Strategic Integration and Financial Impact of Hedging in Bitcoin Mining (ERCOT, Jan–May 2025)

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Prepared by: Abdul-Salem Beibitkhan
Scope: Evaluating LZ_WEST 7x24 hedge performance in ERCOT-based Bitcoin mining operations

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Executive Summary

**Profit figures exclude other operational costs*

**Bitmain Antminer S21 Pro in Normal Mode set as default miner*

Hedge Contracts proved valuable as a tool for protecting real-time energy consumption, not for generating additional profit:

- If hedge contracts were secured at the lowest available rates in each of the 5 study months, the profit would have been -$6.59/MWh at 100% Coverage.

- In contrast, if hedge contracts were secured at the highest observed prices, the profit averaged out across the 5 months would have resulted in a -$25.11/MWh loss on average.

- A simulated well-informed entry at 75th Percentile (Top 25%) yielded a return of -$11.14/MWh.

- Across all 514 total forward hedge prices for the study period, none were at or below the breakeven hedge contract price required to generate a positive profit.

In hindsight, hedging significantly increased price stability and reduced cost exposure risks:

- A 100% hedged position reduced the net electricity cost volatility from $68.47/MW to $6.63/MW, resulting in a 90.3% increase in price stability.

Despite wider risk horizons, lower forecast confidence, and high inherent uncertainty, hedge prices were the lowest when secured 3 or months ahead of delivery date:

- Hedge contracts secured >90 days before delivery averaged $53.52/MWh, compared to the $57.95/MWh when entered within 90 days, equating to a 7.64% price advantage for early entry.

- Early positions also exhibited 63.8% less price volatility with a standard deviation of $1.39/MWh while medium-to-short term entries showed $3.84/MWh.

- Optimal price dips typically occurred within ~30 days after contract listing and >90-100 days before delivery, forming a repeatable and favorable entry window with prices 6-7% lower than the average.

2. Load Zone Hedging @ Load Zone

2.1 Strategy Overview

This strategy involves purchasing a financial hedge contract that settles directly against the LZ_WEST real-time market price, the same location where the mining facility physically draws power. By locking in a fixed electricity cost per megawatt-hour (MWh), the hedge provides full protection against real-time price volatility during the delivery period.

Because the hedge and the energy consumption are both tied to the same load zone, basis risk is eliminated, enabling a true 1:1 financial offset between the hedge and the miner's real-time electricity exposure.

2.2 Risk and Structure Analysis

The LZ_WEST hedge offers a direct and operationally aligned form of risk management, as it settles at the same node where the miner consumes power, making it the simplest and most predictable hedge structure available.

However, this simplicity comes at a cost:

- Hedge premiums are typically higher than hub-based alternatives, especially in high-volatility months.
- In months with low real-time market prices, the miner may pay more for power than if they had remained exposed to spot prices.
- Overhedging (e.g., locking in more MWh than needed due to uncertain mining uptime or curtailment) can lead to negative carry, as the miner is then "long" fixed-price electricity during cheap real-time intervals.

That said, this strategy remains attractive to operators who prioritize cost stability over potential upside, particularly in delivery months with high historical volatility or known risk factors such as seasonal demand spikes, and grid constraints.

2.3 Profitability

	Uncurtailed Mining with Hedging @ LZEW @ 100% Coverage	Uncurtailed Mining with Hedging @ LZEW @ 75% Coverage	Uncurtailed Mining with Hedging @ LZEW @ 50% Coverage		Uncurtailed Bitcoin Mining	Curtailed Bitcoin Mining
January	$101.13/MWh	$103.81/MWh	$106.48/MWh		$111.82/MWh	$117.05/MWh
February	$88.27/MWh	$91.94/MWh	$95.62/MWh		$102.98/MWh	$106.90/MWh
March	$81.82/MWh	$86.40/MWh	$90.98/MWh		$100.15/MWh	$99.40/MWh
April	$78.15/MWh	$80.31/MWh	$82.47/MWh		$86.79/MWh	$91.54/MWh
May	$104.49/MWh	$105.32/MWh	$106.15/MWh		$107.81/MWh	$110.41/MWh

