



# February 2021 Cold Weather Grid Operations: Preliminary Findings and Recommendations

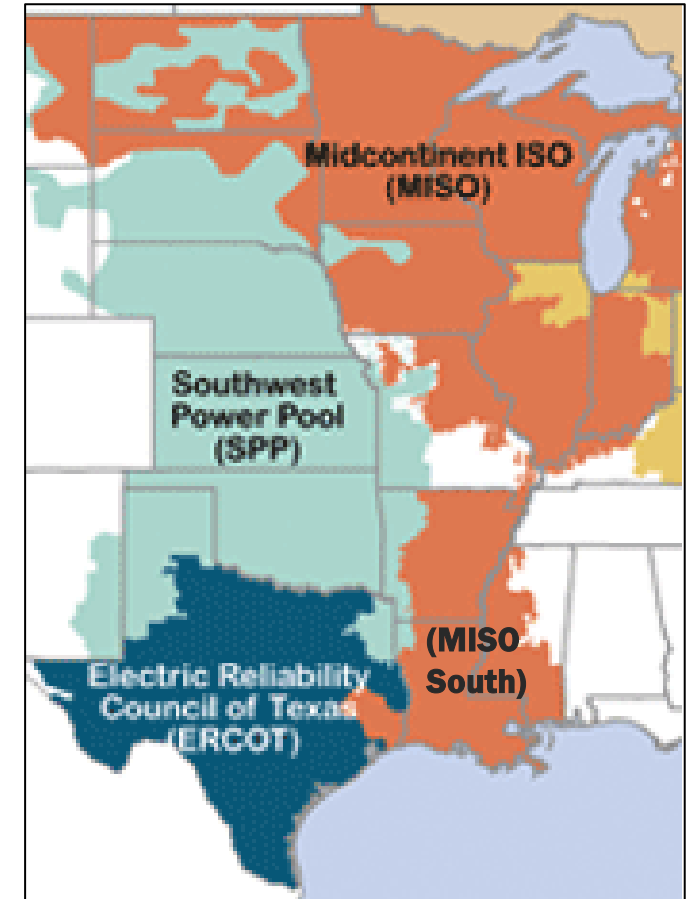
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FERC, NERC and Regional Entity Joint Staff Inquiry

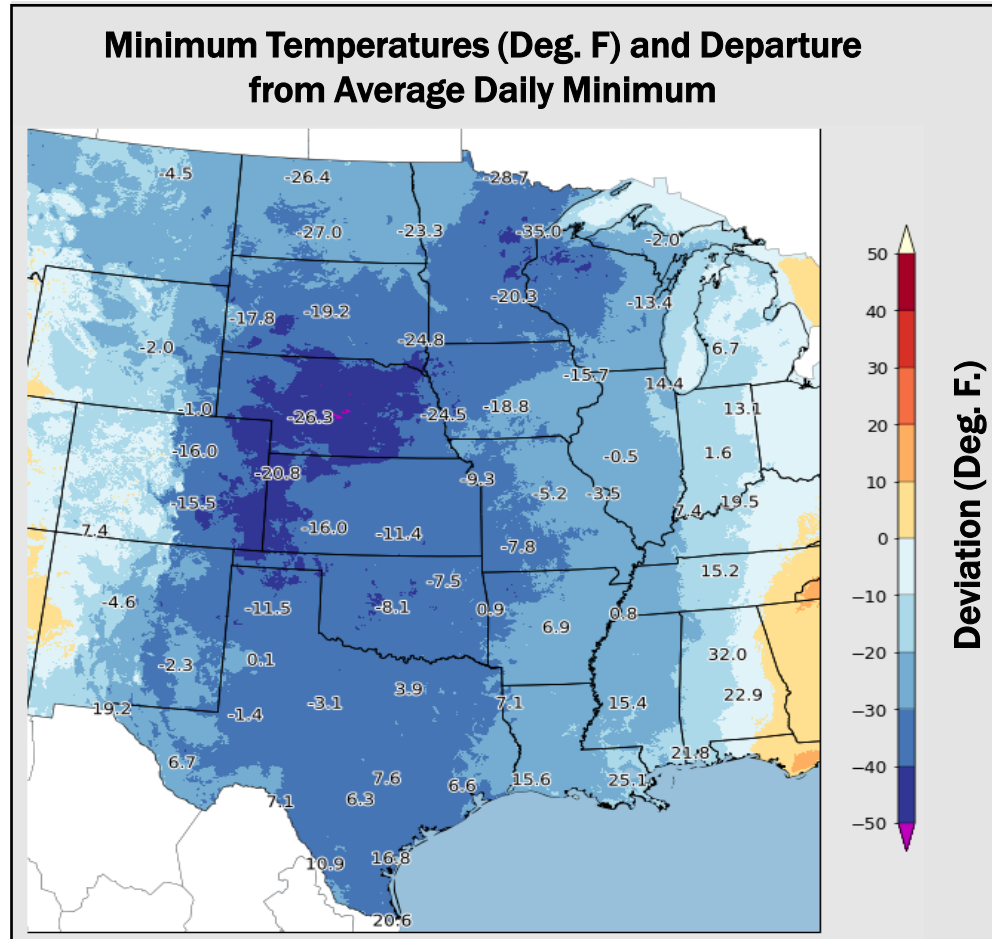
# Inquiry Commencement

## Cold Weather Week of February 14, 2021

- Unprecedented electric generation outages
- Affected Balancing Authorities (BAs) declared Energy Emergencies and ordered firm load shed at different points of time within their respective footprints, in total exceeding **23,400** 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: approximately five hours total and at its worst point, **2,700** MW
  - MISO BA (MISO South): over two hours and at its worst point, **700** MW



