What Texas Tells Us About Lessening the Frequency and Severity of Electricity Blackouts

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Instant Insight

February 23, 2021

KS--2021-II02

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On Monday, February 12, approximately three million homes and businesses in Texas lost power due to an unusual winter storm that simultaneously increased electricity demand and decreased supply.[1] This was not the first time; Texas had a similar incident due to cold weather in 2011.

Severe weather is a frequent cause of large-scale blackouts. For instance, in 2012, the Northeastern region of the United States suffered extensive power outages due to Hurricane Sandy. The hurricane toppled many distribution lines, resulting in several million residents not having electricity for up to two weeks. Other recent power outages include those in California due to wildfires, sparked in part from transmission lines, and in Texas in 2019, again because of severe weather from a heatwave. Table 1 lists some recent major blackouts that have occurred worldwide.

Although severe weather was common to both this year's blackout in Texas and the 2012 Northeast blackouts, their manifestation differed greatly. The loss of power in the Northeast was due to the failure of above-ground electricity distribution lines that toppled over due to the combination of torrential rains that softened the ground and high winds that blew over poles and wires.

In Texas, the problem was with the bulk power grid, which consists of power plants and high voltage transmission lines. The extreme cold weather in the state resulted in fossil fuel-fired plants and wind turbines being unable to generate electricity. There were supply shortages of natural gas suffered, coal piles froze, and wind turbines iced up. According to reports, there was an electricity shortage of 34,000 megawatts (MW), about two-thirds of which was attributed to a reduction in fossil fuel generation and one-third attributed primarily to a reduction in wind generation, among other renewable resources.

The cold weather in Texas also caused electricity demand to increase dramatically: 10,000 MW above the previous winter record, which was even above the state's summer record, as millions of Texans used electricity for heating. With electricity demand exceeding supply, the Texas grid operator and utilities had to implement rolling blackouts. Rolling blackouts are when utilities intentionally cut power to customers to try to keep the power grid in balance to avoid larger-scale and uncontrollable blackouts from occurring. The wholesale cost of power jumped to $9,000 per megawatthour (MWh), an increase of 180 times the pre-storm price level of $50 per MWh.

Blackouts threaten public safety and the economy. In the case of Texas, millions of people did not have heat during a severe winter storm, and carbon monoxide poisoning cases were reported as people resorted to unsafe means of staying warm. The heart of any modern economy is the reliable provision of electricity. It powers all the critical infrastructure that citizens use, such as communications, traffic signals, water treatment plants, medical facilities, and financial systems. With economies becoming increasingly digitized, a growing number of electric vehicles on the roads, and policies in many parts of the world to increase electrification to reduce greenhouse gas emission, reliable and resilient electricity grids are becoming even more important to society.

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[1] https://www.reuters.com/article/us-energy-texas-weather-idUSKBN2AF1QV

Reasonably, people in Texas want to know what the problems were that led to this major failure of infrastructure and what should be done to prevent it from occurring again. There is no single solution to this problem; the most successful efforts to ensure and enhance grid reliability are multifaceted. None of these efforts are exciting or dramatic, but they are nonetheless effective. Reducing the probability of blackouts to zero is not feasible. Instead, policymakers should focus on how to cost-effectively decrease the probability of blackouts to very low levels.

Fundamentally, there are two ways to reduce the likelihood of blackouts: decrease equipment failure rate and increase the amount of redundant equipment. Both approaches are expensive and become even more so as the system is made more reliable. This is because their additional contribution to reliability decreases as failure rates decrease and redundancy increases. Severe weather particularly threatens power systems because it causes the failure of large numbers of power plants and transmission and distribution lines, while increasing electricity demand.

Policymakers should take three steps to avoid blackouts. First, collect and disseminate data: Without accurate data detailing the type and frequency of equipment failures, the allocation of resources to prevent blackouts will not be cost effective. Detailed, accurate, and continual data collection is needed to calculate failure rates, the key variable to assessing the grid's reliability. The frequency and severity of severe weather also need to be estimated, particularly considering the impact of climate change, to ensure that the grid is prepared for more frequent weather disruptions or more severe weather.

Second, policymakers must implement multiple solutions and not look for a single answer to mitigate electricity blackouts. During a blackout the various components of the grid that usually work together do not. Improving the power system's reliability requires systematic investments in generation, transmission, distribution, control devices, information and communication systems, and backup power supplies, including a reliable supply of fuels for power generation. Microgrids, small subsystems that can provide power to customers autonomously outside the grid if necessary, can contribute to reliability, particularly for high-value loads such as public safety and medical facilities, water and sewage systems, communications and financial centers. However, they too are susceptible to failures due to severe weather. No single solution, whether microgrids, burying distribution lines underground, or increasing energy storage, among others, will be sufficient to tackle this problem on its own.

Third, improving resiliency, restoring power quickly, is also necessary. This requires the successful integration of multiple strategies in utility coordination, the cross-training of work crews, the strategic deployment of supplies and backup equipment, and the ability to communicate to customers and public safety officials the status of recovery efforts, what additional resources are needed, and expected restoration times.

Unfortunately, there is no panacea to large-scale blackouts. Instead, the prevention of and restoration from them requires systematic data collection, evidence-based and cost-effective planning, and integrated restoration preparations by power system operators, utilities, and government officials. Improving reliability and resiliency is expensive, so getting the right combination of cost-effective policies is crucial for continuing the grid's role in transitioning to a future of sustainable energy.

Table 1. Selected list of recent global large-scale power outages.

Country/region	Dates of blackout	Number of people who lost power	Initiating cause
Pakistan	January 9, 2021	200 million	A drop in the frequency of the power transmission system. (1)
Indonesia	August 4-5, 2019	120 million	Disruptions in gas turbines. (2)
India	July 30-31, 2012	700 million	Weak inter-regional power transmission corridors. (3)
Texas, U.S.	February 2, 2011	4.4 million	Cold weather. (4)
Brazil and Paraguay	November 10-20, 2009	60 million	Heavy rains and strong winds caused a transmission line to short circuit. (5)
Europe	November 4, 2006	15 million	Lack of coordinated communication across system operators. (6)

Table Ref:

1. https://www.nytimes.com/2021/01/09/world/asia/pakistan-blackout-power-failure.html

2. https://www.thejakartapost.com/news/2019/08/04/major-blackout-hits-greater-jakarta-west-java-on-sunday.html

3. https://www.theguardian.com/world/2012/jul/31/india-blackout-electricity-power-cuts

4. https://www.nerc.com/pa/rrm/ea/Pages/February-2011-Southwest-Cold-Weather-Event.aspx

5. https://www.nytimes.com/2009/11/12/world/americas/12brazil.html

6. http://ecolo.org/documents/documents_in_english/blackout-nov-06-UCTE-report.pdf

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