Figure 2.3.1 - Monthly Profit per MWh at 75th Percentile Entry Point

* To get Curtailed Mining with Hedging, add $5.23/MWh(Jan), $3.92(Feb), -$0.74(Mar), $4.76(Apr), $2.60(May)

Figure 2.3.1 shows the actual Profit per MWh for each month based on hedge contracts secured at top 25% price levels, simulating a real-world, informed buyer scenario. The figures are categorized by three pre-set coverage configurations: 100%, 75%, and 50%. A 100% coverage indicates that the full energy consumption was financially covered at the hedge price, while 50% coverage means that only half was hedged and the remainder was exposed to Real-Time Market pricing.

While hedge contracts are designed to protect against price spikes and offer consistent price security, they also prevent the contract holder from benefiting from low real-time prices effectively locking them into a commitment. In other words, it’s a double-edged sword meant to strike a balance between risk and protection. However, the data shows that the real risk lies in overcommitting to high-coverage hedge positions. Even at fair, well-timed entry prices within the top 25%, hedge premiums can erode profitability.

In 2025, hedge contracts cost an operator an average of $11.14/MWh in lost revenue across January to May, even at informed entry prices.

Even when hedge contracts were secured at the lowest available rates, the contract holder was still left on the short end, with an average loss of $6.59/MWh. On the other hand, contracts locked in at the highest observed price levels resulted in a $25.11/MWh loss in revenue.

2.4 Value Proposition - Is $11.14/MWh Worth It?

While the average hedge contract at the top 25% price level resulted in an $11.14/MWh of lost revenue, this figure is better understood when portrayed as the cost for financial protection, not as another stream of revenue. As with any insurance product, the value depends on the likelihood and the financial impact of a catastrophe it could protect against.

For Bitcoin Mining operations and in fact, any other electricity-intensive line of business with not much backbone and financials, this can be a justifiable trade-off for revenue stability when operating in a high-volatility market like ERCOT. However, for the bigger enterprises with stronger cash positions, a higher tolerance for price risk, greater real-time market insight, and successful curtailment strategies, this $11.14/MWh may pose more as an unnecessary anchor than financial protection.

It's crucial to note that this study period (Jan - May 2025) was considered a normal/low-volatility month therefore the hedge prices are expected to be around 10-20% higher than the average Real Time electricity rates which was the case for this study. Furthermore, the study period did not have extreme market spikes such as those seen during the 2021 Texas Winter freeze or the annual severe Summer congestion where a hedge contract could have been and had been a lifeline for many businesses. In addition, the Bitcoin Mining landscape despite the recent halving has remained lucrative with high margins of profit. This may not always be the case and a simple hedge contract could be the make or break factor for operations that are highly reliant on low and stable electricity rates.

In the other words, the value proposition of a hedge contract is based on more than just lost revenue, it's best valued when compared against:

- Risk Tolerance
- Access to Liquidity
- Curtailment flexibility
- Energy market volatility
- Bitcoin price and Network difficulty
- Time horizon
- Exposure to grid price spikes

Therefore, this study does not answer the question "Is $11.14/MWh Worth It?" because it's an open ended question with endless possibilities with the final answer being dependent on the above factors.

3. Timing the Hedge (Buying Window Optimization)

3.1 Purpose and Methodology

This section evaluates whether timing the hedge market can yield more optimal outcomes and whether consistent, time-based pricing patterns exist within the report's scope. Using the metric Days Until Delivery Date, hedge price movements are analyzed through historical forward price data for delivery periods spanning January to May 2025. Visualizations are used extensively to highlight trends in minimum, maximum, and average pricing across time.

While hedge contracts are primarily used to lock in predictable revenue by mitigating exposure to real-time price volatility, they also carry inherent risks, mainly the potential for margin erosion or lost opportunity during low-priced periods. Beyond that, a second layer of speculation emerges: timing the entry into the hedge itself.

