



Hashrate Index Q1-2024 Report: The Specter and Fallout of the Halving

May 2024

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About Hashrate Index

Hashrate Index is a Bitcoin mining data, analytics and research platform. Our platform offers novel data sets that enable miners, traders, content creators, and investors to gain key insights into the mining industry to generate alpha. Hashrate Index is a product of Luxor Technology Corporation, a Bitcoin mining software and services company.

1 Introduction

2 Hashprice Explodes Then Hits All-Time Lows

- a. At All-Time Lows, Hashprice is Trading in Contango
- b. Historical Hashprice Forward Curve
- c. Hashcost per ASIC at Different Power Costs

3 Inscriptions, Ordinals, Runes, and Transaction Fees

- a. How Runes Impacted Transaction Fees

4 ASIC Market Slows Down Ahead of Halving

- a. Antminer S21 Premiums
- b. Ask-Bid-Spreads
- c. New vs Used ASIC Premiums
- d. ASIC Correlations to Hashprice
- e. ASIC Market Share per Manufacturer and Model
- f. New Mining Rig Manufacturers Make Progress

5 Energy Markets

- a. State-by-State Power Prices
- b. Bitcoin Miners Now Have to Jockey with AI Data Centers for Power

6 Bitcoin Mining Stocks Take a Hit

- a. Hashrate Growth is the Name of the Game for 2024
- b. Public Miners Are Expanding Their MW Capacities
- c. Public Miner Fleet Efficiencies and Power Rates
- d. Public Miner Betas to Bitcoin

7 Mining Pools and Firmware Landscape

- a. Mining Pool Leaderboard
- b. Firmware Revenue Analysis Post-Halving

8 Conclusion and Predictions



1

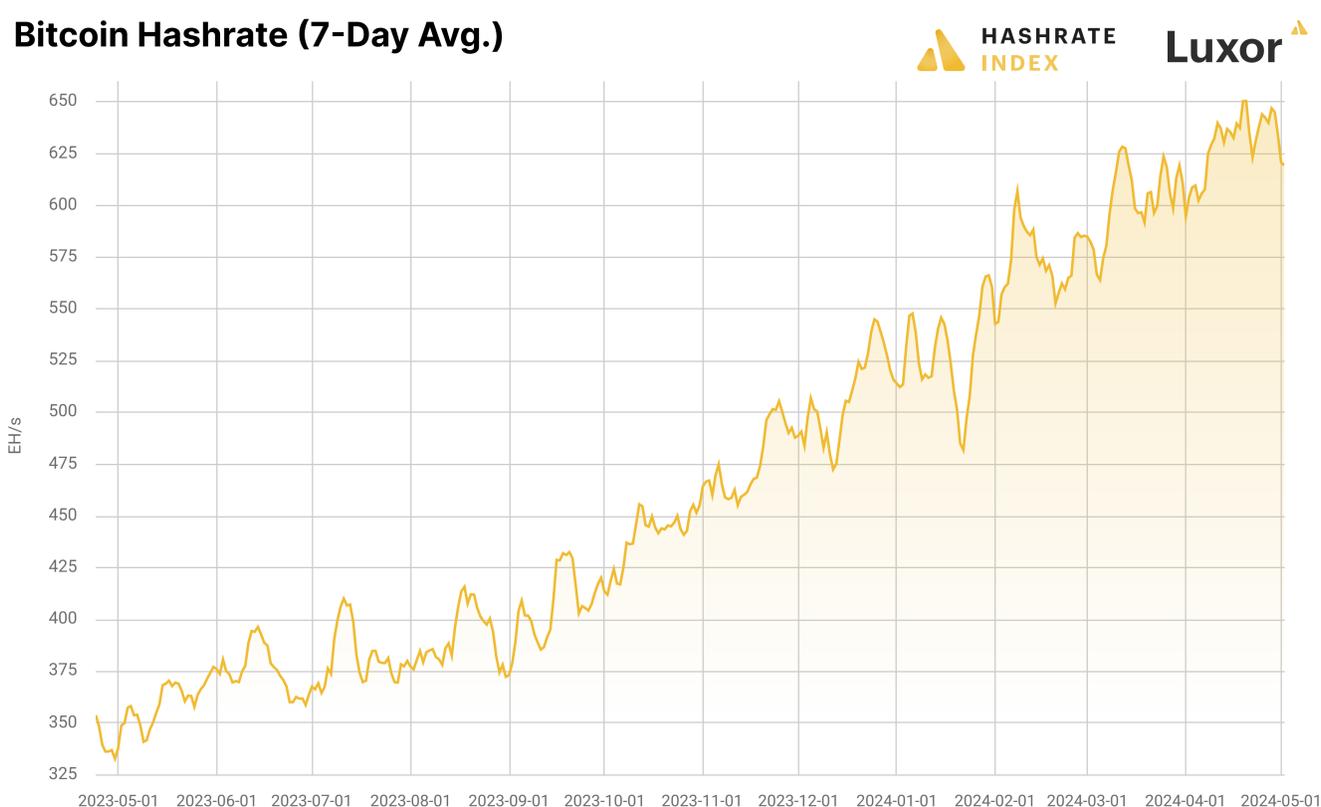
Introduction

Bitcoin's Fourth Halving has come and gone, and the event will go down as the most impactful Halving yet for a number of reasons. For one, the Bitcoin mining industry has never been larger nor has there ever been so much at stake. Further, Bitcoin has attained a mainstream acceptance that it never enjoyed in past Halvings, something that is best exemplified by the Bitcoin ETFs that launched in January of this year. And activity on the Bitcoin network has never been higher, including from alternative, non-financial use cases (namely, Inscriptions/Ordinals and Runes) that are boosting transaction fees when miners need them most.

In this report, we provide a recap of Q1-2024 through the lens of the Fourth Bitcoin Halving, and we include data through April and the first week of May where applicable to show the immediate impact of the event on network data, hashprice, ASIC prices, Bitcoin mining stocks, and other aspects of the mining industry.

As ever, we'll start with hashrate.

Bitcoin's 7-day average hashrate increased by 19% over Q1-2024 to 611 EH/s. As of May 8, 2024, Bitcoin's 7-day average hashrate was 581 EH/s, making the year-to-date change 13% and the year-over-year change 67%.



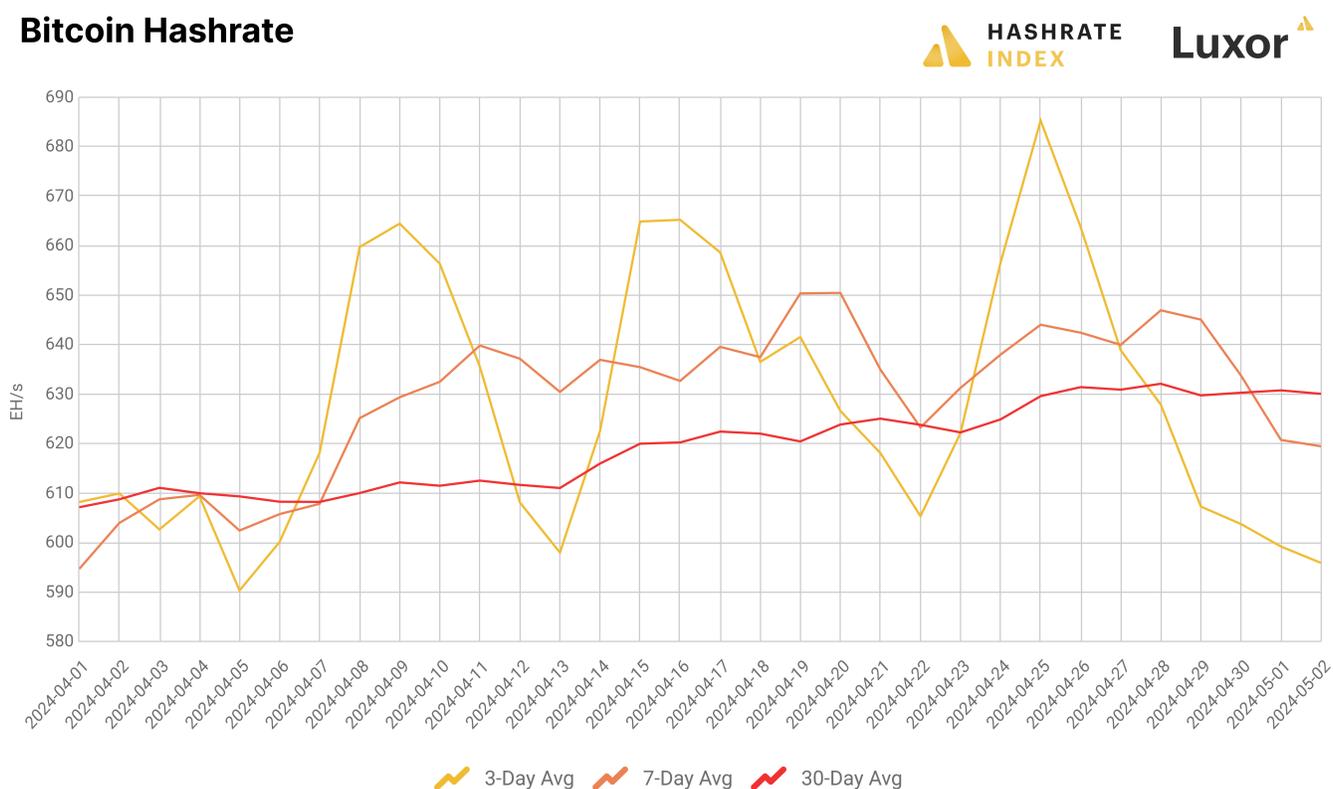
Source: Hashrate Index

In the immediate aftermath of the event, the Halving did not seem to have any meaningful impact on Bitcoin's hashrate. On the day of the Halving (April 19) and the day after, Bitcoin's 7-day average hashrate was 650 EH/s. It proceeded to dip to 623 EH/s on April 22 (a -4.15% drop), but it quickly recovered to 638 EH/s by April 24. Given that hashprice was well above its all-time low of \$55/PH/day in the week after the Halving, it's hard to believe that this drop was anything more than standard variance for Bitcoin's hashrate. In fact, if we look at the standard deviations for 3-day changes to Bitcoin's hashrate over the past year (from April 24, 2023 to April 24, 2024), this drop does not meaningfully diverge from the trend (for our standard deviation, we look at 3-day changes since we are comparing the hashrate decline from April 19 to April 22).

The standard deviation of 3-day changes to Bitcoin's hashrate over the past year is 3.14%, with a mean change of 0.55%. Given these data points, we get a z-score of 1.5 (this score indicates how many standard deviations a value is away from the mean of a dataset) for the -4.15% decrease in hashrate between April 19 and April 22.

While this score indicates a deviation above the mean, it is only moderately above the mean and does not indicate any changes that are out of the ordinary given the general volatility of Bitcoin's hashrate (for example, the largest 3-day drop in Bitcoin's hashrate over the last year was 8.1%).

To be clear, hashrate held up the week or so after the Halving, but miners certainly felt its effects 2 weeks later after hashprice hit an all-time low (something we cover in the next section). Indeed, hashrate began to taper off the network the week of April 29. We can see this drop both on the 3-day average and the 7-day average, as shown in the chart below. As of May 8, Bitcoin's 7-day average hashrate had dropped 11% from 650 EH/s the day of the halving to 581 EH/s. For comparison, the 2020 Halving sun set 15% of Bitcoin's hashrate in its aftermath.



Source: Hashrate Index

If hashprice trades in the \$40-50/PH/Day range for the foreseeable future, then it's probable that hashrate does stay below 600 EH/s for a sustained period of time. It's also unlikely that hashrate doubles in 2024 like it did in 2023, because hashprice will be too compressed for the average miner to aggressively expand their operations. As always, though, if Bitcoin's price continues its bull run throughout the year, then hashrate could grow faster than current hashprice levels would allow.

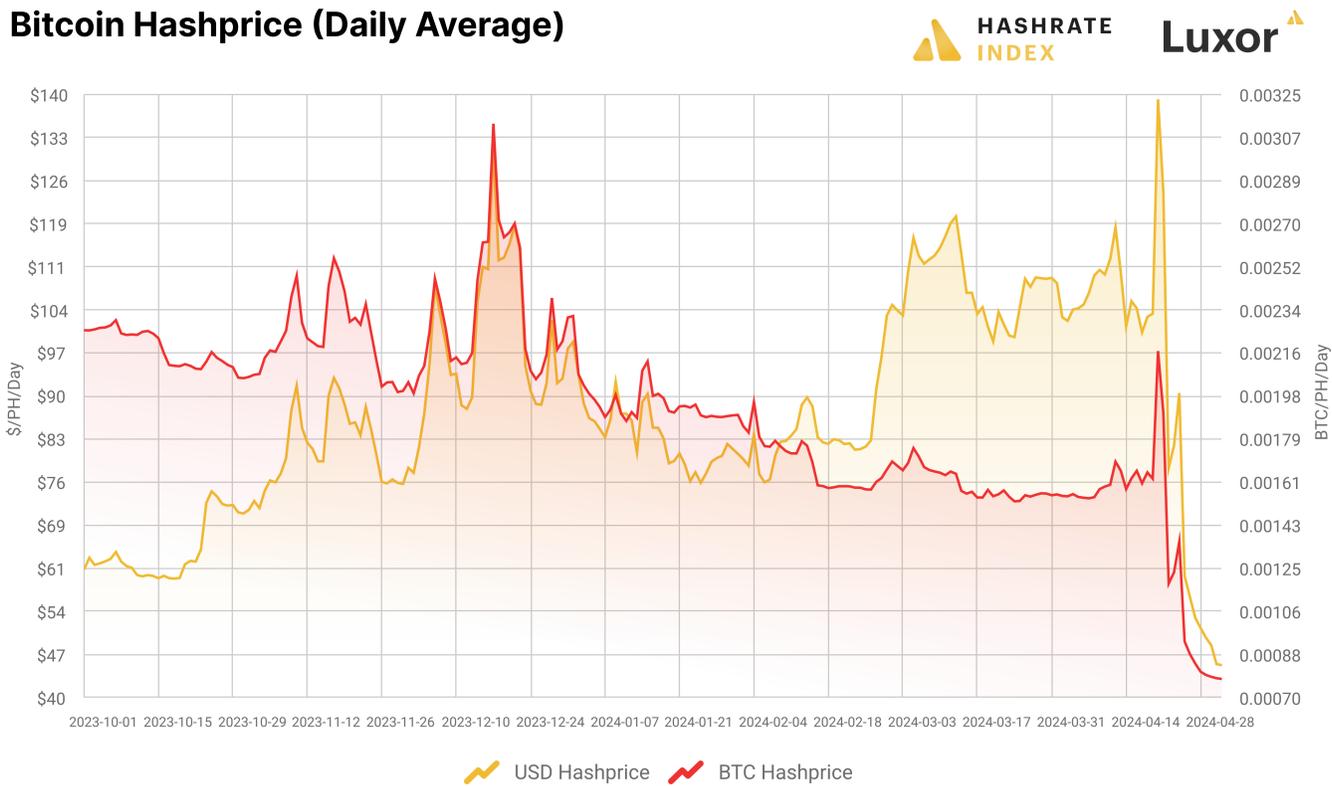


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Hashprice Explodes Then Hits All-Time Lows

The story of the year for miners, of course, is the Bitcoin Halving and how it will affect hashprice. Hashprice had a strong Q1-2024, which set miners up for a less painful experience after the block subsidy reduction. But the pain came all the same, and hashprice swiftly printed all-time lows in the weeks succeeding the event.

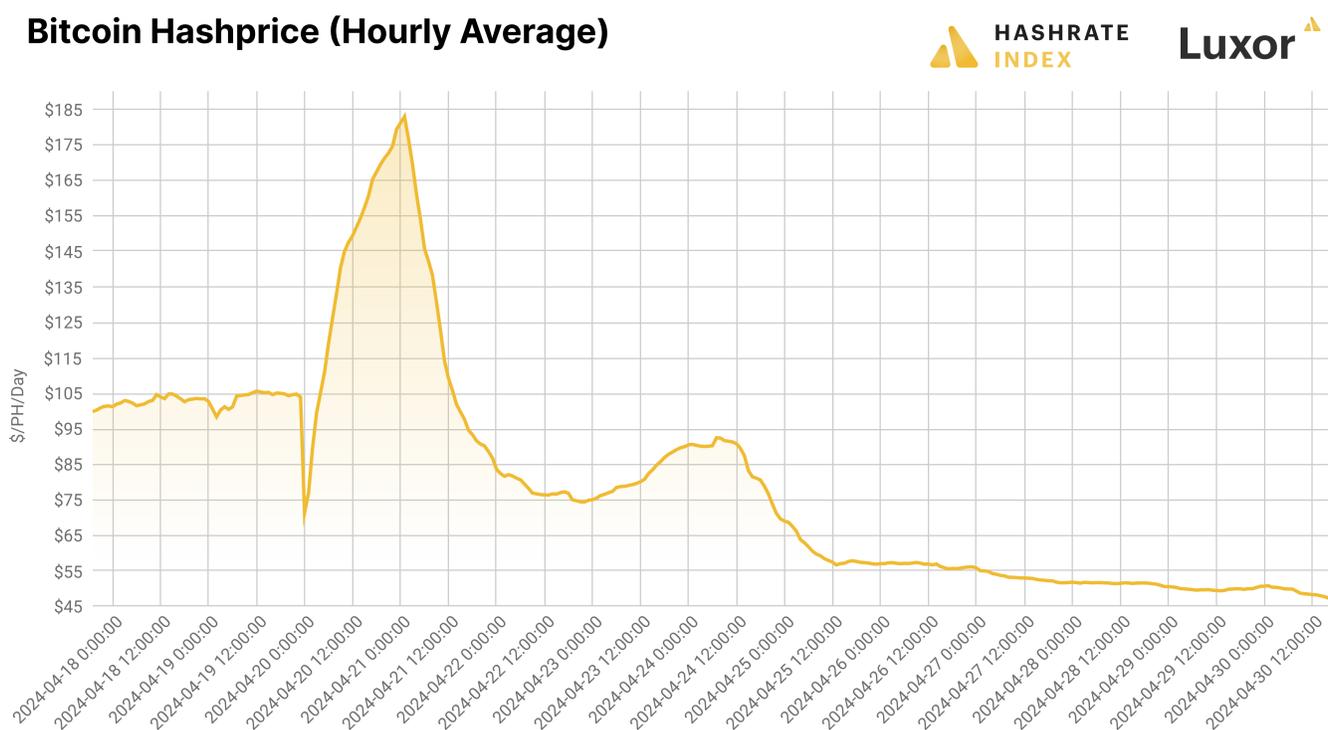
Bitcoin's USD hashprice rose 11% over Q1-2024 to \$109.57/PH/Day, which was also a 38% increase year-over-year. On a BTC-denominated basis, hashprice fell 33% to 0.00156/BTC/PH/Day, a 44% decrease year-over-year.



