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LOOMING ENERGY SECURITY RISKS:

Emerging Demand-Led Vulnerabilities to Energy Infrastructure

Benjamin Dierker and Owen Rogers

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ABSTRACT

Energy security is most often framed in terms of resource supply and generation capacity, with supporting and facilitating infrastructure sometimes being overlooked. However, electrical demand is a growing threat to energy security in Texas and across the country. Commercial and industrial users increasingly require more power for data centers, artificial intelligence applications, cryptocurrency mining, and other high-energy uses. Coupled with population growth, this rising demand growth risks outpacing current energy capacity. This will necessitate significant expansion of energy generation, storage, transmission and distribution capacity. Until this expansion occurs, the grid faces critical vulnerabilities, putting individuals, communities, and businesses at risk. Cascading effects of this demand-driven vulnerability include economic disruptions, supply chain challenges, quality-of-life impacts, and environmental considerations.

Texas is uniquely positioned in this evolving challenge, with rich hydrocarbon reserves, petrochemical assets, nation-leading wind capacity, an independent energy grid, rapid population growth, and an influx of energy-intensive businesses. Additionally, its vast area creates logistical complexities for connecting power projects.

Meeting this rising demand will require both infrastructure expansion and policy innovation. Policymakers and industry leaders must understand the evolving nature of electrical demand to balance capacity and loads. That balance must be system-wide and include resilient material supply chains, commodity and technology expansion, and power generation, transmission, storage, and distribution capacity. If infrastructure cannot expand rapidly enough, policies may need to prioritize critical energy uses to ensure uninterrupted power for essential services. This could include restrictions or incentives on “discretionary” activities like bitcoin mining.

Ideally, energy supply will exceed demand, achieved through coordinated efforts between policymakers and industry. It will be essential to streamline processes, expedite efficient project approvals, and enhance the competitive energy market to develop the infrastructure and capacity needed to secure Texas’s energy future.

Key Words: Energy Capacity, Energy Infrastructure, Power Demand, ERCOT, Electricity

INTRODUCTION

Texas is an energy leader and exporter. While mainly known for its energy commodities of oil and gas, Texas also has the highest energy capacity in the nation for electricity, more than twice the electricity produced by the next highest state. It was responsible for producing 13 percent of the entire nation's electricity in November of 2024.[i] The nearly 42,000 MWh Texas generated in a single month late last year came primarily from coal (15 percent), natural gas (47 percent), nuclear (six percent), solar (eight percent), and wind (26 percent).

Texas hosts nearly a third of the entire nation's installed wind capacity and has the highest potential wind capacity in the country.[ii] This is all managed by the Electric Reliability Council of Texas (ERCOT), the independent grid operator for the state of Texas. Ercot exists separately from the wider Eastern and Western Interconnections that make up the total electrical grid of the United States.

All this power serves the nation's second largest state economy, which in 2024 generated nearly $2.7 trillion in gross domestic product.[iii] The state's 31 million residents, with more arriving each year, have evolving needs and demands. Not only has the state been a magnet for residents, but for businesses. In the ordinary course of events, this would be nothing but a positive, but the type and nature of businesses starting up and coming into the state signal a new vulnerability: energy demand.

A DEMAND DRIVEN VULNERABILITY

Texas' energy grid, ERCOT, will face intense demand in the coming years for increased energy output. This is in part due to the rapid economic and population growth, which added 10 million new residents since the turn of the century. On top of this, American industry is increasingly electrifying, electric vehicles are becoming more common, and a growing number of smart devices and machines are being introduced. However, the primary driver of rising energy demand is likely the rapid expansion of large-scale data centers. Attracted by Texas' low cost and abundant energy, vast open land, and

favorable regulatory environment, dozens of new data centers are already under construction with many more planned. Texas has also been chosen as a key location for the Stargate AI Project, with hundreds of billions of dollars in data center investments on the way.[iv]

Data centers are the foundation of modern digital infrastructure, housing the vast networks of servers that process, store, and distribute data for websites, financial transactions, streaming services, cloud computing, and more. Businesses, governments and consumers have all become increasingly reliant on real-time data access, and the demand for high-performance, on-demand computing has continued to surge. Data centers hosting these processes must operate continuously, as a large data-center outage could disrupt essential services and communications across the nation or even the world. The cascading effects of downtime can total billions of dollars for mere minutes and affect real-world health and safety.