Securing a hedge early in the pricing window generally provides access to lower and more stable rates, while also granting the contract holder more time and optionality, including the ability to adjust the position or exit their position prior to delivery, *depending on the hedge structure**.

In this study, hedge entry points are grouped into two categories:

- Operational Hedge Window (0–100 days before delivery): represents typical short to medium term hedge entry points, often aligned with operational planning cycles.
- Early Positioning Window (100–200 days before delivery): reflects more strategic, long-term entry points where participants seek value ahead of broader market movements.

** Tradable financial hedges such as exchange-traded or cleared OTC contracts offer greater flexibility and liquidity, allowing for easier entry, exit, and margin transparency. In contrast, bilateral OTC contracts are privately negotiated and often less flexible, with limited secondary market options and bespoke terms.*

3.2 Operational Hedge Window (0–100 Days Before Delivery)

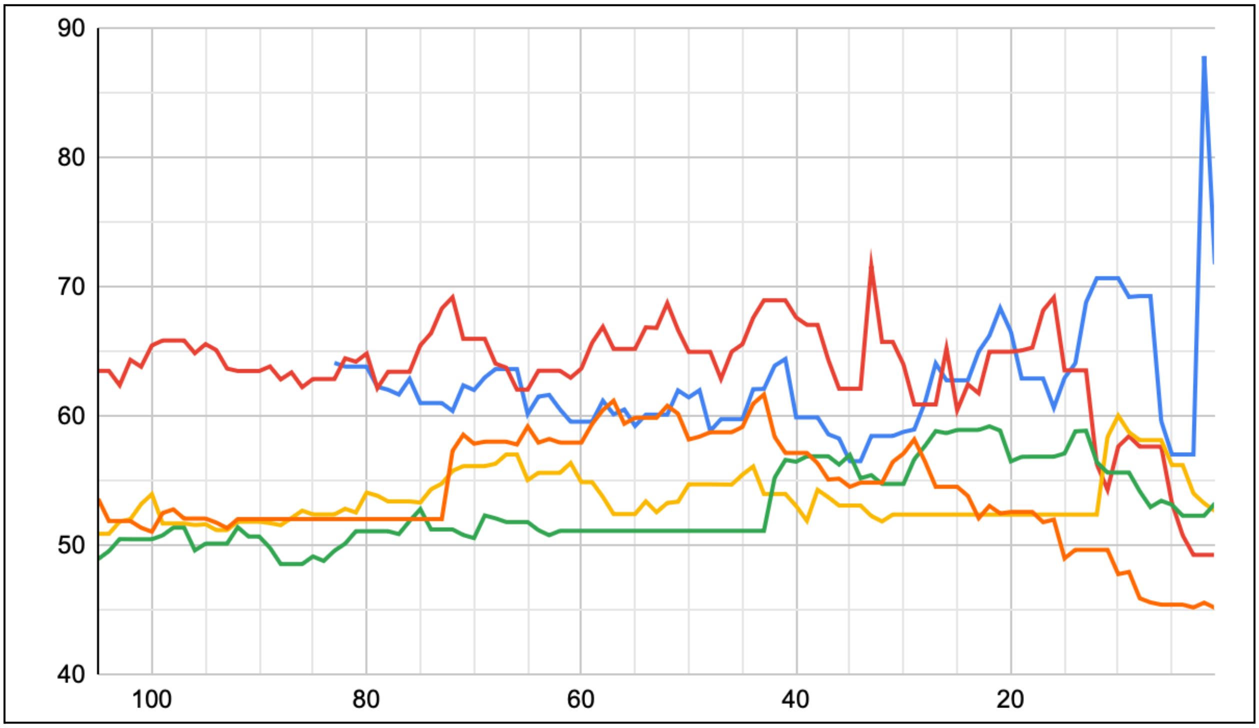

Figure 3.2.1 - Short-Term Entry Window
X-Axis *- Days until Delivery Date,* ***Y-Axis*** *- Hedge Price per MW*

Blue - January 2025, Red - February 2025, Yellow - March 2025, Green - April 2025, Orange - May 2025

