Vulnerabilities in the Texas Electricity Market: A Comparison of Winter Events in 2021 and 1989

JAY ZARNIKAU

Jay Zarnikau is an Adjunct Professor of Public Affairs at the University of Texas at Austin and senior vice president of Frontier Energy. He can be reached at: jayzarnikau@gmail.com

The electric outages in Texas following Valentine's Day of 2021 helped to inspire the theme of this edition of *Forum*. Winter Storm Uri exposed vulnerabilities in the state's electricity markets, resulting in deaths, wealth transfers, and political fallout. It raised questions over the success of efforts to foster competition in the electric generation and retail sectors in the nation's leading state in electricity production and consumption. It renewed debates about the state's considerable degree of independence from other interconnections and limited FERC oversight, as well as the performance of the state's large and powerful natural gas industry. The event attracted media attention and ample "finger pointing." Articles and reports of varying accuracy have been written.

It is instructive to compare the electricity industry's performance during the February deep freeze to an earlier winter event in the days before Christmas of 1989, for a few reasons. First, the weather was similar. The low temperature in Austin was the same in both events. The low in Dallas was just 1°F colder in 2021 than in 1989. Houston reached a low temperature that was 6°F lower in 1989 than in 2021.[1] The weather in 1989 was more-similar to the 2021 event than the relatively-mild winter 2011 curtailment event which is inappropriately used by the ERCOT staff as a severe winter scenario.[2] However, the electricity industry in Texas is far different today, with competition in the generation sector and retail customer choice in many areas of the Electric Reliability of Texas (ERCOT) market. In contrast, the industry was dominated by vertically-integrated electric utilities in 1989 and there was little market-wide control over operations. Texas is now the leader in wind generation in the U.S., though natural gas remains the leading generation fuel. Finally, the comparison is of personal interest to me, since I was the Director of the Electric Division at the Public Utility Commission of Texas (PUCT) back in 1989.

What happened in February 2021?

In Texas, around 60% of homes are heated using electric space heating, so electrical demand spiked as winter storm Uri moved into Texas and neighboring states in mid-February. Had there not been electrical curtailments, electricity demand would have easily reached a new peak during the winter storm. All types of generation sources reported problems, as noted in Fig. 1. At one point, nearly one-half of the generation capacity in the market was unavailable to the ERCOT system operator. Frequency dropped to below 59.4 Hz. To prevent a catastrophic shut-down of the grid, distribution utilities were instructed to curtail load. Because the required demand reduction was so great and the cold weather persisted for many days, "rolling blackouts" became persistent multi-day outages of electric service for many Texans. Frigid temperatures and unheated homes led to over 100 deaths.

Generators failed for a variety of reasons. There were frozen sensing lines, frozen water lines, and frozen values. Ice accumulated on wind turbine blades. Coal piles turned into chunks of ice. Snow gathered on solar panels, diminishing their output. Many natural gas power plants were unable to obtain fuel because electricity had been cut-off to the electric compressors used to produce and transport natural gas. Natural gas production declined due to wellhead and equipment

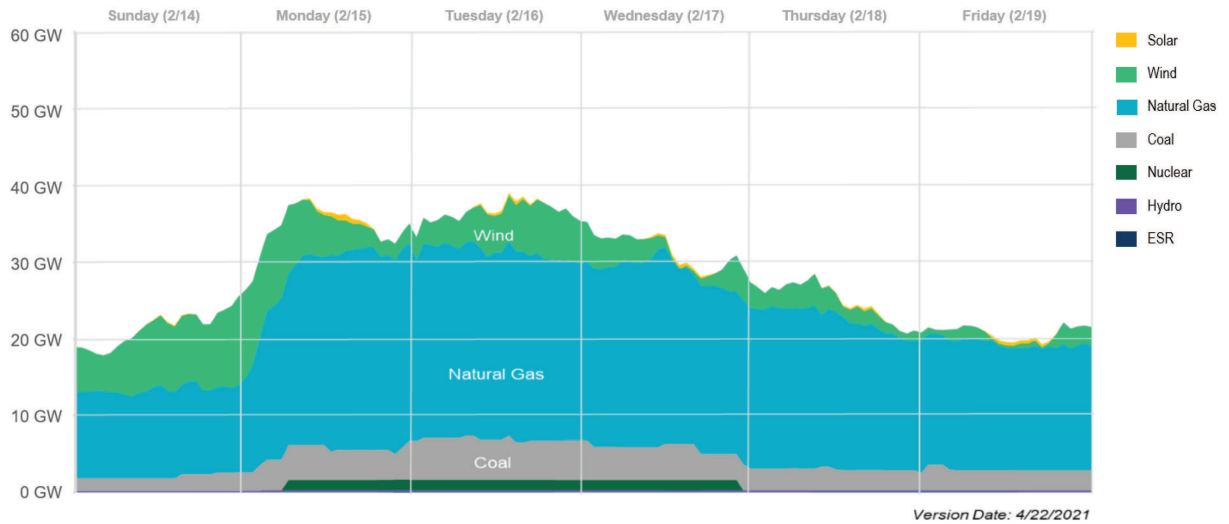

Figure 1. Net Generator Outages and Derates by Fuel Type (Source: ERCOT)

"freeze-offs," as well. Moreover, many peaking units had interruptible natural gas transportation agreements, and providing natural gas service to residential end-use consumers was a higher priority than providing gas to electricity generators since re-instating natural gas service to homes would require labor-intensive physical visits to gas-curtailed homes by the natural gas distribution utilities.

