



# PERSPECTIVES

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## **Assessment of Energy System Reliability Failures During the Extreme Cold Weather Event in the ERCOT Region**

Our perspectives feature the viewpoints of our subject matter experts on current topics and emerging trends.

## INTRODUCTION

The purpose of this white paper is to serve as an initial overview and assessment of electrical system reliability failures experienced during the extreme weather event that occurred within the Electric Reliability Council of Texas (ERCOT) Interconnection service territory from February 14, 2021 until February 18, 2021.<sup>1</sup> The Southwest, Midwest, and Northeast experienced an extreme winter weather event in February 2021. The ERCOT service area underwent extreme winter weather from February 14 through February 18, 2021, with record low temperatures for much of the state of Texas. Those extremes created significant operational (equipment), electrical system (grid), fuel constraints and curtailments as with liquid natural gas (LNG) pipelines, and market (pricing) disruptions. A total of 356 generating units or approximately 50% of the total generating assets were forced offline during the event within the ERCOT service area. Frequency was ultimately impacted and registered below the 59.4 Hz limit for more than four minutes. Load shedding began on February 15 and reached a peak of approximately 20,000 MW. Load shedding was required for more than 70 hours before full system load could be restored.

There were likely several triggers for the number of forced outages related to the extreme weather but generally, they appear to fall into two primary categories. These categories are 1) the inability of a unit to either start or maintain operational status related to weatherization, including both fuel-based facilities as well as renewables—primarily wind—and 2) reduction or loss of priority reassignment of natural gas for gas-fired facilities. It should be noted that there has been significant attention focused on wind assets, but the facts indicate that all resources were substantially impacted with no one category necessarily more affected than others.

There are more likely other events related to icing of transmission and/or distribution systems that may have contributed to loss of service/contingent business interruptions of power, but these are beyond the scope of this paper.

ERCOT is one of nine Independent System Operators (ISOs) in the U.S.<sup>2</sup> and is a membership-based 501(c)(4) nonprofit corporation, governed by a board of directors, that is subject to oversight by the Public Utility Commission of Texas and the Texas Legislature.<sup>3</sup> The Texas Legislature enacted laws which govern all activities of ERCOT under the Public Utilities Regulatory Act (PURA) Section 39.151.<sup>4</sup> ERCOT works with the Texas Reliability Entity (Texas RE), which is the Federal Energy Regulatory Commission (FERC)-approved Regional Entity for the ERCOT region.<sup>5</sup> In addition, Texas RE has been authorized by the Public Utility Commission of Texas (PUCT) and is permitted by North American Electric Reliability Corporation (NERC) to investigate compliance with the ERCOT Protocols and Operating Guides, working with PUCT staff regarding any potential protocol violations.<sup>6</sup>

The focus of this paper is to evaluate the event based on initial reports, identify current processes and procedures that are in place in support system reliability, identify vulnerabilities from initial reports and data, and to examine what, if any, immediate actions may be appropriate to accelerate improvements and mitigate risk for future events. This narrative utilizes an approach like a typical root cause process to evaluate the response challenges and failures of the ERCOT electric system during the February 2021 winter event. This paper should not be construed as a formal, exhaustive, and/or complete root cause analysis that would encompass a more detailed evaluation of equipment and operational performance of the ERCOT system.

## EVENT SCHEDULE

On February 14, 2021, an extreme cold weather event began to take place in the ERCOT service area. The event lasted through February 18, 2021. Total available generation prior to the event was 107,514 MW. By Monday, February 15, 2021, the ERCOT system shed 20,000 MW of load. The peak loss of generation reached 52,277 MW or 48.6% of the total available generation. On Sunday, February 15, demand for power reached a new high for the ERCOT service area at 7:06 PM of 69,222 MW. From approximately Monday, February 15,

<sup>1</sup> Katherine Blunt & Russell Gold, The Texas Freeze: Why the Power Grid Failed, Wall Street Journal (February 19, 2021).

<sup>2</sup> <http://www.isorto.org/site/c.jhKQIZPBImE/b.2603295/k.BEAD/Home.htm>

<sup>3</sup> <http://www.ercot.com/about>

<sup>4</sup> Bill Magness, Review of February 2021 Extreme Cold Weather Event – ERCOT Presentation, Urgent Board of Directors Meeting, February 24, 2021.Slide 3.

<sup>5</sup> <https://web.archive.org/web/20130328213848/http://www.texasre.org/about/Pages/Default.aspx>

<sup>6</sup> Ibid.

through Tuesday, February 16, very little improvement in generation availability was achieved. By Wednesday, February 17, there were small gains in net generation; then, subsequently, as temperatures increased, normal operations and generation capacity were returned by Friday, February 19. It is important to note that normal operations for ERCOT does not necessarily entail full power restoration at the delivery point or to the end user. Simply put, normal operations for the ERCOT electrical grid does not mean that all industrial, commercial, or retail users had their electrical service restored at this time but rather, generation and transmission capabilities had been restored to pre-event levels.