	Average Hedge Price - 6 Months out	Average Hedge Price - 3 Months out	Average Hedge Price - 2 Months out	Average Hedge Price - 1 Month out	Average Hedge Price - 2 Weeks out	Average Hedge Price - 1 Week out	Average Hedge Price - 3 Days out
January	N/A	N/A	$61.99	$60.01	$63.41	$69.78	$65.99
February	N/A	$64.65	$64.09	$65.97	$63.88	$57.91	$51.22
March	N/A	$52.38	$54.27	$53.53	$52.36	$56.87	$54.72
April	N/A	$48.51	$50.75	$53.19	$57.89	$55.60	$52.83
May	$47.36	$48.84	$54.62	$58.14	$53.10	$48.00	$45.34

Figure 3.2.2 - Time-to-Delivery Hedge Price Breakdown: ***LZ_WEST***

	Hedge Price Standard Deviation - 6 Months out	Hedge Price Standard Deviation - 3 Months out	Hedge Price Standard Deviation - 2 Months out	Hedge Price Standard Deviation - 1 Month out	Hedge Price Standard Deviation - 2 Weeks out	Hedge Price Standard Deviation - 1 Week out	Hedge Price Standard Deviation - 3 Days out
January	N/A	N/A	1.313	1.815	2.318	0.829	11.734
February	N/A	1.126	1.748	2.226	2.590	2.825	3.187
March	N/A	0.860	1.693	1.110	0.000	3.146	2.132
April	N/A	1.281	1.151	2.497	1.055	1.843	0.531
May	0.722	2.642	3.054	2.154	2.282	1.755	0.153

Figure 3.2.3 - Hedge Price Volatility by Purchase Timing: ***LZ_WEST***

As seen above on ***Figure 3.2.1***, and ***Figure 3.2.2***, with the delivery period nearing and theta decaying, the futures market starts getting more and more volatile. During the early stages of the Operational Hedge Window, prices were relatively stable with the standard deviation hovering around $1.2/MWh. However, once the 75 day mark is crossed, volatility steadily increases, reaching a standard deviation of $1.96/MWh with a moderate uptrend between 75 and 15 days before delivery.

Once the market enters the final 15-day stretch, prices typically decline sharply due to a combination of structural and behavioral forces:

- **Shrinking Risk horizon**: As time runs out, fewer uncertainties remain to be priced into the hedge.

- **Real-Time Market Clarity**: Forecasts for demand, generation, and weather become more accurate, narrowing the pricing spread.

- **Stronger Weather and Load Forecasts Confidence**: Volatility priced into longer-dated contracts naturally decays as confidence in short-term grid conditions solidifies.

- **Broker & Trader Liquidation Pressure**: Market participants unwind or unload positions that haven't been sold, often at a discount

- **Buyer Drop-off**: Most large hedgers finalize procurement strategies well ahead of the last 2 weeks, leaving fewer active buyers in the market.

This tail-end compression of prices can present opportunities for speculative entries, but also highlights the narrowing margin for error when timing trades close to delivery. The trade-off becomes less about price, and more about liquidity and optionality.

