

Hashrate Index 2024 Year in Review: **New** **Horizons**

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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.

Table of Contents

1 Introduction

- Global Hashrate Market Distribution Estimates

2 Hashrate Markets

- Spot Hashrate Market and Its Components in 2024
- Forward Hashrate Markets in 2024
- Looking Forward to 2025

3 ASIC Hardware

- ASIC Markets in 2024
- ASIC Price Trends in 2024
- ASIC Investments
- Looking Ahead

4 Energy Markets

- Power Price Trends in 2024
- Power Price Expectations for 2025

5 Bitcoin Miners vs. AI/HPC In Power Markets

- Intersection of Bitcoin Mining and AI/HPC

6 Bitcoin Mining Capital Markets

- Capital Markets Landscape
- Estimated Capital Raises

7 Public Bitcoin Mining Equities

- Financial Performance
- Operational Updates

8 Mining Pools and Firmware

- Mining Pools
- Firmware Market

9 Hosting

- Hosting Data

10 Significant Regulatory and Legislative Action in 2024

11 Conclusions and Predictions



1

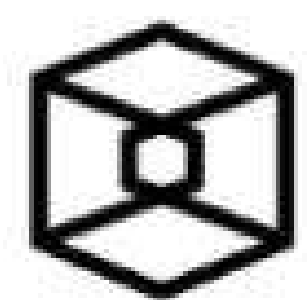
Introduction

2024 was a turning point.

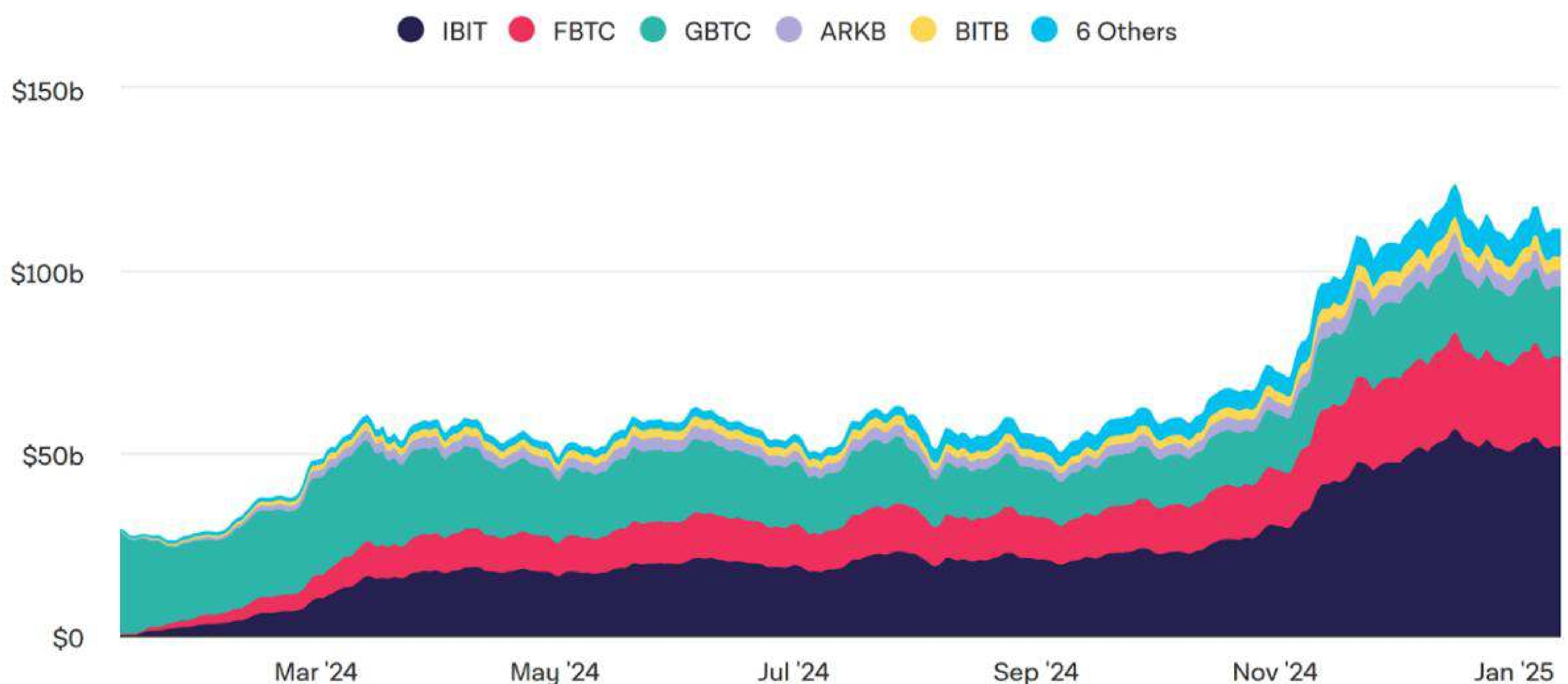
Bitcoin entered the year at just over \$42,000, following the fallout and subsequent redemption of the 2023 market, driven by a wax-and-wane in mining economics and institutional adoption.

Public Bitcoin miners were still recovering from bankruptcy blows and debt restructurings, and with the fourth halving around the corner, it looked like many others could soon be facing a stress test that drove them beyond breakeven costs. As the year unfolded, the industry was taken on a roller-coaster ride.

Q1 was marked by the advent of spot bitcoin exchange-traded funds (ETFs). Following approval from the U.S. Securities and Exchange Commission (SEC) on January 10, 2024, these products amassed \$50B by the end of the quarter and over \$110B by the end of the year, breaking all known records in the ETF space. During this time, Bitcoin rose 65%.



Spot Bitcoin ETF AUM (Daily)

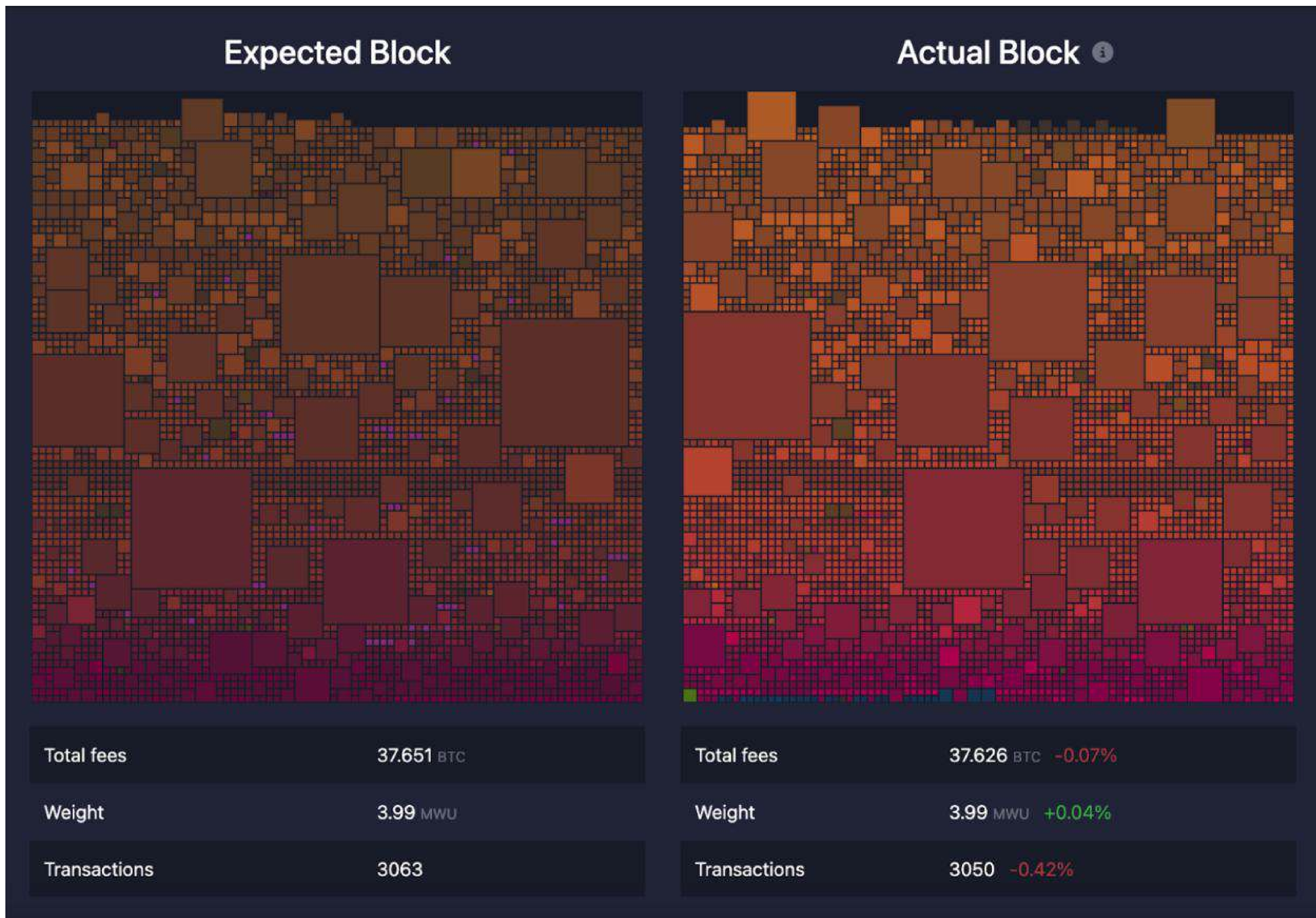


Spot Bitcoin ETF AUM | Source: [The Block](#)

Q2 was a pivotal moment, marked by the network's fourth halving. This highly anticipated event occurred on April 19, 2024 at block height 840,000, reducing the block subsidy from 6.25 BTC to 3.125 BTC. The milestone block included a total block reward of 40.75 BTC with an incredible ~37.6 BTC in transaction fees, which was driven by a land-grab to mint runes, a new token standard introduced on the halving block by ordinals creator Casey Rodarmor. Hashprice spiked from \$104 to \$139 per PH/s/Day, before settling down to \$50 in the following week.

Block < 840000 >

Hash	000000...cda83a5	Fee span	100 - 3,604,819 sat/vB
Timestamp	2024-04-20 03:09:27 (9 months ago)	Median fee	~200 sat/vB \$17.88
Size	2.33 MB	Total fees	37.626 BTC \$2,402,283
Weight	3.99 MWU	Subsidy + fees	40.751 BTC \$2,601,805
Health	100%	Miner	ViaBTC



Block Height 840,000 | Source: [Mempool.space](https://mempool.space)

And just like that, a new mining epoch had begun. Tick tock, next block.

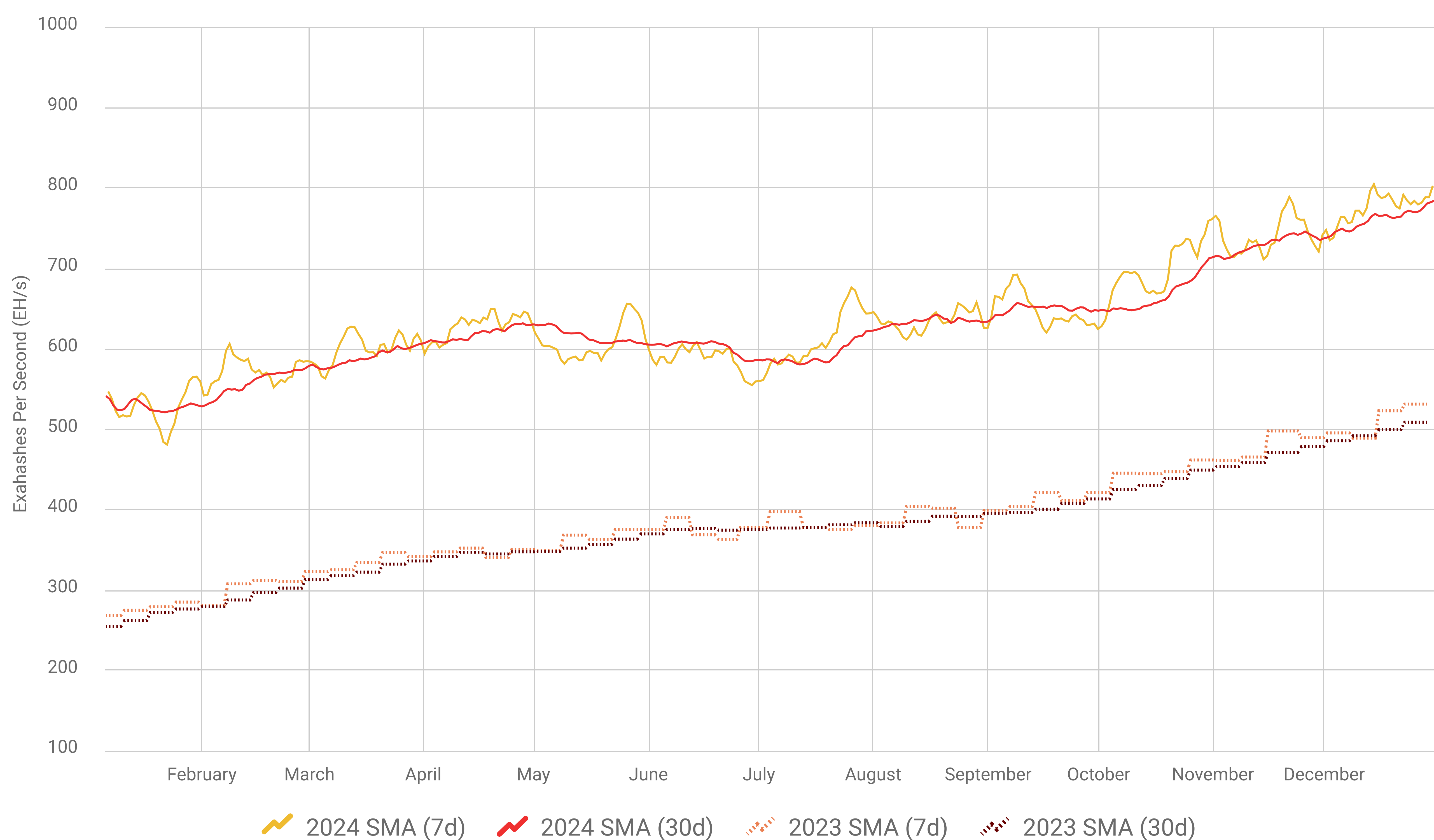
The rest of the quarter was relatively quiet. Bitcoin trended downward, falling 12%. Throughout Q3, the halving's aftermath became more pronounced as the runes bonanza subsided and miner revenues adjusted to reduced block rewards. Efficient operations stood out. Bitcoin chopped sideways throughout the quarter, oscillating around \$64,000.

