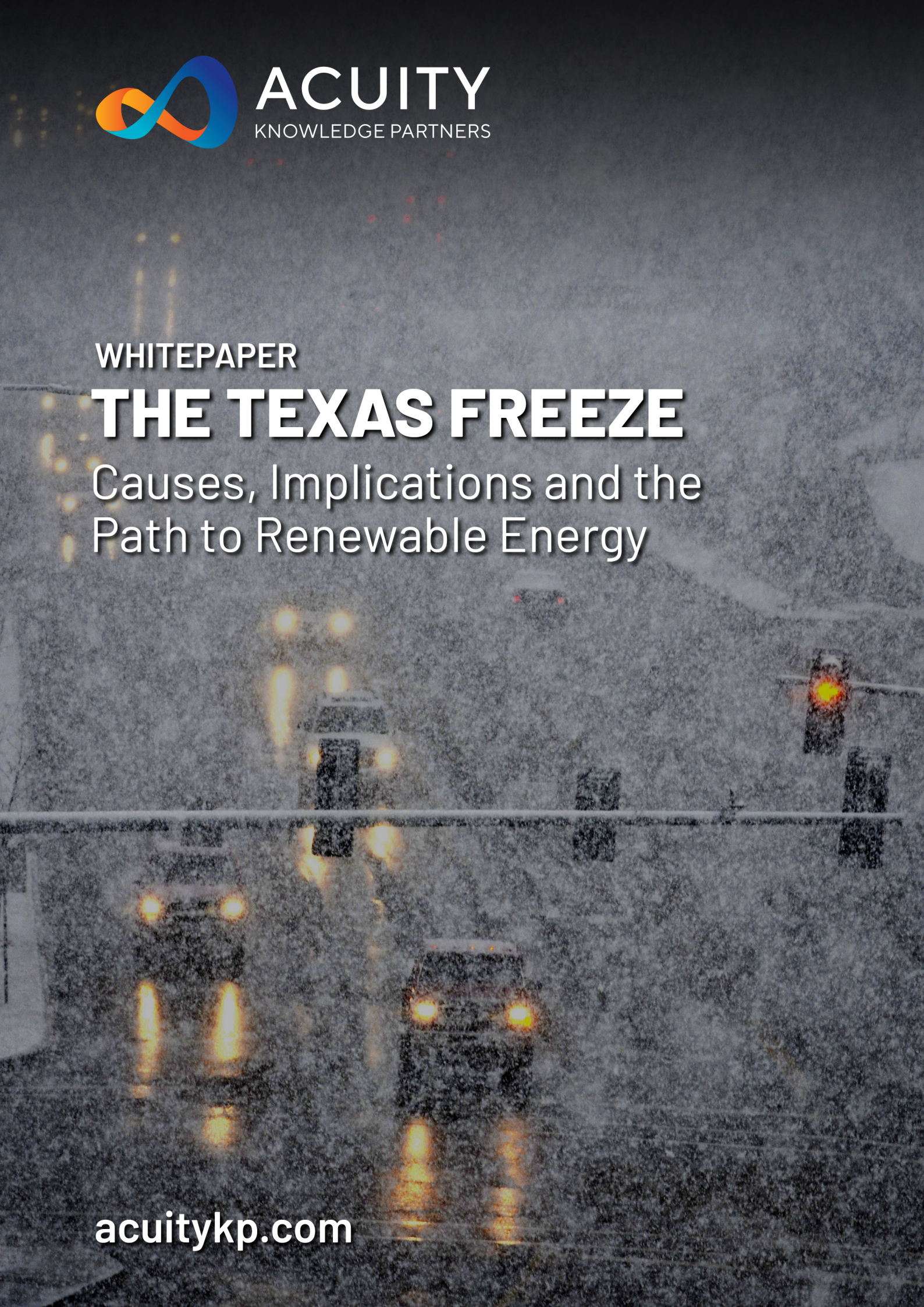

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WHITEPAPER

THE TEXAS FREEZE

Causes, Implications and the Path to Renewable Energy

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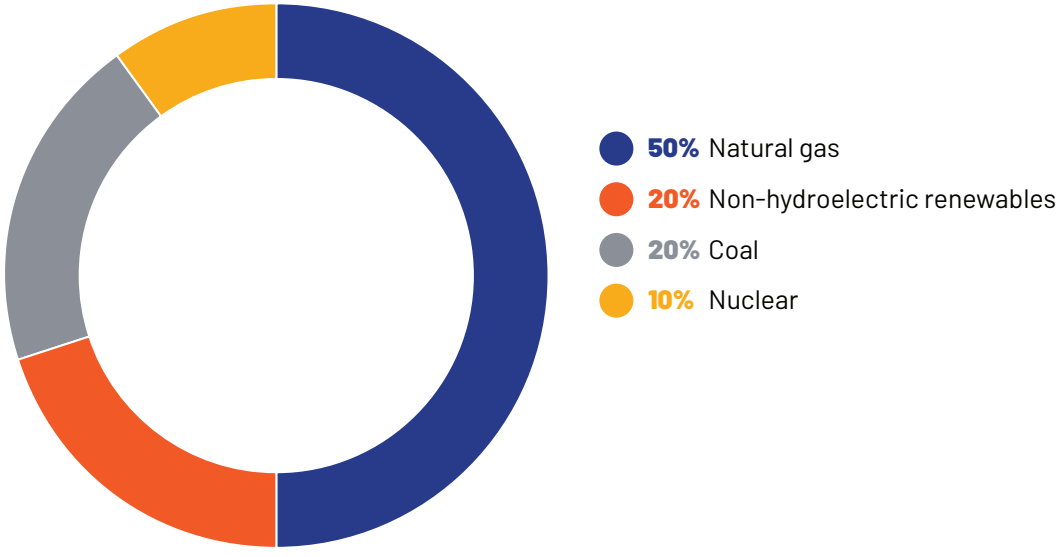
Several US states faced severe weather conditions due to the winter storm Uri in February 2021. The storm was particularly harsh on the state of Texas, which recorded some of its coldest days since 1989. The sudden drop in temperatures due to the storm led to critical energy supply chain disruptions and equipment malfunctions, ultimately leading to state-wide blackouts. The blackouts, caused by electrical grid failure in the state, are estimated to have affected about five million people at the peak of the crisis, leaving a large population of the state without electricity or heating. In addition, those who did receive electricity were charged exorbitantly owing to the unique pricing and grid operating mechanism that the state follows. The storm exposed vulnerabilities in the state's energy grid, which has historically been hailed as a model for other states to follow.