# Cold Weather Conditions – February 15, 2021



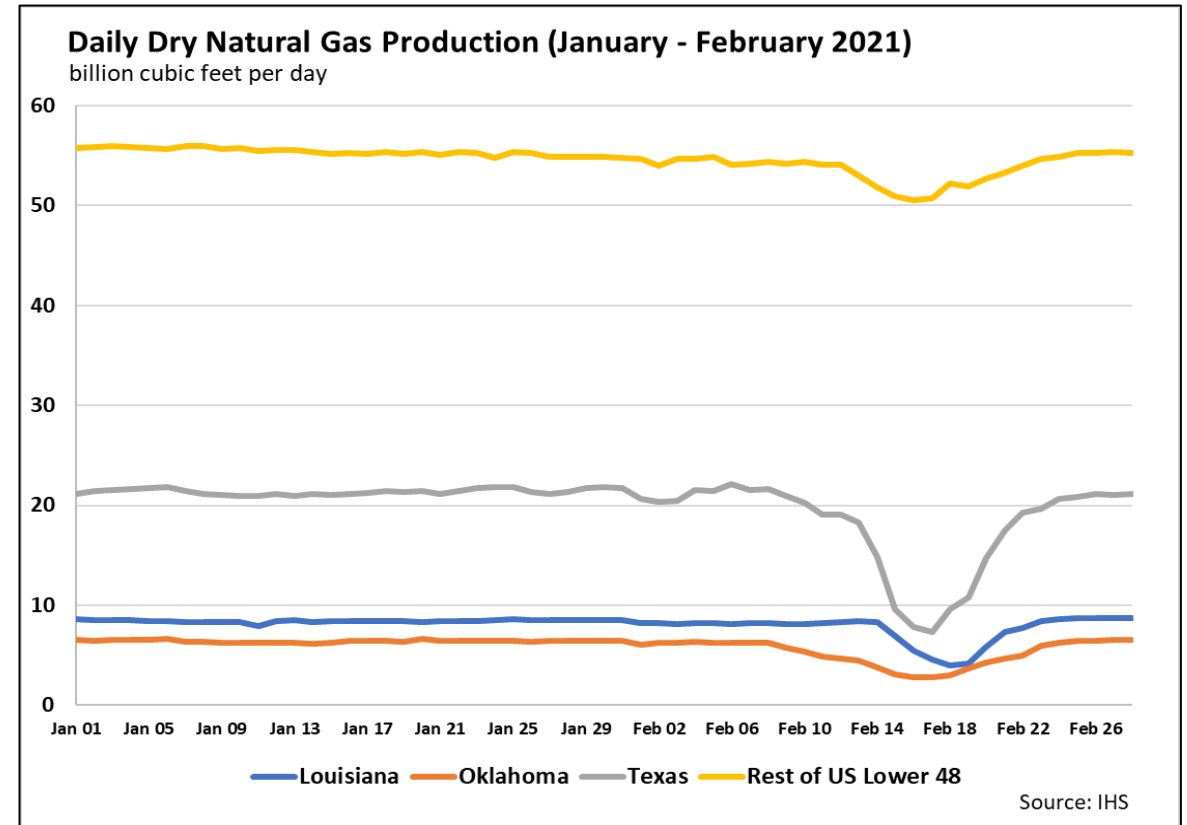
(Source: NOAA)

- The February 2021 event is the **fourth** in the past 10 years which jeopardized bulk-power system reliability due to unplanned cold weather-related generation outages:
  - 2011 – 29,700 MW
  - 2014 – 19,500 MW
  - 2018 – 15,800 MW
  - 2021 – **61,800** MW



# Effect on Natural Gas System

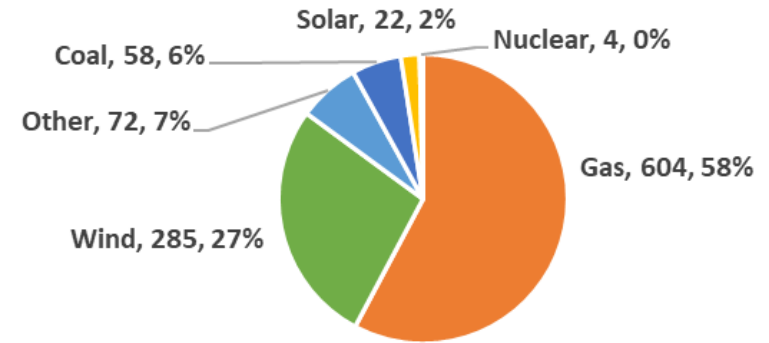
- System experienced largest U.S. monthly decline of natural gas production on record.
- Total U.S. dry gas production fell to 65.4 Bcf/d on February 17, a 28% decline from the 90.8 Bcf/d production level seen on February 4.
- Most producing regions of the U.S. saw a sharp decline and recovery.