Q4 was marked by significant developments in the corporate and political world. Treasury investments in Bitcoin reached new heights, with MicroStrategy continuing to lead the charge. Corporate treasuries expanded beyond the technology industry, with firms in the energy and financial sectors beginning to allocate.

The U.S. presidential election in November added a layer of geopolitical significance to Bitcoin's narrative. The newly-elected Trump administration, plus a Republican sweep of the House and Senate, signaled a friendly stance on cryptocurrency regulation; bipartisan discussions emerged around the role of Bitcoin as a strategic reserve, reigniting debates about sovereign adoption. Bitcoin rallied 49%, breaking the \$100,000 barrier for the first time.

All in all, Bitcoin price rose by 120% throughout the course of 2024. Hashprice fell 45%, an expected reversal from 2023's 71% incline. Despite this challenge, network hashrate experienced relentless growth. **Bitcoin's 7-day average hashrate grew by 52% from 529 EH/s to 803 EH/s over 2024.** Although this is a relatively modest increase in percentage change terms when compared to 2023's enormous 102% growth, it is a relatively similar growth rate in absolute terms. 2024's average for Bitcoin's 7-day average hashrate was 637 EH/s, a 67% increase from 2023's average of 382 EH/s. Similarly, the 30-day average hashrate was 630 EH/s, a 78% increase.

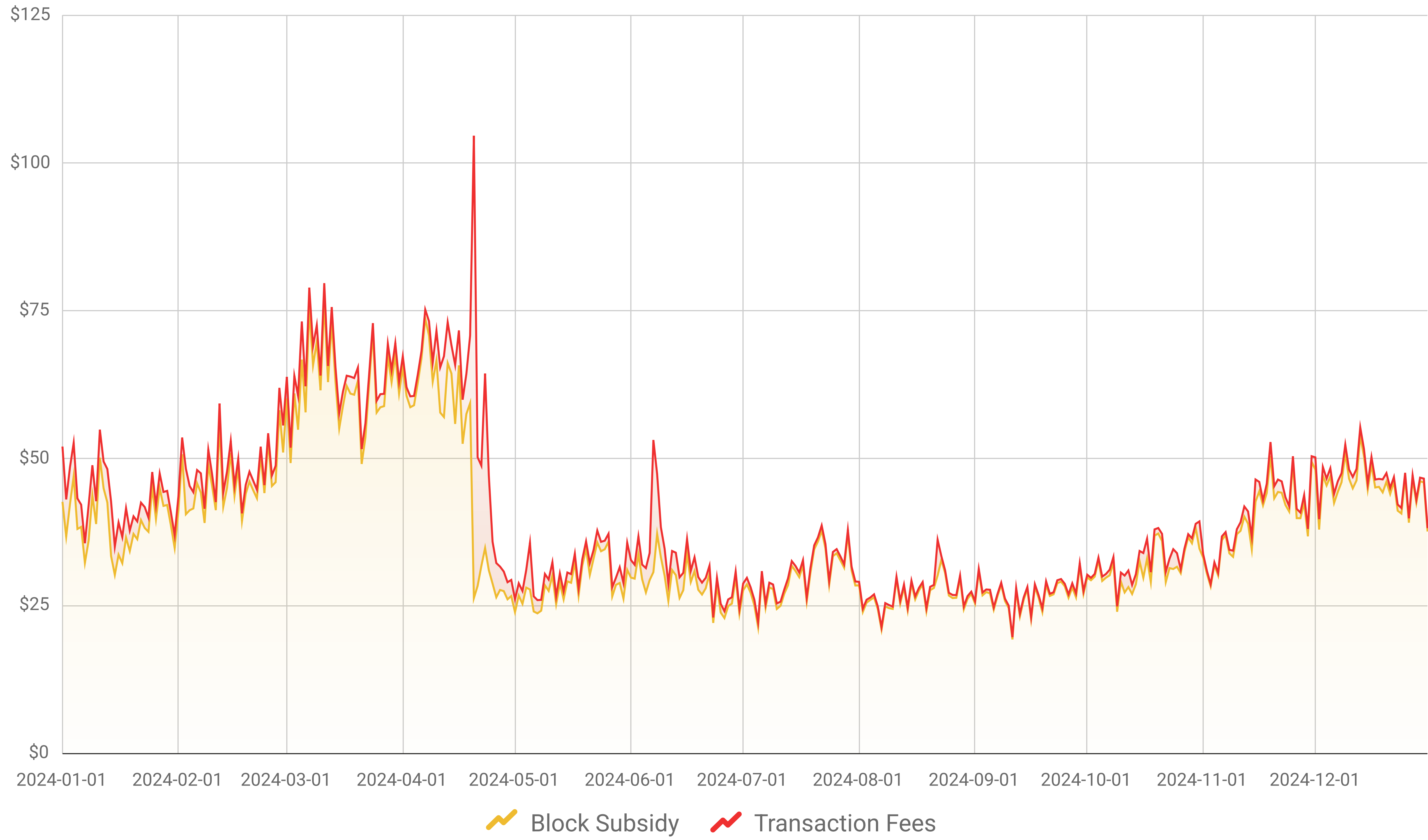
Bitcoin Network Hashrate - 2024 vs. 2023



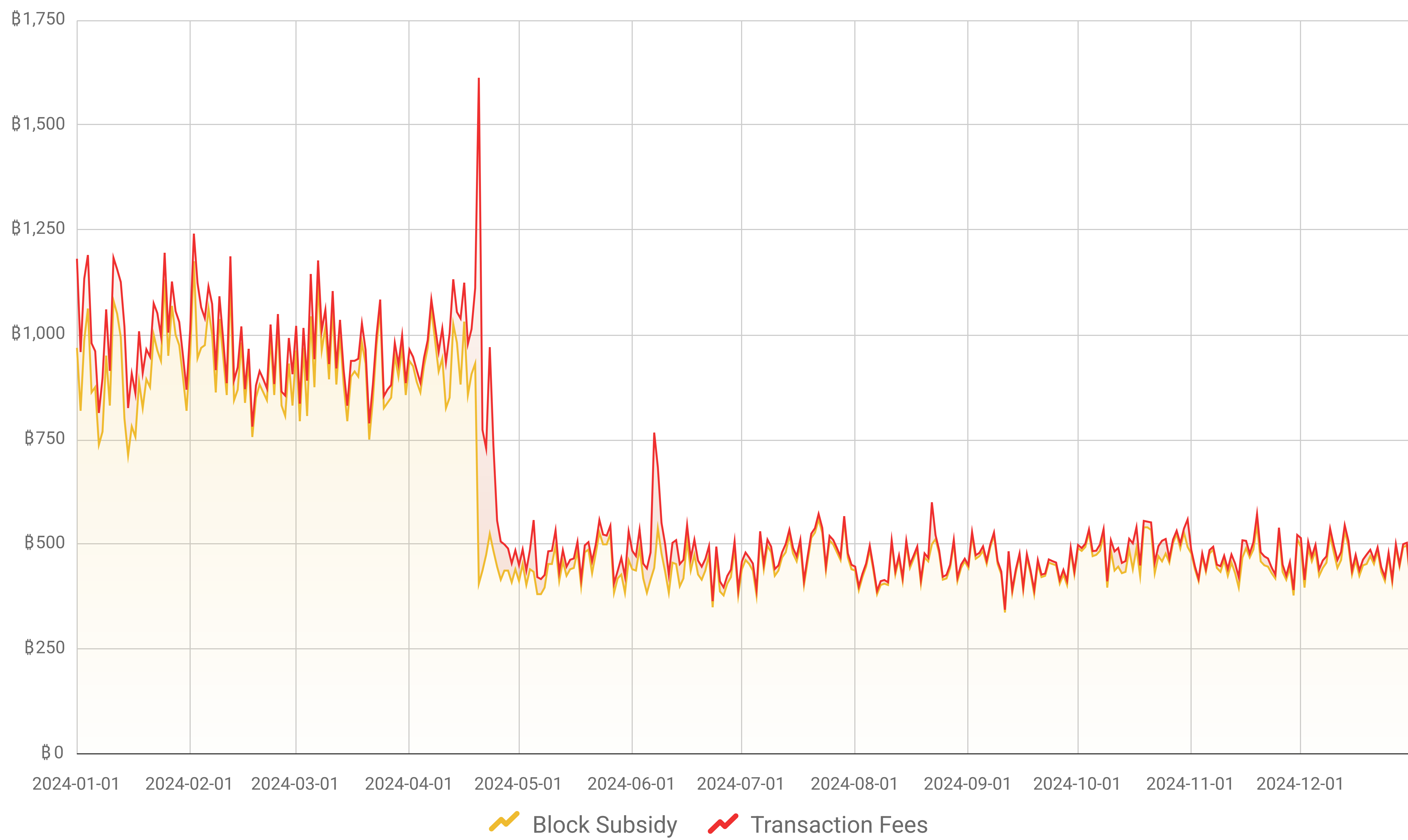
The deployment of next-generation and mid-gen ASICs set the stage for 2024's hashrate growth. Although the halving took its toll, intermittent surges in transaction fees and an eventual improvement in hashprice throughout Q4 allowed operations with older machines and higher power prices to stay online.

In total, 2024 witnessed \$14.78 billion (232,935 BTC) in bitcoin mining block rewards, a 40% increase in USD terms and a 35% decrease in BTC terms from 2023. Transaction fees constituted 5.6% of overall block rewards, versus 7.6% in 2023.

