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

FERC, NERC and Regional Entity Joint Staff Report

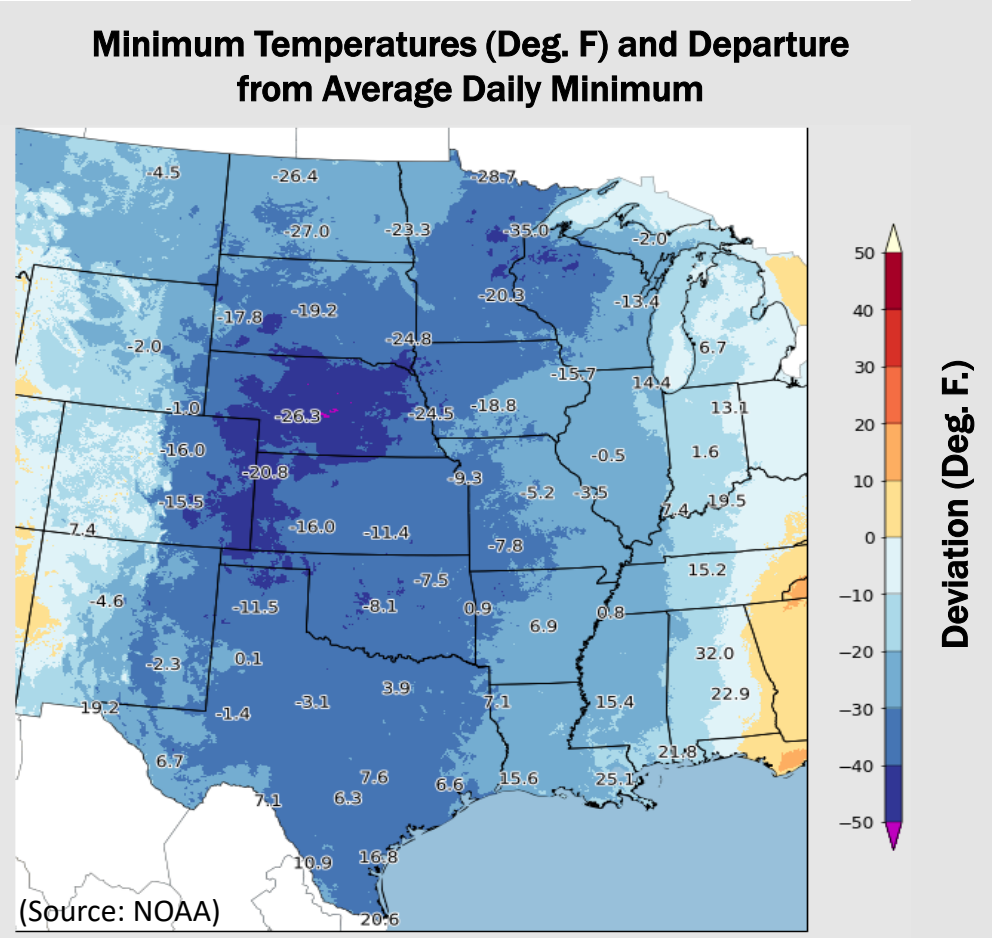
November 2021

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.



