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

Last updated: 06/20/2025
Prepared by: Abdul-Salem Beibitkhan
Scope: Evaluating HB_WEST 7x24 hedge performance in ERCOT-based Bitcoin mining operations

---

Executive Summary

**Profit figures exclude other operational costs*

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

Naked Hub Hedges proved too risky for the return they offered:

- Despite a lower entry point, Naked HB_WEST hedges performed nearly identically to LZ_WEST hedges, with average lost revenues of $11.25/MW and $11.14/MW respectively.
- After accounting for basis risk, the net effective cost of HB_WEST hedging landed at $56.34/MW, barely lower than the $56.40/MW average cost of LZ_WEST hedges.
- However, price stability told a different story: LZ_WEST hedging delivered 90.3% volatility shielding, while HB_WEST only managed 66.19%. Basis risk in some cases spiked to as high as $546.78/MW, exposing operations to unacceptable variance.

Pairing Hub hedges with a Fixed Basis agreement offered a strategic cost edge:

- Load Zone hedges are in essence bundled Hub hedges plus a broker's fixed adder. Separately secured Hub Hedges and Fixed Basis deals could present a better entry cost.
- The average fixed adder between HB_WEST and LZ_WEST was $12.38/MW across the 5 study months. Negotiating a basis agreement below this benchmark could deliver a better price than an off-the-shelf LZ_WEST hedge.

CRRs delivered the most cost-effective strategy while retaining 100% downside coverage:

- CRR-backed strategies lost an average of $9.66/MW (OBL) and $9.92/MW (OPT) in revenue, outperforming LZ_WEST hedging by 13.38% and 11.04%, respectively.
- In fact, both OBL and OPT CRRs alone would have yielded positive returns over the study period, $1.49/MW and $1.23/MW, without requiring a traditional hedge structure.

Best times to lock in HB_WEST hedges: within 3 days of delivery or ~30 days after listing:

- If entering <100 days before delivery, the sharpest discounts, averaging 10.10%, appeared in the final 3 days before the delivery month began.
- Separately, the period ~30 days after the hedge contract was listed consistently offered 6.30% lower prices compared to the overall average.
- For those targeting longer entry horizons, combining the >100-day mark with the ~30-day-after-listing timing created a repeatable window that returned an average discount of 7.16%

2. Hub Hedging @ Load Zone with Basis Risk

2.1 Strategy Overview

This strategy involves securing a financial hedge contract that settles at the ERCOT Western Hub (HB_WEST), while the Bitcoin mining operation continues to physically draw power from LZ_WEST. This mismatch in hedge settlement and physical operational location creates a divergence between the hedge settlement price and the Real Time market electricity cost, better known as Basis Risk.

Unlike an LZ_WEST Hedge contract which protects real time power draw perfectly through a 1:1 ratio as the LZ_WEST Hedge settles at the LZ_WEST node of ERCOT while real time electricity draw is also from the same grid. On the other hand, HB_WEST Hedges are settled at the Western Hub, despite this, HB_WEST hedges serve as another pathway to protecting real time power draw at the Load Zone.

This approach is common among operators due to:
- Greater liquidity and pricing availability for Hub settled contracts
- More competitive and lower pricing compared to Load Zone equivalents
- Delivers strong correlation with Load Zone Real Time prices.

2.2 Risk and Structure Analysis

Basis Risk is the defining feature of this hedge strategy. It refers to the difference between Real Time market prices at LZ_WEST and HB_WEST.

Basis = (RT price at LZ_WEST) - (RT price at HB_WEST)

If the Basis is positive, which is often the case when there is basis, the hedge underperforms. In other words, the operator has to pay the basis risk out of pocket. On the other hand, if the Basis is negative, the hedge overcompensates.