## DISCUSSION

### System Resilience & Reliability

There are generally two components associated with grid architecture which were impacted by the severe weather event: resilience and reliability. Grid resilience is the ability to withstand grid stress events without suffering operational compromise or the ability to adapt to the strain. It is largely about what does not happen to the grid or electricity consumers.<sup>7</sup> Simply put, resilience is the ability of the electrical system to strain or deform without a sustained outage.

Reliability, on the other hand, is a measure of behavior once resilience is broken. The start of a sustained outage is the transition point from the domain of resilience to the domain of reliability.<sup>8</sup>

During this extreme winter event, ERCOT managed the system to satisfy the parameters for reliability within the ERCOT regulatory, operational, and market constraints at the time of this extreme weather event to avoid a total system failure. Emergency system measures utilized load shedding, to avoid a complete compromise of the electrical system. While emergency measures may have been necessary to avoid total system failure, the more significant question is whether the reliability parameters were appropriate. The loss of electrical service to more than 4 million customers within the ERCOT service

territory during very unusual, yet not necessarily unique, winter weather conditions certainly bring into question how reliability parameters were established for such an event and to what extent the impacts should have been anticipated.

One of the primary components of grid reliability is availability of resource reserves that can be deployed to the grid during a sustained outage of generation resources. In the case of this event, both online generation as well as resource reserves, including standby and backup generation resources, were affected by the extreme temperatures and were not available to meet load demand. This, in turn, necessitated load shedding to maintain the real-time balancing of supply and demand.

### System Preparation

Prior to this event, the ERCOT service territory experienced similar extreme cold weather events during the first week of February 2011 as well as in 1983, 1989, 2003, 2006, 2008, and 2010.<sup>9</sup> The following was summarized in the Executive Summary of the 2011 FERC Staff report:

*“Going into the February 2011 storm, neither ERCOT nor the other electric entities that initiated rolling blackouts during the event expected to have a problem meeting customer demand. They all had adequate reserve margins, based on anticipated generator availability. But those reserves proved insufficient for the extraordinary amount of capacity that was lost during the event from trips, derates, and failures to start.”*

The report goes on to say:

*“The actions of the entities in calling for and carrying out the rolling blackouts were largely effective and timely. However, the massive amount of generator failures that were experienced raises the question whether it would have been helpful to increase reserve levels going into the event. This action would have brought more units online earlier, might have prevented some of the freezing problems the generators experienced, and could*

<sup>7</sup> JD Taft, PhD, Electric Grid Resilience and Reliability for Grid Architecture (November 2017).

<sup>8</sup> Ibid. P.3.

<sup>9</sup> FERC Staff, Report on Outages and Curtailments During the Southwest Cold Weather Event of February 1-5, 2011, Executive Summary, (August 2011)

*have exposed operational problems in time to implement corrections before the units were needed to meet customer demand.”*

Essentially, the findings of that report would appear to align with the results from the 2021 extreme winter storm event. The suggestions of that report included 26 recommendations to improve reliability performance during an extreme winter weather event. One specific requirement, highlighted from Recommendation 11, indicated that, *“NERC concluded there would be a reliability benefit from amending Reliability Standards to require Generator Owner/Operators to develop, maintain, and implement plans to winterize plants and units prior to extreme cold weather, in order to maximize generator output and availability.”*<sup>10</sup>

## Follow-Up from Previous Extreme Winter Weather Events

Both the timing (February) and type of extreme weather event in 2011 and 2021 are similar. In 2021, however, there was a significantly greater loss of generation due to forced outages as well as the total number of units that were unavailable due to forced outages. Frequency deviations—resulting from demand exceeding supply—became more critical during the 2021 event. Given that recommendations were developed following the 2011 event, the question remains as to why similar events would produce similar results, though it should be noted that the 2021 event was more “extreme” in terms of low temperatures.

A status review of recommendations from ERCOT’s February 24, 2021 Emergency Meeting indicates that, even though many actions had been taken, the enforcement component to verify that generation owners weatherized their facilities appears to have been insufficient. There are approximately 680 generating units within ERCOT. According to ERCOT, approximately 80 units per year can be spot checked. That is slightly more than 10% per year of the total number of units. One possible vulnerability is the need for additional inspection/assessment support

so that more frequent spot checks can be accomplished, with additional follow up as needed, to assure proper weatherization measures are implemented in accordance with FERC/NERC 2011 recommendations.