Data centers demand huge amounts of power, with the largest requiring hundreds of megawatts in capacity. About 40 percent of energy for data centers is used to keep the computers cool.[v] The number of large data centers is rapidly increasing due to ever-expanding demand for cloud computing and artificial intelligence. Each time someone uses the internet or types into a web browser, a data center is making computations. Artificial intelligence requires significantly more computing power than a simple search engine, requiring up to 10 times as much power per query.[vi] With ChatGPT alone seeing a 300-fold increase in active users in just the last two years,[vii] the rise of both data centers and AI applications signals immense and growing energy demand for the state of Texas.

Energy represents 60 to 70 percent of the operating costs of a data center, meaning that the price of electricity is critical to profitability.[viii] The largest data center in Texas is a crypto-mining center that uses 700 megawatts.[ix] According to ERCOT, one megawatt can power at least 200 homes, so the energy used by that single data center could be used to power 140,000 homes.[x] Data centers currently account for three to four percent of the nation's electricity consumption, but this share is projected to increase to 11 to 12 percent by 2030.[xi]

The number of data centers in Texas is increasing rapidly. Of the 22 “Registered Qualifying Large Data Center Projects” tracked by the Texas Comptroller’s Office, 19 were put in service since 2022.[xii] Texas currently has the second-highest electricity consumption by data centers in the United States, behind only Virginia.[xiii] This data center expansion is destined to heat up even more, with the Texas legislature and ERCOT taking notice. A 2024 report from the Texas Senate Committee on Business and Commerce highlighted this problem, recommending many changes including reducing regulatory barriers to new transmission infrastructure.[xiv]

If not addressed, the probability of blackouts and brownouts will necessarily increase as demand exceeds power generation and could even exceed energy capacity. In 2023, ERCOT listed its theoretical maximum capacity as 154,571 MW and their predicted installed capacity rating for summer 2025 is 173,584 MW.[xv,xvi] This may seem like a healthy margin against the expected 81,364 MW summer 2025 peak, but these numbers represent the theoretical maximum generating capacity. Actual generation is likely closer to 90,000 MW, and it could be even lower with unfavorable weather conditions affecting wind and solar energy.

ERCOT also operates a program for Large Flexible Loads (LFLs). LFLs are major power customers who designate themselves as flexible, meaning that they can reduce power usage during congestion or scarcity conditions.[xvii] Several large power users designate themselves as LFLs to gain benefits from the state. Some data centers are used for cryptocurrency mining and frequently reduce or halt their energy consumption when electricity prices increase, allowing them to minimize costs and avoid operating during periods of peak demand. Some LFLs, like cryptocurrency miner Riot, sold some of their pre-purchased electricity back to the grid during a summer heatwave.[xviii]

Most data centers, however, operate differently. The Texas Senate Committee Report emphasized that most data centers operate continuously and have a non-flexible load profile.[xix] They generally do not participate in demand response programs and require a dependable and uninterrupted power supply. The report recommended that Texas should consider requirements for on-site backup generation for data centers, so they do not overwhelm the grid during emergency periods, like the devastating 2021 Winter

Storm Uri. Due to large load customers, the Energy Information Administration (EIA) has predicted a significant increase in demand in Texas for 2025.[xx] Much depends on how aggressive ERCOT is at approving projects.

Beyond new data centers and overall population growth, several other factors are driving the increase in energy demand. The oil and gas sector is consuming more electricity as it shifts toward electrification to reduce emissions and improve efficiency. Drilling rigs are replacing traditional fuel-powered systems with electric equipment, while natural gas production is also adopting electric-driven systems.[xxi] To support this transition, ERCOT is planning transmission expansions in the Permian Basin, ensuring reliable power for one of Texas' most economically vital regions.[xxii]

Overall, it will require collaboration between the private sector and policymakers in the state - in close coordination with ERCOT itself - to bring new generating capacity, supporting transmission, energy storage, and efficient distribution to life. Known and expected trends indicate an enormous rise in power demand in the best-case scenario. Given project approval timelines, permitting and regulatory compliance, and construction itself, no time can be wasted lest unmet demand becomes an energy security vulnerability to the state grid with untold downstream effects in tow.