This structure exposes the operator to:
- Location Misalignment risk
- Increased volatility of Profit & Loss
- Greater reliance on forecasting accuracy around congestion, weather and load conditions

2.3 Profitability

	Uncurtailed Mining with Hedging @ HB_WEST @ 100% Coverage	Uncurtailed Mining with Hedging @ HB_WEST @ 75% Coverage	Uncurtailed Mining with Hedging @ HB_WEST @ 50% Coverage		Uncurtailed Bitcoin Mining	Curtailed Bitcoin Mining
January	$93.16	$97.83	$102.49		$111.82	$117.05
February	$83.33	$88.25	$93.16		$102.98	$106.90
March	$85.49	$89.15	$92.82		$100.15	$99.40
April	$82.58	$83.63	$84.68		$86.79	$91.54
May	$108.74	$108.51	$108.27		$107.81	$110.41

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 3 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 RTM pricing.

However, due to the imperfect price correlation between LZ_WEST and HB_WEST, a Hub hedge often leaves out a noticeable part of the power draw exposed to unhedged risk, the K-value of the correlation between LZ_WEST and HB_WEST Real Time prices in the study months was 0.92. This means that even with a 100% coverage on paper, the real world coverage was closer to 92%.

Theoretically, it is possible to achieve a 100% coverage through overhedging by increasing initial coverage to 108.7%. Despite this, it won't equate to the same amount of protection and coverage a direct LZ_WEST hedge provides and instead adds additional mismatch risk which can quickly add up costs when basis becomes positive.

Across the 5 study months, a hedge contract cost the operator an average of $11.25/MWh in lost revenue, even at well-informed entry prices.

Even when hedges were secured at the lowest observed across all months, the lost revenue per MW equated to $6.49/MWh. On the contrary, contracts locked in at the highest rates would have resulted in a loss of $24.22/MWh.

2.4 Value Proposition

$11.25 of lost revenue every MWh, better portrayed as a constant 11.04% cut on gross profit, is a tough pill to swallow for many operators and begs the question "*What's the price you put on revenue stability and reduced volatility*?".

While the Hub hedging provides greater entry points and allows for wider profit margins, that reward comes with risk. That risk can backfire quickly when congestion, transmission constraints, or load distribution issues occur, this can cause the HB_WEST hedge to under-compensate or over-compensate.

This was the case in the study scope where the average HB_WEST hedge price came out to $44.02/MWh while the average LZ_WEST hedge price was $56.40/MWh. This may seem like a great deal initially, but with the added average basis risk which equated to $12.32/MWh, the net effective cost of the average HB_WEST hedge price comes out to $56.34/MWh, a mere $0.06/MWh discount compared to its LZ_WEST counterpart.

That marginal saving of $0.06/MWh comes at a huge cost in regards to volatility shielding. A 100% covered LZ_WEST position reduced volatility by 90.3% while its HB_WEST alternative reduced volatility at a much lower rate of 66.19%.

This 24.11% difference left the HB_WEST hedge exposed to a basis risk and in the observed 5 months, there was a positive basis risk 73.18% of the time which included figures as high as $546.78/MW.

All in all, LZ_WEST hedge is the better route compared to an HB_WEST hedge without basis risk protection because at the end of day, their net effective cost is very close but the former offers much superior volatility shielding while the latter brings about basis risk.

3. Hub Hedging @ Load Zone (CRRs / Fixed Basis)

These similar strategies build upon the base Hub Hedging strategies by utilizing mechanisms and financial instruments to reduce or neutralize basis risk which was the main downside of Naked Hub Hedges.

3.1 Strategy Overview: HB_WEST Hedge with Fixed Basis

In this approach, a fixed basis value ($5/MWh, $10/MWh, $15/MWh) was manually added to the naked Hub Hedge to simulate a LZ_WEST hedge through the creation of a built-in basis coverage to bypass basis risk. This strategy is especially handy when trying to secure a LZ_WEST hedge without directly securing LZ_WEST hedges through brokered bilateral OTC agreements which can often be higher priced due to the simplicity and straightforward nature of it.