2024 Bitcoin Mining Rewards (in Millions \$USD)



2024 Bitcoin Mining Rewards (BTC)



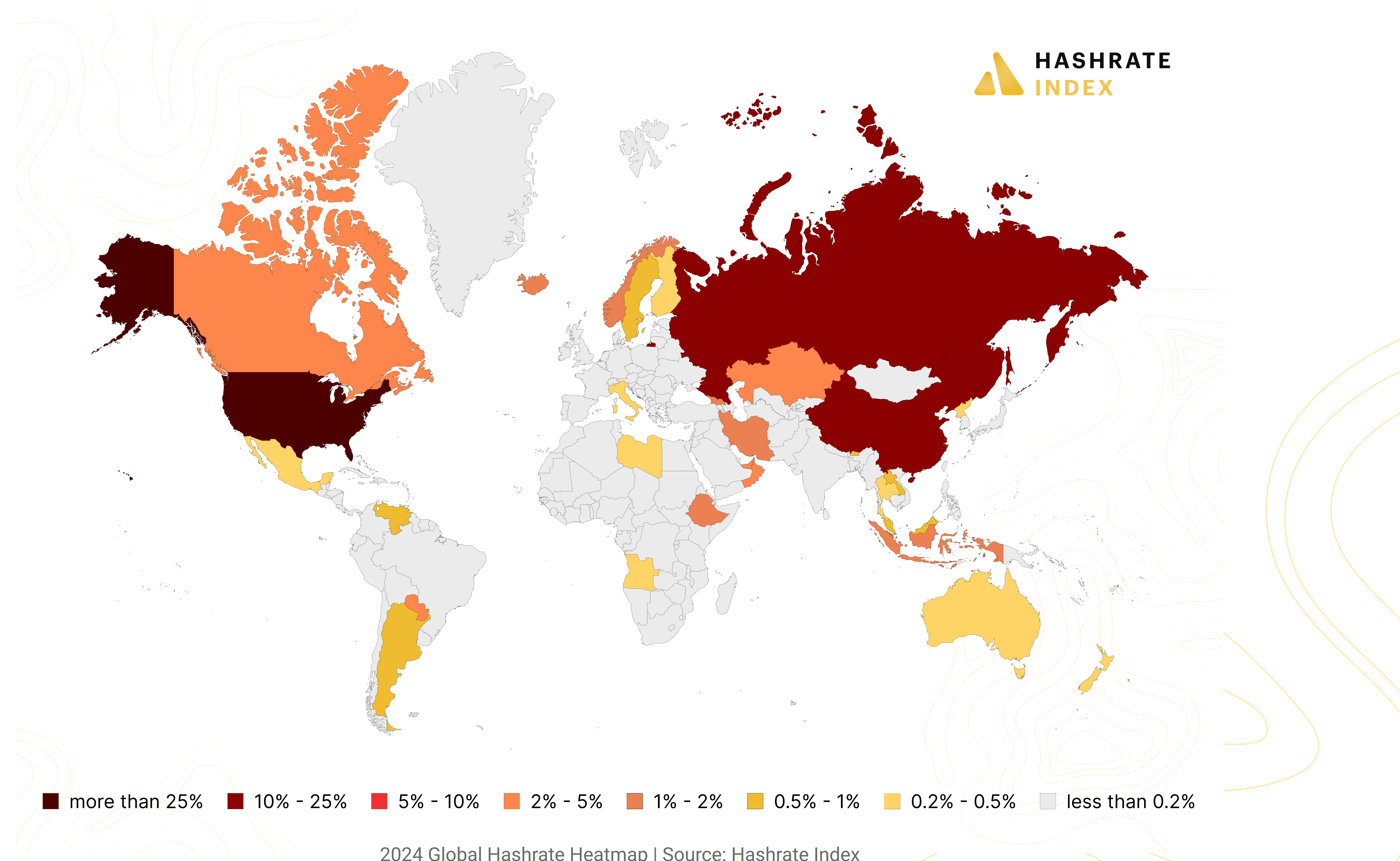
Global Hashrate Market Distribution Estimates

Well-known mining maps, like Cambridge University's, typically track the geographic distribution of Bitcoin's hashrate by aggregating geo-location data from participating Bitcoin mining pools, which collect the IP addresses of their clients' mining pool account dashboards. Participating pools aggregate this data to determine the average geographic distribution of the total hashrate by region.

This methodology serves as a proxy for the global distribution of Bitcoin's hashrate, but it relies on several assumptions, such as relying on pool account IP addresses for geolocation (a miner may access their pool account from a different location than their mining site) and data samples being representative of regional and global hashrate distribution. If these assumptions are incorrect, the results may be skewed.

While current mining maps provide valuable insights into the geographic distribution of Bitcoin mining, their methodologies have inherent limitations which can affect precision and accuracy.

Hashrate Index's **Global Hashrate Heatmap** aims to improve on these attempts by leveraging various data from Luxor's suite of Bitcoin mining services, including mining pools, ASIC trading, and firmware. It aims to provide more accurate, granular, and representative insights into the global mining landscape by integrating proprietary datasets as well as best estimates.



Country	Market Share (%)	Hashrate (EH/s)
United States	36%	288
Russia	15.625%	125
China	13.75%	110
United Arab Emirates	3.75%	30
Paraguay	3.5%	28
Oman	3.125%	25
Canada	3%	24
Kazakhstan	2.5%	20
Norway	1.625%	13
Ethiopia	1.5%	12

2024 Top 10 Bitcoin Mining Countries | Source: Hashrate Index

Bitcoin Mining Companies Landscape

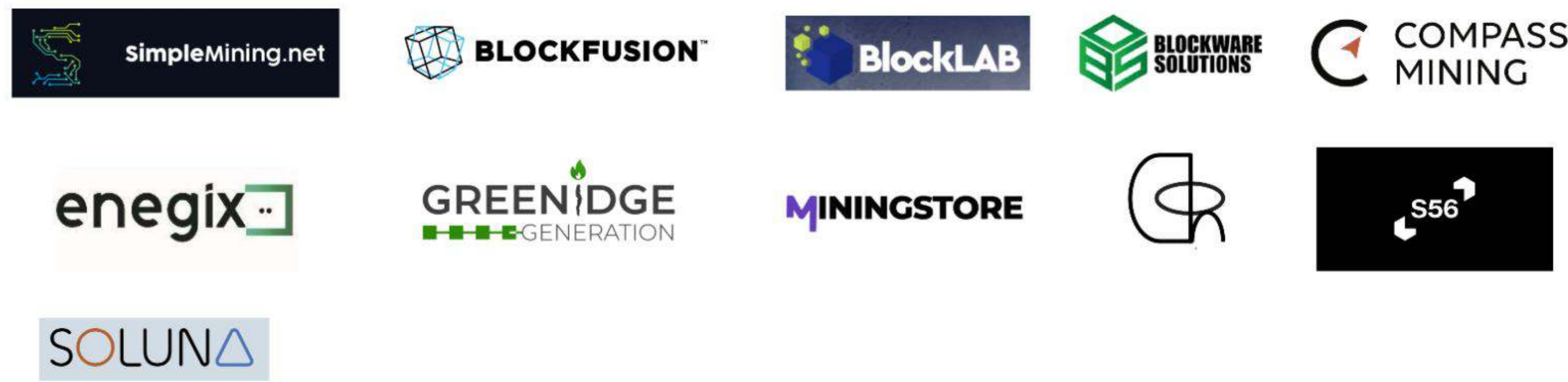
Mining Pools



ASIC Manufacturers



Colocation/Hosting Providers



Foundries



Miners



ASIC Brokerage



Energy Management



Research



Hashrate Derivatives



Custom Firmware



Mining Software



2

Hashrate Markets

2023 High (12/17/2023)

\$130.97 per PH/s/Day
0.00433 BTC per PH/s/Day

2024 High (04/20/2024)

\$139.13 per PH/s/Day
0.00231 BTC per PH/s/Day

2023 Low (09/27/2024)

\$59.70 per PH/s/Day
0.00199 BTC per PH/s/Day

2024 Low (05/08/2024)

\$37.70 per PH/s/Day
0.00058 BTC per PH/s/Day

2023 Average

\$74.77 per PH/s/Day
0.00265 BTC per PH/s/Day

2024 Average

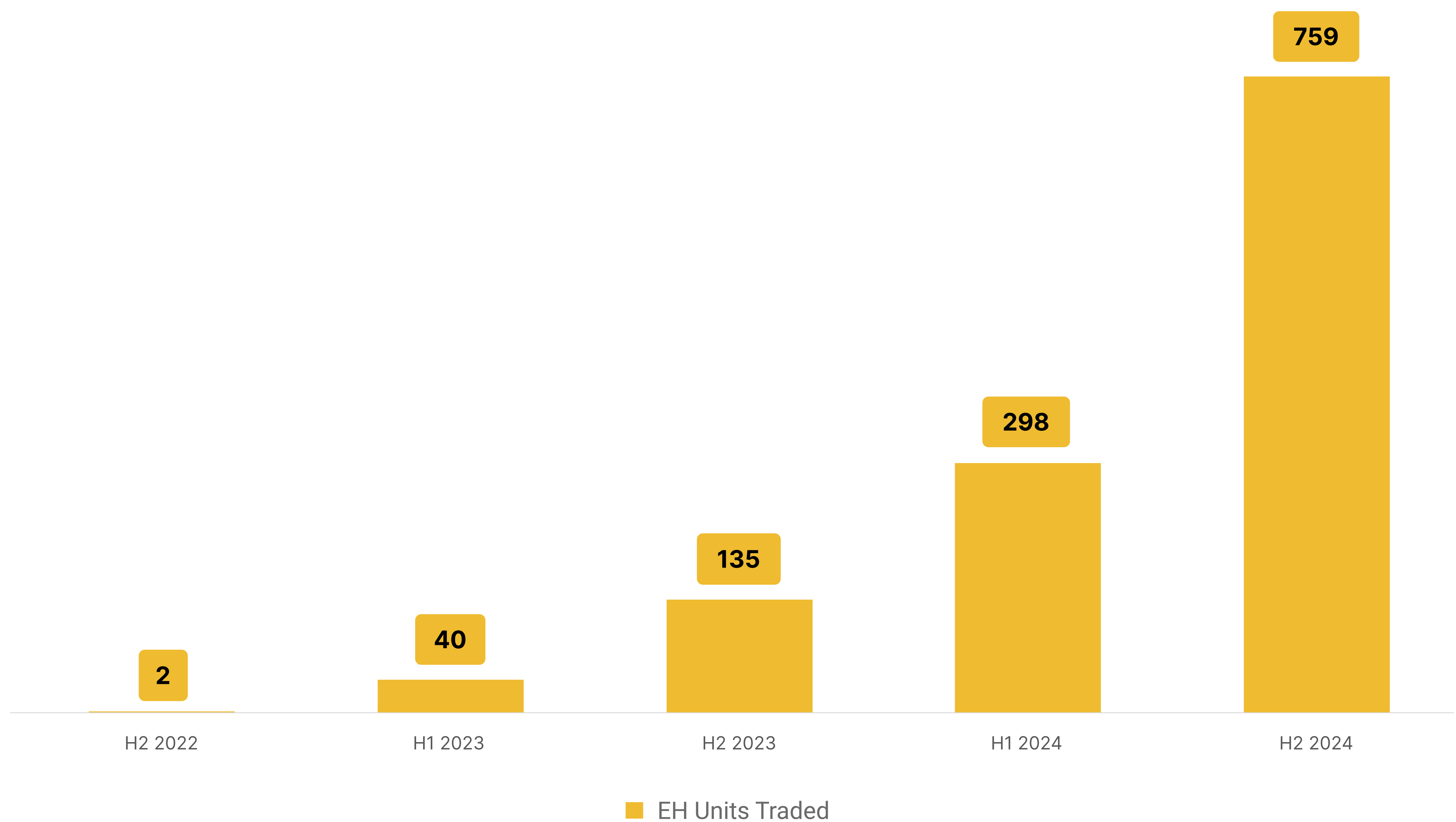
\$64.57 per PH/s/Day
0.00104 BTC per PH/s/Day

In 2024, all-time high spot bitcoin price was the headline. But despite the tailwind, April's block subsidy halving, relentless network difficulty growth, and declining transaction fees weighed on bitcoin mining revenue in hashrate markets. The result was a divergence between bitcoin price and mining markets.

Annual Average	2022	2023	2024
USD Hashprice	\$123.87	\$74.77 (-40%)	\$64.57 (-14%)
BTC Hashprice	0.00426	0.00265 (-38%)	0.00104 (-61%)
BTC Price	\$29,056	\$28,176 (-3%)	\$62,051 (+120%)
Network Difficulty	30.30T	51.85T (+71%)	87.20T (+68%)
Transaction Fees	0.10 BTC	0.43 BTC (+330%)	0.29 BTC (-33%)
Block Subsidy	6.25	6.25 (-)	4.08 (-35%)

Apart from bitcoin's price, the biggest development in hashrate markets in 2024 was the exponential growth of the forward market. Miners increasingly used it to mitigate downside risk, secure financing, and scale hashrate production faster than competitors.

Hashrate Forward Market Volume



Forward hashrate markets priced in Bitcoin's halving. However, network difficulty (i.e., hashrate) was higher, and transaction fees were lower than anticipated. In hindsight, the ideal mining strategy was to hedge against network difficulty and transaction fees, while staying long bitcoin's price. Miners using this approach mined more bitcoin, had higher revenues in USD, lower volatility and greater certainty into the future of their operations.