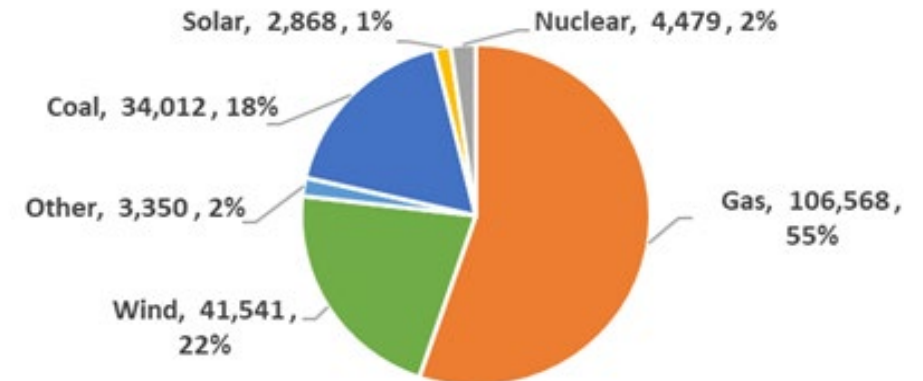
# Unprecedented Electric Generation Shortfalls Due to Cold Weather Conditions

- **1,045** individual generating units experienced **4,124** outages, derates or failures to start, of which **604** were natural-gas fired generators.
- During the week of February 14, 2021, for over two consecutive days, ERCOT averaged **34,000 MW** of generation outages, **49%, or nearly half** of ERCOT's 2021 actual all-time winter peak load of 69,871 MW.

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

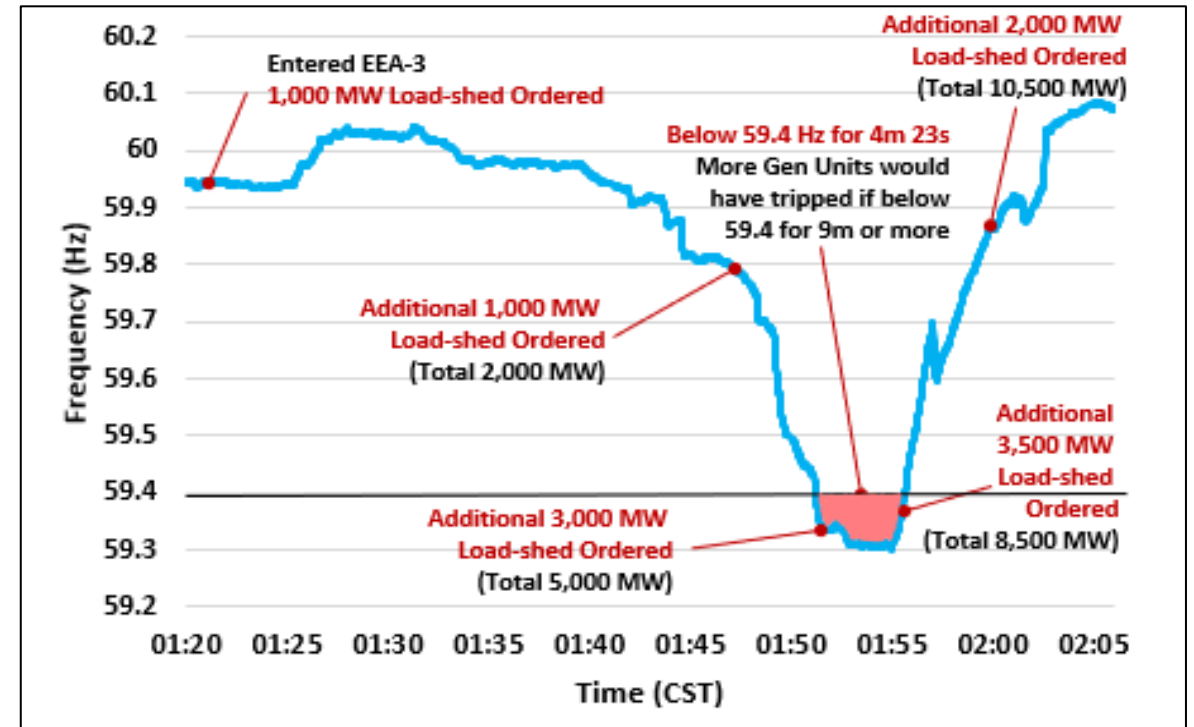


Fuel Type of Generating Units That Experienced Unplanned Outages and Derates (by MW of Nameplate Capacity), Total Event Area



# Generation Decreases and Outages Led To Energy Emergencies in ERCOT, SPP and MISO BAs

- Each BA declared Energy Emergencies and ordered firm load shed, in total exceeding **23,400 MW**:
- ERCOT: nearly three consecutive days of firm load shed and at worst point, **20,000 MW**,
- SPP: approximately five hours total of firm load shed and at worst point, **2,700 MW**, and
- MISO (MISO South): over two hours of firm load shed and at worst point, **700 MW**.