In the aftermath of the crisis, Texas was faced with some difficult questions on its energy security, its clean energy policies, the roles and responsibilities of grid operators and the pricing mechanisms in a crisis situation. This whitepaper analyses the unique characteristics of Texas's electricity policies that led to this crisis and the steps the state is implementing to prevent such an incident from recurring in future.

TEXAS ENERGY MIX (2020)

Texas is the largest energy producing and consuming state in the US. It is one of the largest producers of energy, oil, coal, natural gas, wind energy and electricity in the country. In 2020, Texas accounted for 43% of oil and 26% of natural gas production in the US. The state is the second-largest lignite coal producer in the US and among the country's top 10 coal producers. It is also the largest coal consuming state, with one-third of its coal consumption attributed to power generation.

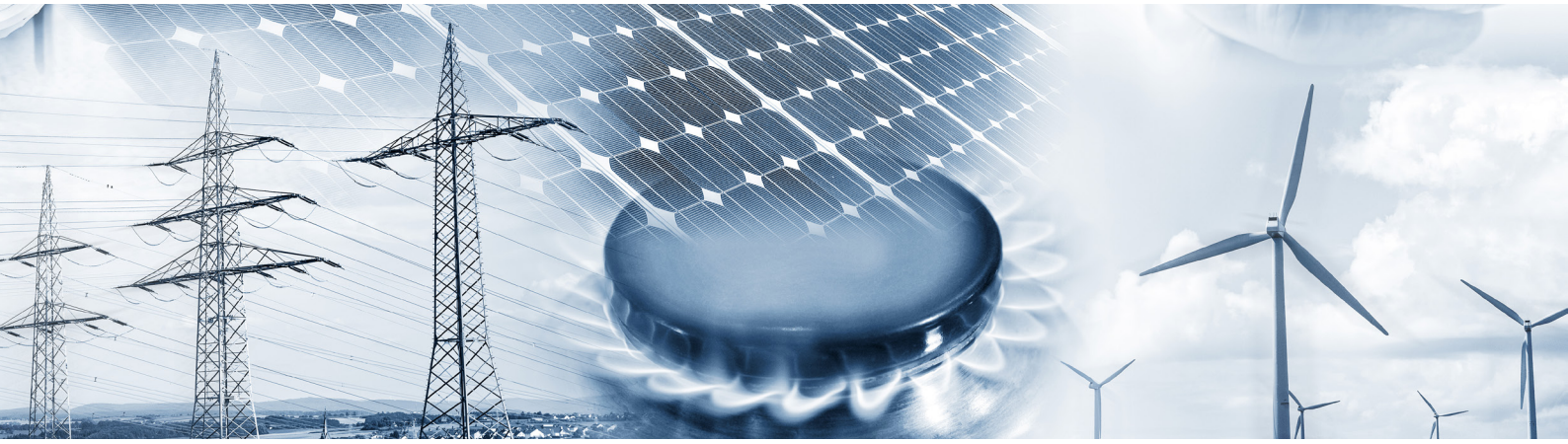
Texas electricity generation capacity - Share by source (December 2020)