3.2 Risk and Structure Analysis: HB_WEST Hedge with Fixed Basis

The HB_WEST hedge with a Fixed Basis can be a powerful and lucrative workaround when seeking to secure a LZ_WEST hedge without directly getting into an LZ_WEST hedge position.

In other words, a cheaper HB_WEST hedge can be transformed into a LZ_WEST hedge through a fixed basis agreement. The benefit of a direct LZ_WEST hedge lies in simplicity and in the hedge market, there is no real/pure LZ_WEST as all LZ_WEST hedge and other Load Zone hedges are simply a pre-packaged deal from brokers which consists of a Hub Hedge + Fixed Adder.

The averaged fixed adder across the 1028 total forward hedge price for HB_WEST and LZ_WEST was $12.38/MWh. In simpler terms, securing an HB_WEST hedge and subsequently negotiating a lower fixed basis rate than the broker premium of $12.38/MWh could lead to bigger profit margins.

3.3 Profitability: HB_WEST Hedge with Fixed Basis

	Uncurtailed Mining + HB_WEST Hedging & $5/MW Fixed Basis @ 100% Coverage	Uncurtailed Mining + HB_WEST Hedging & $5/MW Fixed Basis @ 75% Coverage	Uncurtailed Mining + HB_WEST Hedging & $5/MW Fixed Basis @ 50% Coverage		Uncurtailed Bitcoin Mining	Curtailed Bitcoin Mining
January	$105.72	$107.25	$108.77		$111.82	$117.05
February	$83.52	$85.89	$88.27		$102.98	$106.90
March	$92.99	$94.74	$96.50		$100.15	$99.40
April	$84.49	$84.36	$84.24		$86.79	$91.54
May	$110.60	$109.90	$109.20		$107.81	$110.41

Figure 3.3.1 - Monthly Profit per MWh at 75th Percentile Entry Point with ***$5/MW Fixed Basis***

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

	Uncurtailed Mining + HB_WEST Hedging & $10/MW Fixed Basis @ 100% Coverage	Uncurtailed Mining + HB_WEST Hedging & $10/MW Fixed Basis @ 75% Coverage	Uncurtailed Mining + HB_WEST Hedging & $10/MW Fixed Basis @ 50% Coverage		Uncurtailed Bitcoin Mining	Curtailed Bitcoin Mining
January	$100.72	$103.50	$112.03		$111.82	$117.05
February	$78.52	$82.14	$85.77		$102.98	$106.90
March	$87.99	$90.99	$94.00		$100.15	$99.40
April	$79.49	$80.61	$81.74		$86.79	$91.54
May	$105.60	$106.15	$106.70		$107.81	$110.41

Figure 3.3.2 - Monthly Profit per MWh at 75th Percentile Entry Point with ***$10/MW Fixed Basis***

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

During the study scope, Hub Hedges contracts even with a highly optimistic $5/MW Fixed Basis cost an operator an average of $6.45/MWh in lost revenue, even at informed entry prices.

Even in the best case scenario with the lowest observed hedge rates paired with a well below market average Fixed Basis of $5/MW, the average profit per MWh lagged behind by $1.98/MWh compared to the baseline unhedged Bitcoin mining.

3.4 Strategy Overview: HB_WEST Hedge with CRR

This strategy involves a Naked HB_WEST hedge which settles at the Western Hub and pairing it with a Congestion Revenue Right, better known as CRR.

CRR is classified by ERCOT as a financial instrument and as its own Hedge contract, therefore making it exclusive and its own source of revenue unlike Fixed Basis agreements which are secondary to Hub hedges. This pairing can be another of bypassing brokered OTC contracts which come with certainty and simplicity to newcomers at the price of hefty premiums.

CRRs are only available in 3 time of use configurations:

- Peak Weekdays: 6AM - 10PM on Monday-Friday
- Peak Weekend: 6AM - 10PM on Saturday-Friday
- Off-peak: All other hours not covered by Peak Weekdays and Peak Weekend CRRs

Due to this structure constraint and mismatch, in which the study scope is limited to 7x24 Hedge contracts while CRRs are not available in a 7x24 strip. All 3 CRR configurations were conjoined to achieve a 1:1 Time of use/Strip match between Uncurtailed Bitcoin Mining, 7x24 Hub Hedges, and CRRs.