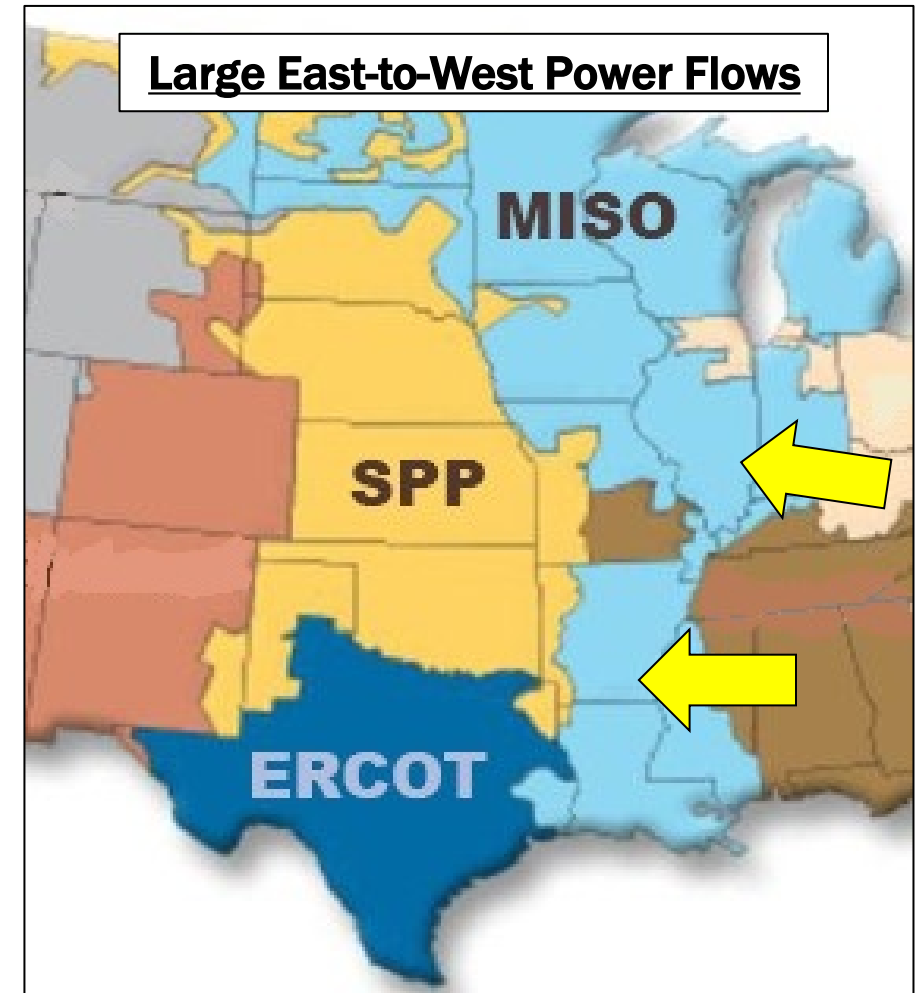


System frequency, an indicator of grid “health”, dropped rapidly in ERCOT on February 15, due to a rapid decrease in generation. ERCOT operators made the correct decision to shed firm load to recover frequency to maintain reliability of the ERCOT grid and prevent further outages from occurring.



# Generation Shortfalls Also Led To Transmission Emergencies in MISO and SPP

- The bulk-power system was heavily constrained with large power flows.
- On February 15, 2021, east-to-west import power flows approached **13,000 MW** to help mitigate generation shortfalls and meet winter peak energy demands in MISO and SPP.
- MISO shed in total over **2,000 MW** firm load at different points in time on February 15 and 16 to avoid transmission overloads.

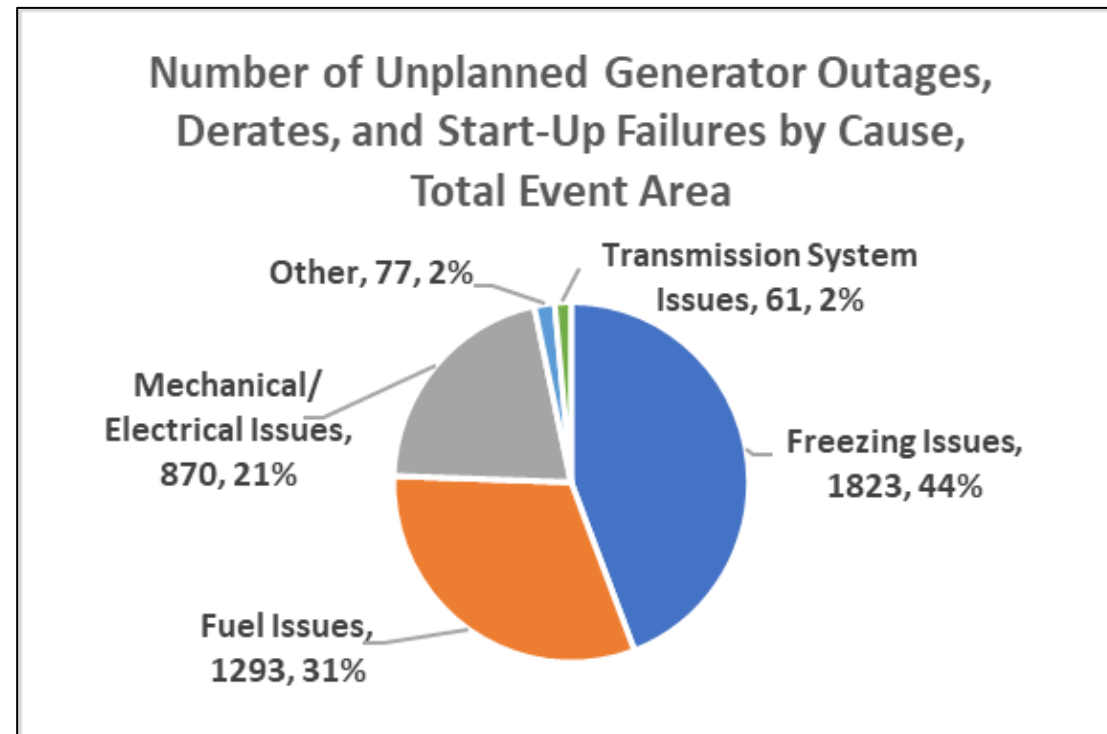




# What Went Wrong - Preliminary Key Findings

## 1. Generation Freezing Issues

- Largest cause: **freezing issues**
- Largest sub-causes were frozen instrumentation and wind turbine blade icing.
- Analysis of Mechanical/ Electrical Issues revealed a relationship between generating unit outages and decreasing temperatures.