3.3 Early Positioning Window (100–200 Days Before Delivery)

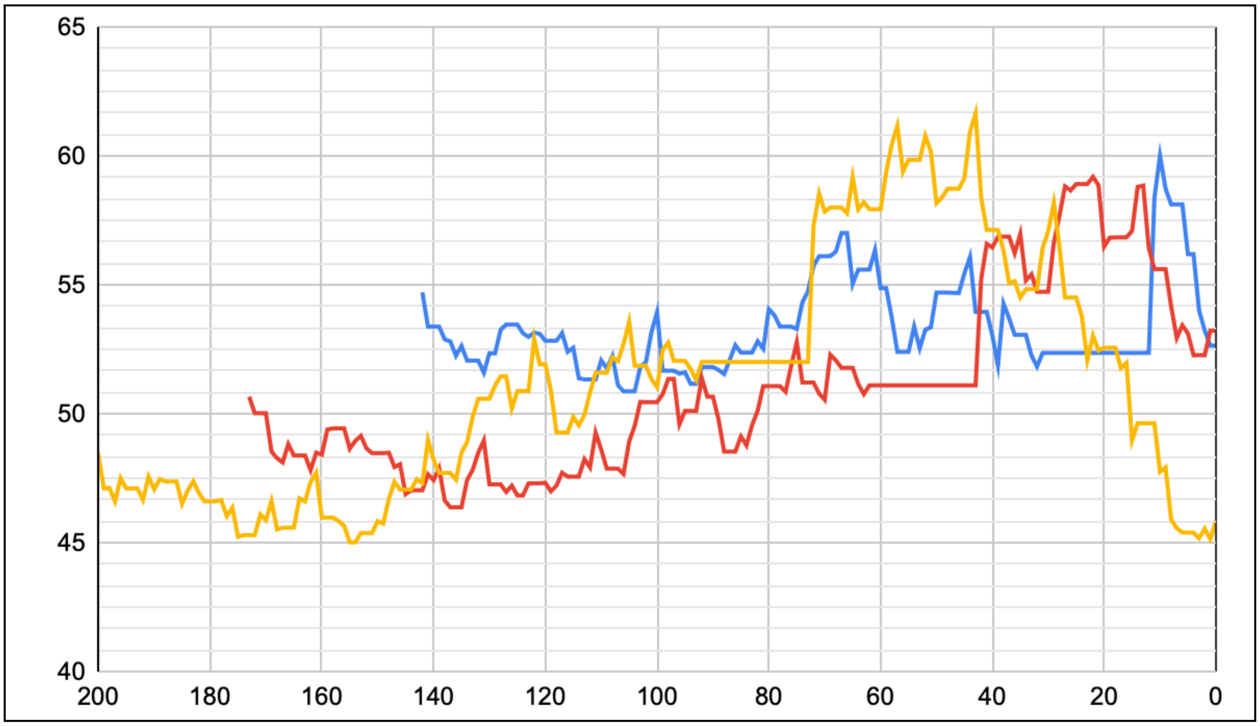

Figure 3.3.1 - Long-Term Entry Window
***X-Axis** - Days until Delivery Date, **Y-Axis** - Hedge Price per MW*
Blue - March 2025, Red - April 2025, Yellow - May 2025

***January 2025**, and **February 2025** not present due to data unavailability*

	Average Hedge Price - 6 Months out	Average Hedge Price - 3 Months out	Average Hedge Price - 2 Months out	Average Hedge Price - 1 Month out	Average Hedge Price - 2 Weeks out	Average Hedge Price - 1 Week out	Average Hedge Price - 3 Days out
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Figure 3.2.3 - Hedge Price Volatility by Purchase Timing: ***LZ_WEST***

The Early Positioning Window consistently offers lower hedge entry points. In fact, across all three delivery months, the lowest-priced hedge contracts were secured during this long-term window.

A broader pattern also emerges: hedge prices tend to be initially overpriced when first posted. As the market digests new hedge offers and forward uncertainty begins to settle, prices gradually decline, often reaching their lowest point around 30 days after contract creation. Beyond this low, the trend reverses, prices begin a steady climb, frequently peaking during the medium-term entry window.

These early low prices, typically observed 4 to 6 months before delivery reflect a market environment marked by wide risk horizons, low forecast confidence, and inherent uncertainty. With limited visibility into future conditions, sellers price in a risk premium that gradually erodes as clarity improves.

While early hedge entries can yield the best pricing, they also carry risk. Lack of near-term market visibility can lead to poor positioning, and exiting or adjusting those contracts may be challenging, especially in less liquid or bespoke OTC agreements.

4. Methodology

This study evaluates the financial effectiveness and performance of electricity hedging strategies in ERCOT's Western Load Zone. The study covers hedge contracts and the Bitcoin mining profitability for the delivery months of January - May 2025 through 15-minute intervals.