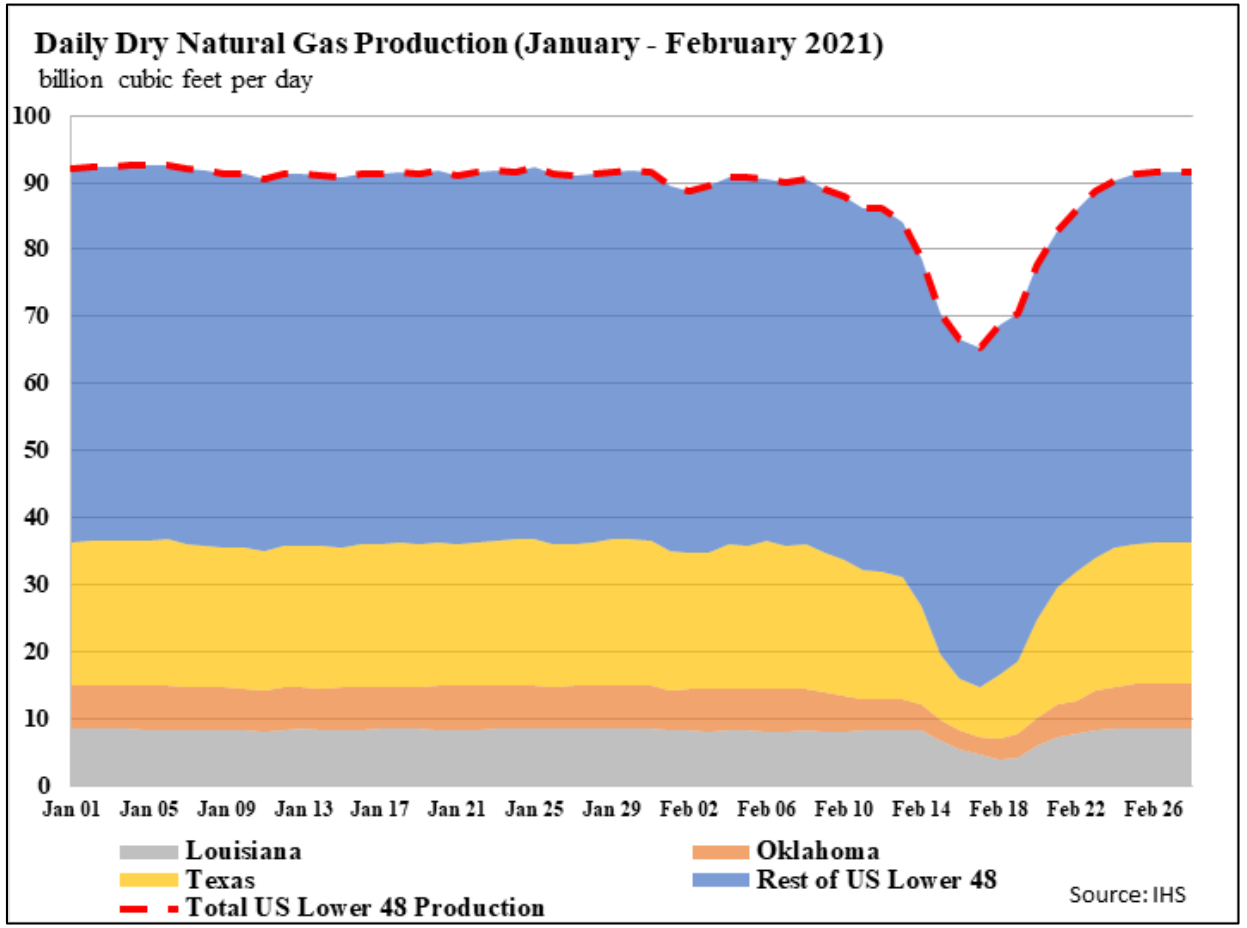
- Comparing 1983, 1989, 2011, 2018 and 2021 cold weather conditions
- In every event, average daily temperatures fell below freezing in Dallas, Houston, and Jackson, for at least 3 days.
- 1983 was colder than 2021 on multiple days in Dallas, Houston and Jackson, MS, and 1989 was still coldest recorded 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