3.5 Risk and Structure Analysis: HB_WEST Hedge with CRR

An HB_WEST Hedge + CRR strategy can be portrayed as a more advanced version of the "HB_WEST Hedge + Fixed Basis" strategy as securing a CRR in itself requires more than just negotiation.

Unlike a Fixed Basis contract which simply converts an HB_WEST hedge to an LZ_WEST hedge whose profitability is only measured through one metric, the Hedge payout, a CRR paired strategy has multiple levels.

A CRR tracks the Day-Ahead-Market and its payout is calculated through the difference between the DAM price of LZ_WEST and the DAM price of HB_WEST.

Furthermore, CRRs fall into 2 categories, an Obligation(OBL) and an Option(OPT) CRR. An OBL CRR means profit can go both ways, a positive congestion from HB_WEST to LZ_WEST means positive profit from the CRR while a negative congestion means owing ERCOT the difference.

However, an OPT CRR provides downside protection, that is to say that there is only positive payout and the maximum downside is capped at CRR purchase price.

Net OBL CRR Payout = LZ_WEST DAM Price per MW - HB_WEST DAM Price per MW - CRR Price per MW

Net OPT CRR Payout:

- If Basis > 0: Net OPT CRR Payout = LZ_WEST DAM Price per MW - HB_WEST DAM Price per MW - CRR Price per MW
- If Basis <= 0: Net OPT CRR Payout = - CRR Price per MW

Another benefit of CRRs is that it can be applied to both types of Hedge contracts, Bilateral OTC and Exchange-traded/Cleared OTC hedges, granting the CRR holder multiple pathways to hedging while a Fixed Basis agreement is exclusive to private Bilateral OTC Hedge contracts.

3.6 Profitability: HB_WEST Hedge with CRR

	Uncurtailed Mining + HB_WEST Hedging & OBL CRR 24x7 @ 100% Coverage	Uncurtailed Mining + HB_WEST Hedging & OBL CRR 24x7 @ 75% Coverage	Uncurtailed Mining + HB_WEST Hedging & OBL CRR 24x7 @ 50% Coverage		Uncurtailed Bitcoin Mining	Curtailed Bitcoin Mining
January	$94.15	$98.56	$102.98		$111.82	$117.05
February	$84.58	$89.18	$93.78		$102.98	$106.90
March	$85.57	$89.22	$92.86		$100.15	$99.40
April	$82.95	$83.91	$84.87		$86.79	$91.54
May	$108.04	$107.99	$107.93		$107.81	$110.41

Figure 3.6.1 - Monthly Profit per MWh at 75th Percentile Entry Point - OBL CRR

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

	Uncurtailed Mining + HB_WEST Hedging & OPT CRR 24x7 @ 100% Coverage	Uncurtailed Mining + HB_WEST Hedging & OPT CRR 24x7 @ 75% Coverage	Uncurtailed Mining + HB_WEST Hedging & OPT CRR 24x7 @ 50% Coverage		Uncurtailed Bitcoin Mining	Curtailed Bitcoin Mining
January	$94.10	$98.53	$102.96		$111.82	$117.05
February	$84.54	$89.15	$93.76		$102.98	$106.90
March	$85.51	$89.17	$92.83		$100.15	$99.40
April	$82.86	$83.84	$84.82		$86.79	$91.54
May	$107.96	$107.92	$107.88		$107.81	$110.41

Figure 3.6.2 - Monthly Profit per MWh at 75th Percentile Entry Point - OPT CRR

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

The average price for OBL CRR per MWh, and OPT CRR per MWh covering the delivery months Jan - May 2025 was $14.28/MWh, and $14.97/MWh. Despite this seemingly high entry point, both CRRs when paired with an HB_WEST hedge returned greater profits compared to Naked HB_WEST hedge.