Source: Hashrate Index

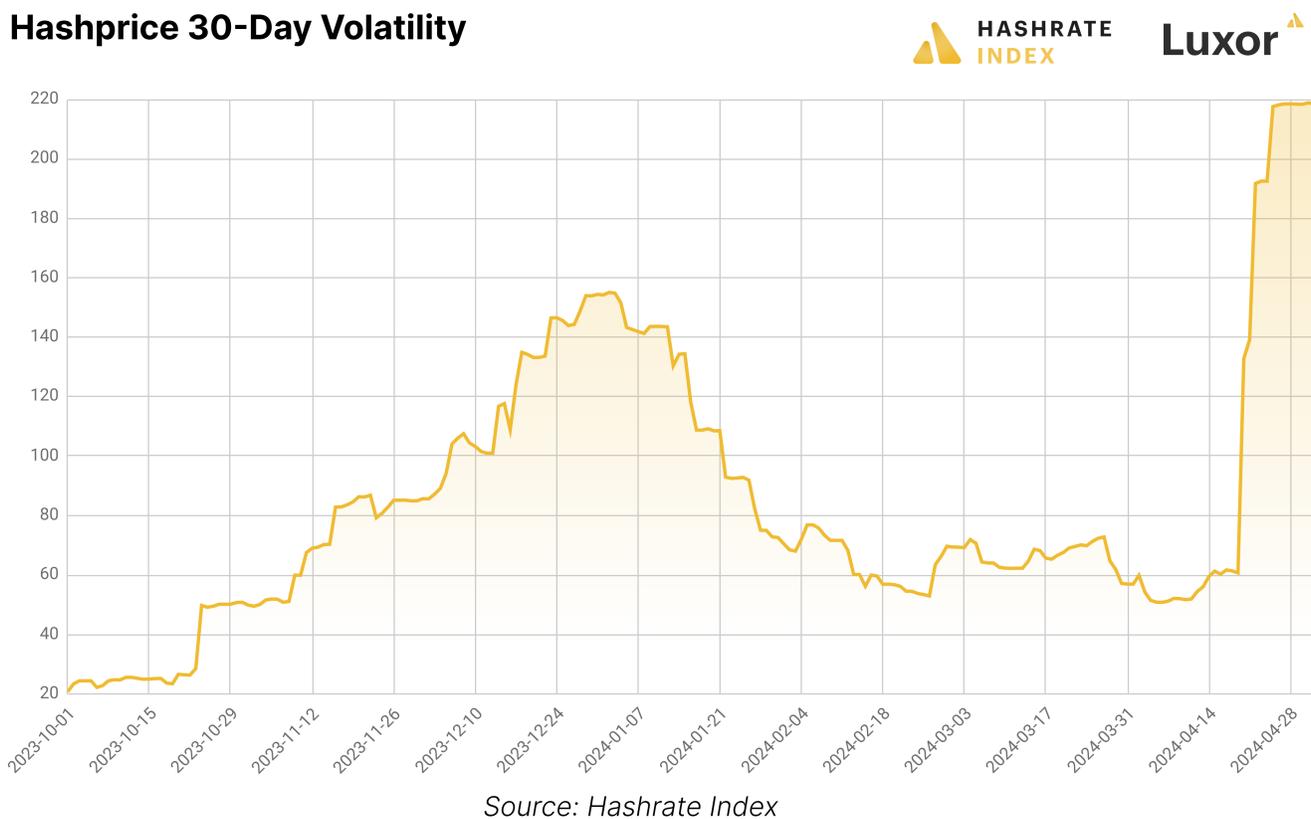
As we write this section on May 2, 2024, USD hashprice is \$45/PH/Day after printing an all-time low of \$44.43/PH/Day on May 1, 2024.

As the chart below shows, hashprice fell to \$71.40/PH/Day on the hour of Halving, but it quickly recovered to above \$100/PH/Day and topped off at \$183/PH/Day the day after the Halving thanks to Runes-related activity, the highest level since April 2022 (all times in the chart below are UTC). As Runes trading fell off a cliff, hashprice did too, dropping below \$50/PH/Day on April 28, 2024 for the first time ever.



Source: Hashrate Index

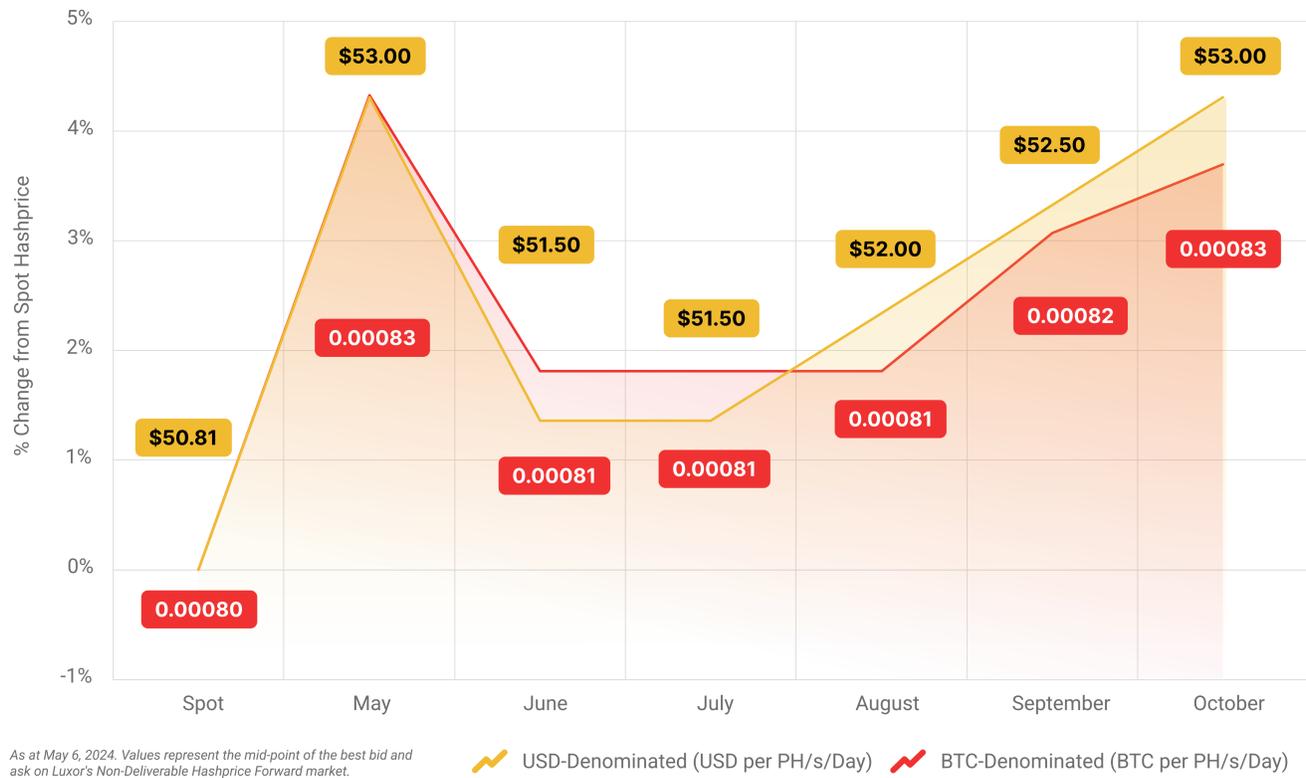
Given the insane hockey-stick movement of hashprice after the Halving (and its subsequent plummet), it should be no surprise that hashprice volatility recently hit a multi-year high, shattering the prior multi-year high set in December of 2023. (When measuring volatility, the higher the number, the more volatile an asset over the 30-day rolling period and vice versa for a low score).



At All-Time Lows, Hashprice is Trading in Contango

Hashprice is lower on a USD basis than it has ever been, but Hashrate traders think that the bottom is in (for the short-term, at least).

Indeed, it's worth noting that, as of May 6, 2024, Luxor's Hashrate Forwards are trading in contango through October, which means that the contract prices for these forward contracts (which are essentially future contracts, although they trade OTC and not on an exchange) are trading above the current spot price. This means that Luxor Hashrate Forward traders expect hashprice to increase over the next five months by way of either an increase in transaction fees or a decrease in Bitcoin mining difficulty. (The forward curve reflects the mid-point between asks and bids on Luxor's Hashrate Forwards marketplace).



Source: Luxor Derivatives

With the introduction of hashrate derivatives like Luxor's Hashrate Forward Contracts, Bitcoin miners finally have a glimpse into market expectations for the future value of hashrate.

Generally speaking, hashrate traders have been bullish on transaction fees, which they are baking into their expectations for hashprice in the coming months. And they will soon have more tools to trade hashrate.

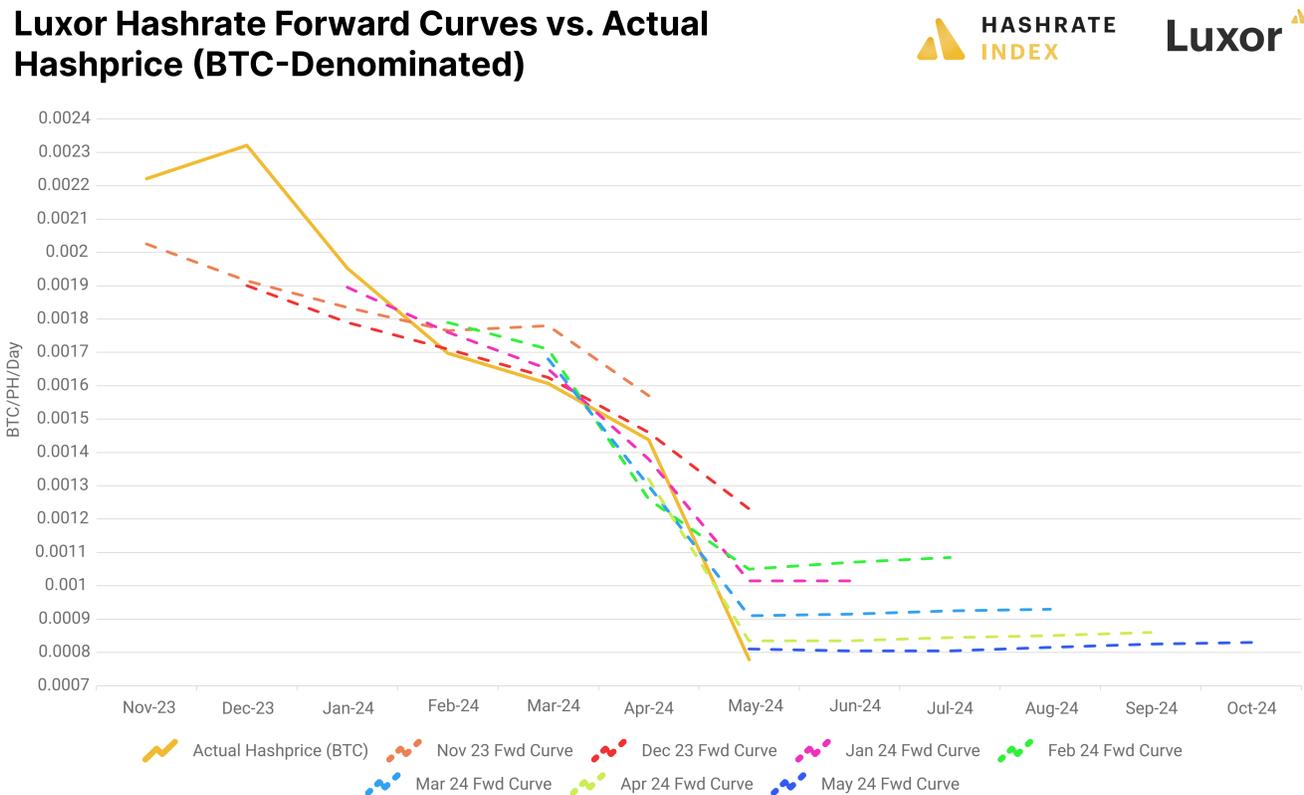
Last quarter, Luxor announced that it will be launching Hashrate Futures in partnership with Bitnomial, a CFTC-regulated derivatives exchange, in Q2-2024. The introduction of these futures will provide miners with increasingly accessible hedging instruments with lower counterparty risk, and they will give miners and analysts even more insight into future hashprice expectations.

Historical Hashprice Forward Curve

Digging into Luxor's Hashrate Forwards, we can look at historical data for the Forward Curve to discern the market's efficiency at gauging future hashprice and extract alpha based on prior trades.

The chart below shows the BTC-denominated curve for Luxor Hashrate Derivatives contracts from November 2023 to May 2024. We derive this forward curve by taking an average of the lowest ask and highest bid on Luxor's Hashrate Forward order book on the first trading week of each calendar month for each Forward contract month. So for example, for the November data point, we take the ask-bid average for forward contracts in the first week of November for November, December, January, February, March, and April forward contracts. We then compare these forward prices to monthly average spot prices for hashprice.

As the chart demonstrates, Luxor Hashrate Forward market participants have been generally accurate at pricing future hashrate. We may expect this given that BTC-denominated hashprice is more static than USD-denominated, because the only variables traders have to account for are changes to mining difficulty and transaction fees. But the latter is where the alpha lies.



For instance, we see the spot price (the black line) rise sharply above forward pricing in November and December. In USD terms, transaction fees were at their highest levels since 2017 for these months thanks to inscriptions trading, and fees stayed elevated for the longest period since 2020/2021's bull market. As a result, hashprice surged during this period.

As such, forward buyers for these months made a pretty penny. Conversely, though, buyers were overconfident that the transaction fee gold rush would last longer than it did, so traders overbid for hashprice in January, February, and March. As such, miners and hashrate sellers who locked in forward prices for these months earned more than they would have if they had mined spot hashprice.

As we mentioned in the prior section and as this chart reiterates, these hashrate forwards are trading in contango over the next six months worth of contracts. Bitcoin's difficulty will be a decisive factor for future hashprice trajectory obviously, but as the above chart suggests, transaction fees will likely have more of an impact.

Hashcost per ASIC at Different Power Costs

Hashcost is a counterpart to hashprice. The metric measures the daily cost to operate an ASIC, and it's typically denominated in \$/PH/Day. Hashcost is the same thing as breakeven hashprice, and as such, we can easily use it to see the breakeven threshold for different ASIC models at various power costs.

The table below displays the hashcost for common ASIC models for electricity rates that range from \$0.01-0.12/kWh. Using May 2, 2024's hashprice of \$45/PH/Day, we can see that miners with older models like the S19 and M30 series need power prices at or below \$0.04/kWh to be mining comfortably in the current hashprice environment, while miners with the latest models (S21 and M60S) have positive margins up to \$0.10/kWh.