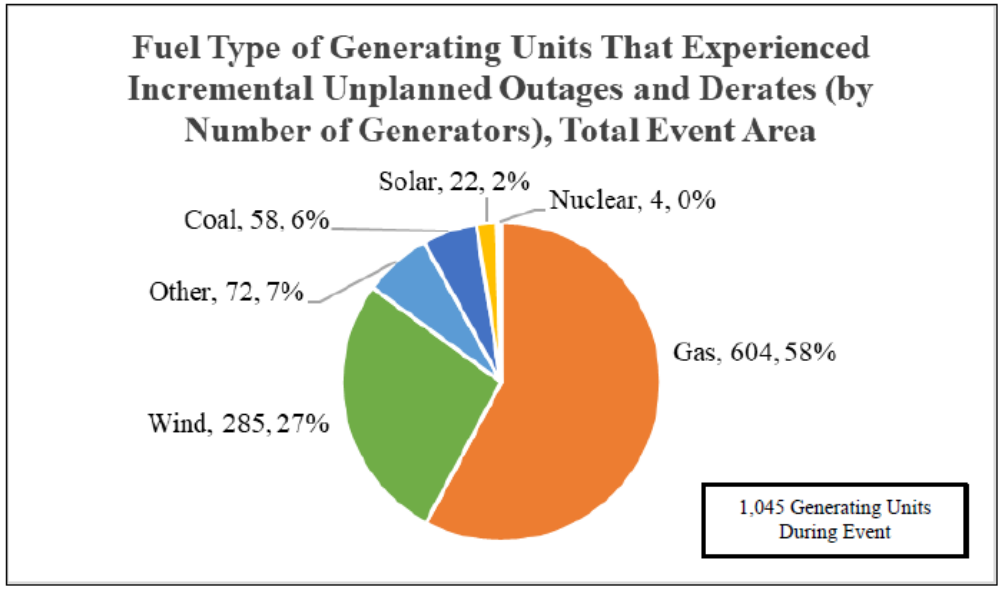
Effect on Natural Gas System

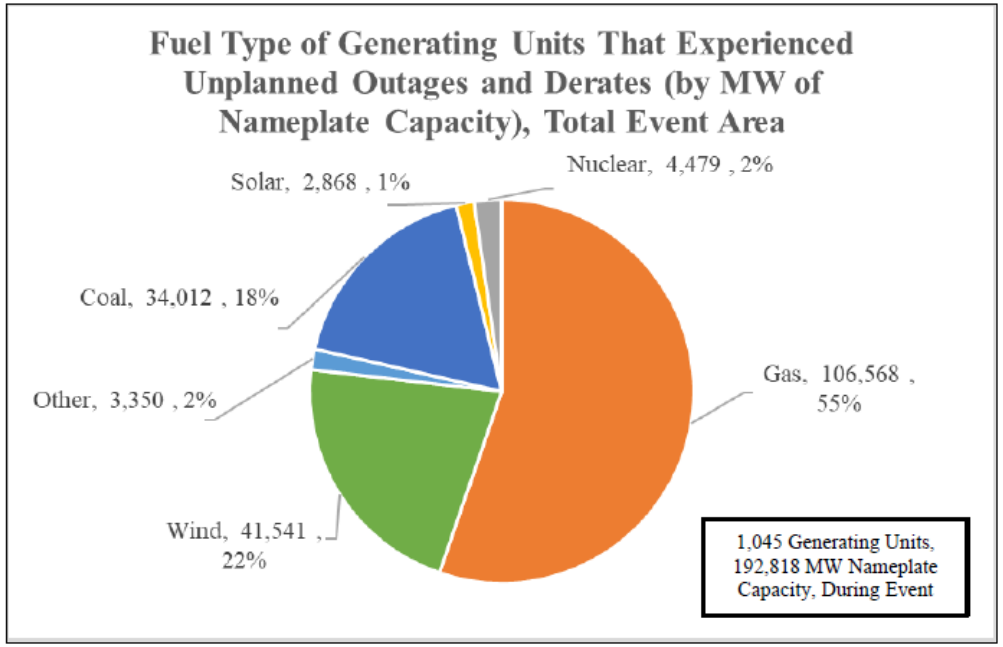
- Largest U.S. monthly decline of natural gas production on record.
- Between February 8 and 17, the total natural gas production in the U.S. Lower 48 fell by 28 percent, while Texas production declined 70.1 percent (as compared to January average).
- Most producing regions of the U.S. saw a sharp decline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