Source: ERCOT

Texas has a high dependence on natural gas for meeting its electricity demand. However, it has a fairly balanced power generation mix compared with other large US states, such as Florida, which generates c.70% of its electricity from natural gas. Texas leads the country's wind production, accounting for 28% of the total wind-powered electricity in the US. It also leads in terms of electricity generation among US states, producing almost twice as much electricity as the second-highest electricity producer, Florida.

TEXAS GRID OPERATOR



> **The ERCOT grid system operates independently and has limited connectivity** with other interconnected grid systems that serve the eastern and western contiguous US. ERCOT functions independent of the Federal Energy Regulatory Commission (FERC).

The state's primary electric grid falls under the jurisdiction of the Electric Reliability Council of Texas (ERCOT). ERCOT manages c.90% of the state's total electricity load and 75% of the state's territory. It administers more than 46,500 miles of transmission lines and 680 generation units, providing electricity to over 26 million customers in the state. It also overlooks retail switching of power distribution services for nearly eight million premises in competitive choice areas.

ERCOT is a non-profit organisation and exists to maintain grid stability and fulfil customers' electricity needs. It does not own assets or have a vested financial interest in the value of energy. The ERCOT grid system operates independently and has limited connectivity with other interconnected grid systems that serve the eastern and western contiguous US. ERCOT also does not fall under federal oversight as its service area does not extend beyond the state's borders, with limited interstate power trading, and it is dependent on its own resources to meet the state's electricity needs. Hence, ERCOT functions independent of the Federal Energy Regulatory Commission (FERC). It orchestrates activities between power generators, retailers and transmission owners in the state, with oversight from the Public Utilities Commission of Texas (PUCT).

THE TEXAS POWER GRID

Texas has a unique grid model unlike those of other US states. ERCOT is the country's only transmission grid operator independent of FERC oversight, due to negligible synchronised power transmission across state lines. That said, while ERCOT operates independently and ensures generation and transmission sufficiency within Texas, its island mode of operation limits its ability to transmit and receive electricity from other states. The state's grid has only a handful of small DC connections to the Mexico grid and to the northern/eastern grids, and these connections are not sufficient for a meaningful exchange of electricity in an extreme scarcity situation.

> **The state's grid has only a handful of small DC connections to the Mexico grid and to the northern/eastern grids,** and these connections are not sufficient for a meaningful exchange of electricity in an extreme scarcity situation