ERCOT FORECAST

On February 14th, 2025, ERCOT released a Capacity Demand, and Reserves (CDR) Report for the years 2025 to 2029.

	New Loads Added to the November 2023 Load Forecast Cumulative MW					
Large Load Type*	Summer 2025	Summer 2026	Summer 2027	Summer 2028	Summer 2029	Ave. Annual Growth
Contracted Loads (non-LFL)	4,017	8,106	12,901	16,533	17,493	44%
Contracted LFLs	1,565	3,443	3,543	3,543	3,543	23%
TSP Officer Letter Loads (non-	900	8,350	17,400	28,284	29,359	139%
TSP Officer Letter LFLs	700	2,335	2,335	2,335	2,335	35%
Total	7,182	22,233	36,178	50,695	52,731	65%

* See the definitions in the previous bullet.

In the report, they predict an overall increase of 52,731 MW by Summer of 2029. Even when considering that many of these additions are yet to be fully approved (Officer Letter Loads[1]), this is a huge amount of power. Only 11 percent of the added capacity is expected to be flexible, meaning the vast majority of added power will need to be continuous.

Energy demand in 2024 peaked in August at 85,199 MW. ERCOT predicts the summer peak will be an astonishing 140,872 MW in 2029.[xxiii] The peak hour is also expected to change from 5:00 p.m. to 10:00 a.m. in 2028 due to price-responsive loads (mostly crypto-currency miners) and rooftop solar growth.[xxiv] A moving peak time is a key potential vulnerability. Not knowing exactly when it will happen makes it even harder to prepare.

Maintaining a gap between the peak load and the maximum capacity is crucial for a functioning power grid and can also help keep energy costs down for consumers. With the rapid increase in demand coming from datacenters and economic expansion, Texas will need to ensure that its capacity can match this burden.

[1] (An officer letter is an attestation indicating confidence that loads are expected to be interconnected even though the interconnection agreement has not been signed yet.)

Planned Generation Installed Capacity Additions by Summer Season (Projects that meet CDR-Eligibility Criteria)						
	Summer 2025	Summer 2026	Summer 2027	Summer 2028	Summer 2029	Trend
Thermal (Natural Gas and Diesel)	267	1,473	1,473	2,147	2,147	
Battery Energy Storage	4,236	11,672	14,912	17,003	17,559	
Dispatchable Total	**4,503**	**13,145**	**16,384**	**19,149**	**19,705**	
Solar	5,176	17,259	24,871	28,157	29,543	
Wind	242	1,980	3,268	3,494	3,493	
Non-Dispatchable Total	**5,418**	**19,239**	**28,138**	**31,651**	**33,036**	
Total	**9,921**	**32,384**	**44,522**	**50,800**	**52,741**	

The ERCOT report also lists the expected increases in capacity. However, much of this growth is still driven by non-dispatchable (non-predictable) sources of energy: solar and wind. Battery Energy Storage Systems (BESS) are also due for significant growth, helping stabilize the intermittency of renewables, shaving peaks, and moving consumption when there is less demand on the system. Natural gas and Diesel projects are currently scheduled to increase by just 2,147 MW by 2029, less than five percent of added capacity. These numbers just represent the currently planned additions, but more are likely to be added in future.