Unprecedented Electric Generation Shortfalls Due to Cold Weather Conditions

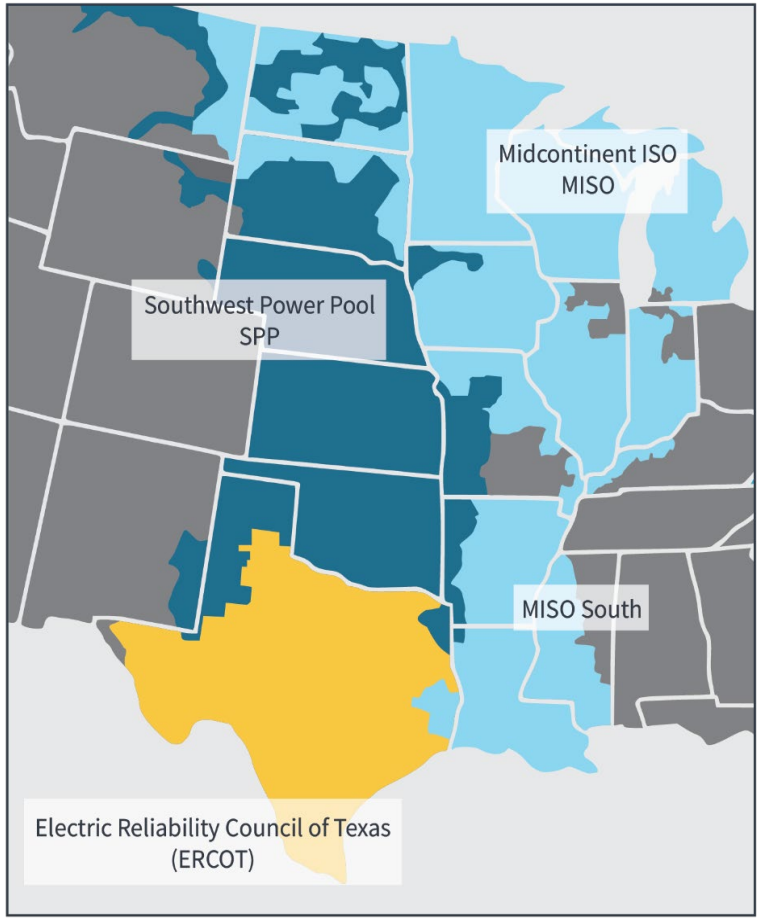
- 1,045 individual generating units experienced 4,124 outages, derates or failures to start, of which 604 (58 percent of all units) were natural gas-fired generators.





