent** were:
 - **Natural Gas Fuel Supply issues (27 percent overall)**.



Causes of Generation Shortfalls

Freezing Issues

- **Freezing Issues – generating units:**
 - Frozen instrumentation (transmitters, sensing lines)
 - **34.5% ERCOT, 55% MISO South, 14.7% SPP**
 - Icing on wind turbine blades
 - **32 percent in both ERCOT and SPP**
- **Protecting transmitters, sensing lines and instrumentation, as well as wind turbine blades against icing, could have cut the MW of generating units experiencing a freeze-related outage:**
 - **by 67 percent in ERCOT,**
 - **by 47 percent in SPP, and**
 - **by 55 percent in MISO South.**



Causes of Generation Shortfalls

Natural Gas Fuel Supply Issues

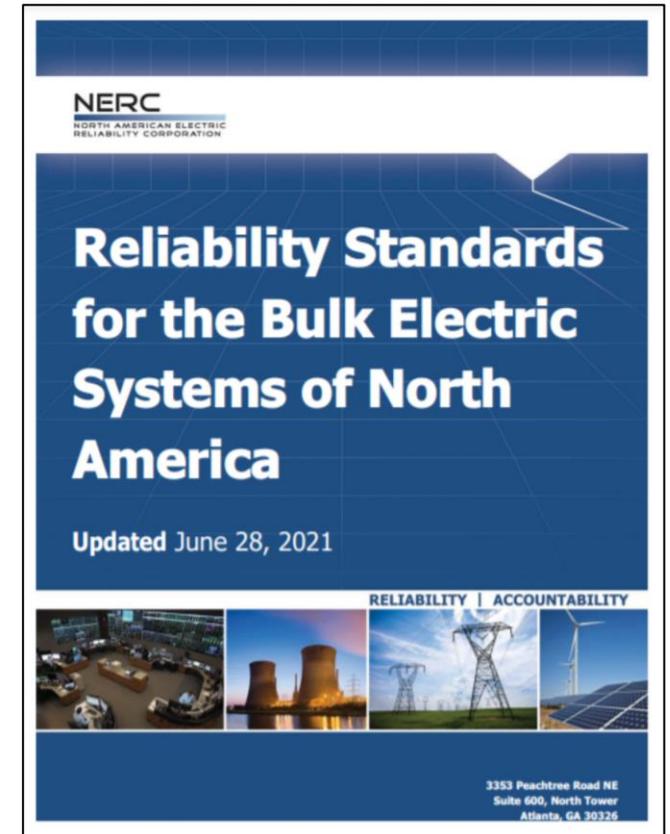
- **Natural Gas Fuel Supply Issues** root cause: natural gas production declines at wellheads, gathering, and processing facilities, due to:
 - Wellhead shut-ins to prevent freezing issues **18.0 percent**
 - Freezing issues (wellhead, midstream, roads) **25.3 percent**
 - Power outages **21.5 percent**
- Natural gas production facility loss of power was primarily due to weather-related power line outages and firm load shed.
- The percentage of production declines caused by power outages on February 14, which only included part of ERCOT's load shed (**18 percent**), varied little from the overall Event, (**21.5 percent**), and the day of maximum production decline, February 17, (**21.5 percent**).



Recommendations

Generator Cold Weather Reliability Standards

- **New or revised Reliability Standards for:**
 - **Corrective action plans for generating units that fail due to freezing issues**
 - **Annual training for cold weather preparedness**
 - **Retrofit or design (if new) generating units to operate to specific extreme cold weather conditions**
 - **Separation of circuits used for manual load shedding from UFLS/UVLS circuits, use UFLS/UVLS circuits for manual load shedding as last resort**



These recommendations are above and beyond the NERC Reliability Standards revisions to address cold weather. See 176 FERC ¶ 61,119 (August 2021).