Hashcost (\$/PH/day) per Power Cost (\$/kWh)	Hashcost (\$/PH/day) per Power Cost (\$/kWh)											
	\$0.12	\$0.11	\$0.10	\$0.09	\$0.08	\$0.07	\$0.06	\$0.05	\$0.04	\$0.03	\$0.02	\$0.01
S21 (200 TH/s 17.5 J/TH)	\$50.40	\$46.20	\$42.00	\$37.80	\$33.60	\$29.40	\$25.20	\$21.00	\$16.80	\$12.60	\$8.40	\$4.20
M60S (186 TH/s 18.5 J/TH)	\$53.28	\$48.84	\$44.40	\$39.96	\$35.52	\$31.08	\$26.64	\$22.20	\$17.76	\$13.32	\$8.88	\$4.44
M60 (162 TH/s 19.2 J/TH)	\$55.30	\$50.69	\$46.08	\$41.47	\$36.86	\$32.26	\$27.65	\$23.04	\$18.43	\$13.82	\$9.22	\$4.61
S19 XP (134 TH/s 21.5 J/TH)	\$61.92	\$56.76	\$51.60	\$46.44	\$41.28	\$36.12	\$30.96	\$25.80	\$20.64	\$15.48	\$10.32	\$5.16
M50S++ (150 TH/s 22 J/TH)	\$63.36	\$58.08	\$52.80	\$47.52	\$42.24	\$36.96	\$31.68	\$26.40	\$21.12	\$15.84	\$10.56	\$5.28
S19k Pro (120 TH/s 23 J/TH)	\$66.24	\$60.72	\$55.20	\$49.68	\$44.16	\$38.64	\$33.12	\$27.60	\$22.08	\$16.56	\$11.04	\$5.52
M50S+ (136 TH/s 24 J/TH)	\$69.12	\$63.36	\$57.60	\$51.84	\$46.08	\$40.32	\$34.56	\$28.80	\$23.04	\$17.28	\$11.52	\$5.76
M50S (126 TH/s 26 J/TH)	\$74.88	\$68.64	\$62.40	\$56.16	\$49.92	\$43.68	\$37.44	\$31.20	\$24.96	\$18.72	\$12.48	\$6.24
S19j Pro+ (122 TH/s 27.5 J/TH)	\$79.20	\$72.60	\$66.00	\$59.40	\$52.80	\$46.20	\$39.60	\$33.00	\$26.40	\$19.80	\$13.20	\$6.60
M50 (114 TH/s 29 J/TH)	\$83.52	\$76.56	\$69.60	\$62.64	\$55.68	\$48.72	\$41.76	\$34.80	\$27.84	\$20.88	\$13.92	\$6.96
S19 Pro (110 TH/s 29.5 J/TH)	\$84.96	\$77.88	\$70.80	\$63.72	\$56.64	\$49.56	\$42.48	\$35.40	\$28.32	\$21.24	\$14.16	\$7.08
S19j Pro (100 TH/s 30.5 J/TH)	\$87.84	\$80.52	\$73.20	\$65.88	\$58.56	\$51.24	\$43.92	\$36.60	\$29.28	\$21.96	\$14.64	\$7.32
M30S+ (100 TH/s 34 J/TH)	\$97.92	\$89.76	\$81.60	\$73.44	\$65.28	\$57.12	\$48.96	\$40.80	\$32.64	\$24.48	\$16.32	\$8.16
S19 (90 TH/s 34.2 J/TH)	\$98.50	\$90.29	\$82.08	\$73.87	\$65.66	\$57.46	\$49.25	\$41.04	\$32.83	\$24.62	\$16.42	\$8.21
M30 (86 TH/s 38 J/TH)	\$109.44	\$100.32	\$91.20	\$82.08	\$72.96	\$63.84	\$54.72	\$45.60	\$36.48	\$27.36	\$18.24	\$9.12
S17 Pro (56 TH/s 45 J/TH)	\$161.28	\$147.84	\$134.40	\$120.96	\$107.52	\$94.08	\$80.64	\$67.20	\$53.76	\$40.32	\$26.88	\$13.44
M20 (68 TH/s 49.4 J/TH)	\$142.27	\$130.42	\$118.56	\$106.70	\$94.85	\$82.99	\$71.14	\$59.28	\$47.42	\$35.57	\$23.71	\$11.86

Source: Hashrate Index

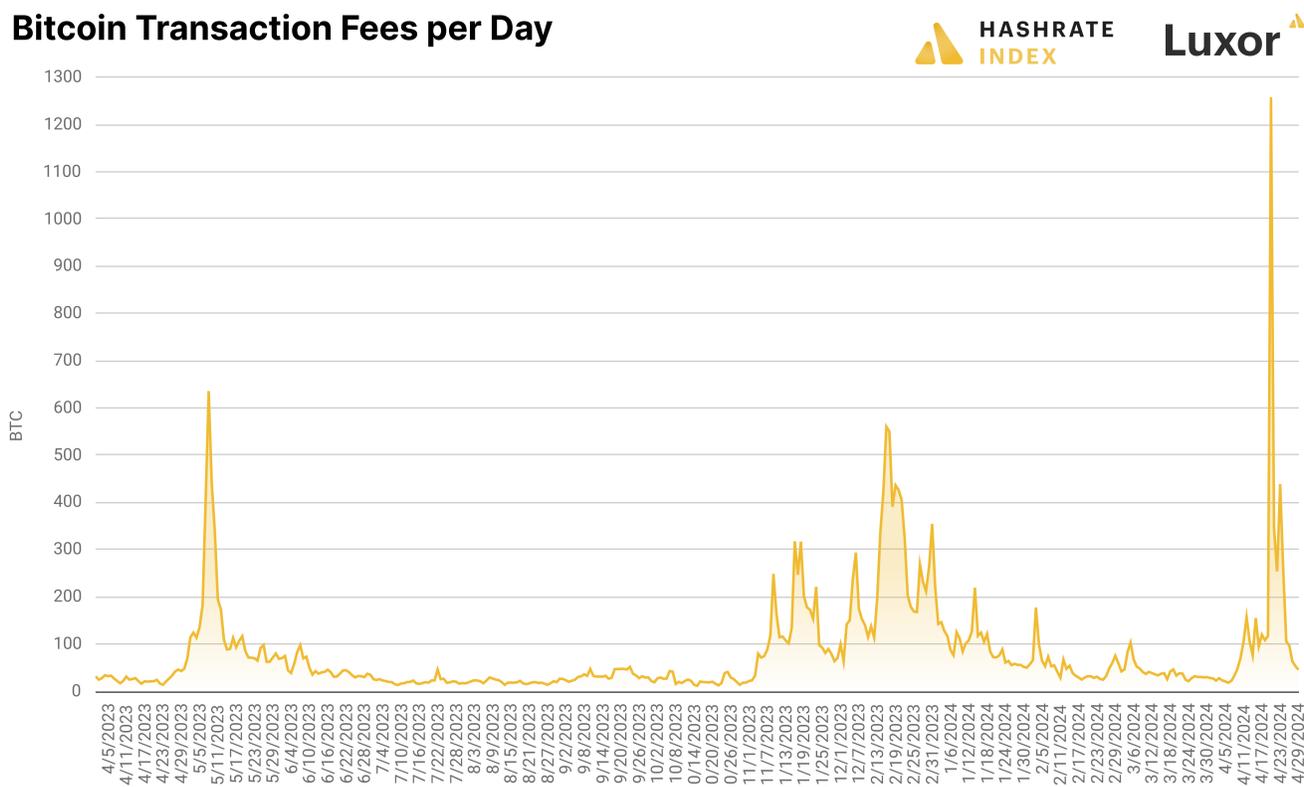
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Inscriptions, Ordinals, Runes, and Transaction Fees

Transaction fees have been the story of the last two years for Bitcoin miners. What had become a paltry share of mining revenue after China's Bitcoin Mining ban in 2021 has reasserted itself as a key component of Bitcoin mining rewards thanks to new (and controversial) NFT/digital collectible standards on Bitcoin: Ordinals/Inscriptions and Runes.

Introduced in December 2022, Ordinals/Inscriptions caught fire last year and sustained transaction fees above the paltry portions miners reaped in 2022. Spikes in trading and minting for these nascent collectibles sparked occasional, meteoric rises to Bitcoin's transaction fees. The first of these notable increases came in late April and early May of last year, but the most impactful and sustained surge to transaction fees from Ordinal/Inscription activity occurred in November and December of 2023.

These spikes look tame, however, compared to the transaction fees miners earned around the Fourth Halving as a result of a new fungible token standard called Runes. In Q4-2023, miners earned 12,493 BTC in transaction fees; in Q1-2024, they earned 5,860 BTC in fees, in April, they earned 4,312 BTC, largely thanks to the Runes token standard.



Source: Hashrate Index

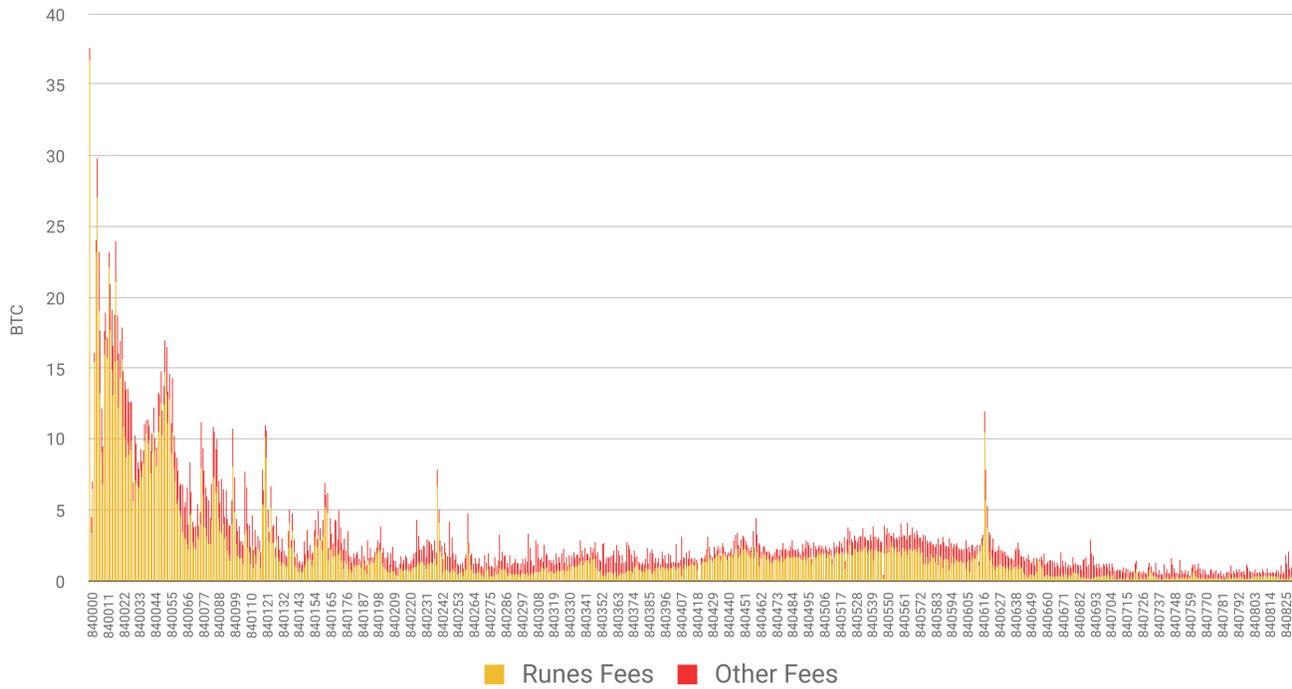
Casey Rodarmor – the inventor of the Ordinal/Inscription standard – unveiled the Runes protocol on block 840,000, the block which marked Bitcoin's Fourth Halving. The ensuing Runes-related activity led to a record level of fee revenue for Bitcoin miners, with miners earning 1,257 BTC in fees on April 20, 2024.

How Runes Impacted Transaction Fees

Miners have Runes to thank for the eye-popping transaction fee activity that kept hashprice frothy in the days after the Halving. This new standard for so-called fungible tokens launched on Halving block 840,000, and they were responsible for 36.75 out of 37.63 BTC in transaction fees that were included in this block, making block 840,000's USD value a record-breaking \$2.6 million at the time it was mined.

Per data from [Matt Kimmell's Dune Dashboard](#), Runes generated 1,819.8 BTC in transaction fees worth \$117 million between the Halving and block 841,539, and they made up 43% of all transaction fees miners earned in this timeframe. For comparison, miners earned 23,445 BTC in fees worth \$797.70 million in 2023.

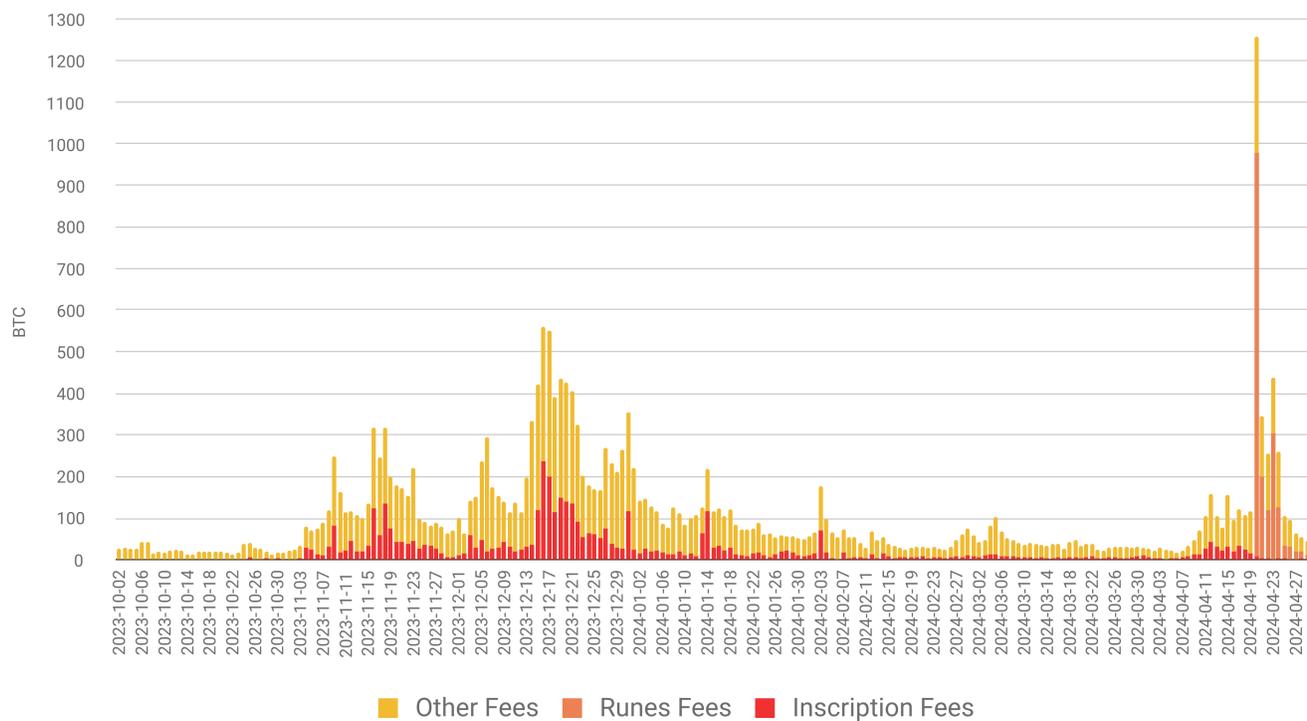
Bitcoin Transaction Fees per Block (April 20 - 25, 2024 UTC)



Source: Matt Kimmell's Dune Dashboard, dataalways Dune Dashboard

As the chart above and the chart below show, Runes trading activity has waned significantly. Indeed, as of April 30, 2024, miners earned the bulk of Runes transaction fees (87%) in the first four days of their introduction.

Bitcoin Daily Transaction Fees

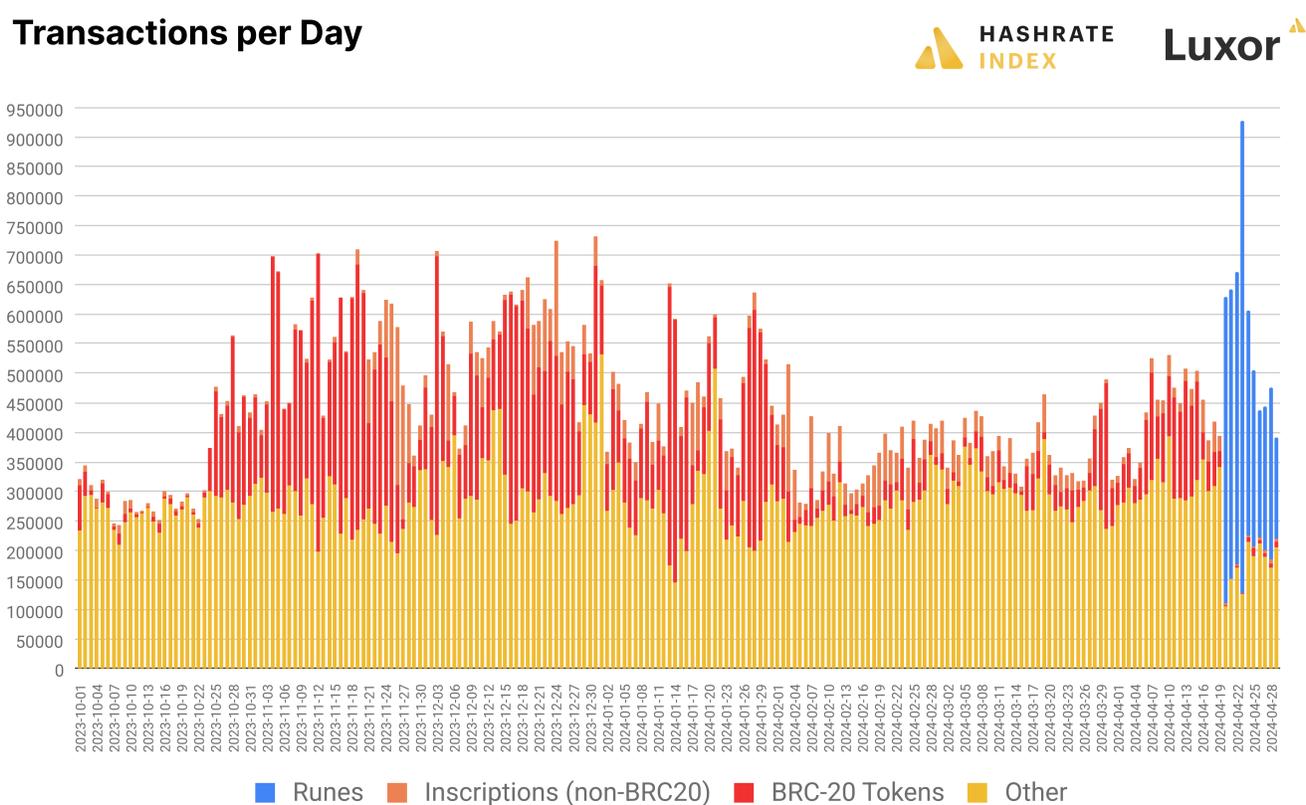


Source: Matt Kimmell's Dune Dashboard

Despite the eye-popping activity at the beginning of the standard's launch, Runes arguably did not make as big of a splash as ordinal/inscriptions enthusiasts expected and miners would have hoped. There could be many reasons for this, but it's probable that collectors and traders were burned by the BRC-20 manias that sent transaction fees flying in May, November, and December of last year. BRC-20 tokens are like proto Runes; they are text based and have the same minting capabilities as Runes, although they use the Segwit data field to store token information, whereas Runes use OP_RETURN for token info.