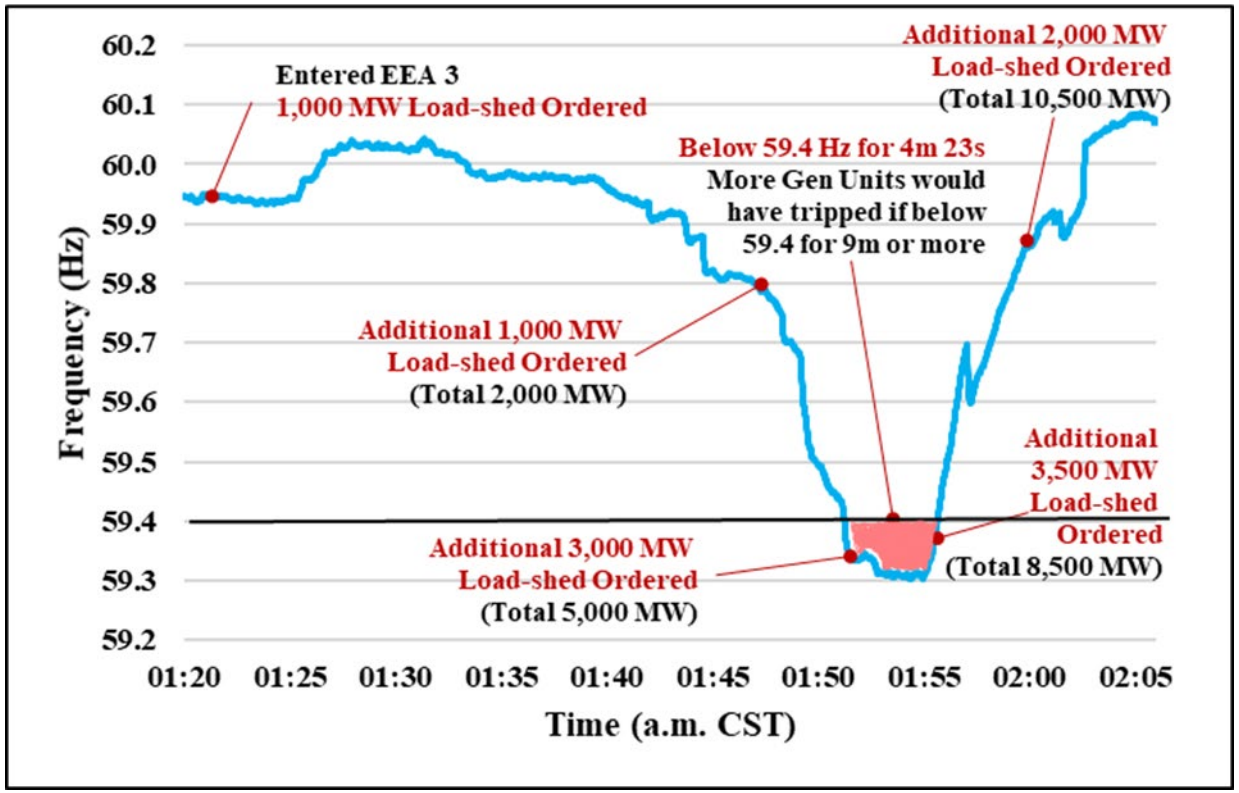
Generation Shortfalls Led to Energy Emergency Firm Load Shed in ERCOT, SPP, and MISO

- 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.



