AUGUST 2024

2025 ERCOT ELECTRICITY MARKET OUTLOOK

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Introduction

As part of an ongoing series, LCG Consulting has produced this study outlining our findings from modeling the ERCOT electricity market in 2025, based on the most likely transmission, generation, and market conditions. The nodal market simulations for this study were performed using LCG's UPLAN Network Power Model (NPM)™ and PLATO-ERCOT™ Data Model with hourly dispatch. UPLAN-NPM is a full network model designed for electricity market simulation. It replicates the engineering protocols and market procedures of the electric system operator and captures commercial activities such as bidding, trading, hedging, and contracting. The model performs coordinated marginal (opportunity) cost-based energy and ancillary service procurement, congestion management, and contingency analysis with Security Constrained Unit Commitment (SCUC) and Security Constrained Economic Dispatch (SCED), replicating the processes used by the ERCOT ISO.

LCG Consulting, based in Los Altos, California, is a widely-recognized leader in the electricity industry and a pioneer in modeling energy markets. Since its founding in 1983, LCG has been at the forefront of providing the utility industry with specialized software and consulting services related to electric and gas deregulation. Our clients include numerous public and private electric utilities, independent system operators, electricity traders, power marketers, federal and state agencies, and several energy research institutes across the United States and internationally. LCG has a long history of modeling the Texas energy market and serves many regional clients, including ERCOT ISO.

ERCOT Outlook 2025

The outlook for 2025 is based on data available as of August 2024 and includes several notable developments and projections. Texas has undergone dramatic changes in its fuel mix and transmission infrastructure in recent years. According to Q2 2024 data, ERCOT's total renewable output increased by 13.92% during the first half of the year, averaging 452.57 GWh per day. ERCOT leads in added total renewable generation capacity and achieved a record solar output of 20 GW at 1:15 p.m. CT on July 16, 2024. The current federal administration has demonstrated strong support for renewable energy generation and storage. The 2022 Inflation Reduction Act (IRA) is a significant driver in promoting investment in these technologies.

In February of 2021, Texas was hit by a major winter storm, Uri, which highlighted vulnerabilities in the electric infrastructure. Since then, ERCOT has implemented several measures to ensure system reliability and resiliency, such as weatherization of equipment and enhancements in communication and coordination. The Firm Fuel Supply Service (FFSS) requires generators to maintain on-site fuel supply. The effectiveness of these reforms was evident during the more recent storms in December 2022 and January 2024, when ERCOT successfully avoided rolling blackouts.

On June 12, 2023, ERCOT launched the ERCOT Contingency Reserve Service (ECRS), the first new daily-procured ancillary service introduced to ERCOT in more than 20 years. Through this service, ERCOT compensates generators that forgo immediate revenue from generating power to maintain their supply in reserve. These generators must then be ready to deploy within 10 minutes and remain online for up to two hours. ECRS presents a significant revenue opportunity for flexible generators capable of generating power for two hours and ramping up within 10 minutes. Since its introduction, ECRS has consistently cleared at higher rates than all other ancillary services.

To upgrade the state's power grid, the Texas legislature approved the $5 billion Texas Energy Fund (TEF) to provide grants and loans for the enhancement of existing generating facilities or the construction of new ones within the ERCOT region. To qualify for this funding for the fiscal years 2024-2025, a generation facility must have a capacity of at least 100 MW.

Both residential and commercial demand in Texas continues to grow. As of this report's publication date, a peak demand of 77.1 GW was recorded on May 27, 2024. This surpasses the previous May peak of 71.6 GW, set in 2022. ERCOT's peak demand for 2023 was 85.7 GW, approximately 7% higher than the 80.0 GW peak demand recorded in 2022.

Industrial load growth along the coast and in West Texas, along with increased oil and gas production activity in the Permian Basin, has contributed to above-normal growth. Growth continues in major load centers such as the Dallas-Fort Worth area and Houston. According to the U.S. Census, Texas is the fastest-growing state. UPLAN projects a peak demand of 88.3 GW and a total energy demand of 500 TWh for 2025. Figure 1 shows the historical peak load and energy demand for ERCOT from 2018 to 2023, along with forecasted UPLAN simulation data for 2024 and 2025. The simulation data is based on the Summer NCP Forecast by Weather Zone report, published in April 2024. The annual average growth rate for peak load from 2018 to 2025 is 2.3%, while the growth rate for energy demand is 4.41%.