## Authority for Enforcement

According to Slide 17 of the ERCOT Emergency Meeting presentation:<sup>11</sup>

*“Generation owners and operators are not required to implement any minimum weatherization standard or perform an exhaustive review of cold weather vulnerability. No entity, including the PUC or ERCOT, has rules to enforce compliance with weatherization plans or enforce minimum weatherization standards.”*<sup>12</sup>

As mentioned earlier, ERCOT performs site visits to review compliance with weatherization plans. However, according to ERCOT, “the only entity that can confirm that a plant is weatherized to any particular standard is the entity that owns the plant.”<sup>13</sup>

A review of other Independent System Operator/Regional Transmission Organization (ISO/RTO) systems such as PJM Interconnection, LLC, shows that formal requirements for cold weather guidelines exist along with a provided checklist of requirements. PJM Manual 14D: Generator Operational Requirements, Appendix N,<sup>14</sup> specifically provides a checklist, safety focus, and annual training requirements. The list includes personnel preparation, staffing needs, and equipment preparation. Appendix N of that manual specifically provides a checklist, safety focus, and annual training requirements for cold weather conditions.<sup>15</sup> The list includes personnel preparation, staffing needs, and equipment preparation. Compliance enforcement includes penalties if certain measures are not in place within specified schedules.

According to the PJM’s standards for mandatory enforcement, Section 215 of the Federal Power Act requires the Electric Reliability Organization (ERO) to develop mandatory and enforceable Reliability

<sup>10</sup> Ibid.

<sup>11</sup> Bill Magness, Review of February 2021 Extreme Cold Weather Event – ERCOT Presentation, Urgent Board of Directors Meeting, February 24, 2021.Slide 17.

<sup>12</sup> Ibid, Slide 17.

<sup>13</sup> Ibid, Slide 17.

<sup>14</sup> PJM Operations Planning Division, PJM Manual 14D: Generator Operational Requirements, Revision: 53, November 23, 2020, Appendix N, P. 145.

<sup>15</sup> PJM Operations Planning Division, PJM Manual 14D: Generator Operational Requirements, Revision: 53, November 23, 2020, Appendix N, P. 145.



Standards, which are subject to FERC review and approval. Commission-approved Reliability Standards become mandatory and enforceable in the U.S. according to the NERC Implementation Plan associated with the Reliability Standard, as approved by the Commission.<sup>16</sup> Pursuant to the Energy Policy Act of 2005 (EPA 2005), Congress expanded FERC’s role and jurisdiction under the Federal Power Act (FPA) by adding a new Section 215 pertaining to electric grid reliability. Section 215(e) of the FPA authorizes the Commission or an Electric Reliability Organization (subject to review by FERC) to impose a penalty on a user, owner, or operator of the bulk power system for a violation of a Reliability Standard.<sup>17</sup>

Because the transmission grid that the ERCOT independent system operator administers is located solely within the state of Texas and is not synchronously interconnected to the rest of the United States, the transmission of electric energy occurring wholly within ERCOT is not subject to the Commission’s jurisdiction under certain enforcement sections of the Federal Power Act. Bulk electric system reliability has been delegated through a delegated authority agreement between NERC and Texas RE that assigns compliance and enforcement authority to Texas RE for purposes of assuring NERC reliability standards are maintained for the bulk electric system. Determining whether Texas RE has compliance and enforcement authority regarding weatherization of generating facilities would require a more detailed assessment of the representations in the ERO agreement between NERC and Texas RE.

ERCOT is an “energy only” system with no capacity market. What is the need and potential benefit of a capacity market? A good analogy is provided by PJM in its description of a capacity market:

*“Capacity represents a commitment of resources to deliver when needed, particularly in case of a grid emergency. A shopping mall, for example, builds enough parking spaces to be filled at its busiest time – Black Friday. The spaces are there when needed, but they may not be used all year round. Capacity, as it relates to electricity, means there are*

*adequate resources on the grid to ensure that the demand for electricity can be met at all times.”<sup>18</sup>*

A capacity market has been suggested as potentially incentivizing additional generation assets that could serve as added backup generation during unusual circumstances such as an extreme weather event. The state of Texas has not implemented a capacity market within ERCOT; rather, it relies on market rules to incentivize the availability of additional capacity assets.

It is beyond the scope of this paper to assess the overall planning process for adding either firm generation or backup generation within the ERCOT service territory. There are several guides and related documents that are relevant to system expansion, including expansion of generation within the ERCOT service area. They are identified in the ERCOT Planning Guide (Planning Guide), dated January 2021. If there is a conflict between the Planning Guide and Protocols, any Public Utility Commission of Texas (PUCT) Substantive Rules or the NERC Reliability Standards, then such PUCT Substantive Rules, NERC Reliability Standards, and the Protocols shall control.<sup>19</sup> It is not clear at this time whether Texas RE, on behalf of ERCOT and in accordance with NERC requirements, can or has implemented compliance enforcement either related to or in anticipation of generation for this or other extreme weather events. Weatherization and associated availability of generation could be one component of resolving grid performance issues that assure compliance with specific NERC operational guidelines. It appears that issues related to the lack of weatherization of generation assets contributed to the significant load shedding associated with the 2021 extreme winter weather event.