Ordinal traders speculated heavily on BRC-20 tokens last year, with many token series pumping in value before crashing hard. It's possible that traders became leery of these so-called fungible tokens, which dampened enthusiasm and trading activity for Runes.

Still, it's clear that in the aftermath of the Halving, Runes sucked up trading marketshare from Ordinals/Inscriptions, as the chart of transaction volumes below suggests.

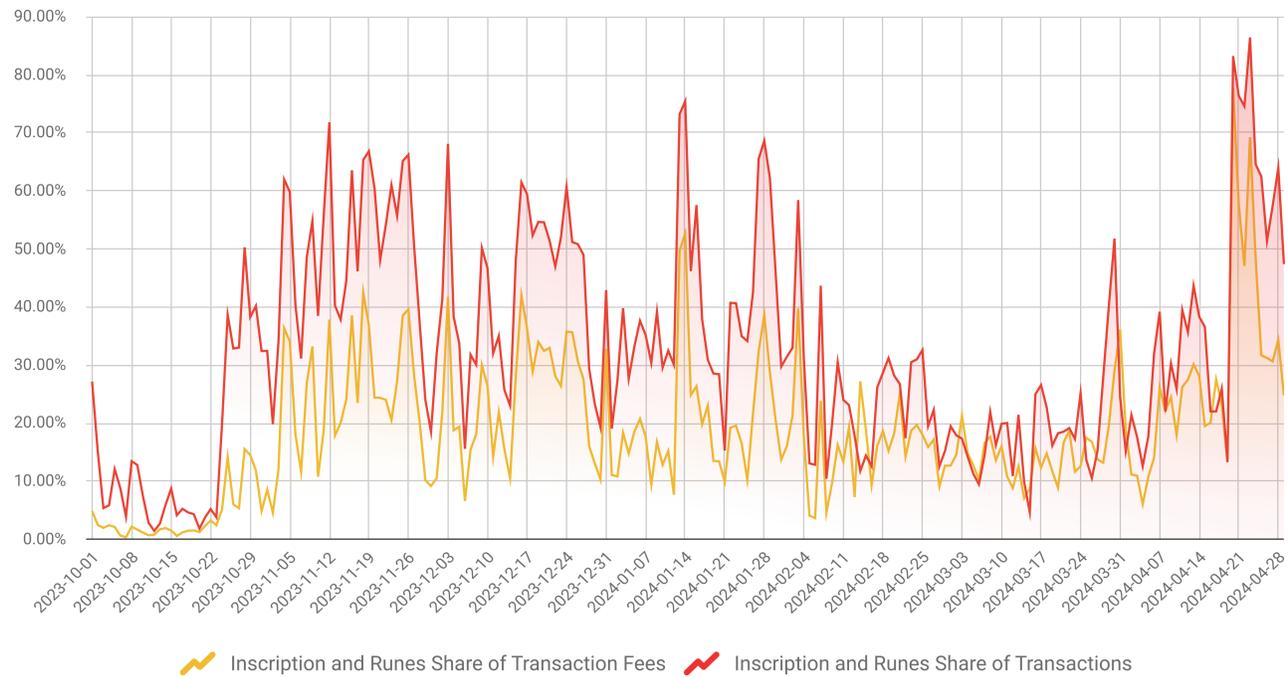


Source: Matt Kimmel's Dune Dashboard | Transaction volume for non-BRC-20 inscriptions only includes transactions that create inscriptions, since there is no sure-fire way of tracking the ordinal-tagged satoshis that are associated with these inscriptions

Despite Runes being somewhat of a flop after their introduction, the fungible token standard and inscriptions writ large are still the most likely candidates for increases to transaction fees in the near future. If usage and adoption continues to eb and flow, we will continue to see notable hashprice volatility over the course of 2024, especially considering that transaction fees now make up a more substantial portion of mining rewards.

We don't know what the future impact of Runes will be, but it's clear that, upon introduction, the standard had a more severe impact on transaction fees and transaction volumes than BRC-20 tokens and other inscriptions – although this impact was much shorter lived. In the chart below, for example, we can see that transaction volumes and fees from Inscriptions/Runes compared to other transactions reached all-time highs after the Halving, but this spike quickly receded, while the high levels of Inscription/Ordinal activity in Q4-2023 form BRC-20s lasted for a longer period of time.

Inscription/Runes Daily Share of Transaction Fees and Total Transactions

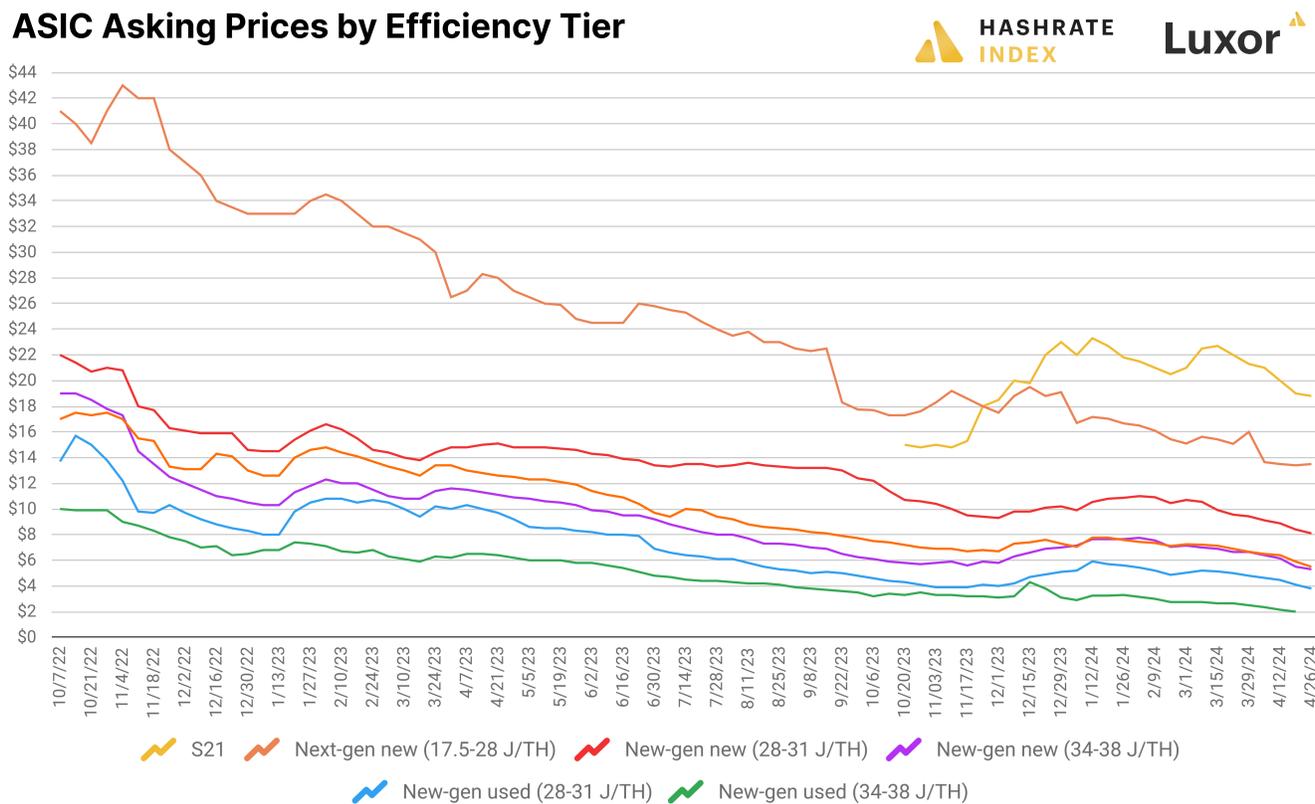


Source: Matt Kimmel's Dune Dashboard, dataaalways Dune Dashboard, Hashrate Index

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ASIC Market Slows Down Ahead of Halving

Unsurprisingly, the ASIC market cooled down significantly leading up to the Halving. Despite Bitcoin's price hitting an all-time high and despite hashprice posting a Q1-2024 average of \$91.14 (a 13% increase over Q4-2023's average), ASIC prices trended down over the quarter, and buying activity stagnated in the weeks leading up to the Halving.



Source: Luxor ASIC Trading Desk

In Q4-2023, the S21 saw significant price increases, with the average asking price according to Luxor Trading Desk data rising 53% over the quarter. Other next-gen rigs like the S19 XP and S19k Pro saw slight increases over Q4-2023, as well, and the only efficiency tier to see decreases over the same quarter, interestingly, was new-gen rigs in the 28-31 J/TH bucket (which we dub 1st tier new-gen ASICs). For those rigs that gained value over Q4-2023, we can attribute the rise to positive changes to hashprice from Inscription activity.

Q1-2024 was an entirely different story, however. Despite further positive changes to hashprice and a higher hashprice average over the quarter when compared to Q4-2023, ASIC prices for all tiers fell over the quarter, and they continued to fall over the course of April before and after the Halving as miners and ASIC traders priced in the Halving's impact on hashprice.

Notably, the S21 saw less of a decrease compared to other next-gen rigs (which we classify as any rig with an efficiency between 17.5 and 28 J/TH).

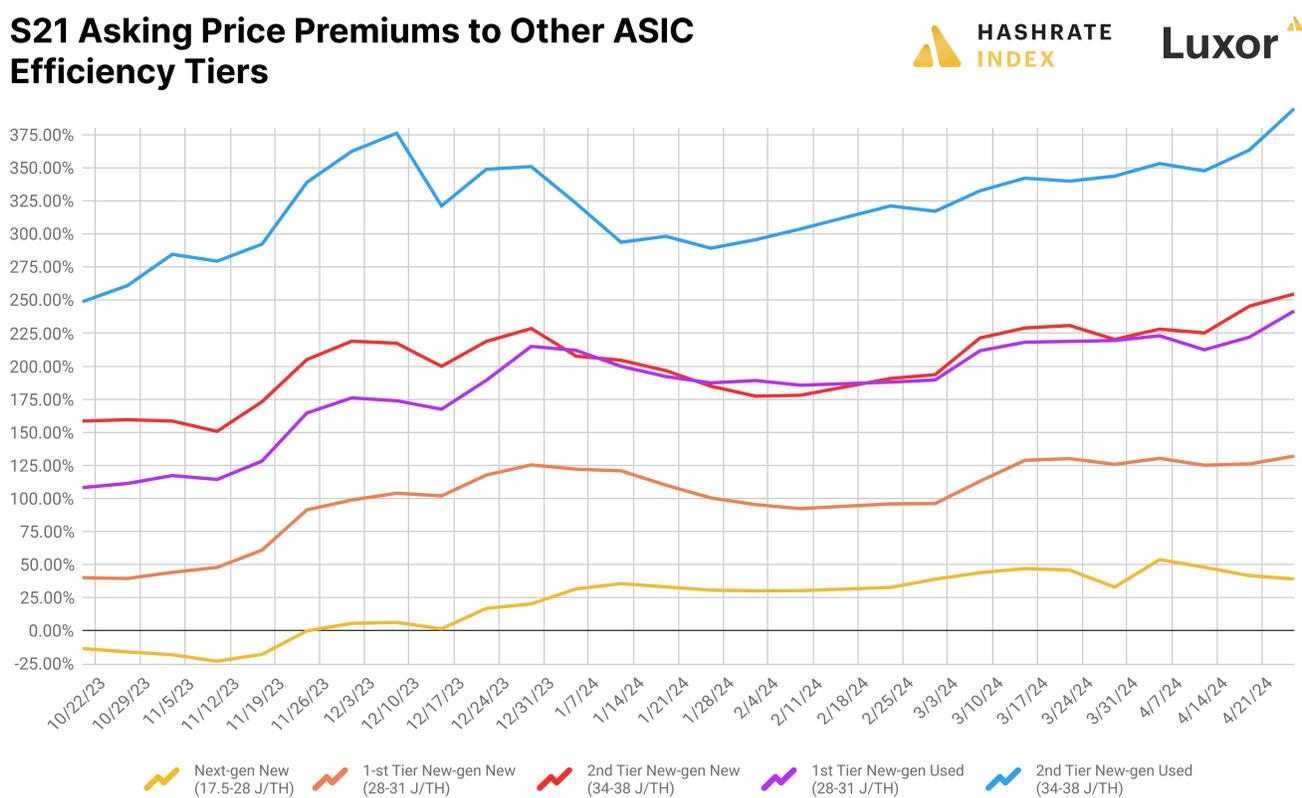
Listing Prices per Efficiency Tier	Q1-23 Change	Q2-23 Change	Q3-23 Change	Q4-23 Change	Yearly Change	Q1-24 Change	YTD Change (May 3, 2024)
S21 (17.5 J/TH) New	-	-	-	53.33%	-	-7.39%	-18.70%
Next-gen (17.5-28 J/TH) New	-19.70%	-4.63%	-30.39%	8.22%	-42.12%	-16.23%	-28.80%
1st Tier New-gen (28-31 J/TH) New	2.16%	-9.98%	-6.51%	-16.22%	-29.66%	-7.56%	-22.55%
2nd Tier New-gen (34-38 J/TH) New	13.41%	-20.43%	-28.57%	14.75%	-31.71%	-5.00%	-25.71%
1st Tier New-gen (28-31 J/TH) Used	6.29%	-25.38%	-17.29%	-3.10%	-41.99%	-8.68%	-26.03%
2nd Tier New-gen (34-38 J/TH) Used	25.00%	-32.52%	-27.14%	10.87%	-36.25%	-5.88%	-25.49%
Mid-gen (38-69 J/TH) Used	-8.64%	-25.39%	-25.00%	17.53%	-43.70%	-19.35%	-
Old-gen (Over 68 J/TH) Used	-	-30.00%	-24.24%	24.00%	-22.50%	-	-

Source: Luxor ASIC Trading Desk

Antminer S21 Premiums

Unsurprisingly, miners are prioritizing the most efficient hardware available, and as a result, price premiums for the S21 continued to grow over the course of Q1-2024.

The premiums stagnated and even decreased slightly for certain tiers in January and February of this year, perhaps as a result of Bitcoin setting a new all-time high. However, as the Halving drew closer – and the S21 began to circulate increasingly on the spot market as deliveries were fulfilled through Q1-2024 – premiums began to rise in March. As of the end of April, these premiums were at all-time highs for every tier except for the next-gen bucket.



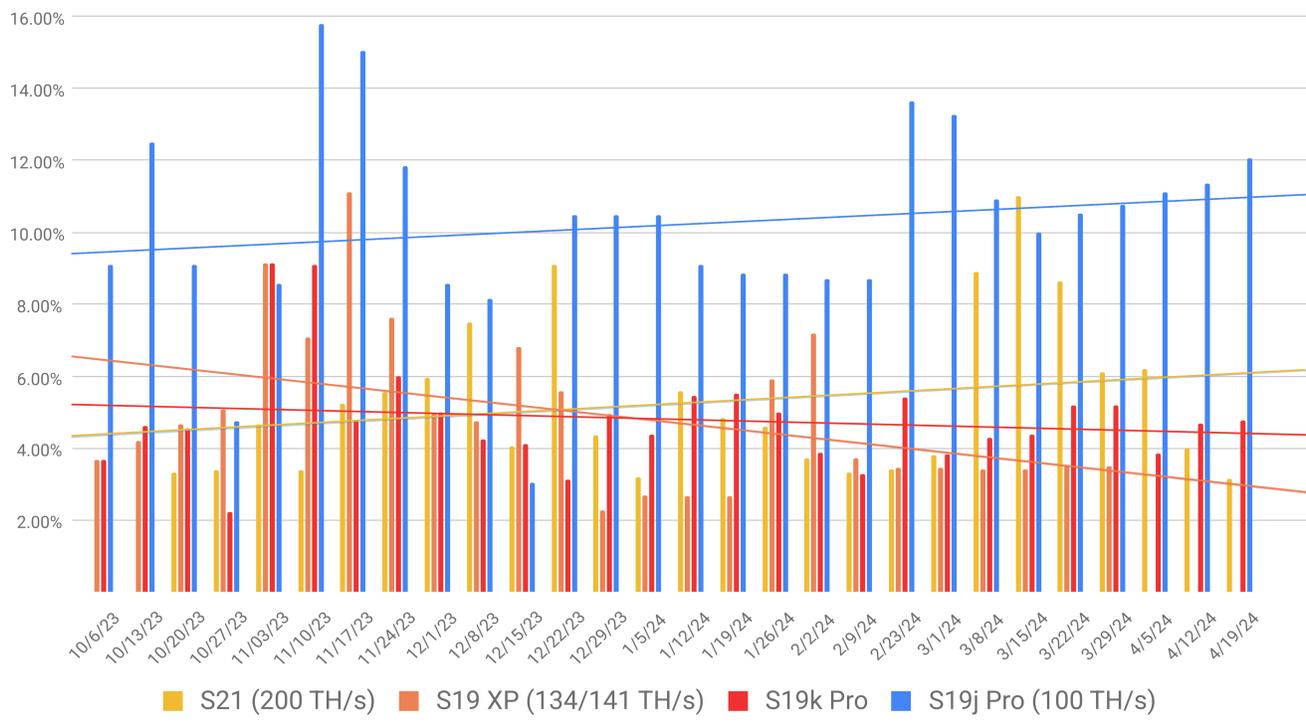
Source: Luxor ASIC Trading Desk

Ask-Bid-Spreads

Notably, since Q4-2023, ask-bid spreads for popular ASIC models have diverged depending on the model.