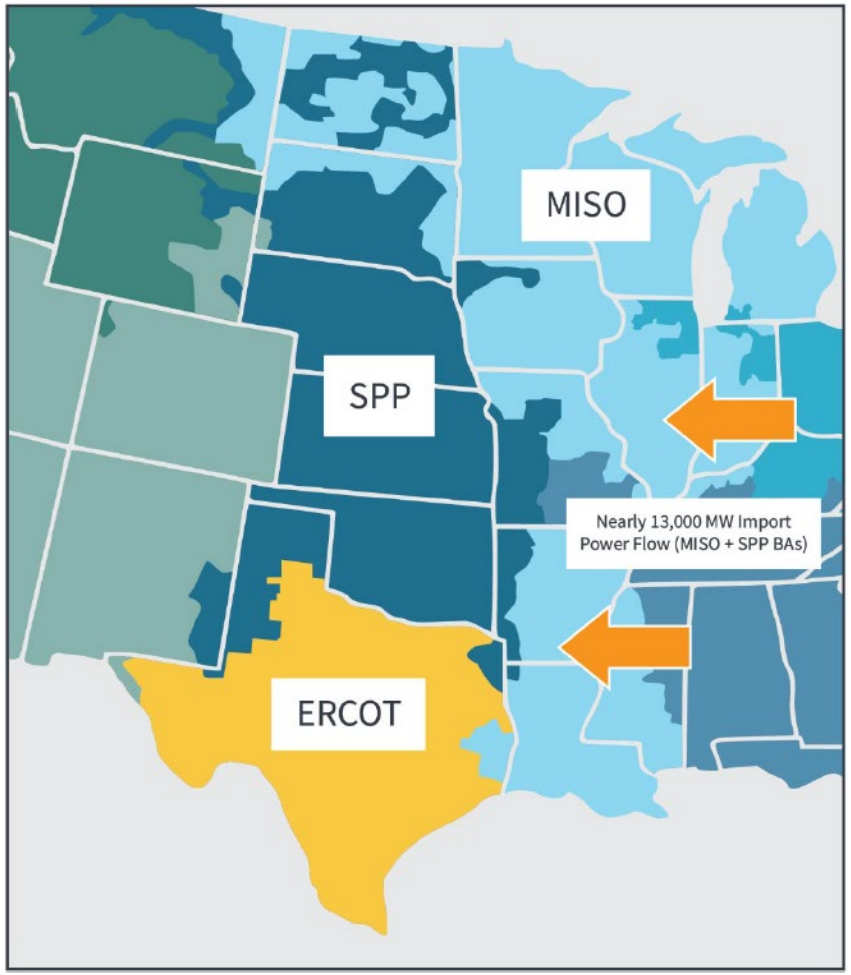
ERCOT Frequency Excursion

- 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

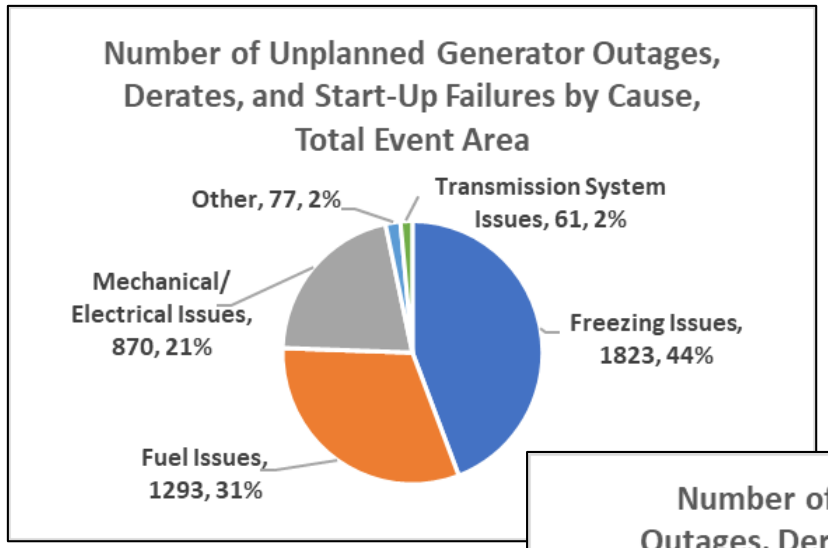
- SPP and MISO imported 13,000 MW of power from grid entities east of their footprints to make up for generation shortfalls.
- The heavy power transfers, combined with the widespread generation outages, created transmission emergencies in MISO and SPP on on February 15 and 16 which, in the MISO footprint,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

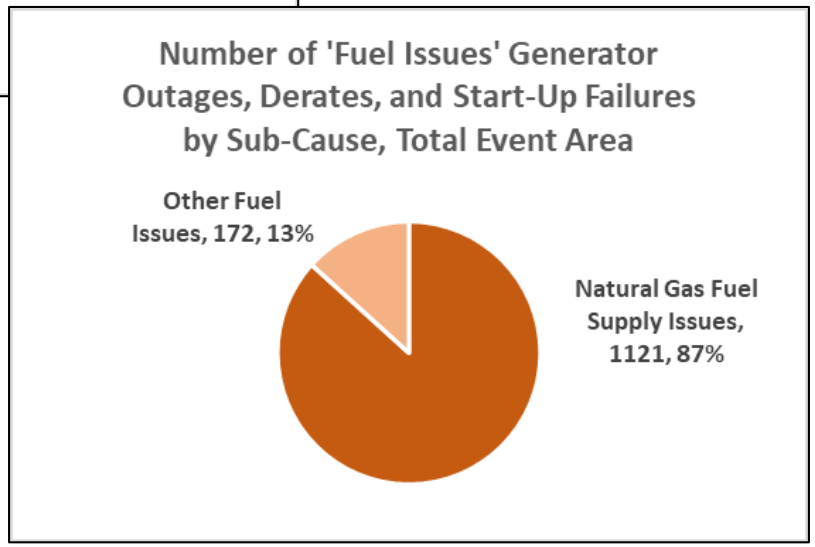


Causes of Generation Shortfalls

- 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).



