Enhancing the reliability of bulk power systems against the threat of extreme weather: lessons from the 2021 Texas electricity crisis

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In February 2021, Texas experienced a 1-in-30-year cold weather event that resulted in sub-freezing temperatures well below average for over six days. Given the state's reliance on electric heating, the extreme cold weather drove winter electricity demand to unprecedented levels. Meanwhile, electricity supply fell significantly, and the grid operator managing about 90% of the state's electric load, the Electric Reliability Council of Texas (ERCOT), was forced to initiate customer load-shedding. More than 10 million people in Texas lost electric distribution service, and a large swath of electricity customers in ERCOT were without power for up to 96 hours. At least 210 people died during the event, and losses to the Texas economy were estimated between $80 and $130 billion.

The event was followed by extensive finger-pointing, and some immediate reactions blamed competition, ERCOT's market structure and grid management, wind's underperformance and limited connectivity with neighboring states. In our view, the major causes of the crisis were not due to wholesale electricity market design, but to problems in planning and awareness of system interdependencies. As of the time of writing, the most significant energy-related bills passed by the Texas Legislature will result in a $18-billion out-of-market directive to build up to 10 gigawatts of new natural gas-fired power plants sitting in reserve; substantial changes to the governance of ERCOT and certain aspects of the ERCOT market (e.g., emergency pricing); a mandate for electricity suppliers in the state to purchase dispatchable power services as insurance; and the ban of wholesale-indexed products that include a direct pass-through of real-time prices for residential customers. To varying extents, these steps are reactions to a particular event, and may address pieces of what was a highly complex failure across multiple infrastructure and regulatory systems. By and large, however, reforms in Texas and elsewhere have not addressed fundamental systems-level practices to enhance the reliability of bulk, i.e., transmission-scale, power systems against the threats of extreme weather.

We contribute to the literature on the Texas electricity crisis by discussing three systems-level strategies to prevent and mitigate the adverse consequences of extreme weather events. Two of these strategies, in particular, have received limited attention in previous analyses.

First, generation resource adequacy and planning processes in the electric power sector should be enhanced to include multiple adverse conditions occurring simultaneously, common mode failures, growing system variability and potentially severe future weather events as part of the calculus. Actions to enhance understanding of the potential impacts of climate change on system load and resource availability are being undertaken in other regions of the U.S. and Europe. The Texas crisis also illustrates that performance incentives and non-performance penalties do not fully solve the market failure due to the misalignment between social welfare maximization and private objectives. Further, markets are not well suited for managing risks associated with catastrophic events, and private incentives often do not provide efficient and socially acceptable solutions under such circumstances. As a result, regulation and standards will likely play an important role to ensure provision of reliability against the threat of extreme weather.

Our second recommendation centers around demand-side solutions, which are vastly underutilized to address reliability challenges. Tools such as energy efficiency in homes, customer-side curtailment beyond existing industrial and commercial programs, and dynamic pricing options that do not expose residential customers to bill volatility could reduce peak demand during emergency conditions.

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Opportunities for improvements in this area are likely larger for Texas than in other regions of the U.S. Further, in our view time-varying pricing should not be abandoned just because of what happened in Texas, although it may not be effective for long-duration power interruptions.

Third, resource adequacy and planning processes in the electric power sector should evolve to better capture critical infrastructure interdependencies and associated vulnerabilities. Strengthening alignment of planning and operating practices across the electric and natural gas industries is especially important, but poses practical implementation challenges in settings where decisions are made by myriad market actors and institutions. Further, reforms in the natural gas market that improve fuel allocation between local distribution companies and power plants during periods of scarcity would help support electric system reliability.