Spreads for the sale price (bid) versus the listed price (ask) of S21 orders actually rose from the beginning of Q1-2023 to the end of April 2024, meaning that buyers saw increasingly greater discounts from the listed price of this model over the last 7 months, indicating perhaps that the S21 was overpriced upon launch. The S19j Pro also saw spreads between asks and bids widen over the same time period, while the S19k Pro and S19 XP experienced shrinking spreads. (All data taken from Luxor's ASIC Trading Desk; trendlines shown and color coded according to respective model).

Ask-Bid Spreads (for 200-500 MoQ Orders)

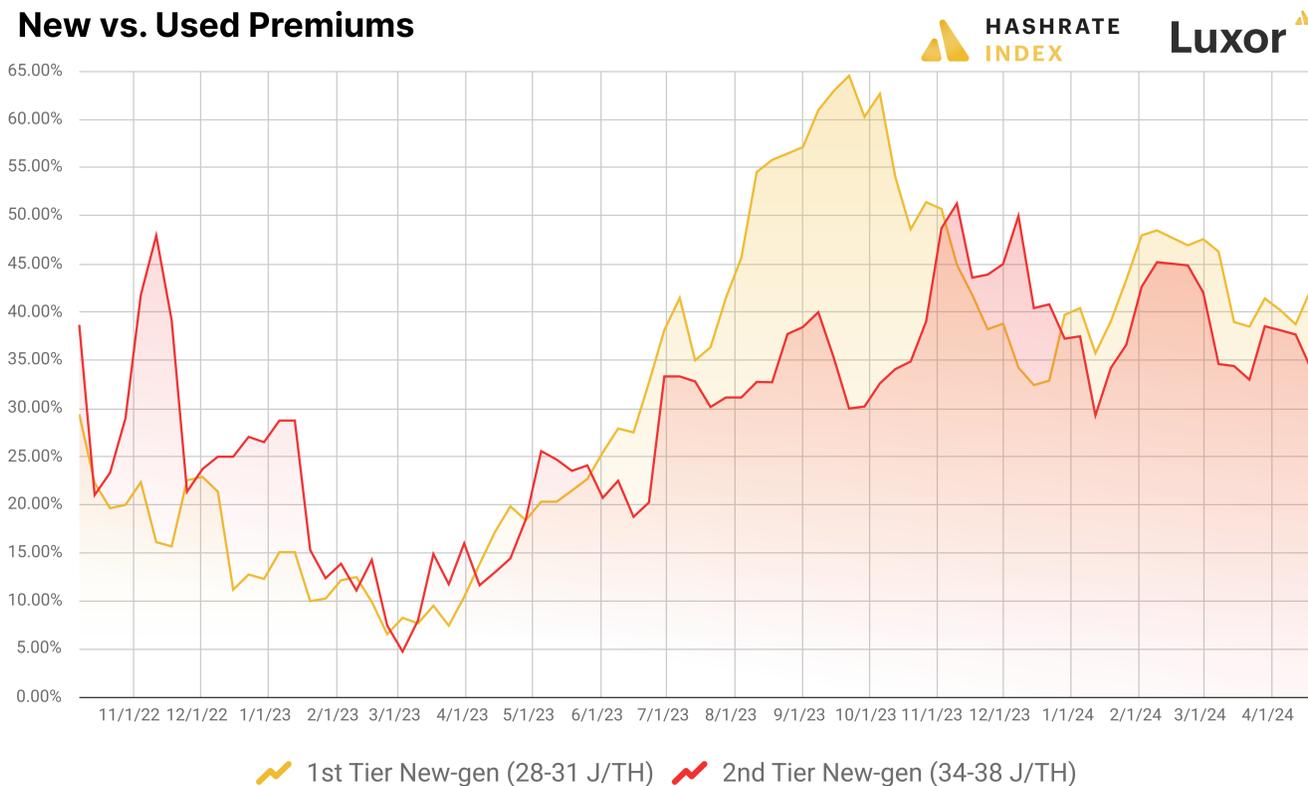


Source: Luxor ASIC Trading Desk

New vs Used ASIC Premiums

Price premiums for new ASICs compared to used ones have been increasing since the beginning of 2023 for our two tiers of new-gen ASICs.

In Q1-2023, these premiums slouched to their lowest level since we've been recording this data, likely as a result of bear market pressures on Bitcoin's price and hashprice in the aftermath of FTX's bankruptcy. These premiums rose substantially over the course of 2023, cooled some in Q4-2023, and rose again throughout Q1-2024.



Source: Luxor ASIC Trading Desk

ASIC Correlations to Hashprice

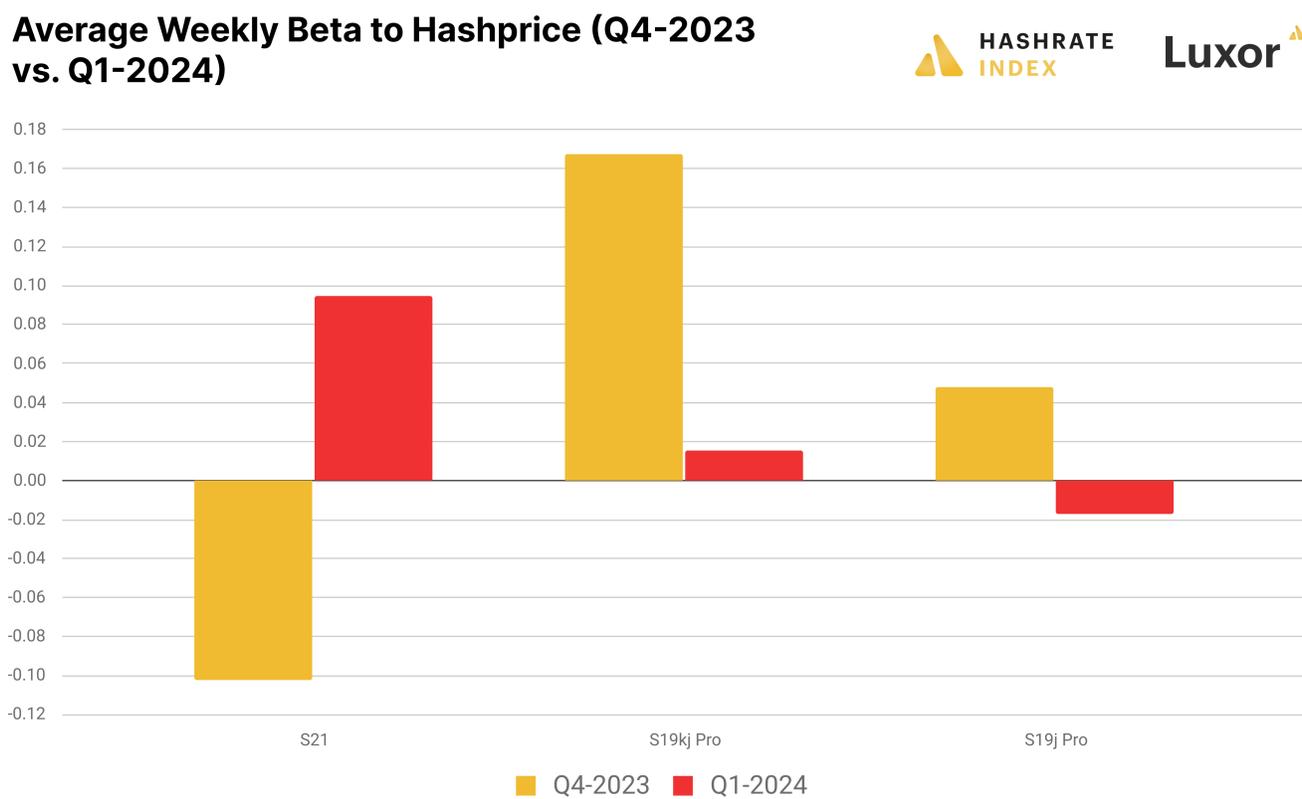
Beta scores are a measure used in finance to determine the correlation and relative volatility of an asset compared to a benchmark, such as another asset or the overall market. A beta of 1 means that the asset's price typically moves with the market.

A beta greater than 1 indicates that the asset is more volatile than the market; if the market goes up or down, the asset's price is expected to increase or decrease more than the market. A beta less than 1 means that an asset is less volatile; it still follows market trends but to a lesser extent. A negative beta is uncommon but it means that the asset moves in the opposite direction to the market.

In the chart below, we show beta scores for the S21, S19k Pro, and S19j Pro to USD-denominated hashprice for Q4-2023 and Q1-2024. We derive these scores by taking the average weekly \$/TH price for each model from Luxor's ASIC Trading Desk price data as well as the average weekly USD hashprice over each quarter. We then calculate the beta scores for each model for each quarter using these weekly averages.

It's worth noting that the S21's trend for Q1-2023 was likely distorted by the fact that prices for this model in this timeframe were for futures orders, so we should expect the S21's price to gradually increase regardless of hashprice over this timeframe as the first delivery dates grew closer and as promotional/coupon pricing subsided.

Overall, this beta analysis reflects trends we see in the decrease in ASIC prices over Q1-2024: principally, that miners and ASIC traders increasingly began pricing in the Halving in Q1 and ASIC prices did not closely track with hashprice. We can see this clearly with the S19k Pro and the S19j Pro, the former of which barely had a positive beta and the latter of which was negatively correlated to hashprice over the quarter. Even the S21's positive beta is relatively small when we consider that a score of 1 equals a perfect correlation.

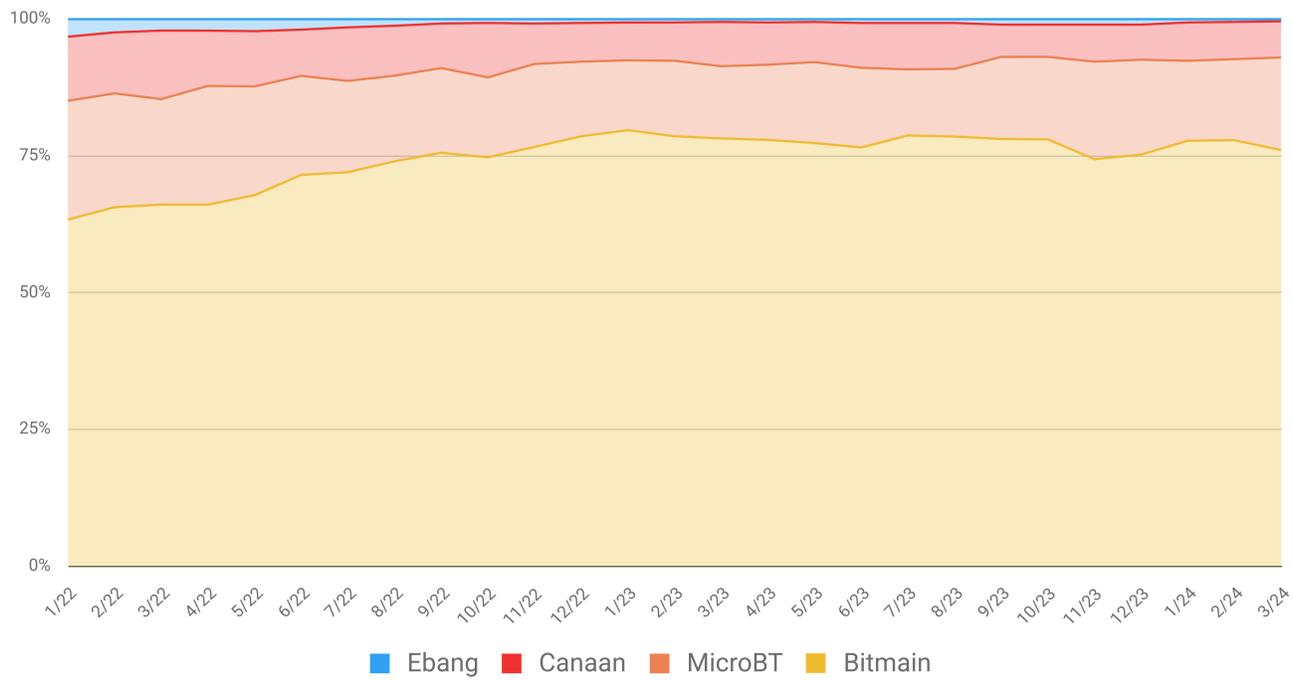


Source: Luxor ASIC Trading Desk, Hashrate Index

ASIC Market Share per Manufacturer and Model

According to Coin Metric's MINE MATCH data, there were no major changes to each ASIC manufacturer's marketshare over the course of Q1-2024. Bitmain's dominance rose 1% over Q1 to 76.1%, while MicroBT's marketshare fell 2% to 16.9%; Canaan's marketshare rose 3% to 6.6% and Ebang's fell 60% to 0.4%.

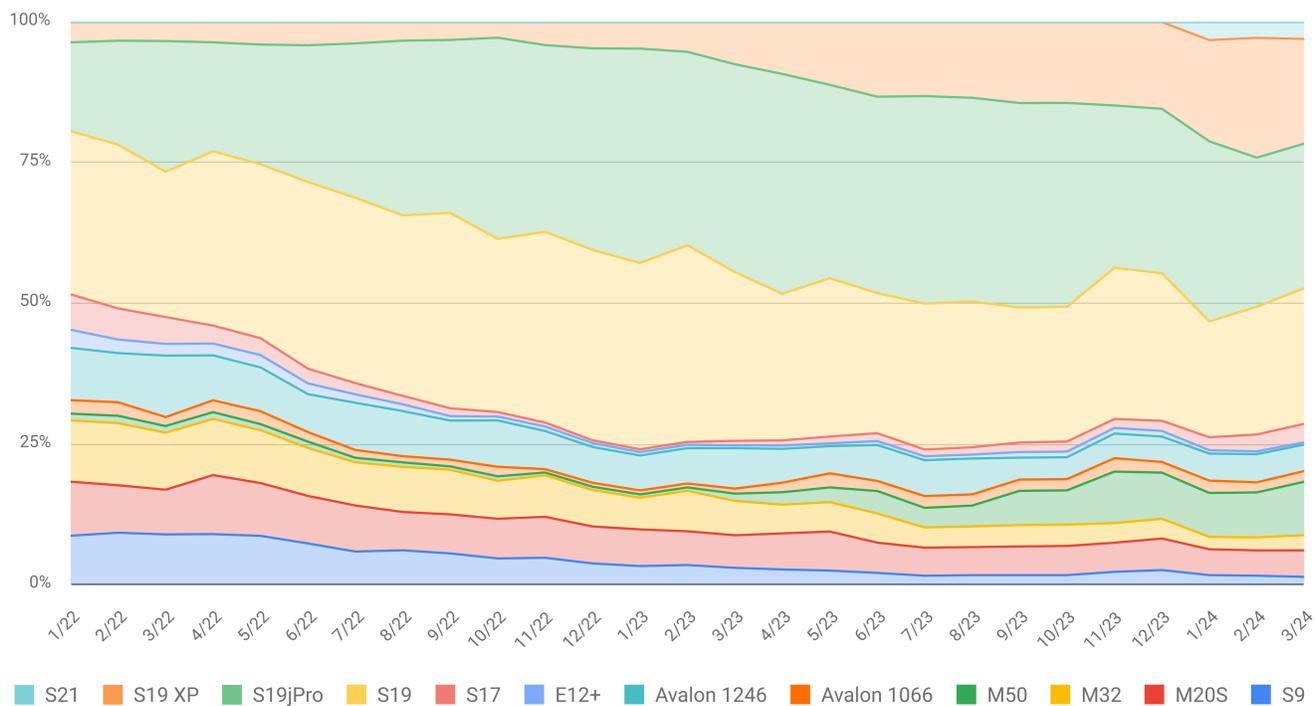
ASIC Marketshare by Manufacturer (Source: Coin Metrics)



Source: Coin Metrics

The chart below shows a model-by-model analysis. Q1-2024 was the first quarter that miners started deploying S21's enmasse, and by the end of the quarter, the model made up 3% of the entire Bitcoin network's hashrate. For other models, we can observe the gradual erosion of market share for older series like the S9, S17, and M20S throughout 2022 as the bear market became firmly entrenched. Conversely, as market conditions dramatically improved in Q4-2023 and hashprice perked up thanks to transaction fees, miners recommissioned a portion of these older models to cash in on the action ahead of the halving. This trend abated in Q1-2024 and these older models saw their market share decline as miners deployed new machines and decommissioned older models in preparation for the Halving.