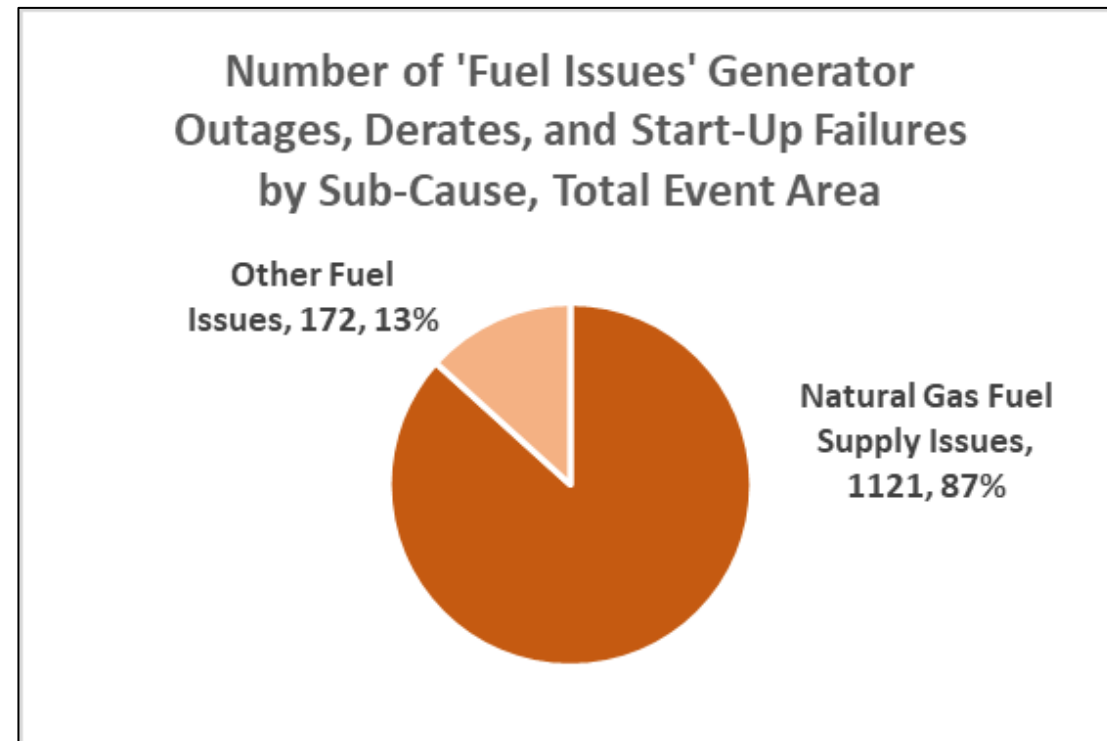




# What Went Wrong - Preliminary Key Findings

## 2. Natural Gas Fuel Supply Issues

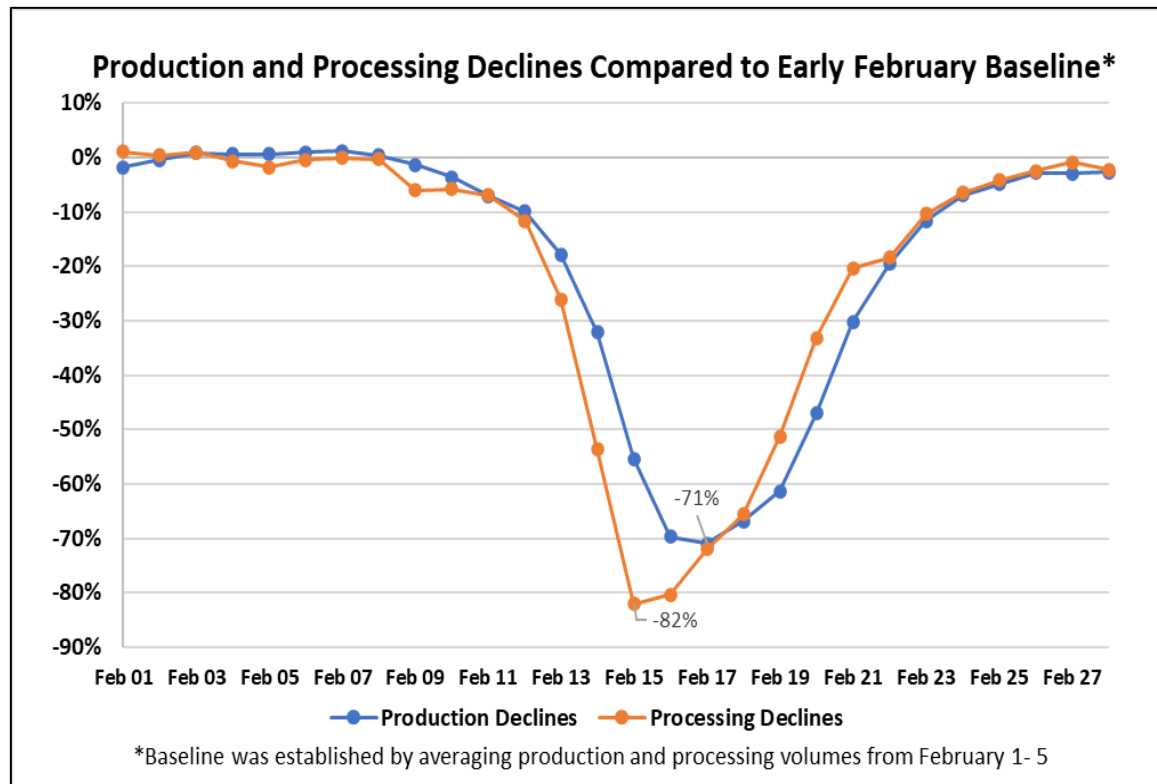
- Second-largest cause:  
**natural gas fuel supply issues**
- Out of all outages and derates caused by Fuel Issues, 87% were natural gas fuel supply issues.
- In the SPP footprint, natural gas fuel supply issues greatly exceeded the number of freezing issues experienced by natural gas-fired generating units (458 versus 86).