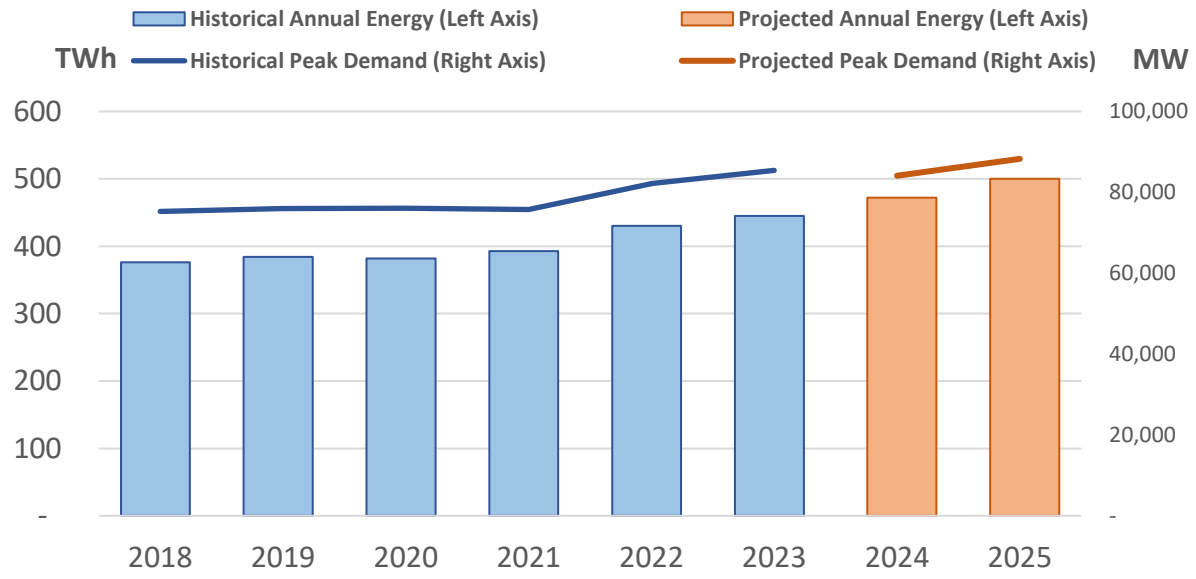


Figure 1 Peak load and energy demand from 2018 to 2025

ERCOT's competitive electricity prices and limited regulation have attracted cryptocurrency miners. By 2025, LCG anticipates that cryptocurrency mining activities will increase electricity demand by as much as 3.5 GW, accounting for a remarkable 3.96% of the forecasted ERCOT-wide peak demand of 88.3 GW. This additional demand will present challenges to the transmission system and impact prices. However, cryptocurrency mining operations act as controllable loads that are price-responsive and can adjust their demand based on orders from the grid operator. While ERCOT remains open and welcoming to miners, in March 2022 it began requiring that they obtain approval before connecting to the grid. Concurrently, AI

ventures have led to substantial investments in building new data centers. Therefore, load growth from these data centers is expected to be significant in the long run.

Transmission continues to be a critical issue in Texas, with the timing and location of upgrades being crucial for predicting economic patterns. Several transmission upgrades have been completed and are under construction to enhance the reliability of the electrical grid.

In the South load zone of ERCOT, a key region for solar, wind, and storage development, congestion issues have been prominent, particularly involving the Spruce to Pawnee 345kV circuit. This circuit serves as the sole, southern-facing 345kV import path to the 345kV ring around San Antonio, often experiencing congestion due to the contingent loss of the Elm Creek to San Miguel 345kV Circuits 1 and 2. To address the severe congestion observed during the summers of 2022 and 2023, ERCOT has initiated upgrades to this double circuit. The CPS San Antonio South Reliability project aims to enhance the network by adding a double-circuit 345kV import path to the San Antonio ring network, with completion targeted for mid-2027.

ERCOT's Permian Basin reliability study considers the increase of transmission needs due to significant load growth, driven by oil and gas sector and other industrial activities. According to ERCOT's historical data, the peak demand of Far West Weather Zone, which includes a significant portion of the Permian Basin, has grown approximately by 255% over the last decade. Moreover, S&P Global developed a 2022 load forecast, where projected growth in peak oil-and-gas related demand as 11,964 MW in 2030 and 14,705 MW in 2039, reflecting an expectation of a transmission expansion in the Permian Basin region. Therefore, ERCOT considered the need of fifteen 138kV and five 345kV reliability upgrades to serve the Permian load by 2025.

The Corpus Christi North Shore Project is designed to enhance the reliability and capacity of the electrical grid in the Corpus Christi area. The project involves several critical upgrades, including the addition of a 345 kV bus and two 345/138 kV transformers at the Resnick substation. It also includes the construction of approximately 44 miles of double-circuit 345 kV transmission lines and the reconductoring of around 1.5 miles of 138 kV transmission lines, expected to be completed in 2024.