A simulated well-informed entry at 75th Percentile (Top 25%) HB_WEST hedge rates yielded a return of -$9.66/MWh for OBL CRRs, and -$9.92/MWh for OPT CRRs. These figures reduced lost revenue compared to Naked Hub Hedging by 14.13% and 11.82%, respectively.

In simpler terms, just hedging CRRs would have bolstered profits. The average OBL CRR payout across 5 months was $1.49/MWh while the OPT CRR returns were slightly lower at $1.23/MWh.

4. Timing the Hedge (Buying Window Optimization)

4.1 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.*

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

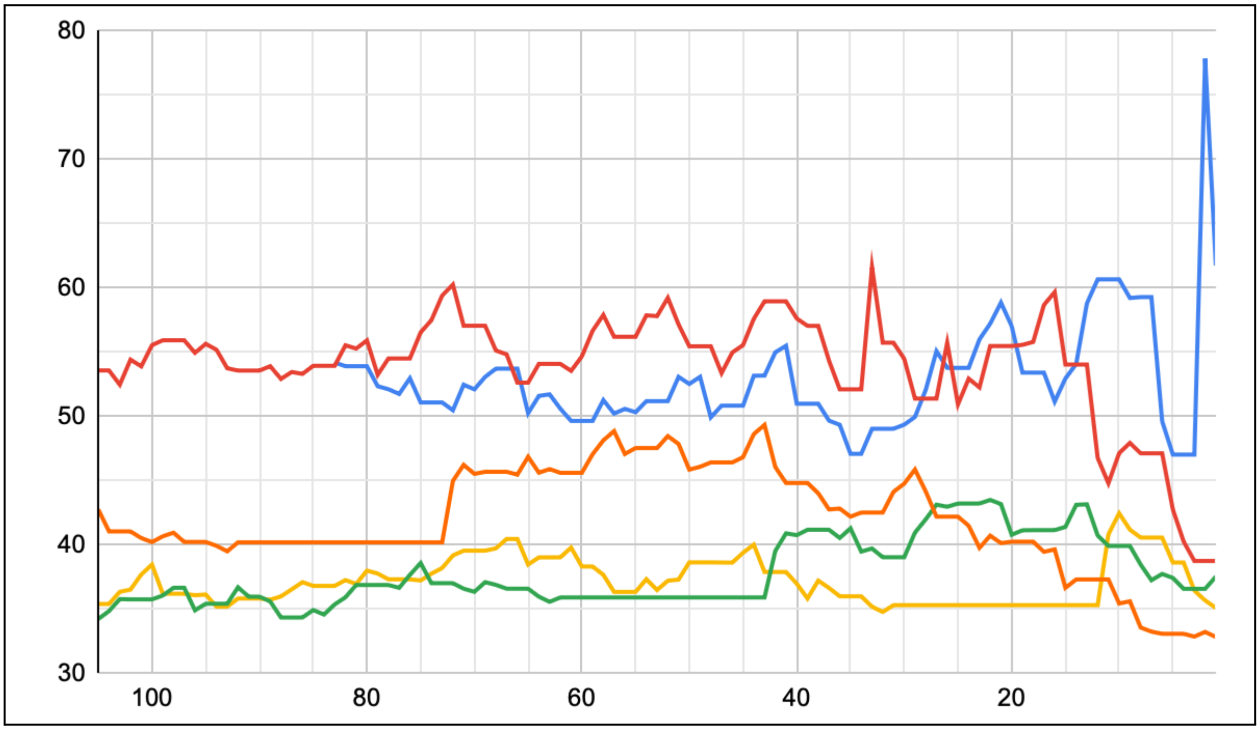

Figure 4.2.1 - Short-Term Entry Window
X-Axis *- Days until Delivery Date,* ***Y-Axis*** *- Hedge Price per MW*