Bitcoin Mining Strategy	Avg. Monthly BTC Production	Std. Dev. Monthly BTC Production	Avg. Monthly USD Revenue	Avg. Monthly USD Revenue
Spot Bitcoin Mining (No Hedging)	0.00104 BTC	0.00048 BTC	\$64.57	\$22.20
5-Mo Rolling USD Hashrate Forward Sale (Hedging Bitcoin Price, Network Difficulty and Transaction Fees)	0.00088 BTC (-15%)	0.00030 BTC (-39%)	\$54.77 (-15%)	\$7.17 (-68%)
5-Mo Rolling BTC Hashrate Forward Sale (Hedging Network Difficulty and Transaction Fees)	0.00115 BTC (+11%)	0.00041 BTC (-15%)	\$72.32 (+12%)	\$18.83 (-15%)

*All figures per PH/s/Day

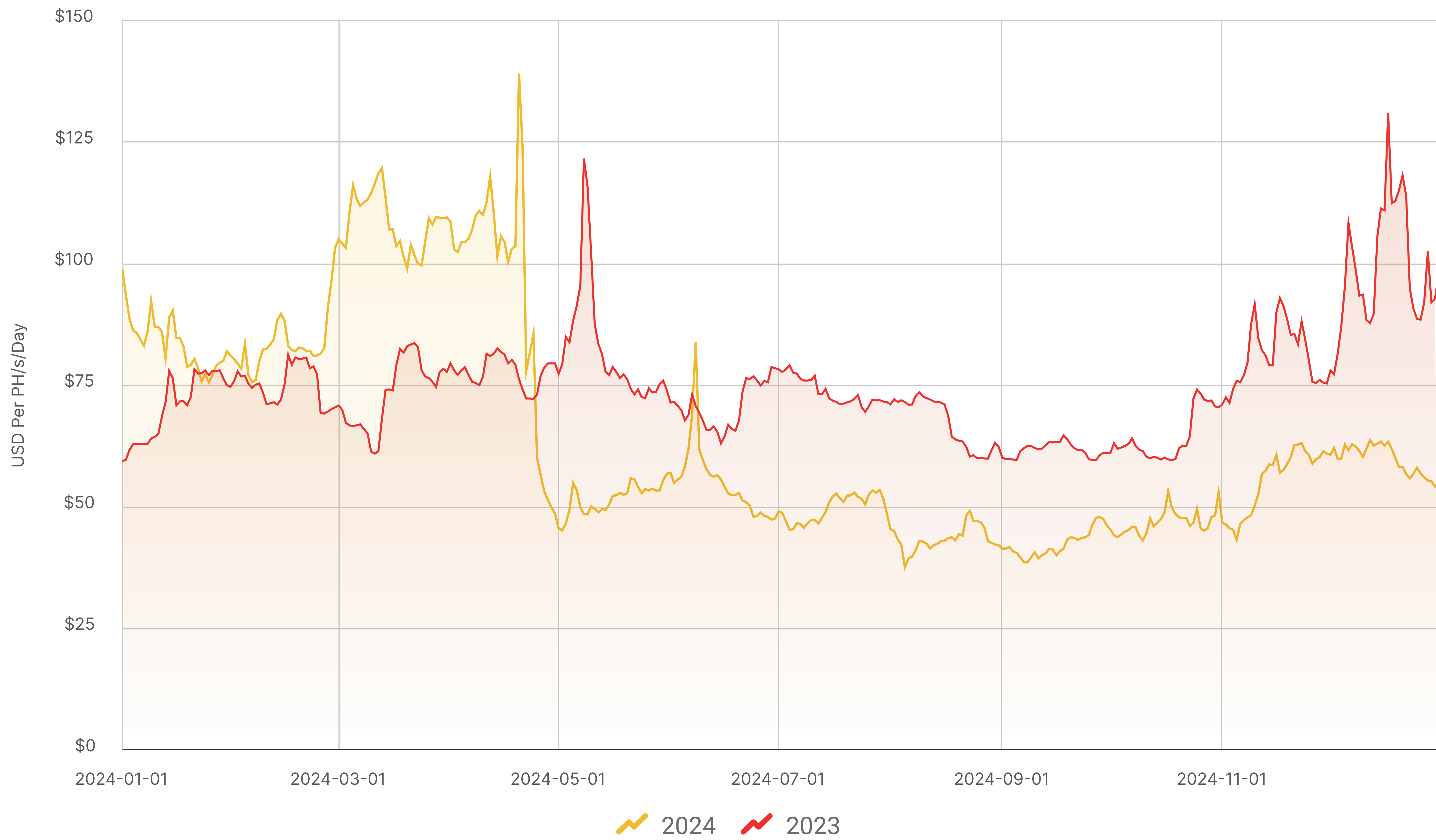
Note: non-spot values represent the mid-point of the best bid and ask on Luxor's Non-Deliverable Hashprice Forward market for 2024.

Spot Hashrate Market and Its Components in 2024

	Start	End	Average	Low	High
Hashprice USD	\$98.96	\$54.29	\$64.57	\$37.70	\$139.14
Hashprice BTC	0.00231283	0.00057997	0.00104056	0.00057997	0.00231283
Bitcoin Price	\$42,787	\$93,606	\$65,894	\$39,400	\$106,739
Network Hashrate	529 EH	803 EH	637 EH	482 EH	805 EH
Network Difficulty	72.01T	109.78T	87.27T	70.34T	109.78T
Avg. Tx Fees per block	1.419 BTC	0.046 BTC	0.288 BTC	0.038 BTC	9.675 BTC
Block Subsidy	6.250 BTC	3.125 BTC	4.064 BTC	3.125 BTC	6.250 BTC

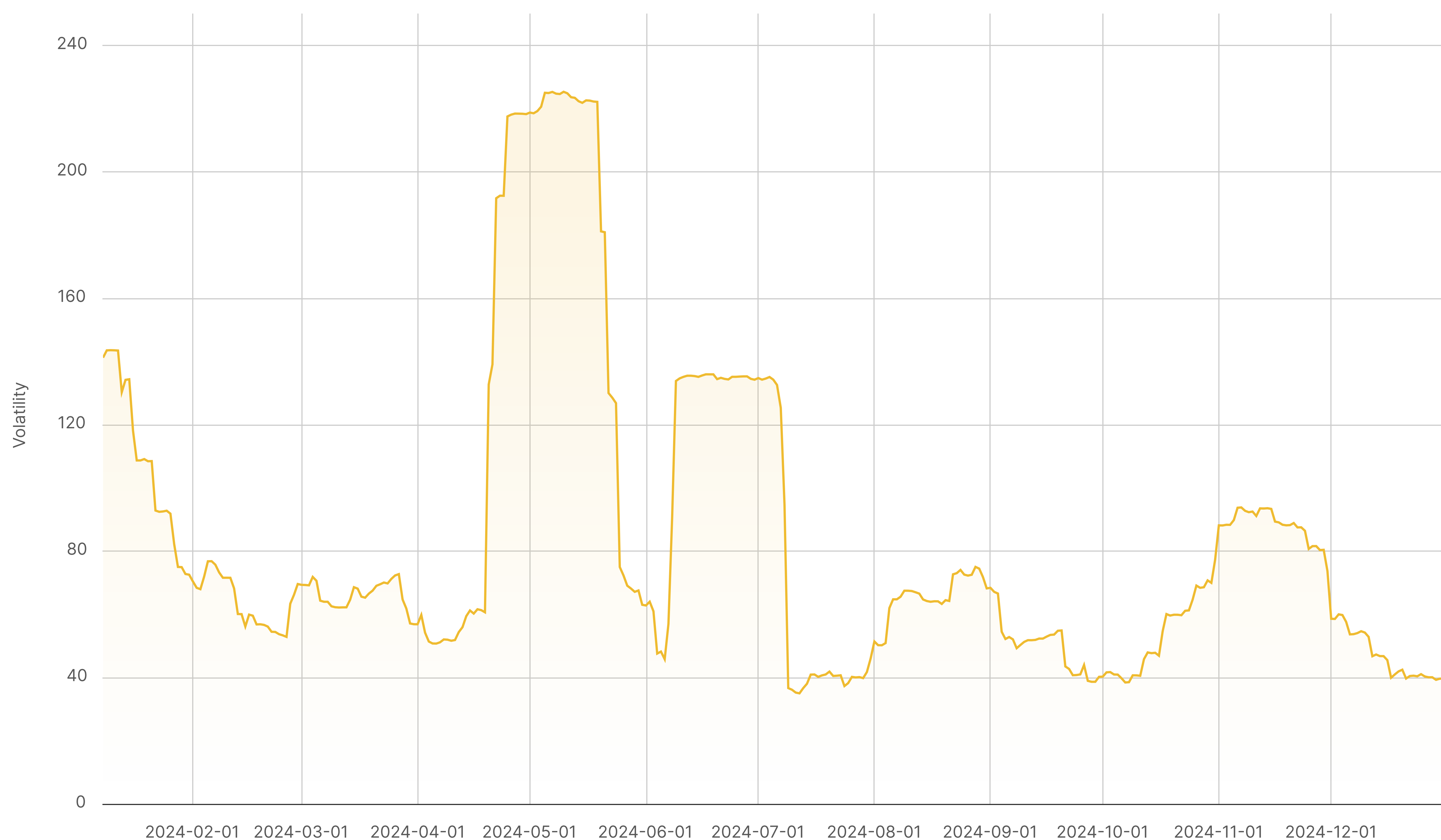
USD Hashprice

USD Hashprice entered 2024 at \$98.96/PH/s/Day and fell by 45% throughout the year, closing at \$54.29/PH/Day. By comparison, hashprice increased by 65% from \$59.42 to \$97.87/PH/Day throughout 2023. 2024 saw an average hashprice of \$64.57/PH/s/Day versus \$74.77/PH/Day in 2023, a 14% decrease.



Hashprice exhibited significant volatility throughout the year, starting Q1 at between the \$70 – \$90/PH/Day range before surging to \$100 – \$120 in late February. The halving itself triggered a brief but intense period of craziness, as transaction fees surged from trading activity for a new Bitcoin-native token standard, runes; hashprice peaked at \$139.14/PH/Day before rapidly declining as interest in runes cooled off.

Hashprice Volatility (30d Rolling Avg.) - 2024

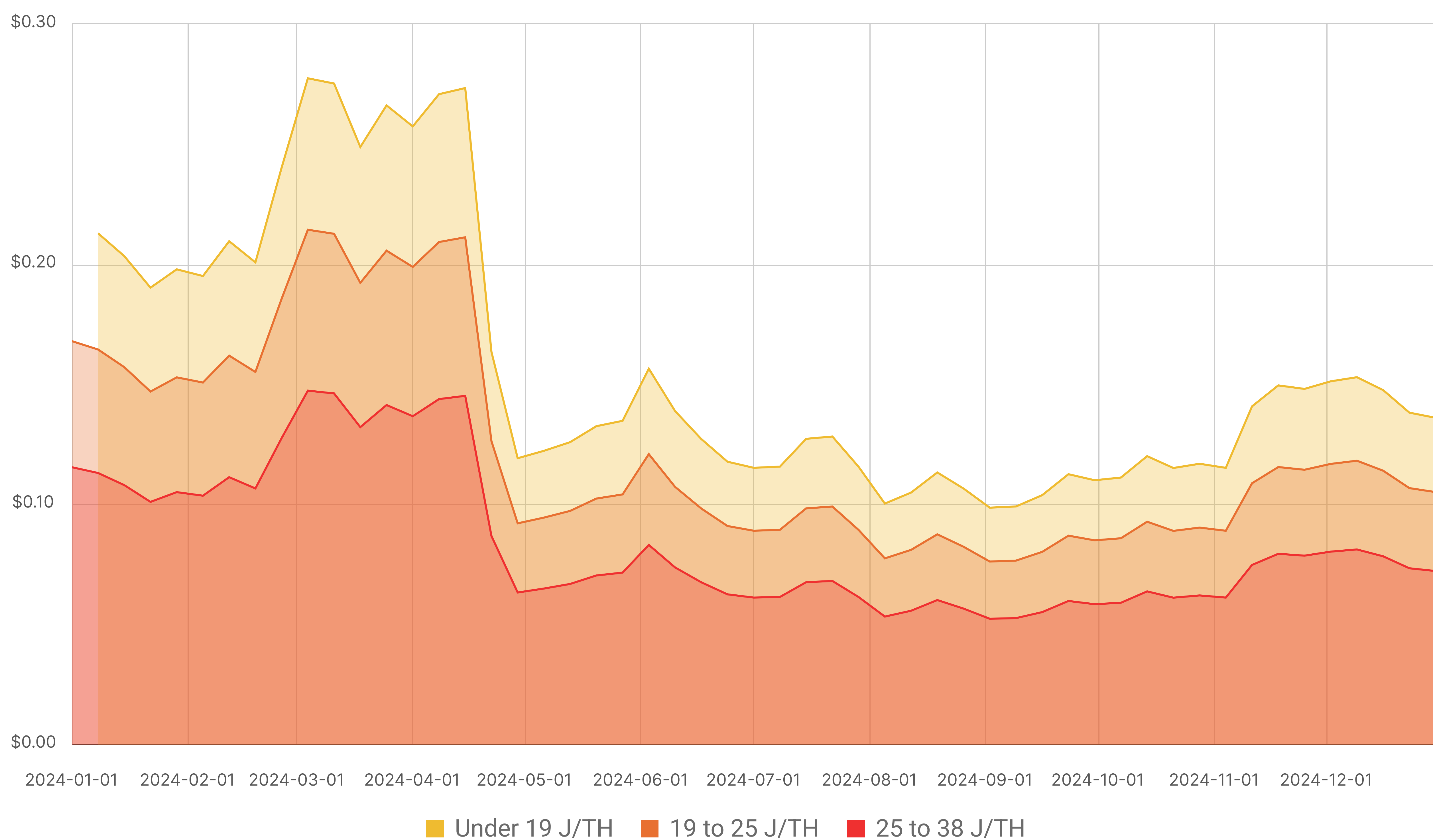


Post-halving, hashprice entered a sustained downturn, reaching all-time lows between \$40 – \$60/PH/Day, as rising network difficulty and hashrate growth squeezed miner margins. Following Donald Trump’s election victory in Q4, hashprice stabilized and rebounded toward the upper end of this range.