Without new capacity, there will almost certainly be energy deficits in peak load hours in both summer and winter. This will either need to be addressed by expanding production or incentivizing/mandating demand cuts. ERCOT has already been among the most proactive regions in demand-response programs.[xxv] The Public Utilities Commission of Texas (PUCT) has pushed for broader changes on this front and has created rules for grid resiliency.[xxvi]

The PUCT also took recommendations from a Texas A&M University report on Demand Response and Energy Efficiency in ERCOT.[xxvii] The Report found that minor changes in resident or commercial behavior could have huge impacts on power usage. Air conditioning is a major part of power usage during the summer peak, but the report found that if 7.74 million households made a 4°F adjustment, it could save 3,480 MW. Of course, conversely, upward adjustments would add to power demand. Based on an existing Austin program, Texas could achieve a 2,030 MW peak reduction for $188

million per year from demand response programs. These incentives would be needed to ensure enough participation.

Upgrades to hardware is another strategy that could help reduce load. Improvements to air conditioning and heating units in residential and commercial buildings could save the grid thousands of megawatts during both summers and winters. High-efficiency windows and insulation offer similar benefits for retaining internal climate control. Switching entirely to high-efficiency heat pumps could save over 13,000 MW in winter, while upgrading AC units would likewise decrease peaks significantly.[xxviii] However, because a third of Texas homes utilize gas heaters, switching to electric temperature systems or can actually increase peak loads if the upgrade is not efficient enough.[xxix]

ERCOT currently has a mandated reserve margin of 13.75 percent, meaning that electricity capacity must exceed peak demand by at least that much.[xxx] However, because ERCOT is a deregulated energy market, there are no mechanisms to ensure that this target is followed. As a result, ERCOT is one of the U.S. regions most at risk for energy shortfalls.[xxxi]

EXISTING LOGISTICAL COMPLEXITIES

The Texas power grid is unique and comes with both advantages and disadvantages. While ERCOT delivers the sixth cheapest commercial electricity rate in the country, it also has notable volatility.[xxxii]

No recent grid-related incident is more notable than February 2021 when prices soared from $50/MWh to more than $1,800/MWh due to the devastating Winter Storm Uri.[xxxiii] Several transmission lines were disrupted by the storm, and power generators of every type failed across portions of the state. Natural gas generators were determined to be poorly equipped for the extreme winter conditions and significantly increased heating demand.[xxxiv] Wind turbines were not winterized and failed to perform at or near capacity during the storm. Due to the anomalous weather event, even natural gas pipelines and facility connection powers that were not winterized froze up or failed.

Texas, like much of the nation, has a critical need for transmission infrastructure. Line congestion is a considerable challenge, especially in connecting new renewable energy infrastructure to the population centers.[xxxv] With more wind turbines than any other state, wind power makes up more than a quarter of Texas energy.[xxxvi] These turbines are located primarily in the west and south of the state, traveling through large-scale transmission infrastructure to reach the population centers farther east. A massive increase in BESS infrastructure in the past few years has helped reduce congestion and intermittency, but a lot of work remains to be done.

This reliance on power generation far from population centers not only strains the transmission grid but also leaves the state vulnerable to security and weather disruptions. The Federal Energy Regulatory Commission (FERC) report after Winter Storm Uri determined that transmission lines were not the primary point of failure, but that they still could become a vulnerability if not adequately addressed.[xxxvii] The report recommended that transmission infrastructure and utilities should enhance winterization standards, operate real-time monitoring systems, and increase coordination with generation facilities. The San Antonio public service (CPS Energy) is increasing its budget substantially as part of an effort to modernize and expand its energy and transmission infrastructure.[xxxviii]

Not only will existing infrastructure need to be made more resilient, but new transmission lines will need to be built. There is a massive nationwide delay in building new transmission infrastructure, slowed by lengthy review processes and ever-increasing demand.[xxxix] Texas was mentioned as one of the regions with the highest growth and need for new transmission infrastructure in a national transmission needs study.[xl] The median rate of transmission expansion by 2035 in Texas is 140 percent across different scenarios, according to the report.

> “Studies consistently find that the largest transmission expansion will take place in Texas to meet future power sector changes across all years.” - 2023 National Transmission Needs Study

Texas is aware of its need to address this historic expansion. In a 2024 board meeting, ERCOT mentioned that “The forecasted pace of load growth could exceed the pace at

which transmission capacity can be built to support it".[xli] Texas was already the region that installed the most circuit-miles of transmission lines between 2011 and 2020, a testament to its unrivaled growth.[xlii] However, the transmission report details how the utility plans for Texas are far below the anticipated needs.[xliii] Moreover, the rate of population and business immigration into the state and the nature and type of power needs were not present during the earlier build out.