ASIC Model Marketshare (Source: Coin Metrics)



Source: Coin Metrics

Editor's note: We adjusted Coin Metric's data to only include the S21 from January onward, as the MINE MATCH analysis registers the model earlier than 2024. MINE MATCH is based on nonce analysis, where the program analyzes nonce patterns from ASICs to derive a makeup for the network's hashrate; as such, errors are possible if models display similar nonce patterns, hence why the S21 appears before it was in production. That said, such errors seem like exceptions, and the dataset as a whole appears to provide a generally accurate estimate for the network's ASIC makeup.

New Mining Rig Manufacturers Make Progress

A handful of companies that are looking to break into the ASIC manufacturing industry gave substantive updates in Q1-2024 and April.

To start, Bitdeer opened up reservations for its pilot model, the SEALMINER A1, this April. Bitdeer has not disclosed a hashrate rating or price point for the machine, but its advertised efficiency is 18.1 J/TH, making it competitive with the S21 and M60 series from Bitmain and MicroBT.

The company expects to ship the first orders of the A1 in August 2024. Bitdeer disclosed that it has secured silicon chip orders from TSMC to generate \$60 million worth of SEALMINERS for the first batch in Q3-2024. If we assume an average sales cost of \$5,000 per machine (roughly comparable to current S21 prices), then Bitdeer's first run of these miners could be 12,000 units.

Jack Dorsey's Block, a Bitcoin development company, announced in April that it had completed its design for a 3nm ASIC chip for Bitcoin mining and that it is planning "a full tapeout of the design with a leading global semiconductor foundry."

Another company to watch in the ASIC manufacturing space, Auradine, raised \$80 million in a series B, which followed an \$81 million series A in 2022 (\$35.5 million of which came from Marathon Digital). Specifications for Auradine's Teraflux mining rigs are hard to come by; there are a few testing units that are floating around in the mining market, typically in the hands of larger miners like public companies. That said, the company advertises that its flagship AT1500 can achieve up to 185 TH/s with overclocking, while its second model, the AT2880, can achieve 260 TH/s after overclocking; in Auradine's words, the "optimal" efficiency for either rig is 22 J/TH and 16 J/TH, respectively.



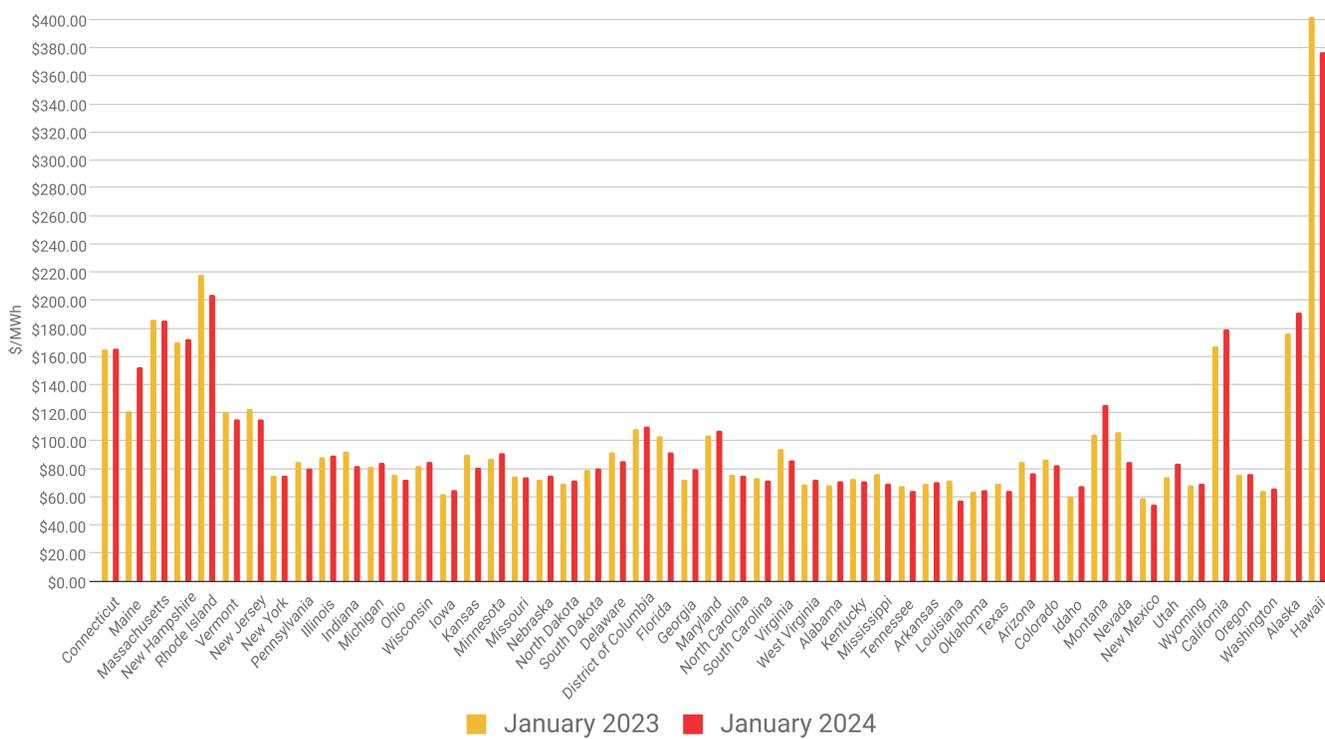
5

Energy Markets

State-by-State Power Prices

Most states in the US saw power rates come down in 2023 from the record energy price inflation they experienced in 2022. Now that the Halving has come to pass and Hashprice is below \$50/PH/Day, the question that's looming is, will US miners be able to compete at current power prices.

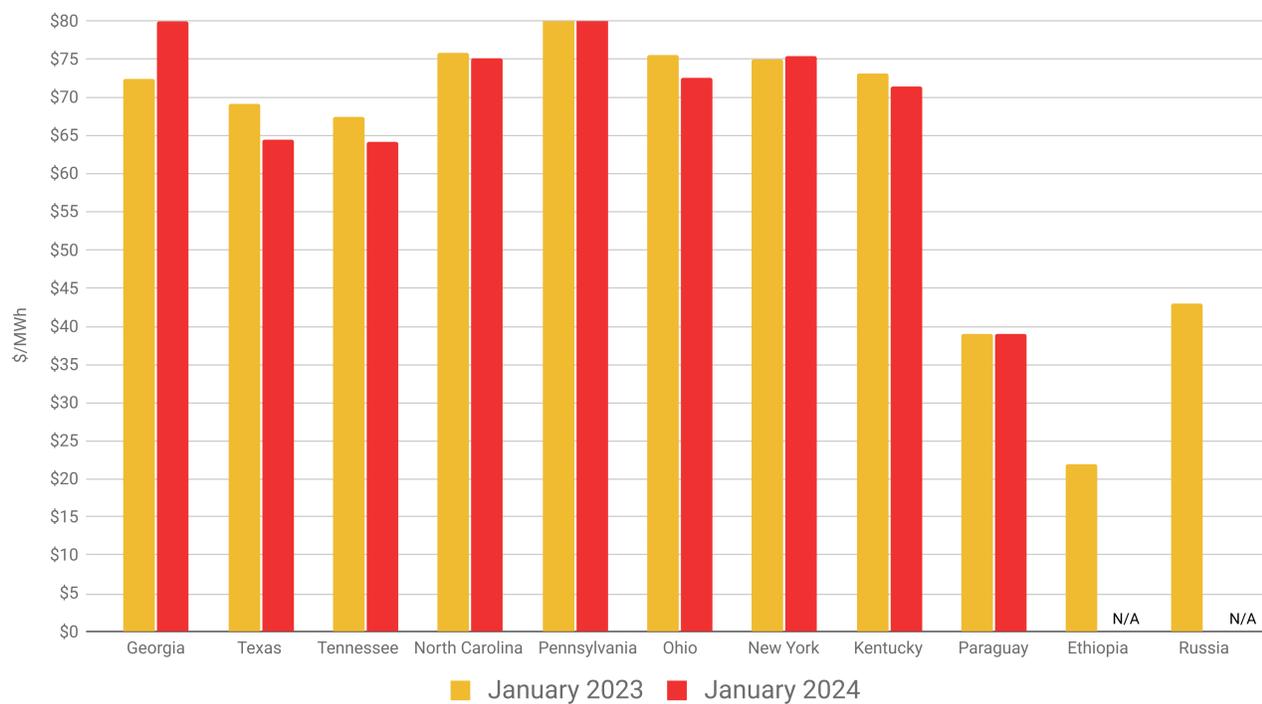
Average Industrial Electricity Rates January 2023 vs. January 2024



Source: EIA

When we compare the average industrial power cost in popular US mining states to other countries that have seen increased mining activity since China's mining ban in 2021, we can see that other geographies offer more competitive rates. Accordingly, we expect to see miners increasingly look toward alternative jurisdictions for more favorable power rates in the current Halving epoch. That said, cheap power rates are not everything. Political stability, property rights, and safety are important considerations, as well. Paraguay's mining industry, for example, could face restrictions for future power allotments should a recently proposed bill pass into law.

Avg. Industrial Power Prices (Jan 2023 and Jan 2024)



Source: EIA, Worldbank, Statista

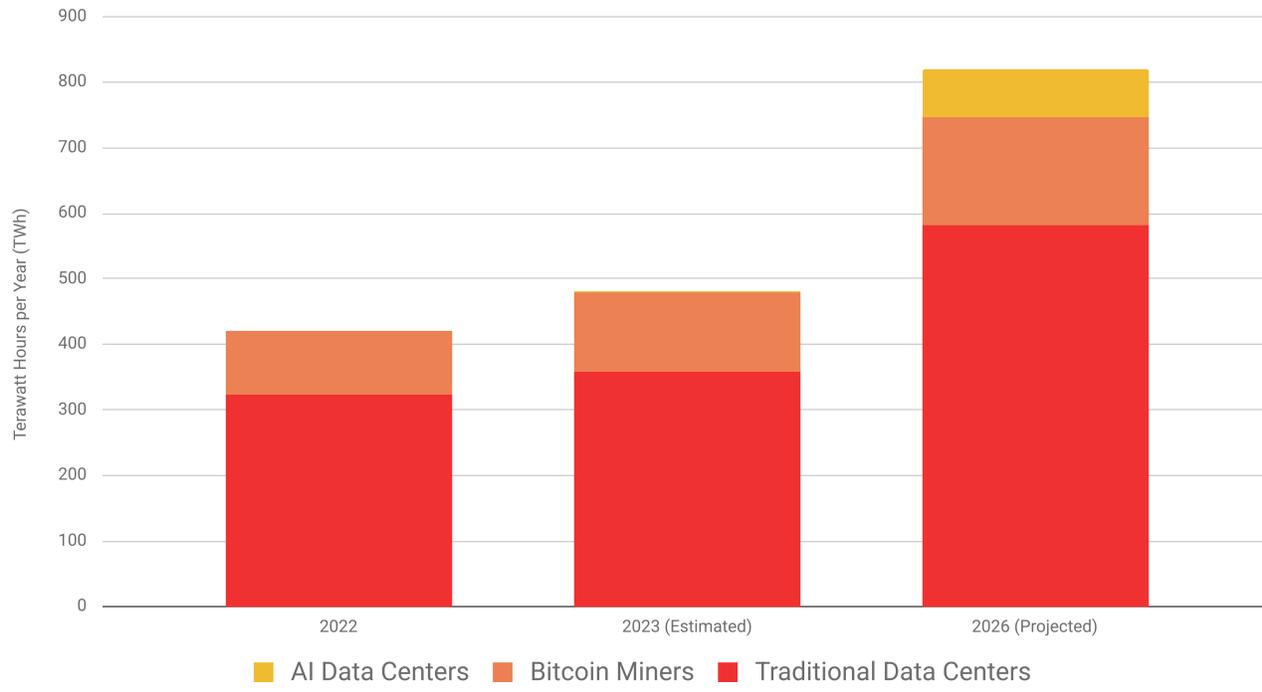
Bitcoin Miners Now Have to Jockey with AI Data Centers for Power

The most impactful and transformative technology to emerge since the internet – if not, the most impactful and transformative ever – will soon compete with Bitcoin for electricity.

AI datacenters consumed relatively small amounts of energy in 2023 compared to other data centers, but that will change over the coming years as AI demand ramps up and new AI data centers come online around the world. Bitcoin miners will compete with these data centers for power resources, something that could inhibit Bitcoin's global hashrate growth.

Taking data from a recent International Energy Agency [report](#), global energy use from AI data centers could grow by a factor of 10 by 2026. In the chart below, we show traditional data center, Bitcoin mining, and AI data center power consumption for 2022, an estimate for 2023 (since there are no clear, public reports on data center numbers for the year yet), and projections for 2026. For Bitcoin mining data, we consult Cambridge's [Bitcoin Electricity Consumption Index](#). For AI data, we use projected figures for 2026 from the IEA report and we estimate 2023 data by cobbling together estimates for Chat-GPT's electricity use per day and extrapolating this out to the rest of the AI compute industry based on Chat-GPT's [marketshare](#). For traditional data centers, we use IEA data for 2022 and projections for 2026, and we estimate 2023's power usage according to annual growth rates for data center power use according to the [International Data Corporation](#).

Traditional Data Centers, Bitcoin Miners and AI Data Centers



Source: Cambridge, IEA, IDC, Joule

6

Bitcoin Mining Stocks Take a Hit

Public Bitcoin miners had a rip roaring 2023, but Q1-2024 was a different story. As the table below indicates for mining stocks with a capitalization greater than \$100 million, as the Halving grew nearer, these stocks started to sell off, and only a handful closed out Q1 in the green. Year-to-date as of May 1, 2024, the only one that was still in the green was Cleanspark.

% Change	CleanSpark	Iris Energy	Riot	Marathon	Cipher	Core Scientific	Hive	Bitdeer	Bitfarms	Terawulf	Hut 8	BitDigital
Q1-2024	70.77%	-4.85%	-25.57%	-5.67%	18.16%	2.62%	-23.69%	-21.62%	-20.25%	5.56%	-14.13%	-27.56%
Year-to-Date*	43.84%	-36.32%	-36.28%	-29.92%	-10.65%	-12.79%	-42.82%	-38.06%	-37.32%	-7.83%	-36.59%	-47.11%
Year-Over-Year*	357.60%	17.98%	-6.65%	83.03%	75.71%	-12.79%	-17.70%	-25.12%	60.36%	26.95%	-3.73%	6.61%
As of May 1, 2024												

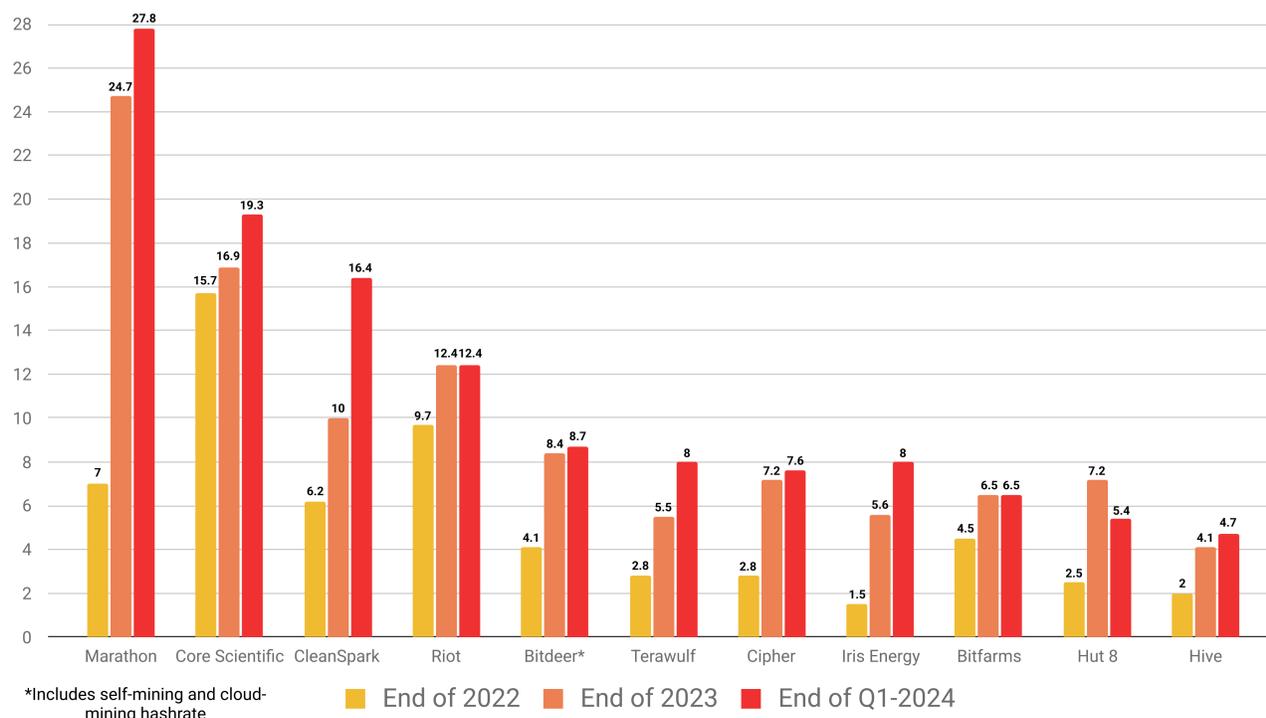
Source: Trading View

These stocks performed poorly in Q1-2024 even as Bitcoin hit an all-time high. This could indicate that, throughout the quarter, investors started pricing in the effects of the Halving. It could also indicate as some have suggested that the Bitcoin ETF is cutting into the price premium mining stocks have traditionally enjoyed as vehicles for indirect BTC exposure. These stocks have historically traded as high-beta price plays compared to bitcoin, so when bitcoin pumps, they pump harder, and vice versa when bitcoin dumps. For the remainder of 2024 as the reality of a 3.125 BTC block subsidy world becomes all the more real, it will be worth tracking the beta scores of these public miners to bitcoin to see how they develop.