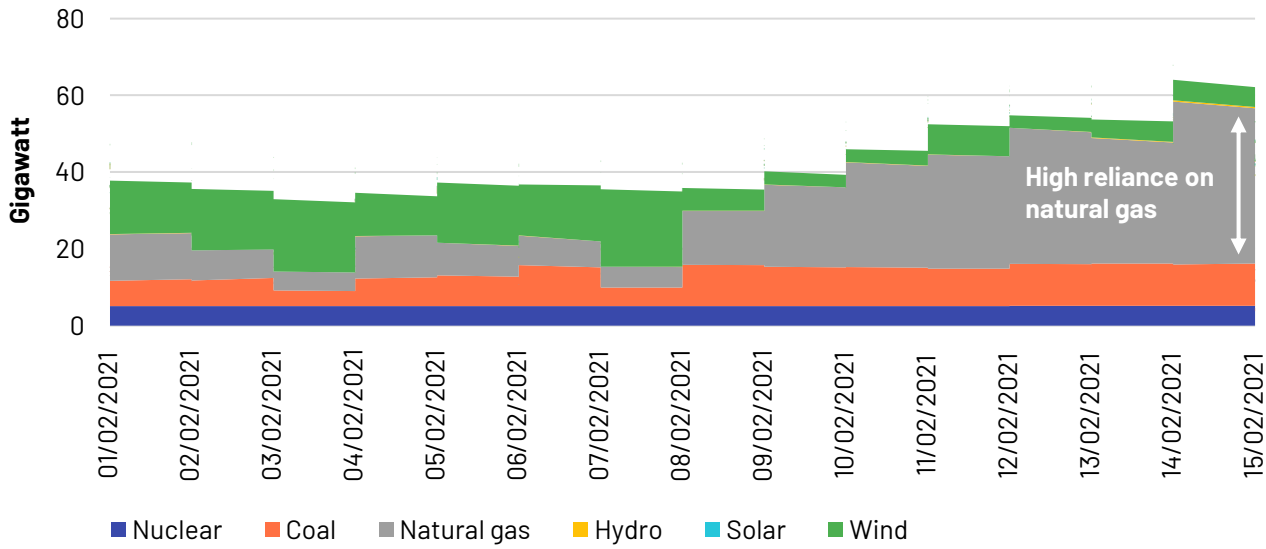
The state has a deregulated market and is one of the few states in the US where consumers are free to choose their retail energy supplier. In the wholesale power market, power generators provide power to ERCOT, which it then sells to retailers at wholesale rates; the retailers then add transmission and distribution charges and resell the electricity to consumers, such as households and businesses.

Texas has established an energy-only market without a forward capacity market, the latter being followed by a majority of the US states. In a capacity market, auctions to procure peak demand electricity are held three years in advance of the delivery date. However, in case of lower than anticipated demand, the onus of paying for surplus capacity falls on consumers. Generators are paid irrespective of whether they produce power or not. In contrast, the market governed by ERCOT reduces costs incurred by its consumers by avoiding maintenance of unnecessary surplus capacity. ERCOT instead maintains a capacity reserve margin based on the difference between the projected peak demand and the total generation capacity available in the state. This allows energy prices to go as high as USD9,000/MWh during scarcity situations to incentivise capacity to come online. Historically, this has not happened frequently.

THE FEBRUARY 2021 CRISIS

As the winter storm hit Texas in February, the state experienced its coldest temperatures in 30 years. This triggered a spike in energy demand as residents needed heat to keep themselves warm, at a time when energy demand was expected to be low and well under summer time peak demand. Around 13 February, the demand for energy rose to c.76,819MW in the state – c.10GWs higher than ERCOT's worst-case scenario peak winter forecast of 67,208MW and 20GW above the February average. This was the highest wintertime and peak demand the state had ever recorded. The highest peak demand the state had previously recorded was 74,820MW during the summer in August 2019.

ERCOT electricity generation by fuel (1-15 February 2021)



Source: IEA

In the winter months, Texas typically has a higher reliance on natural gas-based power plants (at c.60% of demand), as output from wind and solar sources is somewhat reduced. The figure above shows that reliance on natural gas on 15 February reached 71%, as coal and wind energy started falling off – the sub-zero temperatures led to coal piles freezing and wind turbines icing up. In addition, the South Texas nuclear plant tripped offline on the morning of 15 February. The severe weather conditions also had a massive impact on natural gas assets, the state's largest source of electricity. Natural gas plants suffered massive outages as compressor stations were

ERCOT's reserve margin dropped from c.20% in 2010 to c.10% in 2020. This was one of the lowest reserve margins for any grid system in the country.

forced to shut down, icy condensation resulted in natural gas supply outages as pipelines were blocked and natural gas wellheads froze.

The situation was also somewhat aggravated by planned maintenance and scheduled offline periods of some natural gas plants, which typically conduct maintenance activities during winters when energy demand is usually lower. Also, a few wind and solar assets that were accounted for in ERCOT's winter planning were not fully operational.