ENERGY-ONLY MARKET

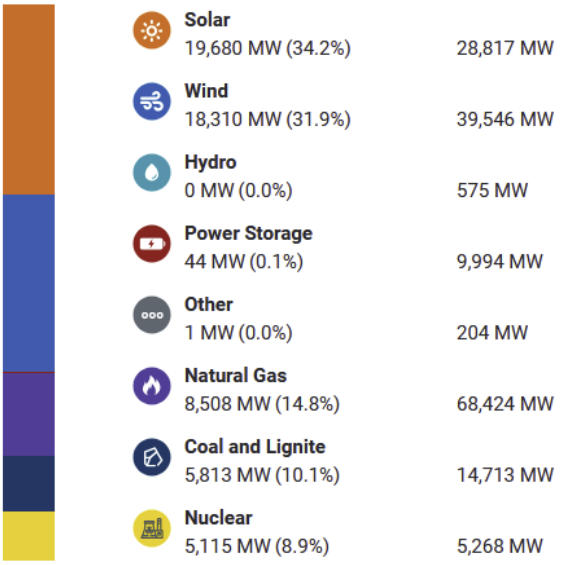
One of Texas' most significant energy grid strengths could also become a key risk and vulnerability. ERCOT operates in a highly deregulated market, where the cheapest energy is prioritized. This can lead to low prices for consumers but also leaves the grid without any legislative teeth when things go wrong, like in Winter Storm Uri. One of the central aspects of this deregulation is that it is an energy-only market. In other words, ERCOT does not pay for capacity, it only pays for energy that has been produced.[xliv]

Being an energy-only market comes with advantages, namely lower costs for consumers by not paying for unneeded capacity and increased efficiency and competitive pricing. Energy-only markets incentivize innovation and flexibility, and low-cost generation. However, it also comes with several disadvantages, including greater price volatility and less incentives for reliability. Under these conditions, renewable energy has thrived, and dispatchable power sources have less incentives because they may not need to operate continuously. By rewarding generation and not capacity, Texas' has increased competition at the potential cost of long-term reliability.

After Winter Storm Uri in 2021, ERCOT considered rule changes that would incentivize building and maintaining generators to be used when needed.[xlv] Called the Performance Credit Mechanism, or PCM, the rule would have paid to ensure that capacity could be used in emergencies, a sort of quasi-capacity market. However, the PCM was ultimately shelved in December 2024 after the Public Utility Commission of Texas (PUCT) concluded that the rule would not provide enough benefits.[xlvi]

Instead, the PUCT is moving forward with other initiatives, including Real-Time Co-optimization (RTC). RTC is designed to optimize energy and ancillary services in the

real-time market.[xlvii] FERC Order No. 2222 directed regional Independent System Operators (ISOs) to allow and expand Distributed Energy Resources (DER) like rooftop solar and battery storage, but ERCOT operates outside of FERC's jurisdiction.[xlviii] ERCOT is instead working on its own pilot programs and rules that would help promote DER and other sources of power.



The energy-only market of Texas has promoted innovation and brought lower prices to consumers, but further development of resources is needed to ensure stable power in the long-term.

EXPANSION OF RENEWABLES AND ENERGY STORAGE

Texas utilizes more than double the natural gas of any other single state, but it also utilizes significant amounts of renewable energy.[xlix] Texas has become the national leader in wind energy over the past two decades, both in terms of its installed capacity and actual power generation.[l] More recently, there has also been a solar boom across Texas, making it second only to California in solar generation.[li] Combined, these sources of renewable energy have helped replace coal and older or less efficient generators across the state, and are part of the reason energy prices are low.[lii]

Increasing proportions of renewable power has meant that many natural gas generators are not needed all the time, despite Texas' remarkable growth.[liii] In fact, solar and wind power regularly make up over fifty percent of energy generation during the day. Energy generated from low-carbon sources has gone as high as 80 percent on certain days.[liv]

The adoption of these renewable sources of energy is a product of the competitive ERCOT energy-only market. However, both solar and wind power are intermittent sources of power and cannot operate all the time. Policymakers should be wary of high-capacity installations and ensure investments account for real-world expected generation, not merely theoretical or potential total capacity. Currently, added energy capacity from natural gas is primarily used at night to make up for the lack of production from solar, but data centers could strain this system. Most data centers need constant energy, day and night, and do not usually adjust to fluctuations in energy capacity.