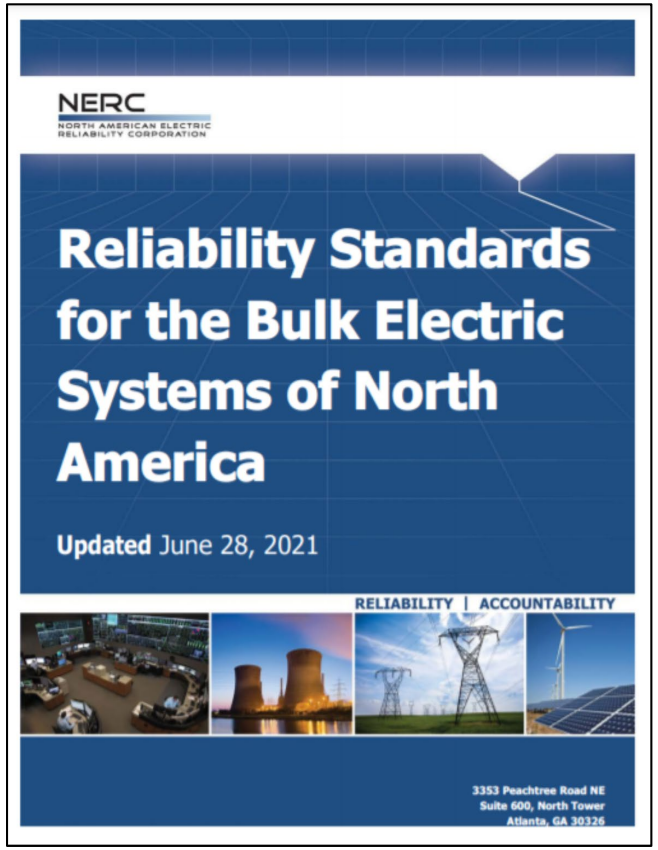


Causes of Generation Shortfalls
Freezing Issues

- **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 freezing-related outage:
  - by 67 percent in ERCOT,
  - by 47 percent in SPP, and
  - by 55 percent in MISO South.

Recommendations
Generator Cold Weather Reliability Standards

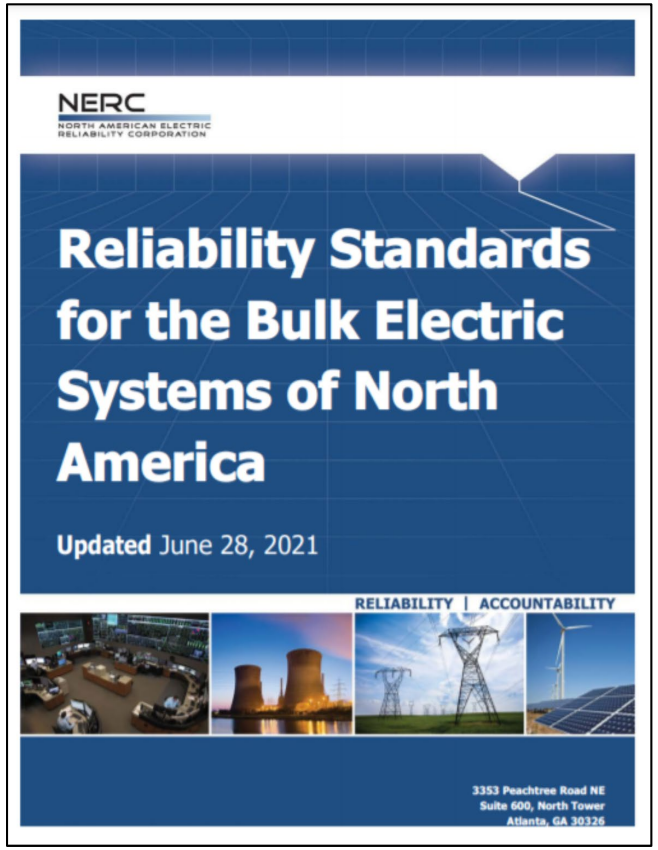
- New or revised Reliability Standards to require:
  - GOs to identify and protect cold weather critical components (1a & 1b)
  - GOs to implement corrective action plans for generating units that fail due to freezing issues (1d)
  - GOs to retrofit generating units to operate to specific extreme cold weather conditions (or design, if building new units) (1f)
  - GOs/GOPs to perform *annual* training on winterization plans (1e)