Another factor that played a part in the crisis was ERCOT's reducing its reserve margin. As mentioned earlier, ERCOT does not have a capacity market and instead follows a deregulated mechanism, in which producers are incentivised to generate more in a scarcity situation. The state's capacity reserve margin, which is a buffer production capacity available on standby over and above the projected peak demand, has been declining over the years, as the grid is based on a system that expects additional capacity to come online in a scarcity situation when prices spike substantially. ERCOT's reserve margin dropped from c.20% in 2010 to c.10% in 2020. This was one of the lowest reserve margins for any grid system in the country. It was later also noted that a percentage of ERCOT's reserve margin supply estimate also included supply that was not yet commercial. ERCOT's target reserve margin now hovers around 13-15%, its highest since 2017.

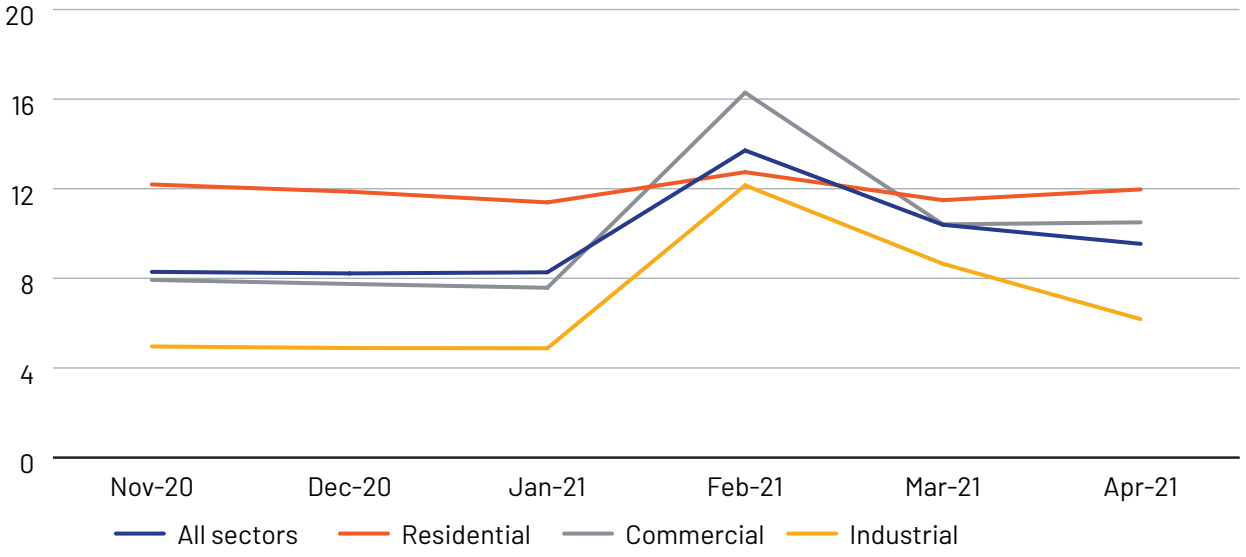
All of these factors together pushed energy demand beyond what was available to the grid, and ERCOT was forced to implement rolling blackouts in the state, which involved stopping electricity supply over different parts of the distribution region for non-overlapping periods of time. About 75% of the state experienced blackouts and over five million consumers were left without access to electricity. At the peak of the crisis, the state fell short of c.50% of the electricity demand.

THE AFTERMATH

In the aftermath of the crisis, several speculations and rumours went around, incorrectly stating that the growing dependence on renewables and the drop in output from these sources were the root causes of the blackouts. However, the debate that brewed in the aftermath of the Texas electrical grid disruption has now been settled, with the primary cause ascertained to be disruption in the fossil fuel generation capacity. As per ERCOT's data, c.30GW of power plant outage in the state were related to gas-fired generators. Though wind generation also suffered owing to the extreme weather conditions, only c.4GW were attributed to wind turbine outages. The crisis has brought greater attention to the issue of high grid dependence on natural gas and fossil fuels and the need to quickly ramp up renewable and distributed energy sources that are connected to the grid.

The blackouts cost the state economy c.USD130bn in damages and losses, and several consumers saw their electricity bills spike as power prices surged to the market cap price of USD9,000/MWh for several days. The chart below shows the increase in average electricity price in the state for February; industrial and commercial consumers, for instance, saw their electricity prices spike 149% and 115%, respectively, month-on-month. However, c.24,000 customers, with an unpaid amount of c.USD29m in electricity bills during the February crisis, were provided relief by the Texas attorney general.