Energy-Adjusted Hashprice is a metric that expresses the revenue a bitcoin miner earns per unit of electricity consumed, rather than per unit of computational power. It incorporates ASIC efficiency into hashprice, allowing for comparisons of how efficiently different miners turn electricity into bitcoin.

Throughout 2024, energy-adjusted hashprice highlighted a significant divergence in miner profitability based on ASIC efficiency. Pre-halving, mid-to-old generation ASIC operators managed to sustain competitive margins, but their earnings per kWh were already under pressure as network hashrate expanded. Leading up to the halving in April, miners with older-generation hardware faced increasing pressure to upgrade as efficiency gaps widened, making it harder to justify their electricity costs.

Energy Adjusted Hashprice



Post-halving, the situation deteriorated sharply for mid-to-old gen miners. The energy-adjusted hashprice for 25-38 J/TH ASICs dropped to 6-8 cents per kWh, pushing many hosted miners to breakeven or unprofitable levels (particularly in regions with higher electricity rates). By contrast, next-generation ASICs (under 19 J/TH) retained stronger margins, allowing them to sustain operations profitably despite the decline in overall hashprice.

Bitcoin Price

Bitcoin had a stellar year in 2024 — starting at \$42,787, peaking at \$106,739, and trailing back down to \$93,606 by year-end. Overall performance stood at 120%.

2024 Bitcoin Price Action



Two major catalysts played a role in bitcoin's performance. The first major rally occurred throughout Q1, following the approval and launch of spot Bitcoin ETFs. This triggered a surge in institutional demand, pushing bitcoin past \$70,000 before stabilizing. The second major breakout came in November, following Donald Trump's election victory, which reignited bullish sentiment around potential bitcoin-friendly policies. This propelled bitcoin to all-time highs, before experiencing minor pullbacks into year-end.

Block Subsidy

In 2024, Bitcoin underwent its fourth halving: a quadrennial, hard-coded event that reduces the block subsidy by 50%. The block subsidy was reduced from 6.25 BTC to 3.125 BTC per block. This event, occurring at block height 840,000 (April 19, 2024), is part of Bitcoin's deflationary monetary policy, which ensures a fixed supply of 21 million BTC.

The halving mechanism will continue every four years until the final subsidy drops to zero at block 6,930,000 (expected in 2140), after which miners will rely solely on transaction fees for revenue. Each halving reduces new Bitcoin issuance, directly impacting mining economics by influencing hashrate, network security, and long-term miner sustainability.

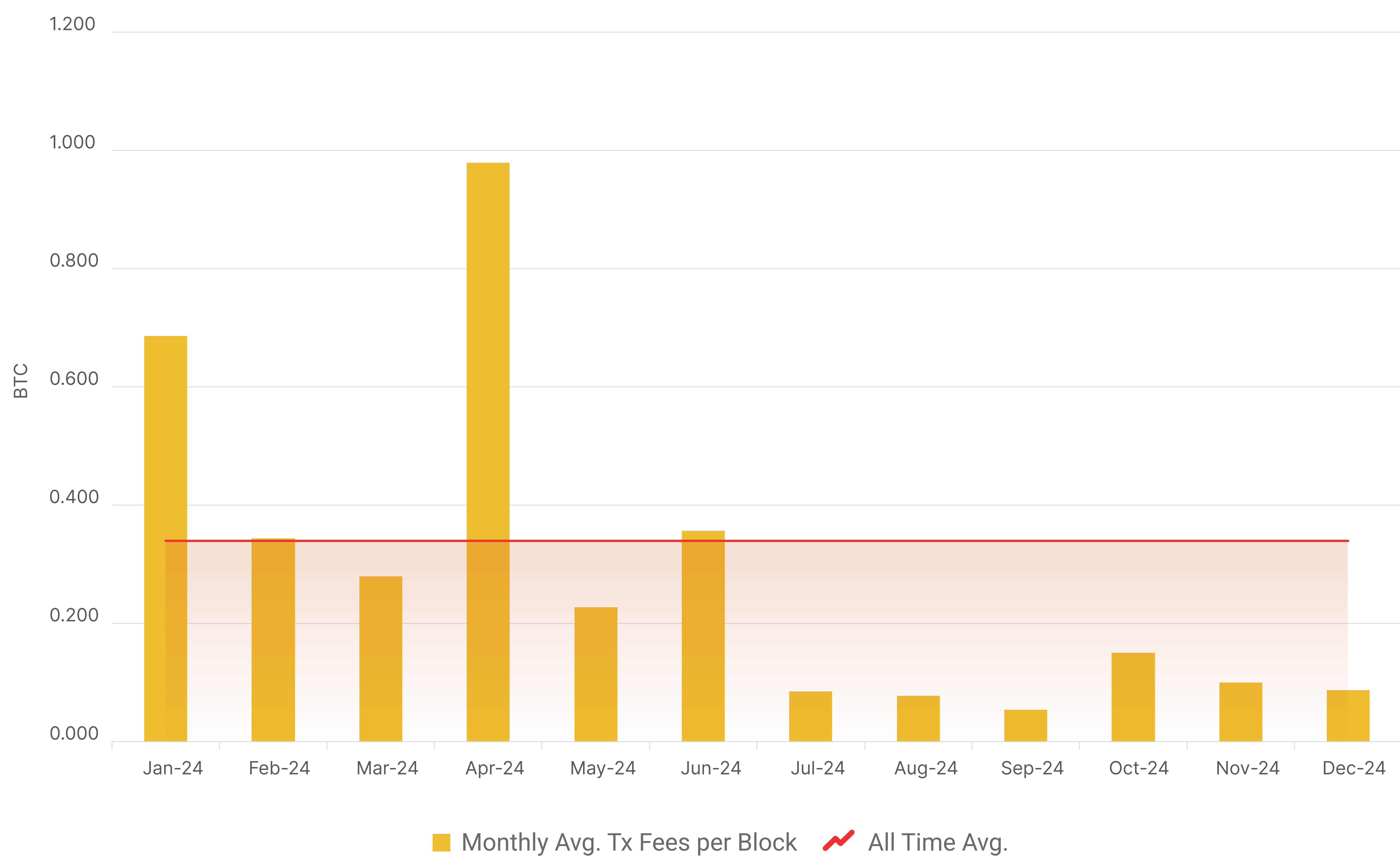
Halving Epoch	Block Range	Block subsidy	UTC Halving Date
1	0 - 209,999	50 BTC	Nov 28, 2012
2	210,00 - 419,999	20 BTC	July 9, 2016
3	420,000 - 629,999	12.5 BTC	May 11, 2020
4	630,000 - 839,999	6.25 BTC	April 19, 2024
5	840,000 - 1,049,000	3.125 BTC	April 13, 2028*

* Estimate based on 10-minute block times.

Transaction Fees

Bitcoin transaction fees experienced significant fluctuations throughout 2024, influenced by various on-chain activities. In the first half of the year, a resurgence of ordinals and BRC-20 tokens led to increased demand for block space, resulting in higher transaction fees. This was exacerbated with the introduction of runes during the halving, causing a brief spike in fees throughout April. However, this surge was short-lived.

Avg. Bitcoin Transaction Fees per Block, Monthly



The popularity of ordinals, BRC-20s, and runes diminished as the year progressed, leading to a substantial decline in transaction fees. By Q3, average fees per block dropped to 0.073 BTC, marking the lowest levels since Q2 2014 and approximately 80% below Bitcoin's lifetime average of 0.34 BTC per block. Despite strong Bitcoin price action in Q4, transaction fees remained subdued, averaging just 0.088 BTC per block in December. This trend deviated from historical patterns where rising Bitcoin prices typically led to increased transaction activity and higher fees, highlighting a shift in fee market dynamics.

Zooming out to annual comparisons, 2024 saw strong USD-denominated transaction fees totaling \$920 million. This surpasses 2023's \$796 million and all other years except 2021 (\$1.02 billion).

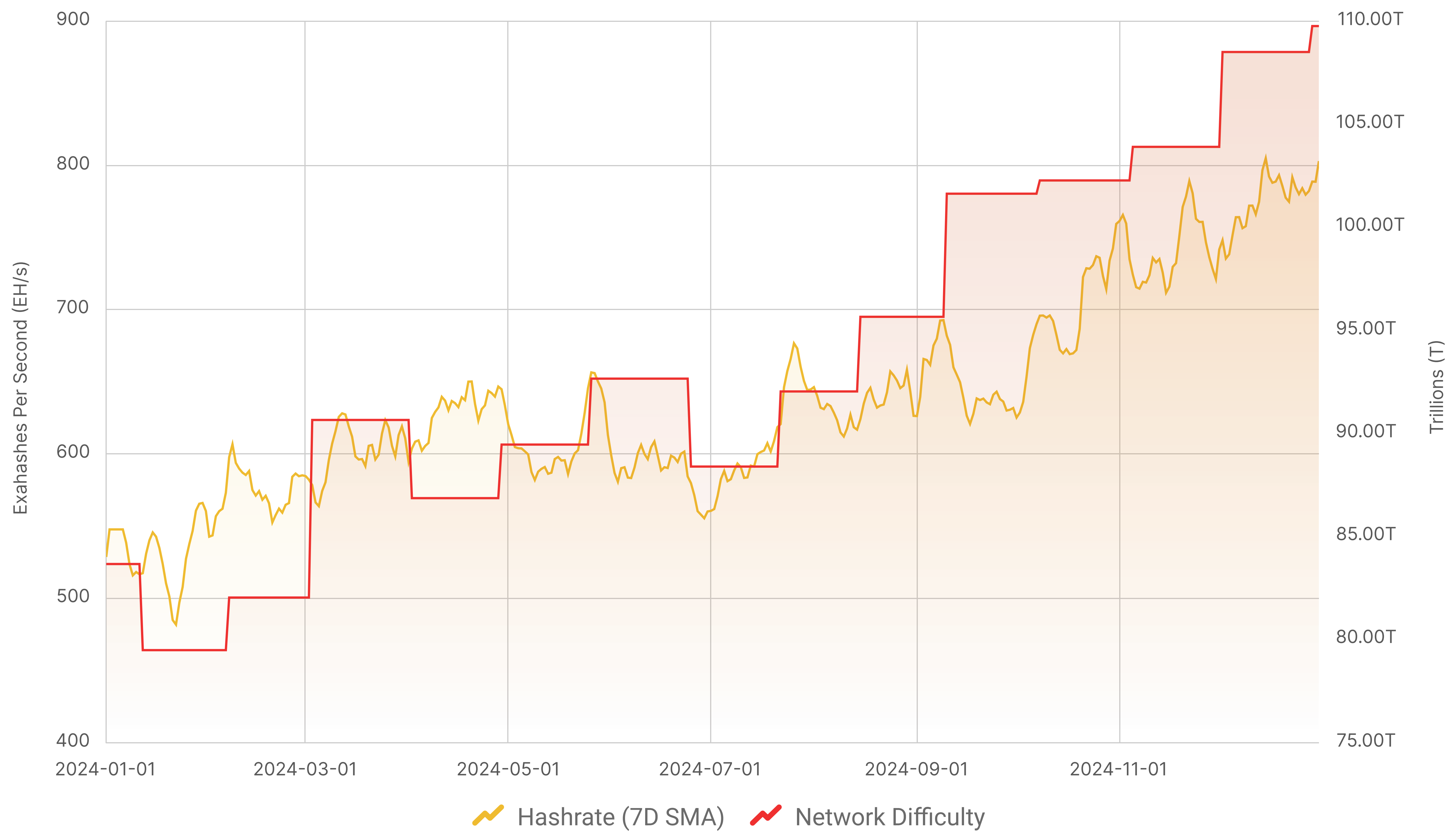
Year	Total Fees (BTC)	Total Fees (USD)
2024	15,132	\$920,223,124
2023	23,432	\$796,360,408
2022	5,374	\$141,990,733
2021	21,462	\$1,018,330,731
2020	26,310	\$324,417,534
2019	19,788	\$155,124,573
2018	25,705	\$283,307,876
2017	100,306	\$551,788,963

However, the year was heavily front-loaded, with 80% of total fees generated in H1 (\$738M), driven by ordinals, BRC-20, and runes mania. H2 was sluggish by contrast, producing only \$182M in fees (just 20% of the year's total), as interest in alternative on-chain activity dried up.