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	$52.04	$50.83	$54.07	$59.75	$55.96
February	N/A	$54.70	$54.93	$56.28	$54.34	$47.80	$40.68
March	N/A	$36.22	$38.05	$37.11	$35.26	$39.41	$37.11
April	N/A	$34.19	$36.18	$37.73	$42.16	$39.86	$37.09
May	$36.08	$37.94	$42.55	$45.78	$40.74	$35.64	$32.98

Figure 4.2.2 - Time-to-Delivery Hedge Price Breakdown

	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	1.947	2.288	0.829	11.733
February	N/A	1.126	1.890	2.230	2.594	2.896	3.187
March	N/A	0.666	1.316	1.342	0.000	2.907	2.130
April	N/A	0.994	1.020	2.253	1.056	1.843	0.531
May	0.721	2.302	2.801	2.154	2.283	1.751	0.153

Figure 4.2.3 - Hedge Price Volatility by Purchase Timing

Giving reference to the ***Figures** above: **4.2.1, 4.2.2, 4.2.3,*** in the Operational Hedge Entry Window, Hedge rates are relatively in the higher end of medium-term entry point with the average standard deviation across the study period coming in at $1.04/MW. Past the 73 days mark, volatility picks up with a moderate uptrend. Between the ~75 days and ~15 days until delivery, volatility more than doubled, jumping to $2.38/MW.
In the final 3 days, hedge entry price fell drastically, coming in at $40.76/MW. On the contrary, average hedge price for the rest of the operational hedge window was $45.34/MW, equating to an average discount of 10.10% in the last 3 days.

This hedge market trend can be credited to the following factors:

- **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 latter stages of the entry window, leaving fewer active buyers in the market.