To combat intermittency, a logical solution would be to increase baseload power generation from continuous sources like natural gas or nuclear power, while BESS expansion provides an alternative.[lv] The EIA projected an increase in natural gas energy generation only under the scenario of stronger growth in large-load demands, forecasting an eight percent rise in 2025 in that case.[lvi] Another potential component to help with increased demand is energy storage. ERCOT has invested heavily in large-scale battery storage in recent years, and it has helped significantly with managing demand peaks.[lvii] Several emergency conservation appeals were avoided using battery power in 2024 during times of peak demand. Energy storage is used regularly to bridge the gap between day and night, when energy demand is increasing before solar power is fully operational.

ERCOT Energy Capacity at
10:39 a.m. CT February 17th, 2025

CONCLUSION

The need for energy is destined to continue expanding in an ever-evolving world. Innovation has helped improve energy efficiency significantly, but it has created new demands for power. Texas has become a core of economic and population growth, and effective policy is needed to ensure that it can maintain energy abundance without compromising its affordable status for consumers.

Texas' energy-only market has created substantial innovation and helped drive down prices, but ERCOT must continue creating new rules that will increase incentives for

continuous power sources. Battery storage can help significantly with dealing with demand, but the need for continuous power from data centers will require additional solutions. ERCOT is aware of this problem and is working on various solutions, but changes will be needed soon in order to keep up with soaring demand.

Additional transmission and grid infrastructure will also be critical for ensuring a stable power supply. The need for more transmission is a national issue, but Texas can be proactive in helping speed up deployment by streamlining permitting regulations, reforming planning processes and interconnection queues, encouraging incentive tax credits, and enacting other regulatory reforms. New transmission infrastructure is partially under federal regulations, but Texas can help along the process by removing unnecessary roadblocks from state rules. Attention may even need to be paid to eminent domain reforms that ensure landowners' rights are protected while balancing the need for major public infrastructure projects.

Distributed energy solutions like DER Aggregators can also help address vulnerabilities but are not a stand-alone comprehensive solution. They are, however, a necessary pillar of the road ahead. Texas can lead in this by promoting distributed energy resources like rooftop solar, advanced small nuclear reactors, smart and microgrid systems, and on-site hydrogen production from natural gas.

Equally important are the improvements in grid resiliency. ERCOT has worked hard in the past few years to upgrade systems and create plans in the event of extreme weather events, but more could always be done. More than 200 people died because of the failures in Winter Storm Uri, where equipment was ill-prepared for the bitter conditions.[lviii] In a world where extreme weather events can strike with little warning, it is critical to be prepared for even rare scenarios.

Texas has been known for decades as a bastion of energy security and strategic reserve for the nation. While nothing will threaten that standing, vulnerabilities are on the horizon from the demand side of the equation. New energy demand is already here and more is on the way. As Texas continues to attract people and businesses, it must ensure its policy environment streamlines and encourages innovation, energy efficiency, new power generation, and supporting infrastructure. Without a comprehensive strategy

and both public and private focus on the issue, excessive demand will create downstream impacts that harm the state's economy, public safety, and overall quality of life.

BIOGRAPHIES

Benjamin Dierker is the Executive Director of the Alliance for Innovation and Infrastructure, specializing in economic, administrative, and legal aspects of American energy, transportation, infrastructure, and innovation. His goal is to analyze and explain the economic and legal realities underpinning public policy at the state and federal level. He strives to bring a balanced, accurate, and accessible perspective to enable students, specialists, the public, and elected representatives to make the best-informed decisions on these critical issues.

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