Half Year	Total Fees (BTC)	Total Fees (USD)	Annual Pace	%
2024-H2	2,482.58	\$182,193,220	\$364,386,440	20%
2024-H1	12,649.85	\$738,029,904	\$1,476,059,807	80%

Network Difficulty & Hashrate

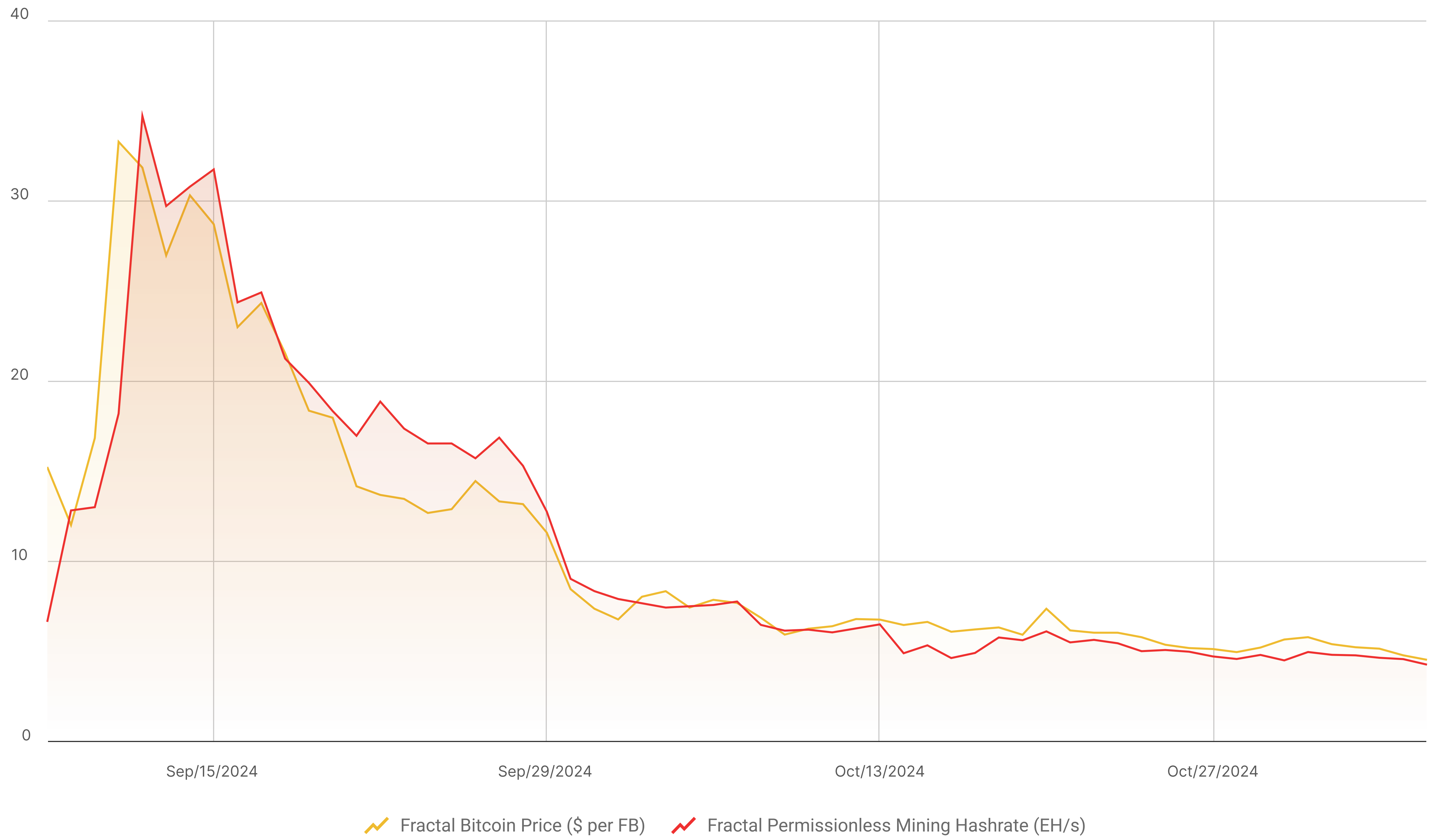
Positive pressure from bitcoin price on hashprice was met with negative pressure from an ever-increasing network difficulty. These forces grappled with each other throughout the year.



Global network hashrate and difficulty saw significant growth throughout 2024, reflecting aggressive miner expansions despite pressured mining economics. The pre-halving period saw steady increases, with hashrate climbing from ~500 EH/s in January to over 600 EH/s by mid-April, driving difficulty to new highs. A period of moderate decline occurred post-halving, influenced by seasonality effects through Texas' 4CP Demand Response program which forced temporary curtailment throughout the summer. By Q4, the network was back to breaking new ground, with hashrate and difficulty marking an all-time high of 805 EH/s and 109.78T respectively.

The launch of Fractal (a Bitcoin sidechain) on September 9, offered miners an alternative platform for their SHA-256 hashrate. At its inception, Fractal Bitcoin provided higher mining revenues compared to the main Bitcoin network, prompting approximately 35 EH/s of hashrate to be allocated to the sidechain by September 12. This migration contributed to a 4.6% decrease in Bitcoin's network difficulty on September 25. However, as Fractal Bitcoin's price declined to around \$8 by early October, many miners returned to the main Bitcoin network throughout the month, leading to a 2.7% increase in network difficulty.

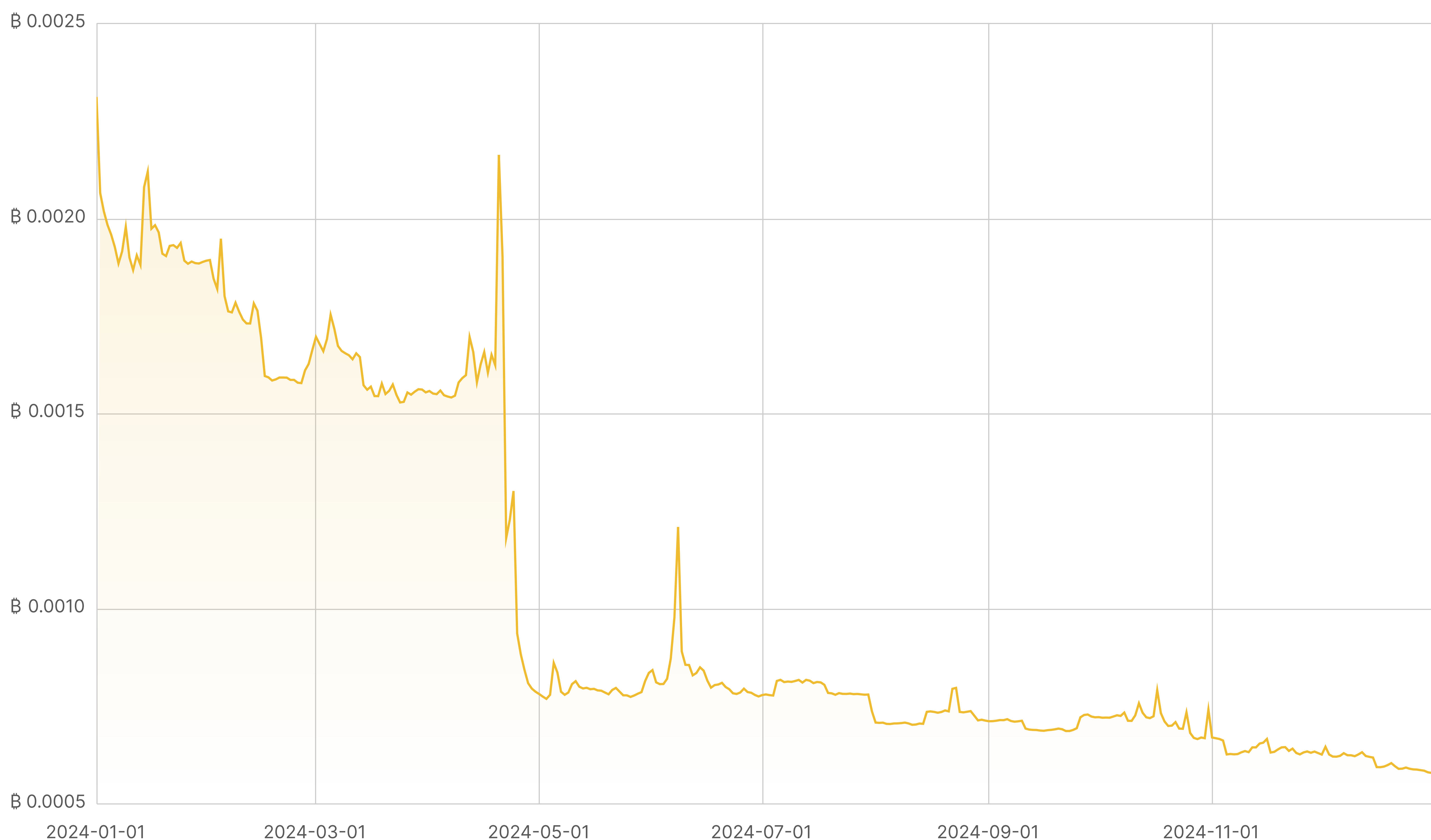
FB Price vs. Hashrate



BTC Hashprice

As a result of the halving, declining transaction fees and higher network difficulty, BTC hashprice fell relatively more sharply. BTC Hashprice entered 2024 at 0.00231283 BTC per PH/s/Day and fell by 75% throughout the year, closing at 0.00057997 BTC per PH/s/Day.

BTC Hashprice Index



All in all, record-high network difficulty and historically low transaction fees post-halving turned out to weigh more heavily on mining economics than Bitcoin price action. The end result was divergence between Bitcoin's price action and mining markets by year end.

% Change From 2021 Peak



Forward Hashrate Markets in 2024

In volatile commodity industries, forward and futures markets are essential for risk management, price discovery, and resource allocation. In 2024, nascent hashrate forward markets experienced rapid growth and maturation. In the OTC markets, volumes grew more than 500% year-over-year on Luxor’s hashrate market and tenors were extended up to 12-months. On exchange, Bitnomial launched hashrate futures, becoming the first regulated exchange to launch a Bitcoin mining derivative product.

The two tables below show the evolution of Luxor’s USD and BTC-denominated Bitcoin hashrate forward markets in 2024. Rows represent specific monthly contracts, while columns represent each trading month. Cell values indicate the average monthly mid-market price — except for the bold highlighted main diagonal — which shows actual spot hashprice settlement during each month. These tables summarize both the forward curve in each trading month (columns) and the trading history of 2024 contracts (rows).

		Trade Month													
		Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jun 2024	Jul 2024	Aug 2024	Sep 2024	Oct 2024	Nov 2024	Dec 2024
Hashrate Contract	Nov 2023	\$81.09													
	Dec 2023	\$71.06	\$98.57												
	Jan 2024	\$66.76	\$79.88	\$83.79											
	Feb 2024	\$63.24	\$74.61	\$75.55	\$83.63										
	Mar 2024	\$61.21	\$70.87	\$71.07	\$80.28	\$108.47									
	Apr 2024	\$54.22	\$59.29	\$58.23	\$62.11	\$86.19	\$95.16								
	May 2024		\$45.73	\$44.39	\$47.89	\$58.26	\$57.92	\$51.72							
	Jun 2024			\$44.51	\$48.44	\$58.52	\$57.46	\$51.91	\$55.20						
	Jul 2024				\$48.99	\$58.96	\$57.80	\$52.05	\$52.99	\$49.81					
	Aug 2024					\$59.42	\$58.30	\$52.42	\$52.31	\$49.36	\$43.54				
	Sep 2024						\$59.37	\$52.57	\$51.96	\$49.31	\$44.18	\$42.37			
	Oct 2024							\$53.09	\$51.77	\$49.23	\$44.03	\$41.86	\$46.87		
Nov 2024								\$51.63	\$49.13	\$43.88	\$41.60	\$44.63	\$55.33		
Dec 2024									\$49.04	\$43.71	\$41.32	\$44.21	\$54.03	\$59.83	