LCRA Transmission Services Corporation is upgrading the Hays Energy to Kendall Corridor transmission line. Expected to be completed in 2025, this project rebuilds an approximately 60-mile transmission line corridor from the Hays Energy Substation near Interstate 35 in San Marcos to the Kendall Substation.

The number of Generic Transmission Constraints (GTC) has increased in recent years, particularly in West Texas and South Texas, as a temporary measure to address the stability constraints related to the long-distance transfer of power from these areas to urban centers. ERCOT has identified a reliability need to limit power transfers in areas south of San Antonio. Therefore, as of March 2024, ERCOT has added four new GTCs to manage these transfers, bringing the total to twelve GTCs in effect by 2025.

The generation capacity mix is expected to remain similar to that of 2023, with no significant changes anticipated between 2024 and 2025. In 2025, natural gas-powered generators are projected to remain the majority of installed capacity, followed by wind and solar resources. Wind and solar energy will play an important role in the capacity mix, with a total nameplate capacity of 39,832 MW and 31,410 MW, respectively, not adjusted for Effective Load Carrying Capability (ELCC). The planning reserve margin for summer 2025 is forecasted to be 21.56%, based on resource updates provided to ERCOT from generation

developers and an updated peak demand forecast. Figure 2 shows installed capacity by fuel type, as modeled in UPLAN. The generation expansion for 2025 is based on the ERCOT Generation Interconnection Study (GIS) Report, published in May 2024. Units with Signed Interconnection Agreements (SGIA) and Financial Security (FS), and notice to proceed posted with the transmission owners have been modeled in UPLAN. However, LCG's statistical analysis of the GIS indicates an average delay of 500 days between the expected commercial operation date reported in the CDR and the actual date when the plant comes into service. Persistent pressure on supply chains has been the primary reason for the delay. Upon reviewing historical Generation Information System (GIS) data, it has been consistently observed that there have been delays in the units. For this reason, simulations exclude 11,863 MW of solar, 6,918 MW of storage, and 2,157 MW of wind units, even though their expected Commercial Operation Date (COD) falls between Q3 and Q4 2025 and they meet the SGIA and FS criteria.

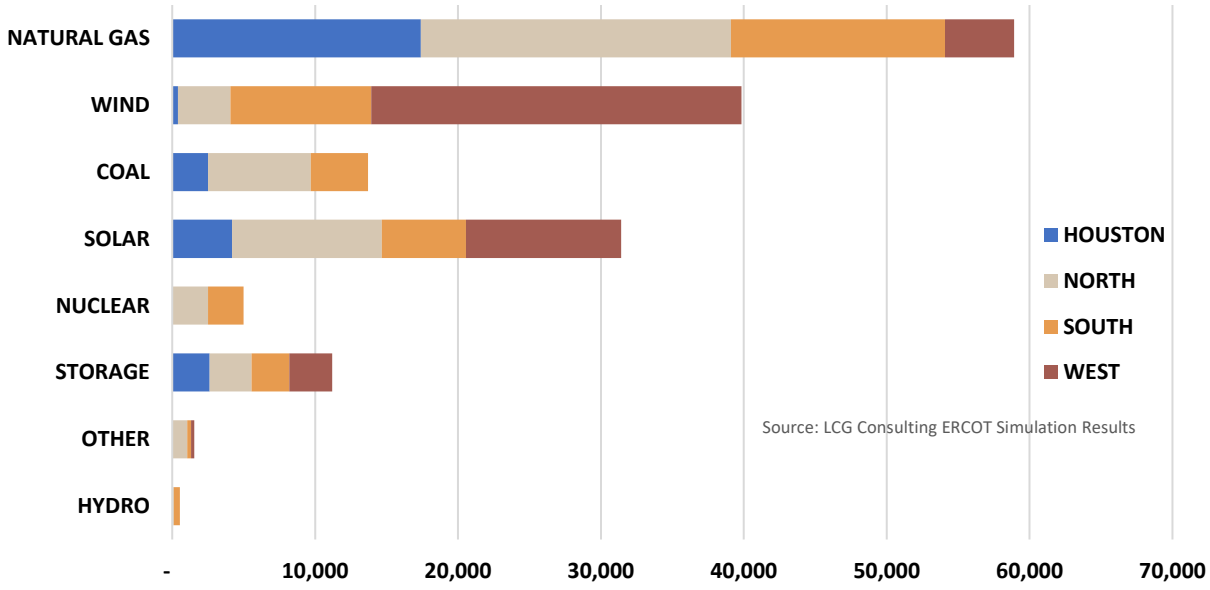


Figure 2 ERCOT installed capacity by fuel type in 2025 (MW)

Approximately 13.8 GW of new capacity is expected to be added to the ERCOT market from Q3 2024 to 2025. The new capacity by 2025 is outlined below in Table 1.