Hashrate Growth is the Name of the Game for 2024

Every Bitcoin miner that we examine in this report expanded its hashrate in 2023, but some have been more proactive than others expanding their hashrates in the first quarter of 2024. Now that the block subsidy is cut in half, it's crucial for miners to upgrade their fleets and stay ahead of the hashrate arms race to ensure they can make up for the Halving's revenue impact.

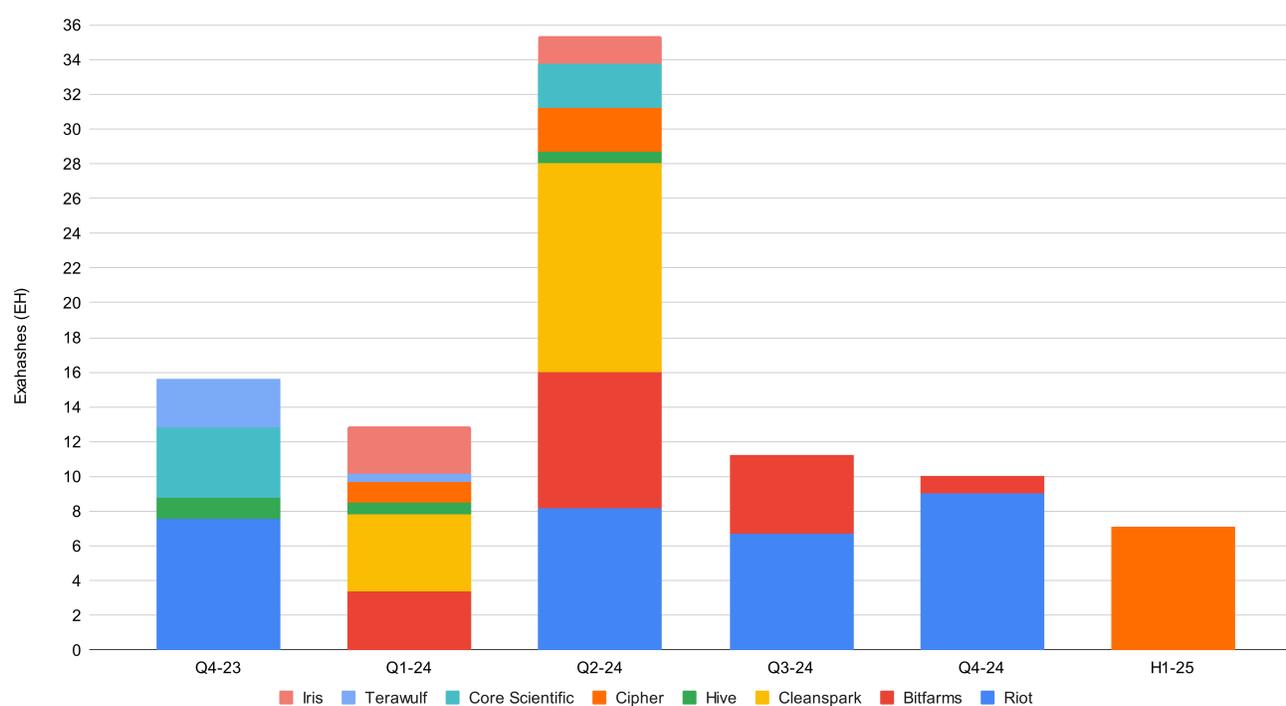
Proprietary Hashrate (in EH/s)



Source: Public Miner Disclosures

Many of these miners were proactive in 2023 and ordered boat-loads of next-generation rigs, namely the S21, T21, M50 series, M60 series, S19k Pro, and S19 XP. These orders will be delivered on a rolling basis throughout the year, and many miners also put money down on options to purchase additional units at a locked-in rate at a later date. Assuming these miners can deploy these units once they are delivered – and not sit on inventory, as we’ve seen in the past with mass ASIC orders – then 2024 and 2025 will see a tidal wave of hashrate come online from these public companies. Case in point, the top public miners have had 76.6 EH/s worth of equipment on order for 2024, 12.9 EH/s of which should have been delivered in Q1-2024 assuming delivery timelines stayed on track.

ASIC Miners on Order (in Exahashes)



Source: Public Miner Disclosures

With regards to orders that have been or will be delivered in 2024, Riot stands out with an impressive \$550.6 million of outstanding orders worth 31.4 EH/s. Riot is constructing a fully immersion-cooled facility, Corsicana, and the company announced it has energized the first of the site’s substations as of April 2024 (although it is not outfitted with ASICs yet).

Bitfarms follows closely behind, with the second-highest hashrate value of outstanding ASIC orders at \$143.7 million worth 16.8 EH/s for mostly T21s and a handful (~1 EH/s) of S21 air-cooled and hydro models.

Cleanspark holds the third position in ASIC orders outstanding, totaling \$281 million for 16.4 EH/s worth of S21s.

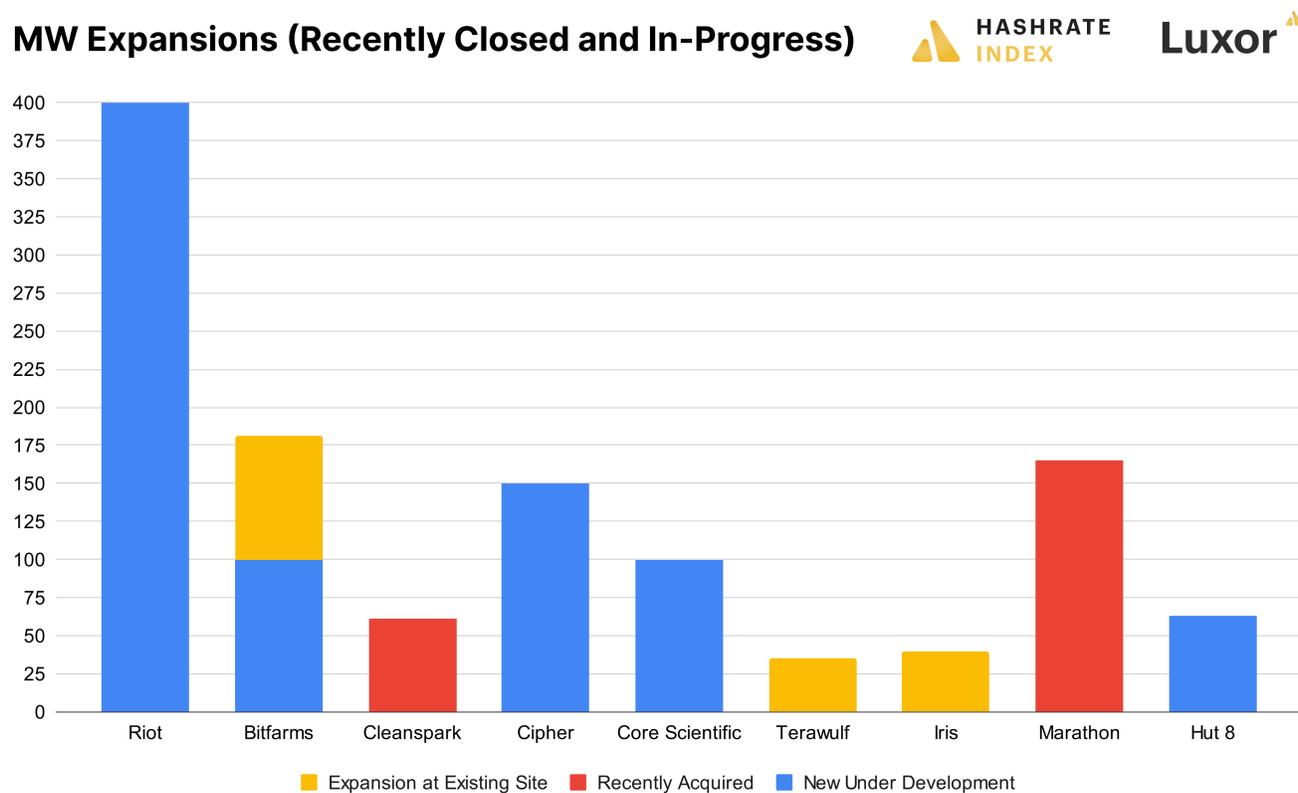
Public Miners Are Expanding Their MW Capacities

Each public mining company plans to deploy these ASIC units either to phase out older equipment and/or to equip new sites. Throughout 2024, significant miners are in the midst of building expansions, with some acquiring operational facilities already in place. To date in 2024, the leading public miners have secured or are in the process of enhancing their operational capacity by an additional 1.2 GW.

Regarding megawatt expansion strategies, approaches differ among the mining companies. Cleanspark and Marathon have focused on mergers and acquisitions to increase their megawatt capacities. In 2022, Cleanspark made a name for itself with multiple acquisitions in Georgia, and it has continued its acquisition streak with the addition of three new locations in Mississippi in 2024.

Conversely, Riot, Cipher, Core Scientific, and Hut 8 have chosen to build new facilities. Riot recently activated the first part of its Corsicana site in Texas, Cipher aims to finish the initial phase of its Black Pearl location in Texas by 2025, and Hut 8 announced the completion of the first phase of its Salt Creek, Texas site in April. Core Scientific has not disclosed timelines for its project in Oklahoma.

Bitfarms, Terawulf, and Iris are focusing on enlarging their current operational sites.



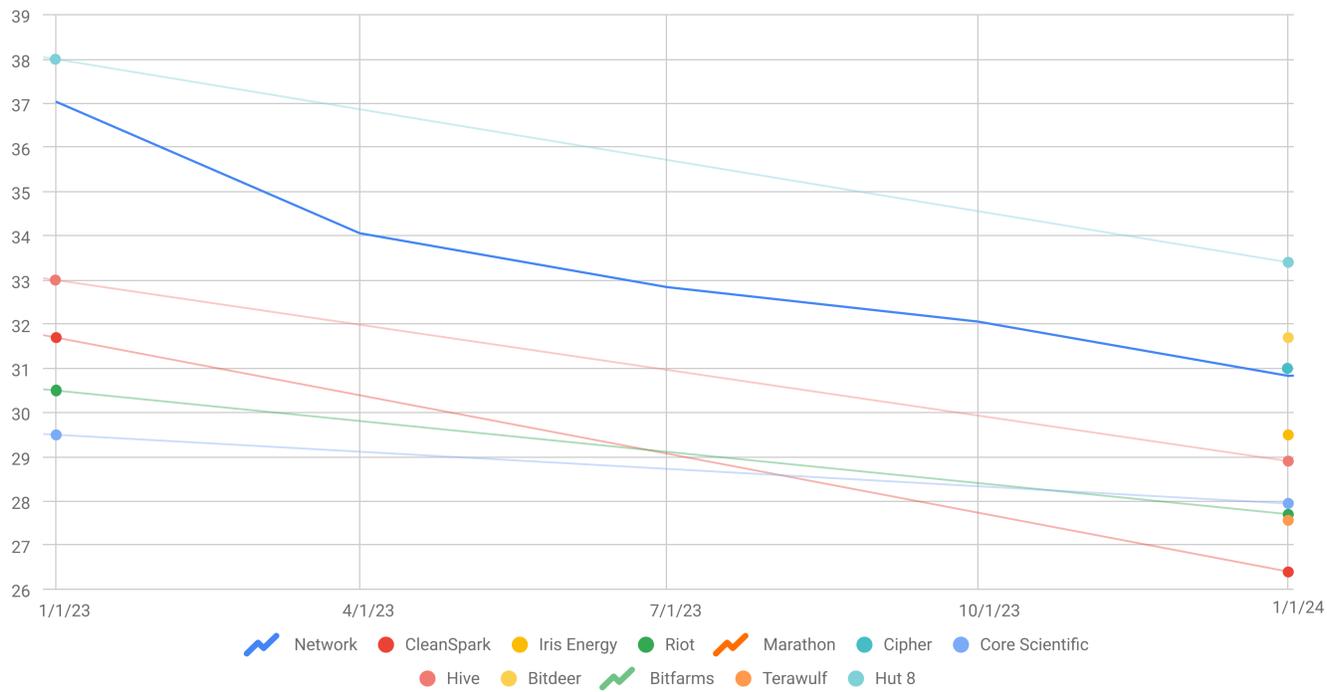
Source: Public Miner Disclosures

Public Miner Fleet Efficiencies and Power Rates

Public miners are making these expansion plans in an effort to both keep (or ideally, increase) their market shares while also lowering their operational costs. The new ASIC orders will go a long way for improving their energy efficiency, while for some, the MW capacity expansion could help them better control power costs.

Most of these miners made significant gains to improve their efficiencies in 2023, and the heaps of next-generation ASICs they have on order will only improve them further.

Bitcoin Network Fleet Efficiency vs. Leading Public Miners



Source: Coin Metrics, Public Miner Disclosures

With their expansion plans, some miners are switching their strategies in an attempt to better control operating costs. Marathon for instance, which has historically operated an asset light strategy that relies on hosting and colocation at other mining facilities, has purchased 3 facilities in 2024 as it moves toward vertical integration. This should help it drive down its historically high power costs, which tended to be higher than its peers that operated their own facilities since it was using hosting services. Marathon, Bitfarms, and Bitdeer have focused on international expansion in a bid for geographic diversity and with the hopes of securing lower power costs. Others like Riot, Cipher, and Iris have attempted to lower power costs via power credits they have earned from curtailment and demand response programs.

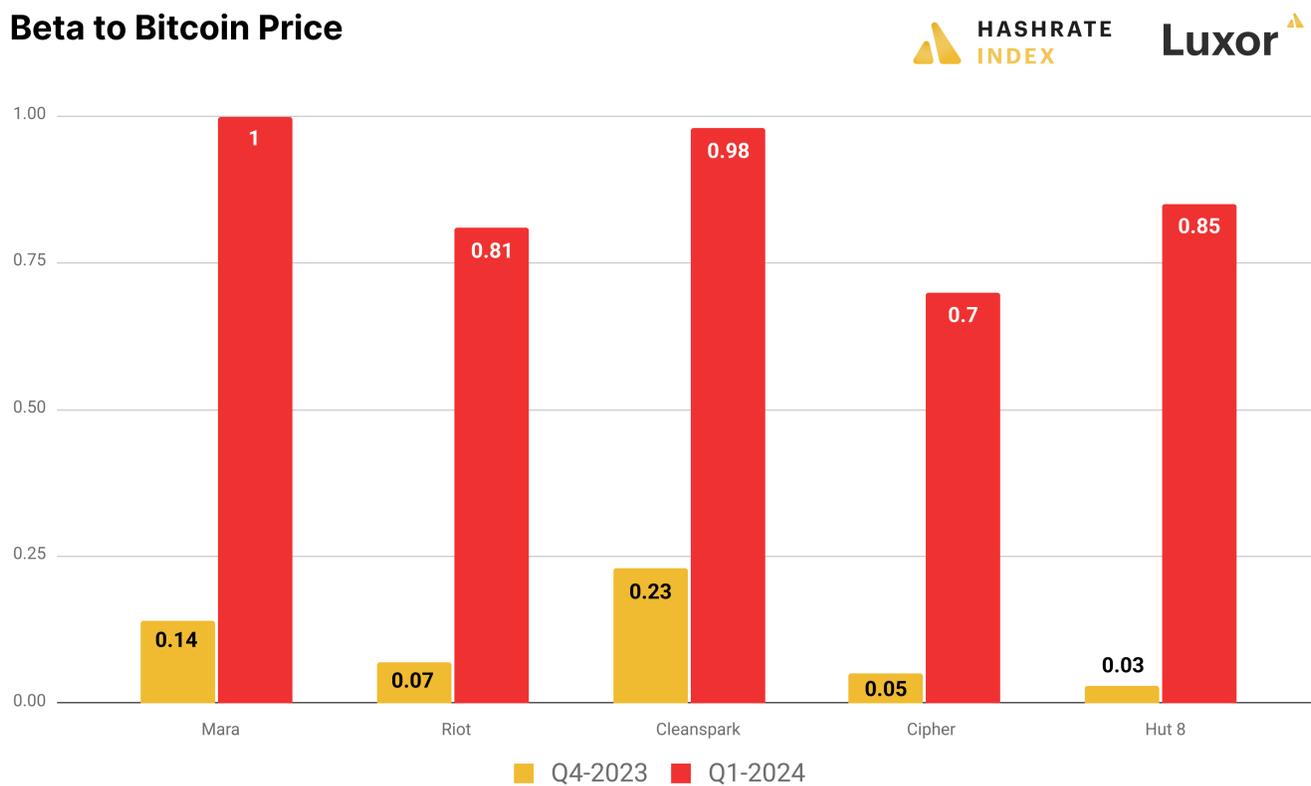
	CleanSpark	Iris Energy	Riot	Marathon	CIPHER	Core Scientific	Hive	Bitdeer	Bitfarms	Terawulf	Hut 8
2023 Implied Power Costs per MWh	\$53	\$53	\$55 (\$29 w/Credits)	\$69	\$36	\$57	\$72	\$54	\$45	\$41	\$56
2023 Implied Hashcost (\$/PH/Day)	\$31.33	\$37.52	\$36.56 (\$19.28 w/ Credits)	\$46.04	\$25.83	\$36.73	\$49.59	\$41.08	\$37.80	\$25.29	\$44.89