# What Went Wrong - Preliminary Key Findings

## 2. Natural Gas Fuel Supply Issues

- Root cause of natural gas fuel supply issues: natural gas production declines
  - Wellheads, gathering facilities
    - Shut-ins
    - Freezing issues
    - Power outages
  - Processing facilities
    - Supply decrease (receipts) from wells, gathering facilities
    - Mechanical failure (freezing issues)
    - Mechanical failure (other issues)
    - Power outages





# What Went Wrong - Preliminary Key Findings

## 3. Natural Gas and Electric Reliability Interdependency

- Natural gas production facility loss of power was primarily due to weather-related power line outages and firm load shed.
- 60% of natural gas-fired generating units affected by fuel supply issues had outages, derates, or failures to start by February 14, and 32% had fuel supply issues before and after February 14.

Natural gas fuel supply reductions caused the outages/derates/failures to start:	<u>2/8 - 2/14</u> Prior to Firm Load Shed	<u>2/15 - 2/20</u> Firm Load Shed (2/15 - 2/18)
<b>Total Individual Generating Units</b>	<b>213</b>	<b>258</b>
ERCOT BA Footprint	111	134
SPP Footprint	91	103
MISO South Footprint	11	21





# What Went Wrong - Preliminary Key Findings

## 4. ERCOT Firm Load Shed Affected Natural Gas Facilities

- Most natural gas production and processing facilities surveyed were not identified as critical load or otherwise protected from load shedding.
- As a result, firm load shed implemented by transmission operators to preserve bulk-power system reliability partially contributed to the decline in production of natural gas.
- Because many critical natural gas infrastructure loads are not identified, and both weather-caused and firm-load-shed-caused power outages were coincident, the exact extent of power outages to critical natural gas infrastructure loads due to firm load shed is unknown.





# What Went Wrong - Preliminary Key Findings

## 5. Manual and Automatic Load Shed Coordination

- From February 15 through 16, 2021, manual firm load shed varied from 10,000-20,000 MW, 14%-28% of ERCOT's peak load.
- ERCOT's manual load shed spanned nearly three days in order to maintain bulk-power system reliability.
- The magnitude and duration of manual load shed needed made it difficult to rotate the outages and required system operators to use automatic/UFLS load shed circuits (configured for 25% of ERCOT's peak load) for manual load shed instead, thereby reducing the circuits available for UFLS.





# What Went Right - Preliminary Key Findings

## 6. Electric Reliability Coordination

- SPP, MISO and ERCOT Reliability Coordinators (RCs) coordinated and communicated well with each other.
  - Beginning February 8, SPP and MISO begin management-level discussions about the upcoming severe cold weather forecast and natural gas fuel restrictions expected, and beginning February 14, they kept an open communication channel between control rooms throughout the Event.
  - On February 12, SPP began coordinating with ERCOT about which BA would rely on switchable generation that both BAs depend on as capacity resources.
  - The RCs recognized that all three footprints were simultaneously having emergencies and cooperated to alleviate the most critical conditions first.





# Preliminary Recommendations

- 28 Recommendations, which include:
    - Nine key recommendations, including Reliability Standards changes
    - Five recommendations for further study
  - Each have recommended timeframes for implementation
    - before Winter 2021/2022
    - before Winter 2022/2023
    - before Winter 2023/2024
- } Most are recommended within these timeframes
- Some could extend beyond winter 2023-2024, but should be completed as soon as possible

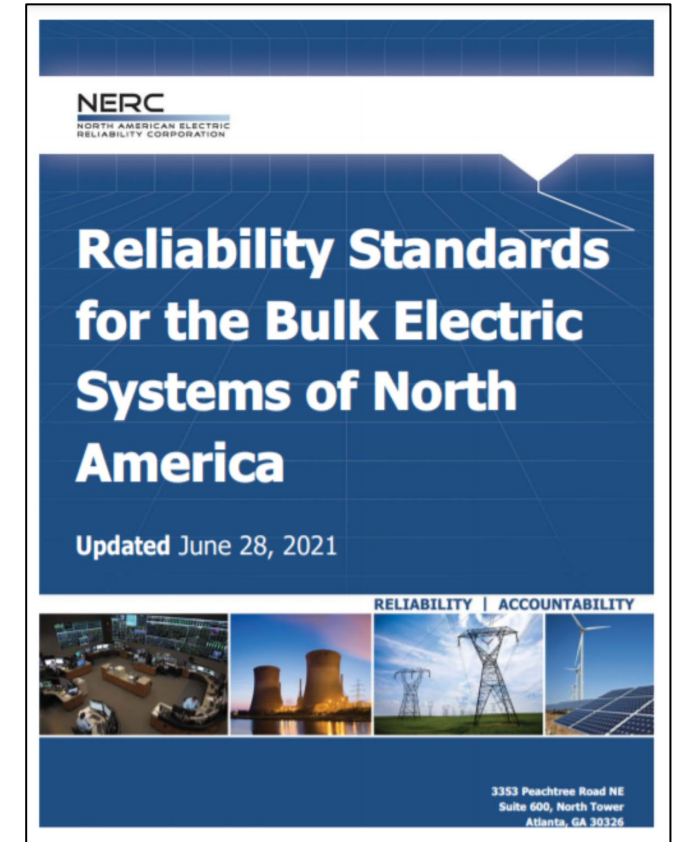


# Key Preliminary Recommendations

## Reliability Standards

### 1. Revise the Reliability Standards to require:

- Generator Owners (GOs) to identify and protect cold-weather-critical components
- GOs to build new generating units, and retrofit existing units, to operate to specific ambient temperatures and weather based on extreme temperature and weather data, and account for effects of precipitation and cooling effect of wind
- Annual training on winterization plans
- GOs that experience freeze-related outages to develop Corrective Action Plans