Table 1 Capacity expansion by fuel type and zone by 2025 (MW)

Zone	STORAGE	SOLAR	WIND	NATURAL GAS	TOTAL
HOUSTON	1,393	1,656	241	204	**3,493**
NORTH	1,149	3,752	727	-	**5,629**
SOUTH	562	2,165	-	-	**2,727**
WEST	229	1,365	385	-	**1,980**
TOTAL	**3,334**	**8,938**	**1,353**	**204**	**13,829**

Energy in ERCOT continues to come primarily from fossil fuels but is increasingly being replaced by wind and solar. Fossil fuels are expected to generate 52% of the electricity, which is similar to the 2024 outlook but represents a sharp decrease of 7% from 2023. Solar generation has been growing rapidly, increasing from 1.0% in 2019 to 2.3% in 2020, nearly doubling again to 4% in 2021, 5.6% in 2022, and 8.7% in 2023. It is expected to grow to 12.8% by 2025. Wind generation is projected to remain around 27.1% in 2025. Coal generation continues to decline due to planned retirements.

Figure 3 shows the annual production by fuel in LCG's 2025 simulation.

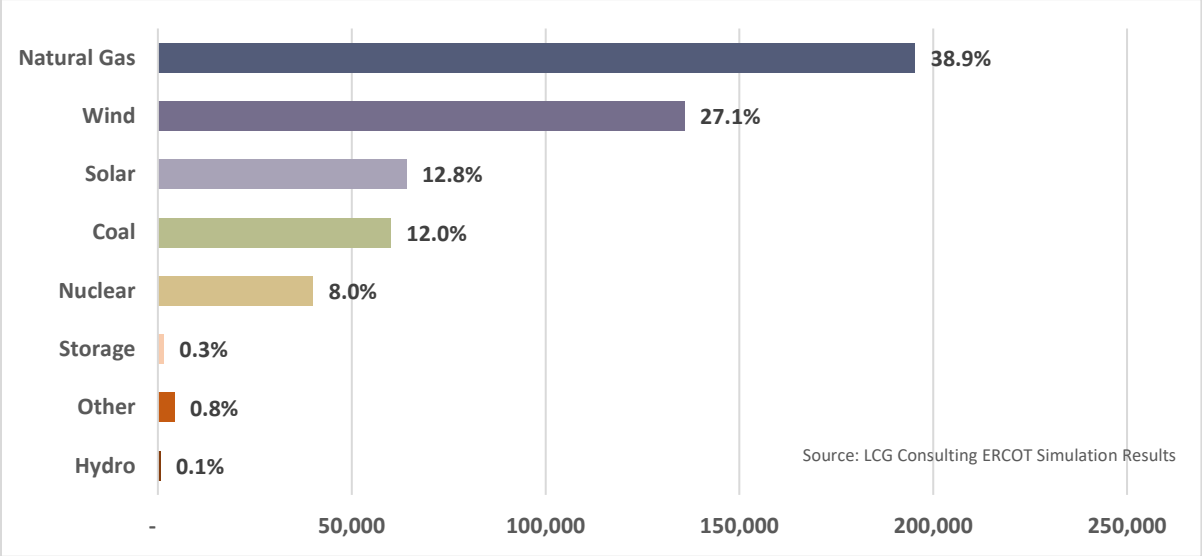


Figure 3 Annual energy production by fuel type (GWh) [1]

Figure 4 below shows a heat map of annual average bus LMPs and the top constraints in the ERCOT region for 2025. The figure displays the top 15 constraints with the highest congestion rent for 2025.

1. North to Houston GTC
2. Farmland to Long Draw 345kV line
3. South Texas project to WA Parish 345kV line
4. Bluff Creek Switch to Knapp 138kV line
5. Zenith to TH Wharton 345kV line
6. PH Robinson to Meadow 345kV line
7. Bell County to Salado Switch 138kV line
8. Mackenzie Substation to Northeast Substation 138kV line
9. Midtown to Polk 345kV line
10. West Texas Export GTC
11. South Texas Export Pawnee Spruce GTC
12. Warrior to Harker Heights South 138kV line
13. Tilden Substation to Fowlerton 138kV line
14. Exchange Switch to Hick Switch 138kV line
15. Bergheim 345kV Auto-transformer

1 Contributions from other fuel types are considered under "Other" fuel type.

The annual average prices tend to be highest in the Houston zone, followed by the South, West, and North zones.