4.3 Early Positioning Window (0–200 Days Before Delivery)

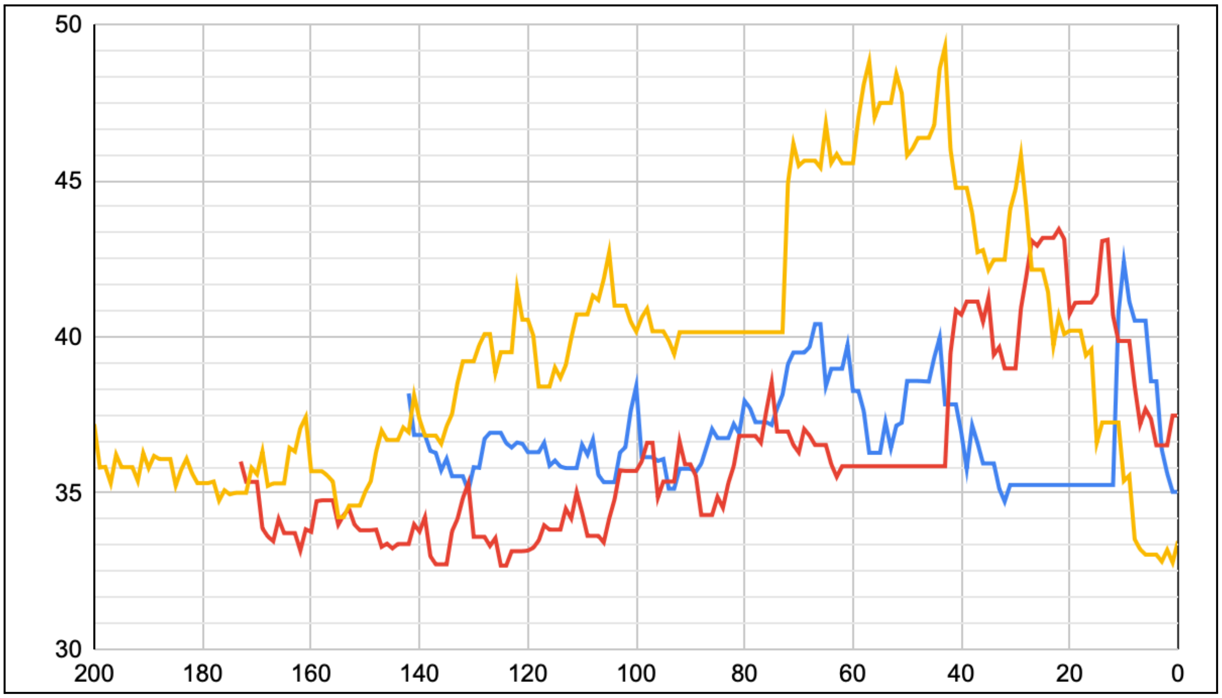

Figure 4.3.1 - Long-Term Entry Window

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
January	N/A	N/A	$52.04	$50.83	$54.07	$59.75	$55.96
February	N/A	$54.70	$54.93	$56.28	$54.34	$47.80	$40.68
March	N/A	$36.22	$38.05	$37.11	$35.26	$39.41	$37.11
April	N/A	$34.19	$36.18	$37.73	$42.16	$39.86	$37.09
May	$36.08	$37.94	$42.55	$45.78	$40.74	$35.64	$32.98

Figure 4.2.2 - Time-to-Delivery Hedge Price Breakdown

	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	1.947	2.288	0.829	11.733
February	N/A	1.126	1.890	2.230	2.594	2.896	3.187
March	N/A	0.666	1.316	1.342	0.000	2.907	2.130
April	N/A	0.994	1.020	2.253	1.056	1.843	0.531
May	0.721	2.302	2.801	2.154	2.283	1.751	0.153

Figure 4.2.3 - Hedge Price Volatility by Purchase Timing

The last week before delivery in the short-term entry was promising, delivering noticeably lower prices but there was a very good reason for that. The risk horizon had shrunk drastically and forecasts for both grid load and weather, in other words, the hedge prices in the latter stages of the short-term were not cheap but rather, the medium-term entry window was over-valued as brokers banked on high demand and volume trading.

On the contrary, the bigger picture, T+90/100 or more days before delivery showed even lower prices and more stability. This trend was also spotted in the LZ_WEST hedge prices, where earlier entries granted better flexibility and more time for adjustment. Part of the reason is that LZ_WEST hedges are essentially HB_WEST hedges paired with a fixed adder from the broker, the K-value between LZ_WEST and HB_WEST prices across the 5 study months came in at 0.982, exhibiting a near perfect 1:1 correlation between the two. For that reason, the timing strategy for either one can be exactly the same and the outcomes will be the same, the real art of the deal lies in negotiating a Fixed Basis agreement that is lower than the Broker added Fixed Basis which often plays out in favor of the broker.

The very high 0.982 K-value also means that a similar ~30 days after contract listing entry window serves as the most optimal opportunity. Contracts(March, April, May) within the Early Positioning Window saw an average price drop of 7.16% after contract listing while contracts(January, February) listed in the Operational Hedging Window dropped 5.02%. This equates to an average discount of 6.30% for contracts after ~30 days of listing regardless of their posted hedge window.

5. Optimal Hedge Coverage Probability Model

Deciding the most optimal hedge coverage in terms of maximizing profits isn't just a game of guessing or using pre-set coverage rates of 100%, 75% or 50%.

While Hedging in itself is a strategy used to mitigate risk rather than boost revenue, a well strategized hedge can do both without sacrificing either.

The following logistic probability based model gives the most optimal coverage % to maximize profits from hedging:

$$\text{Coverage} = \frac{1}{1 + e^{-k(P_{\text{breakeven}} - P_{\text{hedge}})}}$$

For Excel: =1 / (1 + EXP(-k * (Breakeven_Hedge_Price - Actual_Hedge_Price)))

5.1 Formula Breakdown

$P_{\text{breakeven}}$: Breakeven Hedge Price at which hedging results in $0 PnL

P_{hedge} : Actual Hedge Price

k : Steepness Efficient (controls the model response to hedge price differences)

e : Euler's number, base of the natural algorithm

Steepness Efficient can be modified 1 to any infinitely positive number but it's best to keep the value between 0.01-10.

k = 0.01 - 2: Sacrifices some profit for better protection, most appropriate for volatile markets

k = 3 - 7: - Strikes the balance between profit preservation and downside protection

k = 8 - 12: - Highly prioritizes profit, aggressive cutoff when hedge price exceeds breakeven price.