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 to require:
  - GOs to account for effects of precipitation and cooling effect of wind (when providing temperature data to BAs under EOP-011-2, R7.3.2) (1c)
  - GOs/GOPs to provide the BA with the percentage of total unit capacity that BA can rely on during local forecasted cold weather, including reliability risks related to natural gas fuel contracts (1g)



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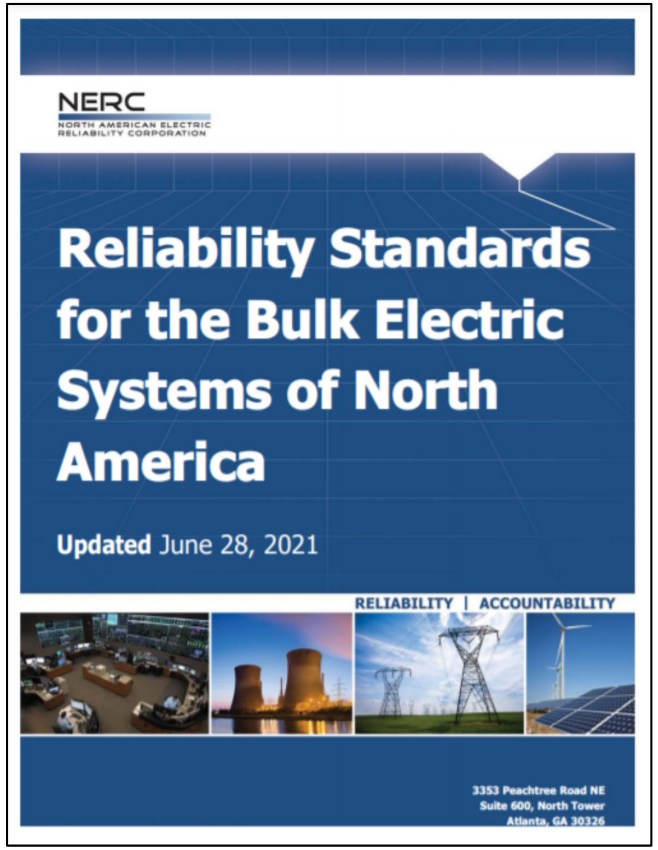
Causes of Generation Shortfalls
Natural Gas Fuel Supply Issues

- **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).

Next Steps: Bulk Electric System -> Natural Gas Infrastructure

- New or revised Reliability Standards to require:
  - BAs, TOPs and other entities involved in load shedding to take actions to protect critical natural gas infrastructure from losing power during load shedding events (1i); and
  - BAs' operating plans to prohibit use of critical natural gas infrastructure as demand response (1h)



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Recommendations:
Natural Gas Infrastructure Winterization

- 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 performed with long- or short-lead-times) (6)

Recommendation:
Natural Gas-Electric Reliability Forum

- 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.**

Other Recommendation Areas

- Identify and communicate reliability risks of natural gas fuel contracts.
- Conduct technical conference to discuss how to improve generator winter readiness—Commission has set date of April 27 and 28, 2022 (3)
- Inspection and maintenance of freeze protection measures at specific winter weather timeframes.
- Improve reserve margin projections for winter peak conditions.
- 14 other recommendations and 5 recommendations for further study, including one for ERCOT to study additional connections to other interconnections.

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