Average retail price of electricity (cents per kilowatt hour)



Source: EIA

The impact of the winter storm was particularly severe for utilities, both generators and retailers. As of March 2021, ERCOT had been unable to pay generators and owed USD1.3bn to suppliers for power it had distributed during the crisis. Similarly, several distributors and retailers owed debts of up to USD2.9bn to ERCOT as they awaited payments from customers, who in turn had expressed inability to settle the electricity bills that skyrocketed during the crisis. Three utilities, Griddy Energy, Just Energy and Brazos Electric Power Cooperative, filed for bankruptcy in the snow-storm fallout. While Griddy Energy and Just Energy were retailers, Brazos Electric Power owned power generation assets.

The crisis also highlighted utilities' lack of weatherisation vigour and the underlying cascading effect that deregulated market pricing can have during a severe scarcity situation. The primary root issue that caused the February crisis was the lack of investments to weatherproof equipment and supply chain, such as wellheads, pipelines, wind turbines and nuclear plant cooling systems. The Texas grid operates by encouraging producers to supply power to the grid through massive price hikes during a scarcity. However, such a model and the cap of USD9,000/MWh failed to encourage investments in the insulation and winterisation of essential equipment, as utilities struggled to plan investments in a system that did not have firm electricity supply contracts. In traditional regulated grid systems, generators have supply contracts that allow them to sit idle during excess supply but require them to ensure availability during emergencies. The contracts also impose severe penalties on generators if they are not available during emergencies, which has driven them to weatherise critical equipment and feedstock supply even in sub-zero temperatures. ERCOT does provide generators with voluntary guidelines and incentives to weatherise and winterise operations, but generators, distributors and retailers are under no obligation to carry out expensive upgrades, and the guidelines are not enforceable under the current regulations.

“The primary root issue that caused the February crisis was the lack of investments to weatherproof equipment and supply chain, such as wellheads, pipelines, wind turbines and nuclear plant cooling systems.

The Texas grid witnessed several near critical incidents after the February 2021 incident. The state recorded 1,280 summer outages until June, including 90 unplanned outages in May and 1,100 in June. The week of June 14 saw several regions in the state experience a heatwave as temperatures soared, with June 2021 becoming the hottest month on record for the US. This led to a sudden demand spike and several unplanned outages as 11GW of generation went offline. However, the demand and prices moderated in a short span and ERCOT overcame the shortfalls to meet record June demand by urging consumers to conserve energy.

THE WAY FORWARD

In July 2021, ERCOT formulated a 60-item roadmap to improve grid operations and resiliency. The key features of the roadmap are summarised below:

Improve reserve margin:
ERCOT aims to bring more generation online soon and aims to purchase more reserve power, particularly in view of uncertain weather conditions

Weatherisation completion certificates:
Generators, retailers, distributors and transmitters are now required to submit a letter signed by the CEO twice a year certifying completion of weatherisation preparations for summer as well as winter seasons

Address transmission limitations:
ERCOT plans to initiate a process that aims to improve transmission limitations in Rio Grande Valley for increased connectivity and energy access from other grid systems to the state during normal and high-risk weather conditions

Frequent generator updates:
It has proposed regulations that require generators to provide operational updates more frequently to ERCOT

Unannounced audits:
It also plans to conduct unannounced testing of generation assets to verify the authenticity of generation-related information

> **The steps summarised above do tackle the primary risk factors for the Texas grid:** low reserve margin, lack of weatherisation and isolation from other US grids.

> **Battery storage is also an important part of the solution** to improve the state's grid flexibility and resilience against extreme weather conditions.

However, there are several avenues that Texas can explore, given its unique position in the US energy market. A part of the solution could be the viability of green hydrogen. Texas is the nation's largest hydrogen producer because of its massive petrochemicals sector, which primarily utilises cheap natural gas as feedstock. The state also has the largest installed and under construction wind capacity, with cumulative capacity of c.37GW (March 2021). In addition, it has an installed solar capacity of c.7GW. Both these factors could bolster the production of carbon-free hydrogen from water using renewable energy.

Apart from production infrastructure, the state also has hydrogen transportation and storage facilities. Texas has c.1,600 miles of dedicated hydrogen pipeline infrastructure and houses three underground hydrogen storage fields, with cumulative capacity of 6bcf.