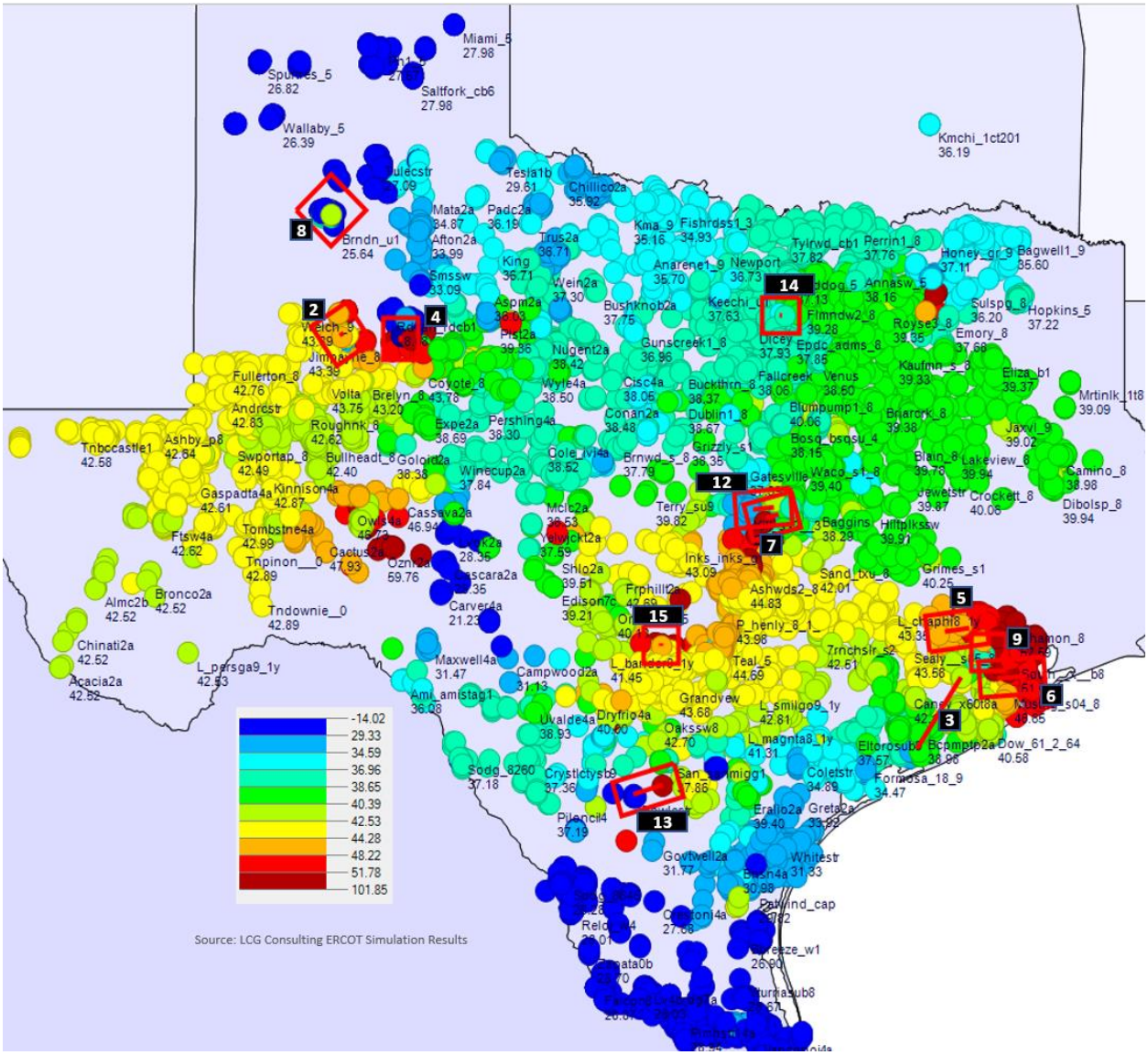
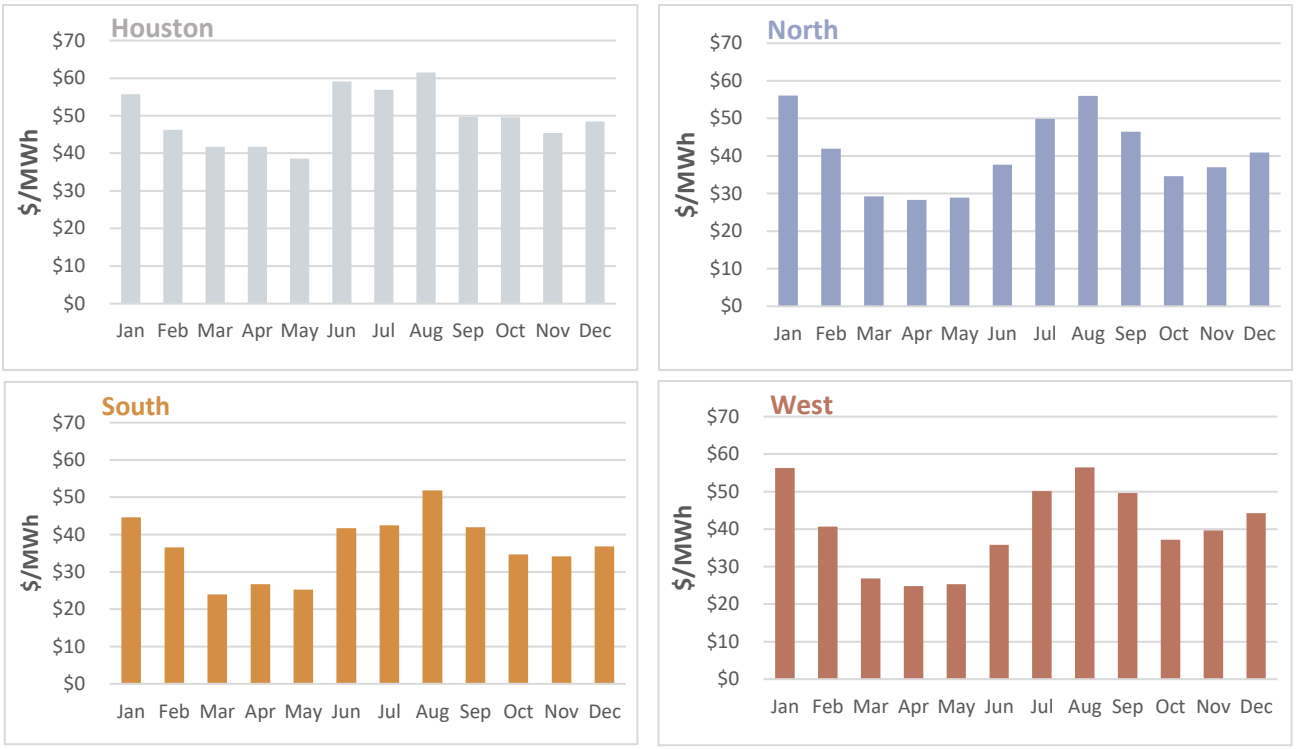