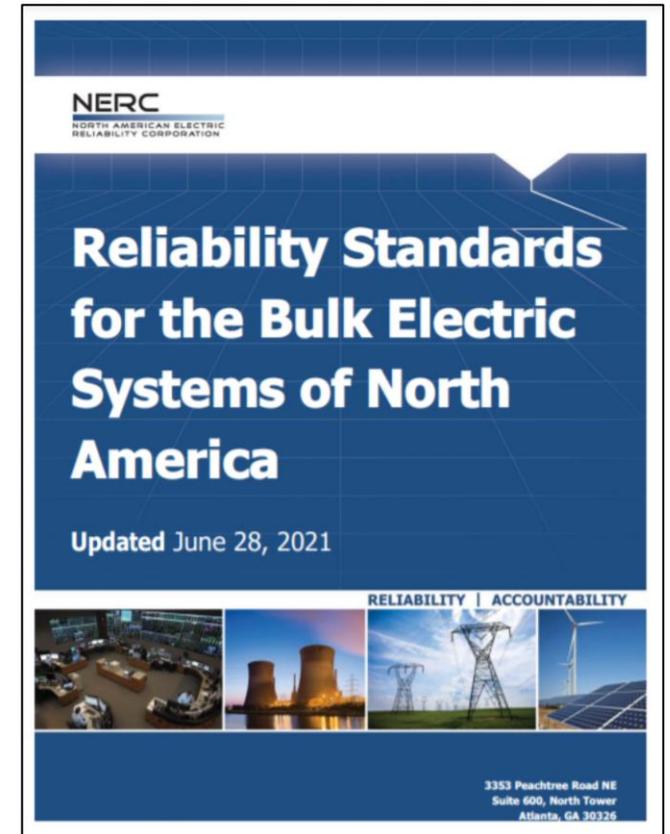


Recommendations

Generator Cold Weather Reliability Standards

- **New or revised Reliability Standards for:**
 - Identification and protection of cold weather critical components
 - GOs/GOPs to provide percentage of total unit capacity that BA can rely on during local forecasted cold weather, including reliability risks related to natural gas fuel contracts
 - Entities involved in load shedding to take actions to protect critical natural gas infrastructure from losing power during demand response and load shedding events
 - Account for effects of precipitation and cooling effects of wind

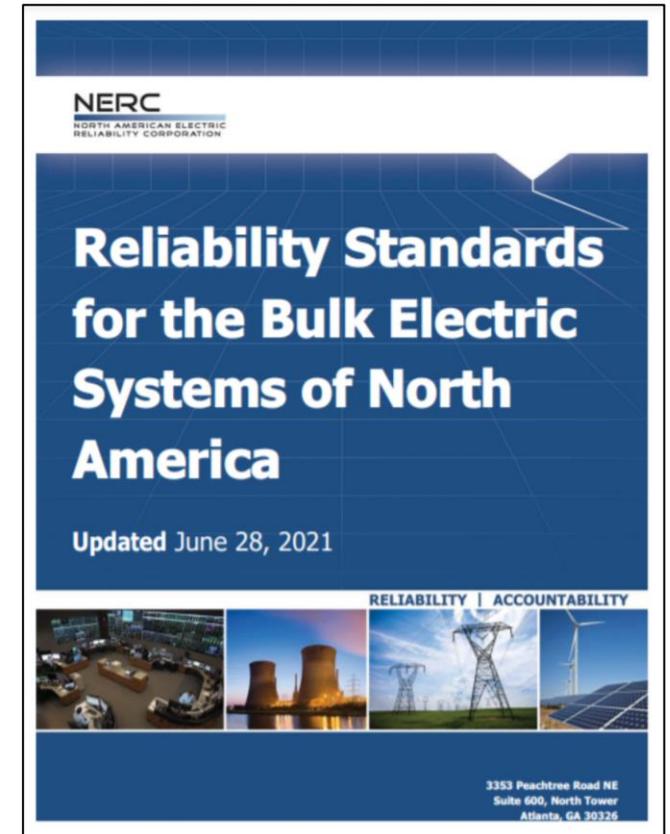
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Recommendations

Generator Cold Weather Reliability Standards

- **Standards Drafting Team currently working to implement the recommendations.**
 - Two phases—Slide 14 recommendations, Phase 1; Slide 15 recommendations, Phase 2
- **Timing of Phases:**
 - Phase 1 proposed Standards are currently under development; to be filed with Commission by **11/1/22**
 - Plan is for 2 rounds of industry comments
 - Phase 2 proposed Standards not in development yet; would be filed with Commission by **11/1/23**



These recommendations are above and beyond the NERC Reliability Standards revisions to address cold weather. See 176 FERC ¶ 61,119 (August 2021).



Bulk Electric System Depends on Natural Gas Infrastructure Reliability

- Congress, state legislatures and regulators with jurisdiction over natural gas infrastructure should require those natural gas infrastructure facilities to have cold weather preparedness plans, including measures to prepare to operate during a weather emergency (5).
- Natural gas infrastructure entities undertake voluntary measures to prepare for cold weather (Report provides a list of measures that can be performed with long- or short-lead-times) (6).



Need to Gather Stakeholders to Solve Natural Gas - Electric Interdependency Issues

- Team proposed a forum in which representatives of state legislatures and/or regulators with jurisdiction over natural gas infrastructure, in cooperation with FERC, NERC and the Regional Entities, and with input from the grid operators and gas infrastructure entities, identify concrete actions (consistent with the forum participants' jurisdiction) to improve the reliability of the natural gas infrastructure system necessary to support bulk-power system reliability (7).