5.2 Probability Model in Action

Scenario #1:

Breakeven Hedge Price: $40/MW

Actual Hedge Price: $45/MW

Risk Averseness: 0.01 (Downside Protection > Profit Maximization)

Output: 0.4875 (Model Recommended Hedge Coverage: 48.75%)

Scenario #2:

Breakeven Hedge Price: $30/MW

Actual Hedge Price: $32/MW

Risk Averseness: 8 (Profit Maximization > Downside Protection)

Output: 0.1680 (Model Recommended Hedge Coverage: 16.80%)

6. Methodology

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

6.1 Data and Granularity

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

6.2 Hedge Strategy Construction

Primary Hedging strategy is modeled after a Naked Hub Hedge contract settling at HB_WEST, exposing the physical electricity and operational location to basis risk. To offset and prevent basis risk, numerous Hedging strategies building up on the Naked Hub Hedge were tested and reviewed.

All Hedge Strategy 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

6.3 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 Naked Hub Hedging.

For more advanced strategies, additional calculations such as basis risk stabilization and neutralization, and CRR payouts were incorporated.

6.4 Formulas ****All Value have defaulted $/MW***

Baseline Bitcoin Mining Revenue Calculation:
Revenue = (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 = Revenue - RTM Settlement Price

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

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

Bitcoin Mining with 100% Coverage Fixed Basis Hub Hedging Profit Calculation:
Hedge Payout= Real-Time Load Zone Settlement Price - Entry Hub Hedge Price - Fixed Basis Value

Profit = Baseline Bitcoin Mining profit + Hedge Payout

Bitcoin Mining with Custom % Coverage Fixed Basis Hub Hedging Profit Calculation:
Hedge Payout= Real-Time Load Zone Settlement Price - Hub Hedge Price - Fixed Basis Value

Profit = Baseline Bitcoin Mining profit + (Hedge Payout * Coverage %)

Bitcoin Mining with CRR paired Hub Hedging Profit Calculation:

Hub Hedge Payout = Real-Time Hub Settlement Price - Hub Hedge Price

OBL CRR Hedge Payout = LZ_WEST DAM Price - HB_WEST DAM Price - CRR Price

OPT CRR Payout:
- If Basis > 0: Net OPT CRR Payout = LZ_WEST DAM Price - HB_WEST DAM Price - CRR Price
- If Basis <= 0: Net OPT CRR Payout = - CRR Price

Net Profit with 100% Coverage = Baseline Bitcoin Mining profit + Hedge Payout + CRR Payout

Net Profit with Custom % Coverage = Baseline Bitcoin Mining profit + (Hedge Payout + CRR Payout) * Coverage %

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

6.5 Assumptions & Limitations

January 2025 and February 2025 Hedge Contracts were not represented in the 4.3 Early Position Window subsection due to unavailability of price data.

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.

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

7. References

Data Sources:

- ERCOT Historical Load Zone Settlement prices: Yearly Settlement Point Price Data for the Western Texas Load Zone and Western Hub, including 15-minute interval records
- HashRateIndex Hash price Data: Historical Bitcoin Hash Price Data
- Intercontinental Exchange ERCOT West Load Zone options: ICE traded ERCOT HB_WEST options data
- ERCOT Monthly CRR Auction Results: Finalized Monthly Auction Results for OBL and OPT HB_WEST -> LZ_WEST Routed CRRs
- ERCOT Annual CRR Auction Results: Finalized Annual Auction Results for OBL and OPT HB_WEST -> LZ_WEST Routed CRRs

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