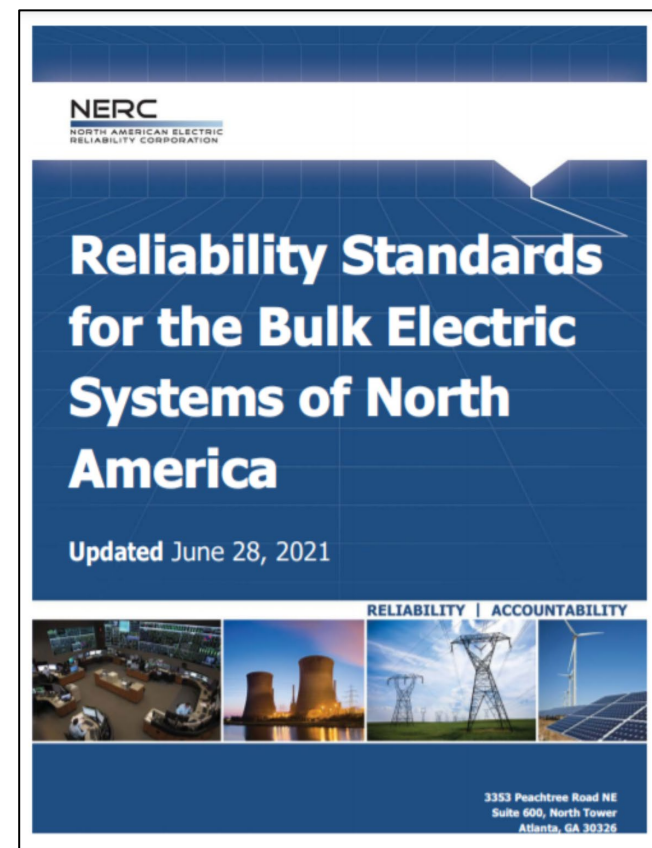
*These recommendations are above and beyond the NERC Reliability Standards revisions to address cold weather. See 176 FERC ¶ 61,119 (August 2021).*



# Key Preliminary Recommendations

## Reliability Standards

- Each GO/Generator Operator (GOP) to provide the BA with the percentage of the total generating unit capacity that the BA can rely upon during the “local forecasted cold weather,” including reliability risks related to natural gas fuel contracts.
- Each BA to use the data provided by the GO/GOP, combined with its evaluation, based on experience, to calculate the percentage of each individual generating unit’s total capacity that it can rely upon during the forecasted cold weather for its operating plans (season-ahead, day(s)-ahead) and real-time monitoring, and share with the RC.



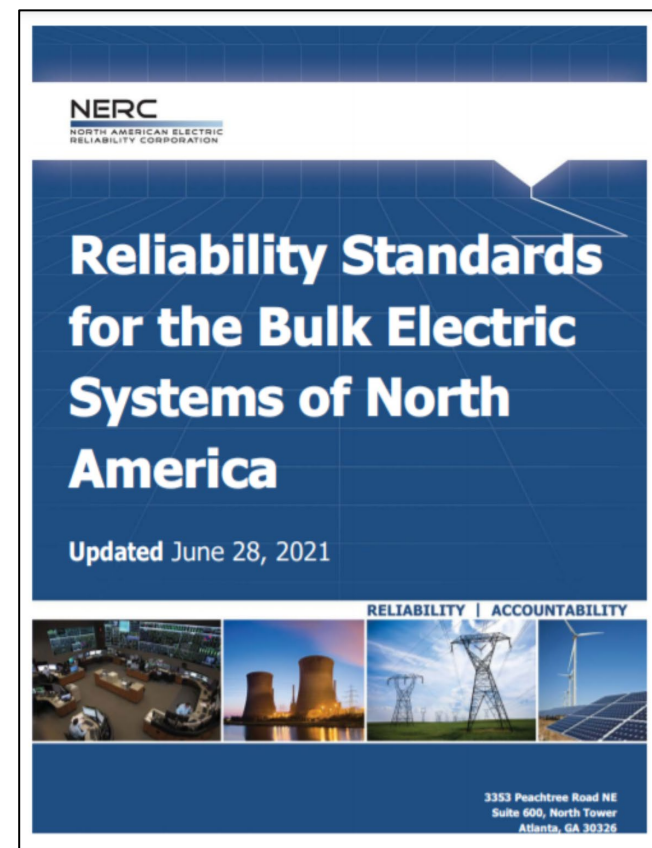
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# Key Preliminary Recommendations

## Reliability Standards

- GOs to account for effects of precipitation and accelerated cooling effect of wind when providing temperature data.
- BAs' and Transmission Operators' (TOPs) manual load shed provisions to include processes for identifying and protecting critical natural gas infrastructure loads from firm load shed to avoid adversely affecting bulk-power system reliability.
- BAs' operating plans for contingency reserves and to mitigate capacity and energy emergencies to prohibit use of critical natural gas infrastructure loads for demand response.