The economic consequences of the event were enormous and unprecedented. Due to a shortage of generation, prices reached the offer cap of $9,000 per MWh during certain periods on February 13th and 14th and were subsequently pegged at that high level from the morning of February 15th to the morning of February 19th in hopes of attracting more generation resources to enter the market and to keep price-sensitive load out of the market. The value of electricity consumed during the week – based on real-time prices and consumption – was roughly $50 billion, or about 5 times the value of electricity consumed during entire years. This value may be misleading, however, given the ample hedging opportunities provided by the market structure.

The ensuing high natural gas prices and high prices of electricity in the wholesale markets for energy and ancillary services operated by ERCOT had large and disparate impacts on market participants. As the centralized counter-party in the markets for energy and ancillary services that it administers, ERCOT reported cumulative aggregate "short payments" or under-collections of approximately $2.9 Billion.[3] ERCOT estimates that it will take 96 years to collect the amounts owed to it by defaulting parties (Brazos Electric Power Cooperative, Rayburn Country Electric Cooperative, and some competitive retailers) from market participants under its existing Default Uplift Invoice process.[4] Among the winners, Kinder Morgan, an owner and operator of natural gas pipelines, terminals and storage, announced a $1 billion windfall profit from gas sales during the storm.[5] Various financial institutions providing financing and hedges to participants in ERCOT's markets also received windfall profits.[6] Among the losers were Brazos Electric Power Cooperative Inc., Rayburn Country Electric Cooperative, and CPS Energy. Retailers Griddy Energy, Entrust Energy, Inc., and Power of Texas Holdings Inc. filed for bankruptcy, as well as Just Energy, which does business under a variety of brand names. Generators who were unable to meet their commitments with their own generating units due to performance problems were among the big losers, having to purchase power in the real-time market at the offer cap to satisfy their commitments to load-serving entities. NRG and Vistra – leaders in both the generation and retail sectors – appear to be among the losers.

What happened in 1989?

Many months before the 1989 winter event, the PUCT Staff warned of reliability concerns associated with ERCOT's high reliance on natural gas for electricity generation:

> Dependence on natural gas in the ERCOT generation mix (almost three times the national dependence) represents some reliability concern. . . . if severe winter conditions were to occur, there could be curtailment of gas supply for generating unites. If such curtailment does occur and it becomes necessary to substitute fuel oil for gas, the rated capability of some units will be reduced due to equipment design, pipeline delivery constraints and/or oil inventories.[7]

Natural gas and oil represented 53% of the generation mix in 1989.[8]

During the winter freeze of December 21-23, 1989, Texas saw record low temperatures, very similar to those experienced in February 2021. Demand for electricity increased, along with the demand for natural gas for space heating. Weather-related equipment problems caused generating units to go offline. Many power plant outages were traced to frozen instruments, frozen valves, boiler tube leaks, frozen batteries, and fish plugging cooling water intakes. Consistent with the concerns expressed by the PUCT staff earlier in the year, natural gas flows were curtailed by Lone Star Gas to the utilities in North Texas in early hours of December 21st, and many utilities serving South Texas lost their natural gas supplies the following morning. This triggered a near loss of the entire ERCOT electric grid.[9] There was firm load shed of 1,710 MW (4.5% of peak load) on December 23rd, 1989, which was far smaller than the magnitude of the outages in 2021. "Rolling" blackouts were achieved. System frequency remained above 59.65 Hz throughout the event.

Differences

Both winter storms resulted in rolling blackouts. During both events, weather-related problems forced outages and de-ratings at power plants and the availability of natural gas to gas-fired power plants was a significant problem. But these were otherwise very different events. The extent and duration of the outages was far greater in 2021. No loss of life was linked to the outages in 1989.

The 1989 event was an inconvenience. The February 2021 event was a disaster.

What accounts for the differences between these two events? Some of the difference is no-doubt related to changes in the physical characteristics of the system over the past 32 years. In 1989, much of the fleet of natural gas generators had dual-fuel capability and switched to fuel oil when natural gas supplies were curtailed.[10] This resulted in de-ratings of 1.5 GW,[11] but kept many plants on-line. There is less dual-fuel capability today. ERCOT's (summer) planning reserve margin was over 20% in 1989,[12] in contrast to the 15.5% reserve margin projected for the summer of 2021.[13] Thus, there was a greater "cushion" of capacity to work with.