		Trade Month													
		Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024	May 2024	Jun 2024	Jul 2024	Aug 2024	Sep 2024	Oct 2024	Nov 2024	Dec 2024
Hashrate Contract	Nov 2023	0.00222													
	Dec 2023	0.00194	0.00232												
	Jan 2024	0.00182	0.00188	0.00195											
	Feb 2024	0.00174	0.00175	0.00177	0.00170										
	Mar 2024	0.00167	0.00166	0.00166	0.00163	0.00161									
	Apr 2024	0.00149	0.00140	0.00136	0.00125	0.00127	0.00144								
	May 2024		0.00108	0.00103	0.00097	0.00086	0.00089	0.00079							
	Jun 2024			0.00104	0.00098	0.00086	0.00088	0.00081	0.00083						
	Jul 2024				0.00099	0.00087	0.00088	0.00081	0.00078	0.00079					
	Aug 2024					0.00088	0.00089	0.00081	0.00076	0.00077	0.00072				
	Sep 2024						0.00089	0.00082	0.00074	0.00076	0.00073	0.00070			
	Oct 2024							0.00082	0.00072	0.00075	0.00072	0.00070	0.00072		
Nov 2024								0.00070	0.00073	0.00070	0.00068	0.00067	0.00064		
Dec 2024									0.00072	0.00069	0.00067	0.00066	0.00062	0.00061	

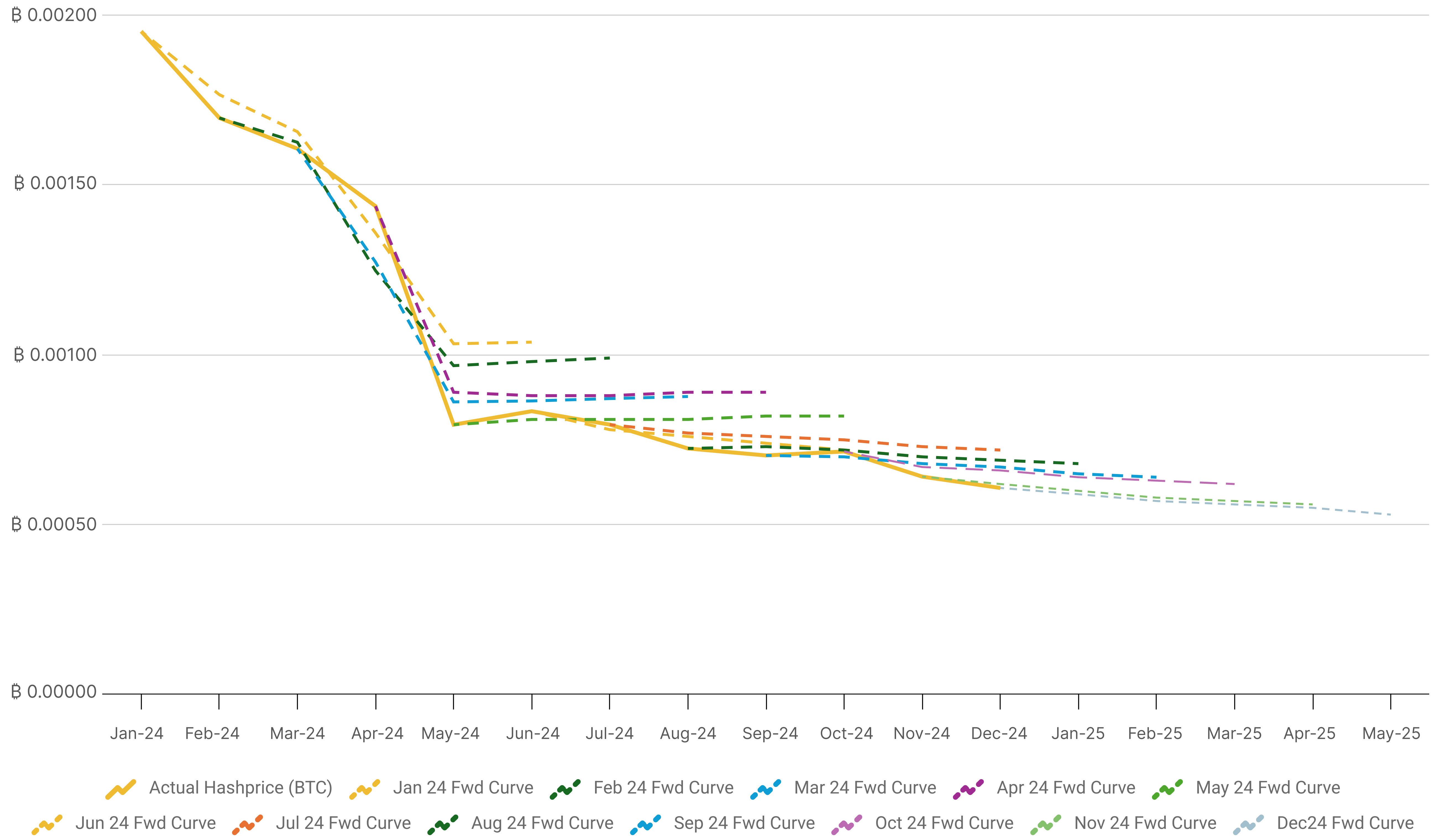
Note: all values shown in figures represent the midpoint of the best bid and ask on Luxor's Non-Deliverable Hashprice Forward market.

The Forward Curve in 2024

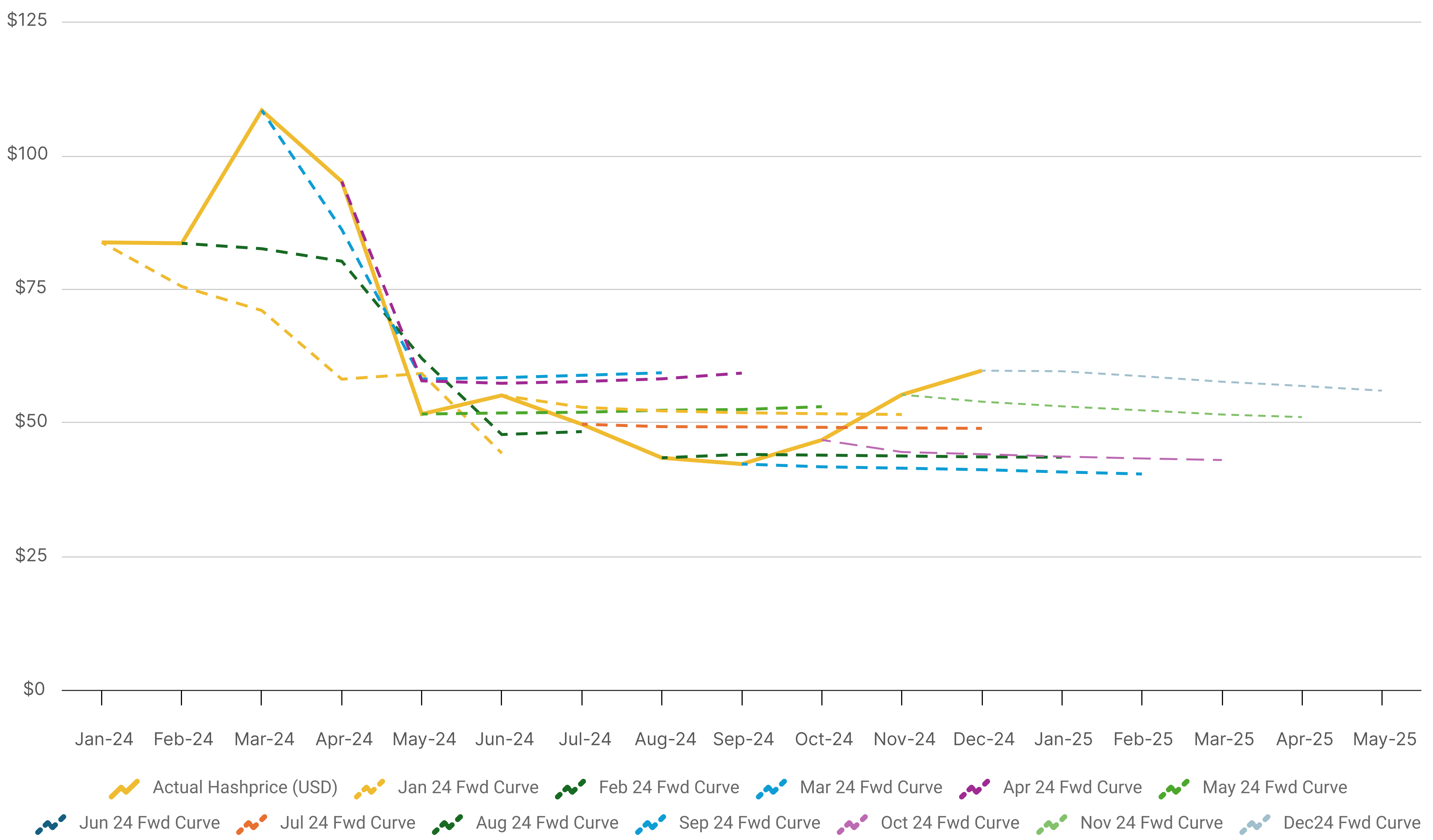
In 2024, the hashrate forward market tended to trade in backwardation. That means for any given trading period (column), future hashprice tended to trade below current spot hashprice and the market expected future hashrate to be less valuable in BTC and USD in the future. There were a number of reasons for this.

The first is the halving. Being a pre-determined, hardcoded event, the halving of Bitcoin's block subsidy in April was priced in to the forward market, driving expectations of hashprice post-halving below spot hashprice pre-halving over the period. The charts below, which plot the data from the tables above, clearly indicate that the market anticipated the halving.

BTC Forward Hashprice vs. Actual Hashprice



USD Forward Hashprice vs. Actual Hashprice



Post-halving, backwardation was driven by market expectations – namely, that hashrate and network difficulty would grow more quickly than Bitcoin’s price and transaction fees. The exceptions, where hashprice traded in contango (i.e., when future prices were higher than spot), were after the halving when the market expected hashrate to come offline due to unprofitability and during Texas’ 4CP months where the market expected hashrate growth to decrease due to local electricity market dynamics.

Forward vs. Spot Bitcoin Mining Performance in 2024

The tables below show the performance of each monthly hashrate contract from 2024 (rows), traded one to five months in advance (columns) of spot settlement. Positive values indicate that hashprice for a specific month (row) increased, while negative values indicate hashprice declined relative to market expectations one to five months in advance (columns). When the value is positive, it was profitable to purchase hashrate in the forward market and better to mine at spot hashprice. Conversely, when the values are negative, it was not profitable to purchase hashrate in the forward market and it was better for miners to sell hashrate forward.

USD-Denominated Forward Hashprice vs. Spot						BTC-Denominated Forward Hashprice vs. Spot					
Contract	1-Mo Hedge	2-Mo Hedge	3-Mo Hedge	4-Mo Hedge	5-Mo Hedge	Contract	1-Mo Ahead	2-Mo Ahead	3-Mo Ahead	4-Mo Ahead	5-Mo Ahead
Jan-24	5%	26%	26%	26%	26%	Jan-24	4%	7%	7%	7%	7%
Feb-24	11%	12%	32%	32%	32%	Feb-24	-4%	-3%	-2%	-2%	-2%
Mar-24	35%	53%	53%	77%	77%	Mar-24	-1%	-3%	-3%	-4%	-4%
Apr-24	10%	53%	63%	60%	76%	Apr-24	13%	15%	6%	3%	-3%
May-24	-11%	-11%	8%	16%	13%	May-24	-10%	-8%	-18%	-23%	-26%
Jun-24	6%	-4%	-6%	14%	24%	Jun-24	3%	-5%	-3%	-15%	-20%
Jul-24	-6%	-4%	-14%	-16%	2%	Jul-24	1%	-2%	-10%	-9%	-20%
Aug-24	-12%	-17%	-17%	-25%	-27%	Aug-24	-6%	-4%	-10%	-18%	-17%
Sep-24	-4%	-14%	-18%	-19%	-29%	Sep-24	-3%	-7%	-4%	-14%	-21%
Oct-24	12%	6%	-5%	-9%	-12%	Oct-24	3%	0%	-4%	0%	-13%
Nov-24	24%	33%	26%	13%	7%	Nov-24	-5%	-6%	-9%	-12%	-8%
Dec-24	11%	35%	45%	37%	22%	Dec-24	-1%	-8%	-9%	-12%	-16%

Note: this mining strategy performance analysis incorporates data from November 2023 onwards, i.e., since the inception of Luxor’s Non-Deliverable Hashprice Forward market order book. For example, January data only has up to 2 months forward, February has only up to 3 months forward, and so on. In effect, selling 6 months ahead in January is considered the same as selling 2 months ahead, given the availability of trading data since inception.

Outside elevated fees early in the year and immediately after the halving, BTC-denominated hashrate contracts settled lower than traded in the forward market. This means network difficulty and hashrate were higher and transaction fees lower than the forward market predicted, and it was generally favorable for miners to hedge network difficulty and transaction fees in 2024.

Performance of the USD-denominated hashrate contracts reflected changes in the BTC-denominated contracts, and most notably, changes in Bitcoin’s spot price. When Bitcoin price increased at the beginning and end of the year, USD hashprice settled higher than traded, and it was generally profitable to be a purchaser of hashrate, and better to mine unhedged.