Figure 4 Annual average nodal price heat map and top 15 transmission constraints

Figure 5 shows the load-weighted, monthly average prices by load zone. Prices are typically higher during the summer (June–September) and winter (December–February) months. The highest zonal price from the simulation is around $1,944/MWh, which is well below the newly reduced System-Wide Offer Cap (SWOC) of $5,000/MWh.



Source: LCG Consulting ERCOT Simulation Results

Figure 5 Monthly load-weighted average prices ($/MWh) by load zone – 2025

Historical real-time market prices for load zones monthly are shown in Figure 6. Note that the extreme weather events of February 2021 have been removed for better comparison.

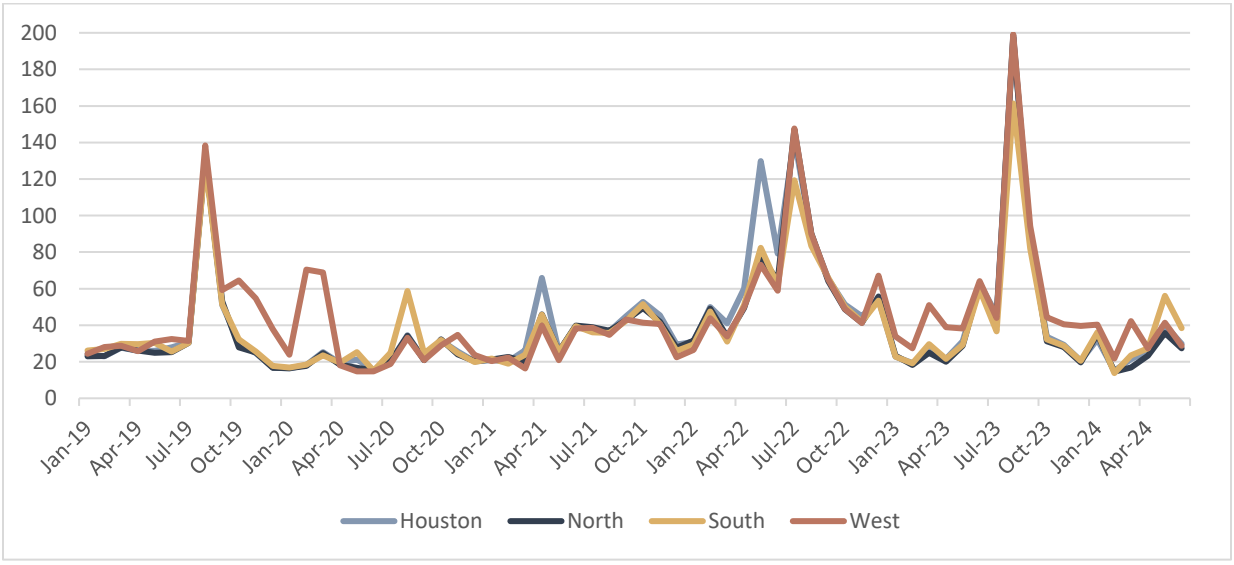
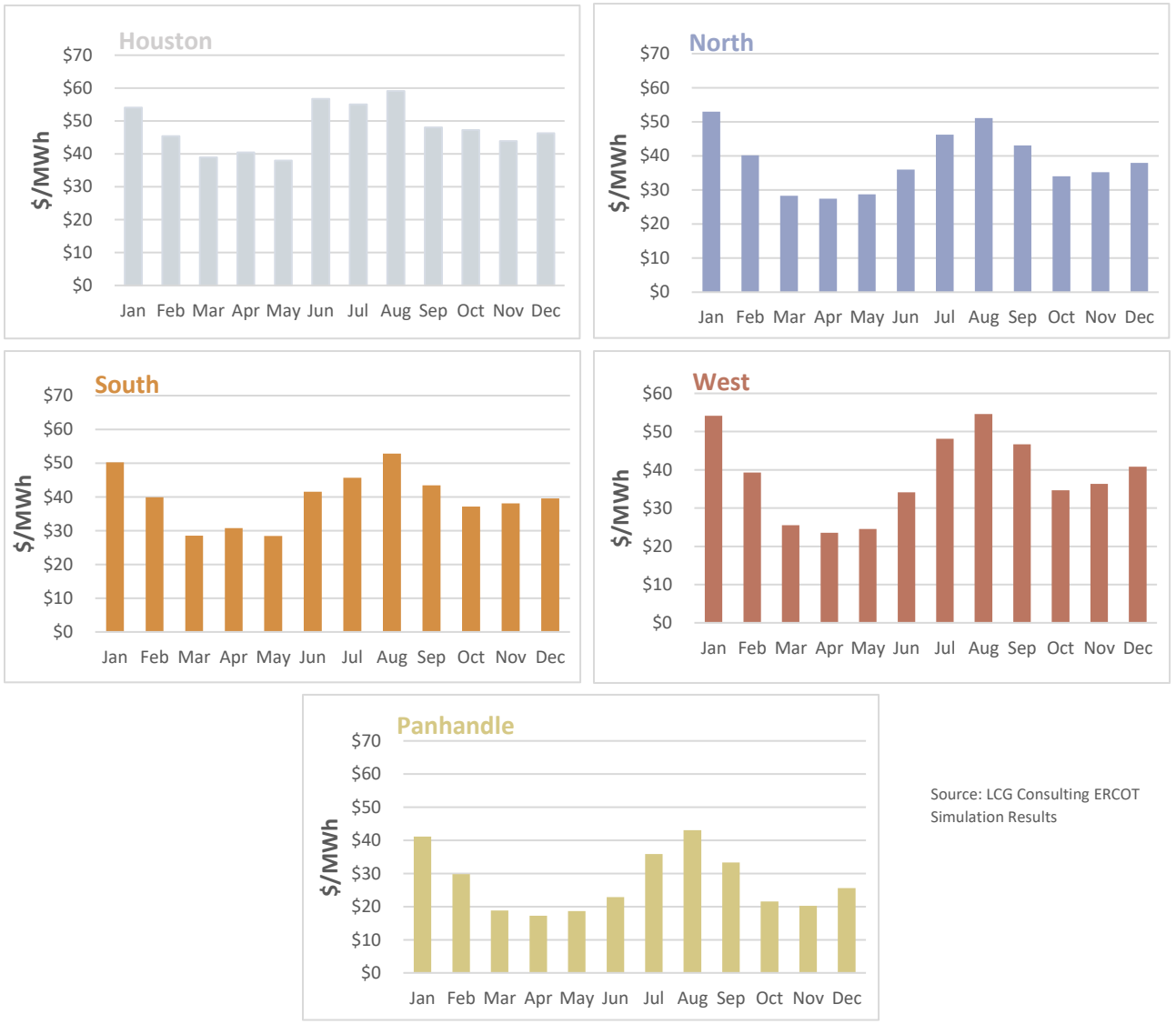


Figure 6 Historical monthly load-weighted average prices ($/MWh) by load zone

ERCOT has defined seven hubs for calculating average LMPs and assisting transactions between hubs, zones, and individual buses. These hubs include: Houston with 20 buses, North with 75 buses, South with 31 buses, and West with 17 buses. A Panhandle Hub was created in 2019 and includes 12 buses.