Battery storage is also an important part of the solution to improve the state's grid flexibility and resilience against extreme weather conditions. Texas expects to have 1,400MW of battery storage available by September 2021, about eight times more than in 2020. ERCOT expects 1,771MW of storage capacity by end-2021, a significant increase from the 225MW capacity it had at end-2020. Furthermore, storage capacity is expected to reach 3,008MW by end-2022. The storage projects range from 50MW to 200MW and are scheduled to start operations from July 2021; the 203MW Crossett Power Battery Storage system in Crane County is expected to come online in August 2021. Developers have also announced large-scale projects since the February crisis, such as the 200MW storage facility by Wärtsilä Energy, expected to come online in 2022.

HOW ACUITY KNOWLEDGE PARTNERS CAN SUPPORT UTILITIES AND ENERGY SERVICE PROVIDERS

Acuity Knowledge Partners has been a partner of choice for many energy companies and utilities. We have experience in supporting a number of energy service providers in developing go-to-market, business expansion, diversification, product roadmap and customer retention strategies in emerging sectors such as electric vehicles (EVs), smart home, energy storage and distributed generation. Our experience also includes working with various stakeholders along the value chain – policymakers, regulators, independent power producers, utilities, financial institutions and donor agencies. This positions us well to support business challenges faced by energy service providers.

Our customised service offerings include:

Business intelligence

- Analyse regional and national grid policies and regulatory frameworks and the impact of upcoming policies on the business and the grid
- Identify consumer patterns for new grid products and services, such as bundled EV charging, rooftop solar and storage, and virtual power plants
- Analyse overarching renewable sector trends and the impact of the evolving external business environment on the power sector

Competitive landscaping

- Develop capability matrices and identify value-chain presence of peer utilities
- Analyse long-term utility strategy to futureproof businesses from evolving business and consumer trends
- Benchmark peer profitability to identify operational and financial strengths and weaknesses

Cost and revenue models

- Develop revenue models based on selection of business cases
- Prepare financial models and analyse profitability in multiple business scenarios
- Determine should-be supplier service and product cost models to optimise spend on suppliers

Opportunity identification

- Analyse industry drivers to identify lucrative opportunities across the energy sector value chain
- Identify business opportunities by analysing trends in target customer segments
- Benchmark target companies on the basis of risk and financial strength to understand potential investment upsides
- Map capabilities to identify and leverage best possible synergies between existing business models and potential investment opportunities

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Keshav Ahuja is part of the Private Equity and Consulting team at Acuity Knowledge Partners, Gurgaon. He has over 8 years of experience working across the energy sectors in multiple business intelligence, corporate strategy and consulting roles. He is currently supporting clients in formulating decarbonization strategies to enable businesses to transition towards sustainability and carbon neutrality. Prior to joining Acuity Knowledge Partners, Keshav has worked with an Oil and Gas Supermajor and a clean-tech venture capital firm.

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About Acuity Knowledge Partners

Acuity Knowledge Partners (Acuity), formerly part of Moody's Corporation, is a leading provider of bespoke research, analytics, staffing and technology solutions to the financial services sector. Headquartered in London, Acuity Knowledge Partners has nearly two decades of experience in servicing over 350 clients by deploying its 3,000+ specialist workforce of analysts and delivery experts across its global delivery network.

We provide our clients with unique assistance to innovate, implement transformation programmes, increase operational efficiency, and manage costs and improve their top lines.

Our expertise includes the following:

» Investment Banking: origination and trading support
» Investment Research support: covering all asset classes in terms of ideation, data science, and research support across the buy side and sell side
» Commercial Lending support: across origination, credit assessment, underwriting, and covenant and portfolio risk for all lending types
» Private Equity: origination, valuation and portfolio monitoring support
» Asset Management services support: across marketing, investment research, portfolio management/ optimisation, risk and compliance
» Corporate and Consulting services: market and strategic research; survey work; treasury and counterparty risk support; and CEO office support, including M&A, FP&A and investor relations support
» Compliance support: AML analytics, KYC, counterparty credit risk modelling and servicing across banks, asset managers and corporates
» Data Science: web scraping, data structuring, analytics and visualisation These services are supported by our proprietary suite of Business Excellence and Automation Tools (BEAT) that offer domain-specific contextual technology.

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