Source: Public Miner Disclosures

Public Miner Betas to Bitcoin

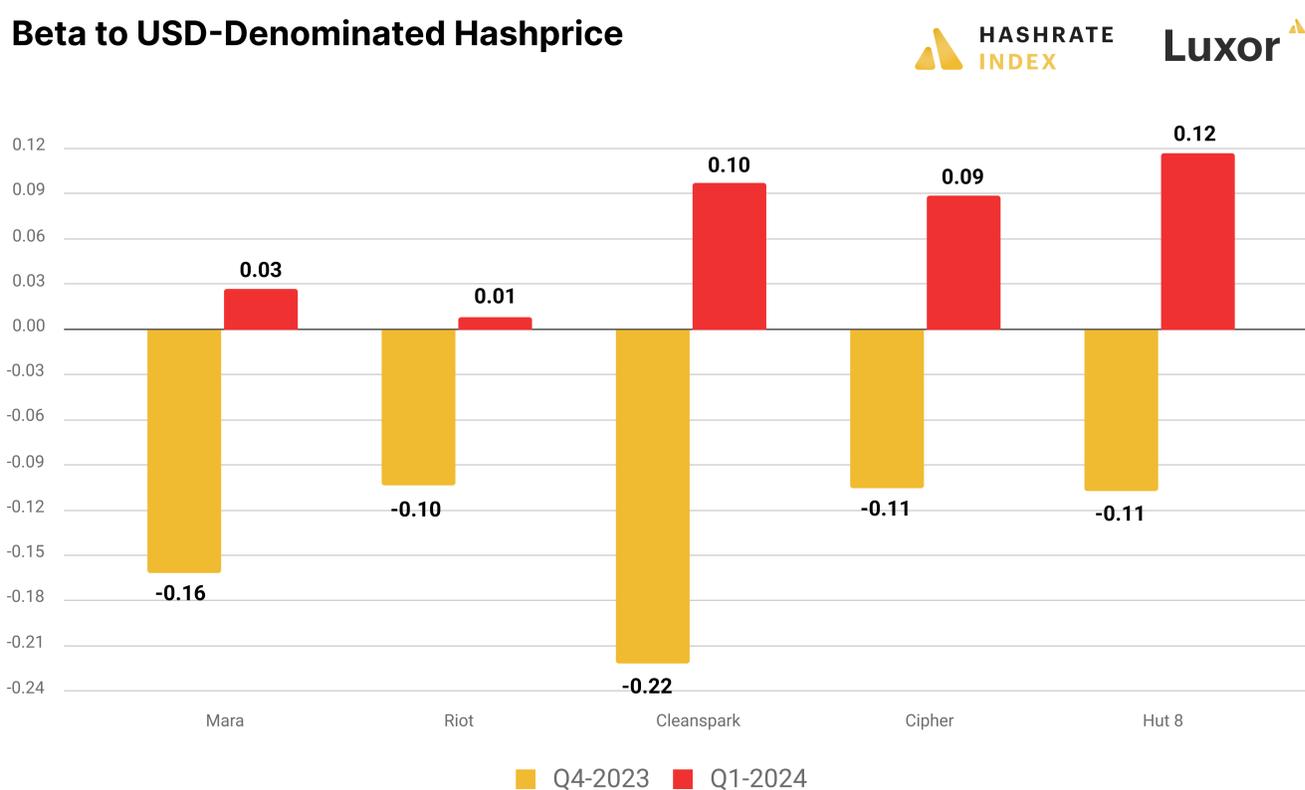
Beta scores are a measure used in finance to determine the correlation and relative volatility of an asset compared to a benchmark, such as another asset or the overall market. A beta of 1 means that the asset's price typically moves with the market. A beta greater than 1 indicates that the asset is more volatile than the market; if the market goes up or down, the asset's price is expected to increase or decrease more than the market. A beta less than 1 means that an asset is less volatile; it still follows market trends but to a lesser extent. A negative beta is uncommon but it means that the asset moves in the opposite direction to the market. In the chart below, we show bitcoin mining stock price betas to BTC price for Q1-2023 and Q4-2024 for five of the leading public bitcoin miners. We take the average daily price change for each stock over either quarter as well as the average daily change for bitcoin over the quarters as well. Curiously, these stocks had a much higher beta to bitcoin in Q1-2024 than Q4-2023. It's worth noting, though, that these stocks typically have betas greater than 1 to bitcoin, especially in bull markets.

We can view the higher betas in 2024 as the market adjusting valuations of Bitcoin mining stocks in Q4-2023. In Q1-2024, Bitcoin continued its ascent higher, and Bitcoin mining stocks moved upwards at the beginning of the quarter with bitcoin's price in advance of the Halving, although these stocks eventually closed the quarter in the red.



Source: Trading View, Hashrate Index

As the next chart demonstrates, investors generally are not pricing public bitcoin miners based on changes to hashprice. Every stock in our analysis, for example, had a negative correlation to hashprice in Q4-2023, even though hashprice more than doubled from its quarterly low in October (\$59/PH/Day) to its quarterly high in December (\$133/PH/Day) thanks to transaction fees. Further, even though the correlations to hashprice in Q1-2024 were positive, they were extremely low for each stock.



Source: Trading View, Hashrate Index



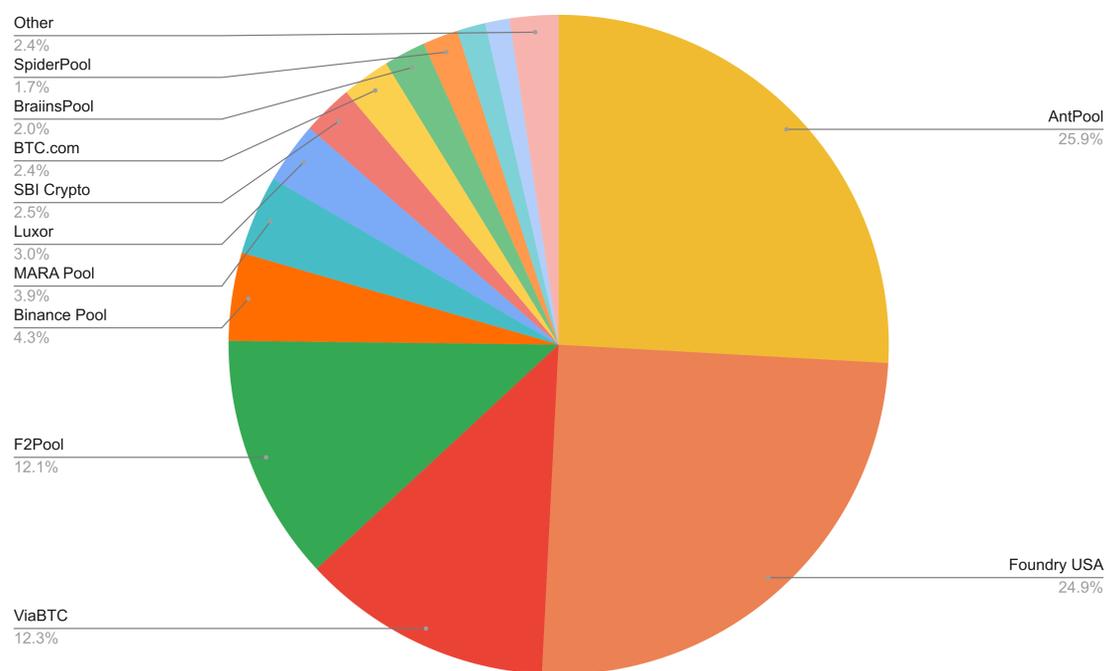
7

Mining Pools and Firmware Landscape

Mining Pool Leaderboard

As of May 2, 2024, the mining pool landscape was relatively unchanged compared to the end of 2023, though there have been a few notable changes in the top 10 ranks. Namely, Antpool has closed the gap with Foundry, and on the 7-day average as of May 2, the pool pulled slightly ahead of Foundry to take the number 1 spot as the largest pool in the world. It's worth noting, though, that this is likely due to Antpool's recent bout of stellar luck compared to Foundry's. Indeed, Foundry's reported hashrate as of May 2 was 175 EH/s to Antpool's 155 EH/s, whereas either pool's estimated hashrate based on the blocks they had found from April 25 - May 1 was 159 EH/s and 165 EH/s respectively.

Bitcoin Mining Pool Marketshare (7-Day Avg. as of May 2, 2024)



Source: Hashrate Index

The distribution of mining pools highlights another point we touched on in our 2023 year in review: miners continue to converge on FPPS and PPS+ mining pools. Per the May 2, 2024 data for the chart above, FPPS and PPS+ pools account for 91% of the entire network hashrate. Unlike PPLNS, where individual miners only get paid when the pool finds blocks, FPPS and PPS+ pools assume the risk of luck variance for their miners and pay them on a consistent basis regardless of the number of blocks found in a given time frame.

Now that the Halving has dropped the block subsidy to 3.125 BTC, transaction fees will now take up a larger share of overall mining rewards than they did during last epoch when the block subsidy was 6.25. As such, luck variance becomes even more crucial for FPPS and PPS+ mining pools, especially considering the transaction fee volatility the Bitcoin network has experienced with Ordinals/Inscriptions. Those mining pools that operate alternative business lines and have diversified revenue will be best positioned to weather this volatility and variance.

Firmware Revenue Analysis Post-Halving

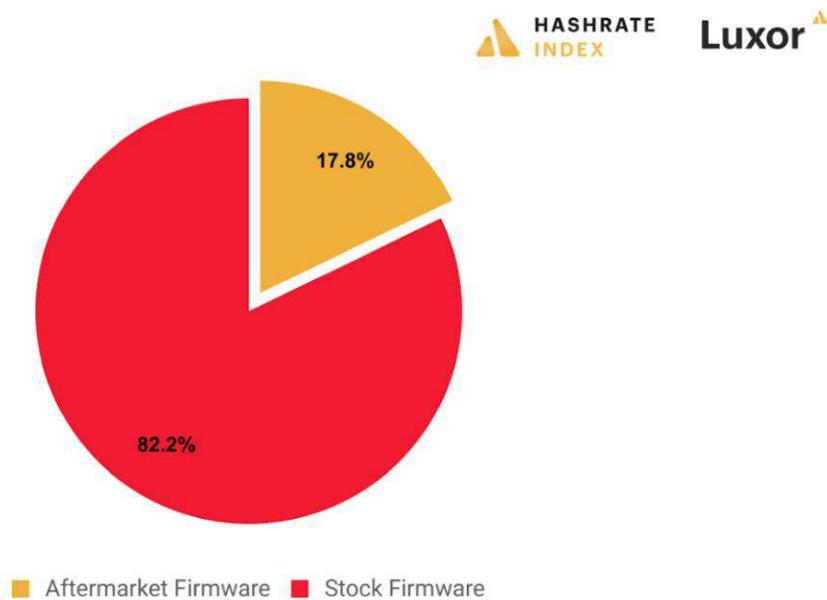
We anticipate that firmware strategies will become a necessary focus for any miner's operational strategy after the Halving. For Bitmain's Antminer S19 series – the most common in the industry – there are four primary custom firmwares in the market.

After-Market Firmware	Domiciled	Released	Firmware Type	Model	SOC 2 Compliant?
ePIC UMC	Canada	2023	Proprietary	Purchase	No
Luxor Firmware	USA	2023	Proprietary	Subscription	Yes
Braiiins OS	Czechia	2018	Proprietary	Subscription	No
Vnish.com	Russia	2018	Proprietary	Subscription	No

Source: Company Documentations, Luxor business data

At the end of 2023, Luxor business data estimated that roughly 18% of the Bitcoin mining industry was running after-market firmware. We anticipate that this percentage will grow over the course of 2024 as more miners turn to after-market firmware to optimize their fleets since margins are now so thin.

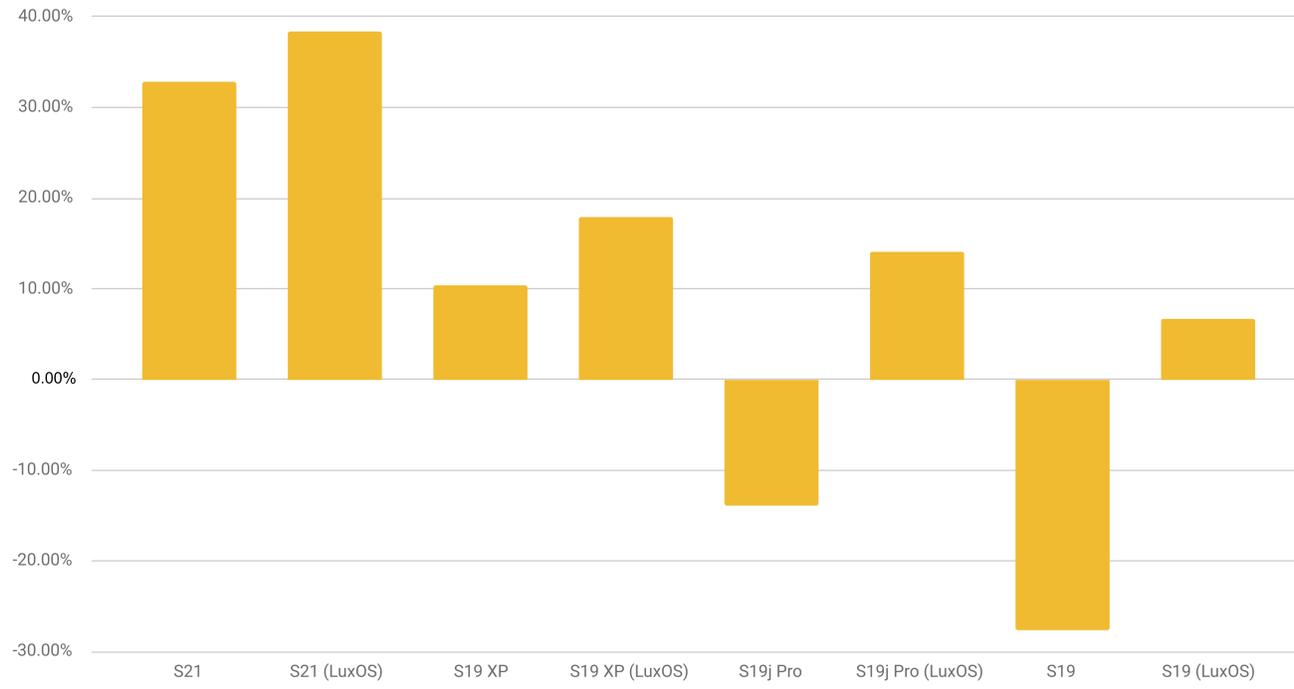
After-Market Firmware Adoption



Source: Luxor business data

Indeed, when we observe operating margins at current hashprice levels when running an ASIC at default settings versus optimized settings with LuxOS, it becomes clear that miners can improve their operations with after-market firmware. Even next-gen machines like the S21 and S19 XP can earn more when optimized with LuxOS, while older models like the S19 and S19j Pro (which are unprofitable at average power costs with default settings enabled) can turn a profit when underclocked with LuxOS.

Operating Margin at \$45/PH/Day and \$0.07/kWh (Default Settings vs. LuxOS Optimized)



Source: Hashrate Index, Luxor business data



8

Conclusion and Predictions

Unless Bitcoin's price increases substantively from here, the remainder of 2024 will be a year of hardship for the Bitcoin mining industry.

Public and private miners will do what they can to expand their fleets and upgrade to more efficient hardware, but expansions will be hampered somewhat by the current compressed hashprice environment. As such, we believe that the network will not reach 1 zetahash (1,000 exahashes) by the end of the year, but it's plausible that the Bitcoin network could surpass this milestone next year.

To remain competitive in the foreseeable future, miners that are in the middle of the cost curve (\$0.05-0.07/kWh) will have to upgrade to next-generation rigs and/or get creative with their operational strategies by adopting after market firmware, adopting hedging strategies, and exploring alternative streams of revenue. We expect that miners will continue to seek out lower cost power in under-explored geographies like the Global South; further, we would not be surprised to see the United State's hashrate dominance wane this Halving epoch.

In both public and private mining markets, we expect the next two years to provide opportunities for mergers, acquisition, and general consolidation.

As with 2023, the biggest wild card for 2024 will be transaction fee trends. The advent of Inscriptions, Ordinals, and now Runes has placed a technical powder keg at the feet of the Bitcoin network; all it takes is surge of interest in these new digital collectibles, trading activity, and FOMO to spark a transaction fee bull run which could turn the tides of fortune for Bitcoin miners, even if for a short period of time.

The Fourth Bitcoin Halving represents a marked transition from the seminal days of Bitcoin mining to a new era where the scope and scale of the sector has never been larger. Bitcoin mining will become increasingly institutionalized, and we believe that the current epoch will also be foundational for Bitcoin mining's continued integration into electricity and power systems.

Tick tock, next block.