Under expected conditions, the most competitive average hub price is observed in the Panhandle Hub, with progressively more expensive prices experienced in the North, West, South, and Houston Hubs. The hub price averages are higher during the summer and winter months, a trend similar to load zone prices. Monthly average prices in 2025 at the Houston, North, South, West, and Panhandle Hubs are shown below in Figure 7.



Source: LCG Consulting ERCOT Simulation Results

Figure 7 Monthly average prices ($/MWh) by trading hub – 2025

The implied Heat Rate (IHR) is the cost of fuel needed to generate one megawatt-hour of electricity. It is calculated by dividing the electricity price ($/MWh) by the natural gas price ($/MMBtu). Only a natural

gas generator with an operating heat rate—a measure of unit efficiency—below the implied heat rate value can be profitable. In-house natural gas price predictions show that the average natural gas price ranges from $2.02/MMBtu to $3.30/MMBtu across the four ERCOT load zones. Based on UPLAN projections, the lowest implied heat rate occurs in March in the North load zone. During the summer months, the implied heat rate averages around 15-24 MMBtu/MWh, while in non-summer months, it averages around 11-16 MMBtu/MWh. Monthly implied heat rates by load zone are shown in Figure 8.

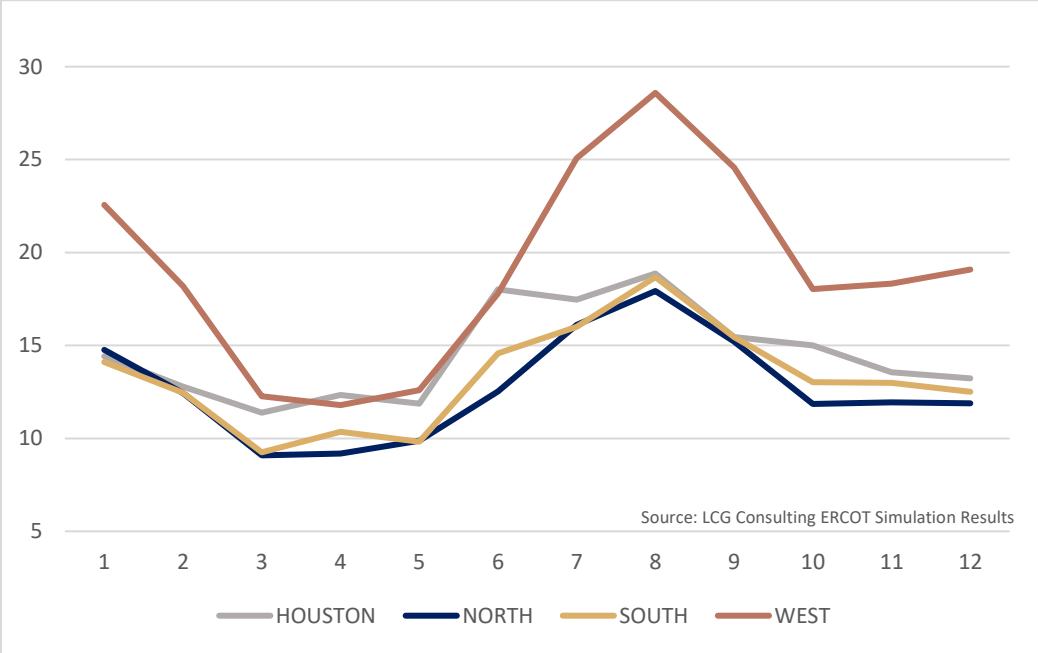


Figure 8 Monthly implied heat rate by load zone - 2025 (MMBtu/MWh)

The ERCOT region is poised for a rapid transition toward increased reliance on renewable energy resources. Battery storage is expected to play a crucial role in maintaining system reliability and ensuring resource adequacy amid high levels of renewable penetration, helping to balance supply and demand. Additionally, the anticipated load growth driven by artificial intelligence, crypto-currency mining operations, and oil & gas production in the ERCOT region may spur investments in new generation capacity. However, this rapid transition also presents several challenges, including the need for increased transmission capacity to support the rising demand, addressing intermittency issues associated with renewable energy sources, and accurately forecasting large load growth.