The Texas legislature passed a law after the 2011 weather event that required 1) mandatory reporting of emergency operations and 2) independent review by the PUCT.<sup>20</sup> As part of the report following the 2011 extreme cold weather event, FERC Staff recommended that winterization practices for Texas be mandatory and that the legislature grant the PUCT the authority to impose penalties for non-compliance as well as hold senior management responsible for a particular generation asset

<sup>16</sup> <https://www.nerc.net/standardsreports/standardssummary.aspx>  
<sup>17</sup> <https://www.ferc.gov/enforcement-legal/enforcement/enforcement-reliability>  
<sup>18</sup> <https://learn.pjm.com/three-priorities/buying-and-selling-energy/capacity-markets.aspx>  
<sup>19</sup> ERCOT Planning Guide, January 1, 2021, P. 1-1.  
<sup>20</sup> FERC Staff, Report on Outages and Curtailments During the Southwest Cold Weather Event of February 1-5, 2011, Executive Summary, (August 2011).

to review and acknowledge that their winterization plans were appropriate.<sup>21</sup>

## Standard of Care

Standard of care generally refers to the duty of a professional to provide services as expected to be provided by similar professionals under similar circumstances.<sup>22</sup> In the case of generation assets within the ERCOT service area and, more importantly, performance of those assets during the most recent extreme weather event, there is a standard of care that a reasonable owner/operator would be expected to take to assure that their facilities were available. Whether those standards were met is yet to be determined but there will certainly be substantial review as to whether reasonable care was appropriately applied to the weatherization of generation assets. From all current indications, one of the weak links in the overall performance within ERCOT appears to be related to a lack of sufficient weatherization of generation assets.

So, what should reasonable standard of care related to weatherization of electrical grid assets and, more specifically, generation assets take into consideration? According to the previous FERC findings, reasonable standard of care includes, but is not limited to:<sup>23</sup>

- Consideration during plant design
- Equipment and material selections
- Maintenance and inspections of its freeze protection elements
- Evaluation of specific freeze protection maintenance items
- Inspection and maintenance of heat tracing equipment
- Inspection and maintenance of thermal insulation
- Inspection of valves and piping
- Use of wind breaks/enclosures

- Proper training of personnel specific to extreme weather events

In addition, consideration should be given to any changes or modifications during the lifecycle of the facility as well as to how those changes may impact current weatherization or require additional weatherization.

ERCOT stated in its initial findings after the 2021 event that generation owners and operators are not required to implement any minimum weatherization standard. However, this may not relieve owner/operators from what would be considered a reasonable standard of care, given the importance of the product provided and the potential consequence if that product is not delivered.

## CONCLUSION

There will be a number of detailed follow-up assessments of this winter storm to determine root cause of system failures, potential contingent business interruption, system vulnerabilities, and improvements required to mitigate risk for future events.

Regarding system improvements, an independent and detailed audit and assessment of weatherization (i.e., what worked, what needs to be improved, etc.) at all generating facilities would be an important first step, especially from the perspective of generation owners and operators. Periodic critical review of performance is an important indicator to customers, shareholders, and regulators that reasonable standards of care are being considered and updated as needed. By self-initiating this type of detailed weatherization audit, owners/operators will also be in front of the eventual regulatory examinations that will certainly follow such an event.

Another important consideration is the potential impact this winter storm had on Environmental, Social, and Governance (ESG) criteria performance—perceived or actual. ESG is used to measure the sustainability and societal impact of an investment in a company or business. This is a particularly important measurement for private equity and other investors and has a growing interest for customers as well.

<sup>21</sup> Ibid.

<sup>22</sup> <https://www.insureon.com/insurance-glossary/standard-of-care>

<sup>23</sup> FERC Staff, Report on Outages and Curtailments During the Southwest Cold Weather Event of February 1-5, 2011, Executive Summary, (August 2011).

Questions that should be considered include those seeking to understand how the recent performance of a facility or system affected:

- Public image and public health and safety
- Reputation
- License to operate
- Regulatory scrutiny
- Attraction of future investment
- Ability to obtain insurance coverage and cost of that coverage
- Shareholder value
- Pricing impacts and effect on customer rates

All these questions and the associated answers ultimately go directly to the bottom line of a company's financial performance. A materiality assessment of ESG programs and attributes following this extreme weather event would provide a baseline measure of potential impact from the storm event as well as a measure of improvement going forward.

Both independent weatherization audit assessments and materiality assessments of ESG programs and attributes would have an immediate and measurable benefit to energy providers as well as their customers.

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