Having more market players and less vertical-integration can certainly increase the coordination necessary to preserve reliability. In 1989, there were far fewer participants in the industry.

In 1989, operations were handled by ten local control centers, rather than a single independent system operator. Quality and reliability standards were applied to all investor-owned utilities under the PUCT's regulatory oversight.

There was no large "wealth transfer" from the electric industry to the natural gas and financial services industries in 1989, unlike the 2021 event. Natural gas prices remained fairly stable in December 1989, while prices spiked in February 2021 with dire consequences for end-use consumers and gas-fired power plant owners exposed to those prices.[14] The December 1989 event preceded the establishment of formal wholesale markets for electricity in the ERCOT power region and the PUCT was able to review the costs incurred by the utilities under its jurisdiction and approve recovery of those costs determined to be reasonable and necessary and prudently-incurred.

Responsibility for meeting targeted planning reserve levels was assigned to various utilities in 1989. Today, markets are relied upon to provide sufficient profit opportunities to attract existing resources into the real-time market and foster long-term investment in the generation sector.

In Conclusion

The December 1989 and February 2021 firm load shed events in ERCOT had similar causes. Temperatures were similar. The explanations for generation outages and deratings were similar. The interdependence of the electric and natural gas industries was highlighted each time. The types of recommendations that were made by the PUCT staff and the North American Electric Reliability Corporation (NERC) following the outages in 1989 and 2011 for better winterization of the generation and transmission infrastructure and better coordination with the natural gas industry[15] will probably again be repeated.

But the industry structure is far different today than it was in 1989. Texas now has competitive markets for electricity, with many market participants in the generation and retail sectors. Markets are relied-upon to balance supply and demand in the short-run and long-run, and prices are permitted to reach higher levels than in most other restructured markets for electricity. Simply tracing who was financially-impacted by the 2021 event is very difficult, due to the presence of hedging arrangements, global markets for energy, and many proprietary arrangements among market participants. The economic impacts of this type of event on consumers and market participants have become enormous and better-mitigating some of those impacts is now a focus of attention.

Footnotes

[1] It is noteworthy that the winter storms during December 1989 and February 2021 are not without precedent in Texas. See James Doss-Gollin, David Farnham, Upmanu Lall, Vijay Modi (2021). How unprecedented was the February 2021 Texas cold snap? Accepted for publication in *Environmental Research Letters.*

[2] See, for the example, the Scenario tab in: http://www.ercot.com/content/wcm/lists/197378/SARA-FinalWinter2020-2021.xlsx.

[3] Electric Reliability Council of Texas Inc.'s Notice of Planned Implementation of Default Uplift Invoice Process, PUCT Project No. 51812: Issues Related to the State of Disaster for the February 2021 Winter Weather Event.

[4]Electric Reliability Council of Texas Inc.'s Notice of Planned Implementation of Default Uplift Invoice Process, PUCT Project No. 51812: Issues Related to the State of Disaster for the February 2021 Winter Weather Event.

[5] Gerson Freitas, Kinder Morgan Posts Blowout Profit on Texas Winter Storm, Bloomberg. April 22, 202; Harry Weber, Kinder Morgan gets big first-quarter lift from gas price volatility due to Texas freeze. S&P Global Platts, April 21, 2021.

[6] Chung, J, Blunt, K. Texas Storm is a Windfall for some Wall Street Firms. The Wall Street Journal. April 2021.

[7] Public Utility Commission of Texas, Long-Term Electric Peak Demand and Capacity Resource Forecast for Texas, 1988, Volume I: Summary of Results and Recommendations, Feb. 1989, p. 6.7.

[8] Public Utility Commission of Texas, Long-Term Electric Peak Demand and Capacity Resource Forecast for Texas, 1988, Volume I: Summary of Results and Recommendations, Feb. 1989, p. 6.6.

[9] Electric Division Evaluation Report, Electric Utility Response to the Winter Freeze, Public Utility Commission of Texas, November 1990.

[10] ERCOT's natural gas and fuel oil accounted for ~53% of ERCOT's generation mix in 1989. In recent years, natural gas has comprised about 47% of the generation mix, per: http://www.ercot.com/content/wcm/lists/197391/2019_ERCOT_State_of_the_Grid_Report.pdf

[11]https://www.nerc.com/pa/rrm/ea/February%202011%20Southwest%20Cold%20Weather%20Event/ERCOT%20Emergency%20Operation%201989.pdf

[12] Public Utility Commission of Texas, Long-Term Electric Peak Demand and Capacity Resource Forecast for Texas, 1988, Volume I: Summary of Results and Recommendations, Feb. 1989, p. 6.6.

[13] http://www.ercot.com/content/wcm/lists/219840/SARA-Preliminary-Summer2021.pdf

[14] https://www.eia.gov/dnav/ng/hist/n3050tx3m.htm

[15] FERC and NERC, Report on Outages and Curtailments during the Southwest Cold Weather Event of February 1-5, 2011: Causes and Recommendations. August 2011.