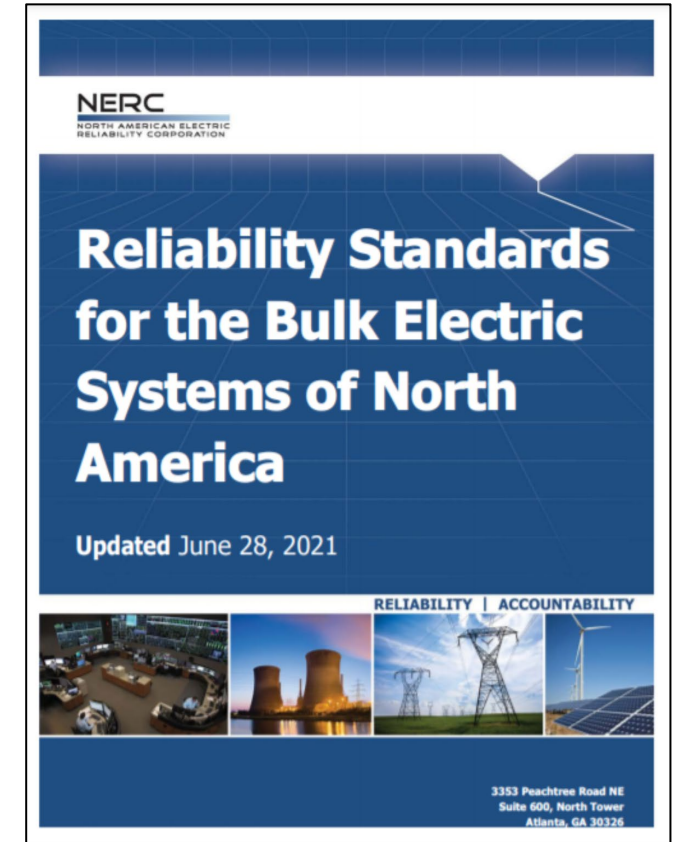
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# Key Preliminary Recommendations

## Reliability Standards

- The load shed procedures of TOPs, Transmission Owners (TOs) and Distribution Providers (DPs) to separate circuits that will be used for manual load shed from circuits used for underfrequency load shed (UFLS) or serving critical load, use UFLS circuits only as a last resort, and if necessary, start with the final stage (lowest frequency) to minimize the overlap of manual and automatic load shed.



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





# Key Preliminary Recommendations

## Funding for Generator Winterization

2. Generator owners should have the opportunity to be compensated for the costs of building or retrofitting their units to operate to a specified ambient temperature and weather conditions through markets or through cost recovery approved by state public utility commissions (e.g., as a reliability surcharge) to be included in end-users' electric service rates. The applicable ISOs/RTOs and/or public utility commissions should identify how best to ensure GOs have the opportunity to be compensated for making these infrastructure investments.





# Key Preliminary Recommendations

## Natural Gas Infrastructure Winterization

3. Congress, state legislatures and regulators with jurisdiction over facilities used for producing, treating, processing, pressurizing, storing, or transporting natural gas should require those gas facilities to have cold weather preparedness plans, including measures to prepare to operate during a weather emergency.
4. Natural gas production, gathering and processing facilities should consider implementing measures to protect against freezing and other cold-related limitations which can affect the production, gathering and processing of gas. Examples include:
  - covering or sheltering sensitive facilities, adding heating equipment, and
  - installing backup generation at critical sites.





# Key Preliminary Recommendations

## Natural Gas-Electric Reliability Forum

5. FERC should consider establishing 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 Balancing Authorities 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. Options for establishing the forum could include:
- joint task force with NARUC,
  - a Federal Advisory Committee, or
  - series of technical conferences.







# Key Preliminary Recommendations

## Natural Gas-Electric Reliability Forum

5. At such a 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 Key Preliminary Recommendation Areas

6. **GO/GOPs should identify reliability risks of natural gas fuel contracts and communicate these risks to BAs.**
7. **FERC, NERC, and Regional Entities should host joint technical conference to discuss how to improve generator winter readiness.**
8. **GOs' plans should include performing inspection/maintenance of freeze protection measures prior to and during the winter season, and pre-event when specific cold weather events are forecast.**
9. **Planning Coordinators should reconsider some of the inputs to their publicly-reported winter season anticipated reserve margin calculations for their respective BA footprints so that the reported reserve margins will better predict the reserve levels that the BAs could experience during winter peak conditions.**





# Other Preliminary Recommendation Areas

Fourteen additional recommendations covering issues including:

- Effects of cold weather on mechanical fatigue
- Increasing the flexibility of manual load shedding
- GO/GOP use of weather forecasts
- Coordination of protective relay settings associated with generator underfrequency relays
- Coordination of UFLS relay settings with generating unit time-delay protection systems
- Increase real-time monitoring of gas well-heads





## Other Preliminary Recommendation Areas (Cont'd.)

- Emergency response centers for severe weather events
- Improve near-term load forecasts for extreme weather conditions
- Analyze intermittent generation effects to improve load forecasts
- Rapidly-deploying demand response
- Additional load shed training for system operators
- Retail incentives for energy efficiency improvements
- Studies of large power transfers during stressed conditions
- Reducing the time for reporting generation or transmission outages





# Other Preliminary Recommendation Areas *For Further Study*

- Black start unit reliability
- Additional ERCOT connections
- Potential measures to address natural gas supply shortfalls
- Potential effect of low-frequency events on generators in the Western and Eastern Interconnections
- Guidelines for identifying critical natural gas infrastructure loads

THE RECOMMENDATIONS PRESENTED TODAY ARE PRELIMINARY.

THE FINAL RECOMMENDATIONS WILL BE INCLUDED IN THE FULL REPORT, WHICH IS EXPECTED TO BE ISSUED BY WINTER.





# February 2021 Cold Weather Grid Operations: Preliminary Findings and Recommendations

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**FERC, NERC and Regional Entity Joint Staff Inquiry**