4.1 Data and Granularity

Real-Time Market (RTM) Prices: Sourced from ERCOT's historical RTM Dataset for LZ_WEST.

Hedge Pricing Data: Forward Hedge Prices from a broker, recorded across varying days before delivery.

BTC Mining Metrics: Modeled using historical network difficulty, hash price data, and miner efficiency and power metrics of the Bitmain Antminer S21 Pro miner.

4.2 Hedge Strategy Construction

Primary Hedging strategy is modeled after a Load Zone/Node Hedge contract settling at LZ_WEST, directly aligning with the Bitcoin Mining operation physical electricity draw location.

Hedge positions were simulated at 3 industry standard coverage levels:

- 100% Coverage: All RTM power draw costs hedged at forward contract price
- 75% Coverage: Partial hedge, remaining 25% power purchased at RTM price, uncovered by the hedge.
- 50% Coverage: Minimal Hedge Exposure, half of all energy of draw is at hedge contract price while the other half is at RTM market price.

Hedge prices were evaluated at 4 entry points to capture real-world variance and max risk-reward factor:

- Maximum Observed Hedge price
- Minimum Observed Hedge price
- Average Hedge Price
- 75th Percentile(Top 25%) Hedge price

4.3 Profitability Modeling

Uncurtailed Nonstop Bitcoin Mining with Hedging was used as the baseline profit figure.

The Hedge Payout at every 15 minute interval was used to simulate profit figures for calculating Uncurtailed Bitcoin Mining with Hedging.

4.4 Formulas

Baseline Bitcoin Mining Revenue Calculation:
Revenue per MW = (Hashprice / 96 * (1,000 / Miner Hashrate)) * (4,000,000 / Miner Wattage)

Units:

- Hashprice: $USD per PH/s
- Miner Hashrate: TH/s
- Miner Wattage: Watts

Baseline Bitcoin Mining Profit Calculation:
Profit per MW = Revenue per MW - RTM Settlement Price per MW

Bitcoin Mining with 100% Coverage Hedging Profit Calculation:
Profit per MW = Baseline Bitcoin Mining profit per MW + Hedge Payout per MW

Bitcoin Mining with Custom % Coverage Hedging Profit Calculation:
Profit per MW = Baseline Bitcoin Mining profit per MW + (Hedge Payout per MW * Coverage %)

Volatility Shielding Calculation:
Volatility Shielding = (1 - Profit with Hedging Std Ev / Profit without Hedging Std Ev) * 100

4.5 Assumptions & Limitations

Due to utilizing a Load Zone/Node Hedge to directly align with the physical electricity draw location, hedge strategy flexibility has been limited to coverage only. More advanced and multi-layered hedging strategies such as Split Allocation, CRRs, Fixed Basis and more have been covered in alternative studies.

As a result of restricted access to hedge forward prices and Bilateral OTC contracts, the following have not been assumed: Slippage, Counterparty Risk, Contract Friction.

In addition, Trade Exchanged and Cleared OTC forward hedge prices have not been explored due to data unavailability. For that reason, additional risks such as cash flow volatility which come as part of Variation Margin in tradable financial hedges have been excluded.

January 2025 and February 2025 Hedge Contracts were not represented in the 3.3 Early Position Window subsection due to unavailability of price data.

The report assumes 100% uptime for Bitcoin Mining operations as a result of strict data management and privacy within Bitcoin Mining firms.

5. References

Data Sources:

- ERCOT Historical Load Zone Settlement prices: Yearly Settlement Point Price Data for the Western Texas Load Zone, including 15-minute interval records
- HashRateIndex Hash price Data: Historical Bitcoin Hash Price Data
- Intercontinental Exchange ERCOT West Load Zone options: ICE traded ERCOT LZ_WEST options data

Tools and Technologies:

- PostgreSQL (Version 17.2): Official Webpage
- Python (Version 3.13.1): Official Webpage
- Tableau Desktop (Version 2024.3.1 Professional Edition): Official Webpage
- Google Sheets: Google Workspace Official Webpage
- Microsoft Excel (Version 16.94): Official Webpage