Key Recommendations

Natural Gas-Electric Reliability Forum

- **Topics could include:**
 - **Whether and how natural gas information could be aggregated on a regional basis for sharing with electric system operators in preparation for and during events in which demand is expected to rise sharply for both electricity and natural gas, including whether creation of a voluntary natural gas coordinator would be feasible.**
 - **Whether Congress should provide exclusive or comprehensive authority over natural gas pipeline reliability matters given that it appears that no federal agency has responsibility to ensure the reliability of the interstate natural gas pipeline system.**
 - **Additional state actions (including possibly establishing an organization to set voluntary standards) to enhance the systemic reliability of intra-state natural gas pipelines and other intrastate natural gas facilities.**



Key Recommendations

Improve Winter Reserve Margin Calculations

- **ERCOT, MISO and SPP anticipated winter reserve margins of 50, 49 and 59 percent, respectively, in NERC seasonal assessment yet shed firm load during the Event.**
- **PCs should reconsider components including reflecting actual historic peak loads during severe cold weather events, reflect potential for exponential load increase due to resistive heating used in southern states, amount of natural gas-fired generation that can be relied upon during peak.**
- **For MISO South, MISO should use actual prior winter peak loads, rather than modified summer peak loads; SPP consider preparing a northern & southern forecast (9).**



Recommendations:

Improving Rotation of Load Shedding

- **TOs/TOPs, in coordination with DPs and RCs, should evaluate load shedding plans for opportunities to improve their capacity for rotating load shedding, especially when required for extended periods. Consider:**
 - **When UFLS circuits may be used during extended events;**
 - **Use of remote-controlled distribution circuit load interrupting devices**
 - **Whether advanced metering infrastructure can be used to more strategically deploy or better rotate manual load shedding (10).**



Recommendation:

Bi-directional Seasonal Transfer Studies

- **Adjacent RCs, BAs and TOPs should perform bi-directional seasonal transfer studies and sensitivity analyses that vary dispatch of modeled generation-to-load power transfers to reveal constraints that may occur, to prepare for extreme weather events spanning multiple BA/RC areas**
- **Should include transmission limits on imports/exports to/from neighboring areas and unusual flow patterns (for example, during the Event, heavy E-to-W flows instead of the normal W-to-E in MISO and SPP)**
- **Consider sub-areas or load pockets that may become constrained (20).**



Recommendation:

OTS Simulations of Firm Load Shed Scenarios

- **At least once a year, RCs, TOPs and DPs should perform Operator Training Simulator simulations of firm load shed scenarios to train system operators**
- **Should include scenarios similar to the Event which require rotating load shed and system restoration (21).**



Recommendation:

Coordination of UFLS and Generator Underfrequency Relays

- **PCs, TOs, and TOPs should coordinate with GOs/GOPs to ensure that generating units are not tripped by time-delay protection systems before the first step of UFLS is deployed**
- **May require notification to BA, possible changes to PRC-006-5 (Automatic Underfrequency Load Shedding) (22).**



Recommendation:

More Rapid Reporting of Outages and Derates During Emergencies

- **BAs, RCs, and TOPs should amend their outage and/or emergency operations procedures to reduce the time that GOs/GOPs and TOs have to report generation and transmission derates and outages during declared emergency situations.**
- **This will better allow BAs and RCs to identify trends during events where grid conditions are rapidly changing, forecast future conditions and prepare for potential system operator actions (23).**



Recommendation:

Guidelines for Identifying Critical Natural Gas Infrastructure Loads to be Protected from Load Shedding

- **BAs, RCs, Regional Entities, TOs, DPs and TOPs and one or more entities representing U.S. natural gas infrastructure should jointly conduct a study to establish guidelines to assist natural gas infrastructure entities in identifying critical natural gas infrastructure loads to manual and automatic load shedding entities**
- **The guidelines should be in a format that can be readily distributed to natural gas infrastructure entities**
- **(28 (Further Study))**



Other Recommendation Areas

- Identify and communicate reliability risks of natural gas fuel contracts (8).
- Conduct technical conference to discuss how to improve generator winter readiness-**April 27 and 28, 2022** (3).
- Inspection and maintenance of freeze protection measures at specific winter weather timeframes (4).
- Opportunity for generator owners to be compensated for costs of retrofitting their generating units to perform at specific ambient temperatures (2)
- Effects of cold weather on mechanical fatigue (11)
- GOs/GOPs use weather forecasts (12)



Other Recommendation Areas

- **Coordinate protective relay settings of generator underfrequency relays (13)**
- **Increase real-time monitoring of natural gas wellheads (14)**
- **Create or enhance emergency response centers for severe weather events (15)**
- **Improve near-term load forecasts for extreme weather conditions (16)**
- **Analyze intermittent generation effects to improve load forecasts (17)**
- **Incent additional rapidly-deploying demand response (18)**
- **Create additional retail incentives for energy efficiency improvements (19)**



Other Recommendation Areas: Further Study

- ERCOT to study additional connections to other interconnections (25)
- Black start generating unit reliability (26)
- Potential effects of low-frequency events on generating units in Eastern and Western Interconnections (27)
- Potential measures to address natural gas supply shortfalls (24, complementary to 7)





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The full report can be found at:

<https://www.ferc.gov/media/february-2021-cold-weather-outages-texas-and-south-central-united-states-ferc-nerc-and>

or

<https://www.nerc.com/news/Pages/Final-Report-on-February-2021-Freeze-Underscores-Winterization-Recommendations.aspx>

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The background of the slide features a blurred Texas state flag on the left and a target with several darts on the right. The darts are clustered in the center of the target, suggesting a focus on a specific point.

Questions?



TEXAS RE

Ensuring electric reliability for Texans