The tables below compare different hashrate forward market strategies with normal bitcoin mining in the spot market for 2024. Each table compares, by hedging strategy, the average monthly hashprice and standard deviation of monthly hashprice for January - December 2024.

USD Hedging Strategy

	5-Mo Hedge	4-Mo Hedge	3-Mo Hedge	2-Mo Hedge	1-Mo Hedge	Spot
Avg. Hashprice	\$54.77	\$54.81	\$55.18	\$56.15	\$59.90	\$64.64
% From Spot	-15%	-15%	-15%	-13%	-7%	0%
St. Dev Hashprice	\$7.17	\$7.53	\$9.04	\$10.86	\$16.00	\$22.20
% From Spot	-68%	-66%	-59%	-51%	-28%	0%

BTC Hedging Strategy

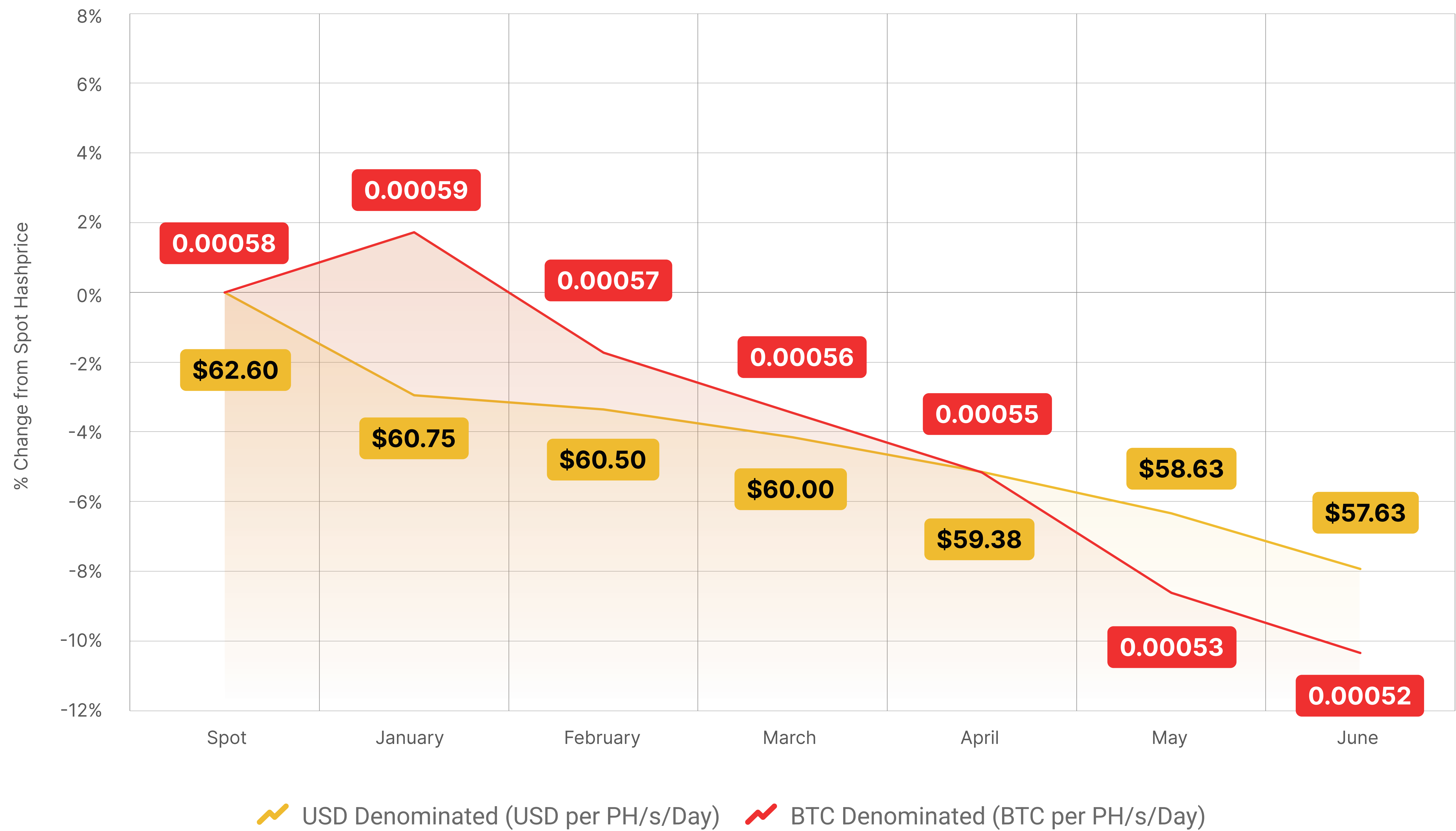
	5-Mo Hedge	4-Mo Hedge	3-Mo Hedge	2-Mo Hedge	1-Mo Hedge	Spot
Avg. Hashprice	0.00115	0.00111	0.00108	0.00105	0.00104	0.00104
% From Spot	11%	7%	4%	1%	0%	0%
St. Dev Hashprice	0.00041	0.00043	0.00044	0.00045	0.00046	0.00048
% From Spot	-15%	-12%	-9%	-8%	-4%	0%

For 2024 as a whole, the ideal mining strategy was to hedge against network difficulty and transaction fees, while staying long on Bitcoin's price, **by selling in the BTC-denominated hashrate market 5-months in advance.** Miners using this approach mined 11% more bitcoin, had lower volatility and more predictability. Miners who hedged USD had 15% lower revenue, but significantly reduced volatility (-68% standard deviation).

Note: although selling forward proved to be favorable in retrospect, it is critical to recognize that hedging is typically a cost of business rather than a revenue generation method. Hedgers willingly pay a price to buy certainty and obtain more predictable cash flows, which increases valuation, reduces cost of capital, and ultimately attracts investments.

Looking Forward to 2025

Looking forward, Luxor's Hashrate Market is pricing in an average hashprice of \$59.48/PH/Day or 0.00057 BTC/PH/Day over the next six months. Sellers can currently secure this hashprice while buyers have the opportunity to lock in the same hashcost through to June 2025.



We are keeping our eye on three key trends in 2025. The first is the race between Bitcoin price and network difficulty. If Bitcoin price continues to outpace network difficulty, like it has the last few months, then 2025 could be a very lucrative year for miners. However, if Bitcoin price falls, then higher network difficulty will mean hashprice is significantly lower for any given previous Bitcoin price. This is a key risk miners should consider hedging against in 2025.

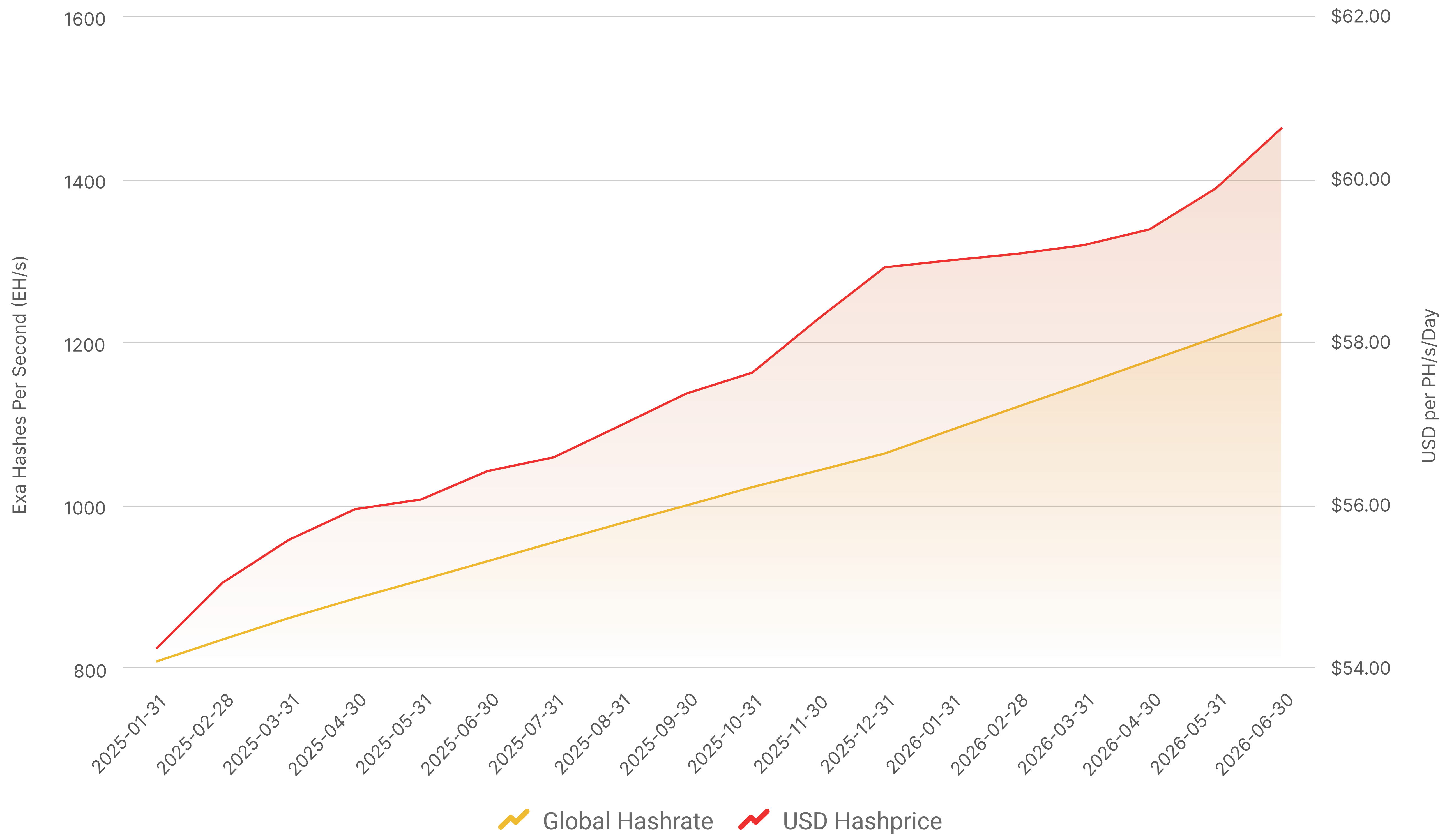
The second key trend is low transaction fees, which will be the wild card for hashprice in the coming year. Since the April 2024 halving, fees have been historically and unexpectedly low. But as we know, volatility in blockspace markets can pick up at any time and provide a production boost for miners.

The final key trend is hashrate markets going mainstream in 2025. With volumes at an all time high, we see miners deploying two key strategies in hashrate markets. The first is to buy hashrate directly, which enables miners to deploy capital and generate BTC instantly. The second is to sell hashrate forward and receive non-dilutive financing for fleet expansion.

2025 Base Case Hashprice Projection

On the next page is a chart that projects our Base Case trajectory for Bitcoin’s hashrate and hashprice throughout 2025 and into 2026. For those interested in more detailed analysis with multiple projections, this is available to [Hashrate Index Premium Gold and Platinum subscribers](#). Our Base Case anticipates a 53% increase in hashrate and for hashprice to range between \$54-61 per /PH/s/Day over the next 18 months.

Base Case Projection





3

ASIC Hardware

ASIC Markets in 2024

Estimated ASIC Market Size

Bitcoin mining is the backbone of the Bitcoin network, and application-specific integrated circuits (ASICs) lie at the heart of bitcoin mining. Bitcoin mining ASIC machines are specialized computer hardware designed exclusively to perform SHA-256 hashing required for Bitcoin's Proof-of-Work consensus mechanism. This process transforms raw computational power into decentralized cybersecurity, securing the blockchain by imposing a computationally prohibitive and economically infeasible cost to malicious actors.

Bitcoin is — by far — the most powerful computer network in the world, as demonstrated by its immense computational scale. Using data from Hashrate Index's [Bitcoin Mining Consumption Index](#) and Coin Metrics' [MINE MATCH](#), the global network is estimated to have drawn approximately 25 GW of power (as of December 2024), with a total hashrate of ~800 EH/s. Taking the Antminer S19j Pro as a representative machine (100 TH/s at 2950W), this suggests that around 8 million units could be actively hashing. This unprecedented scale of distributed computing is what makes Bitcoin special and sets it apart as a technological marvel.

New ASIC Models in 2024

2024 brought with it a slew of new ASIC models that will be indispensable for miners in the new mining epoch.

Bitmain added new units to its S21 series, including the S21 Pro, S21+, and S21 XP, which includes immersion and hydro models. The leading manufacturer also unveiled the hydro-cooled U3S21EXPH, the first-ever ASIC miner with a traditional U-form factor that is standard in the data center industry. MicroBT added to its M60 series with the M60S++ (including hydro and immersion units), and Canaan introduced its A15 series with the Avalon A15, A15 Pro, A15SE, and A15 XP, a line that also comes with an immersion option.

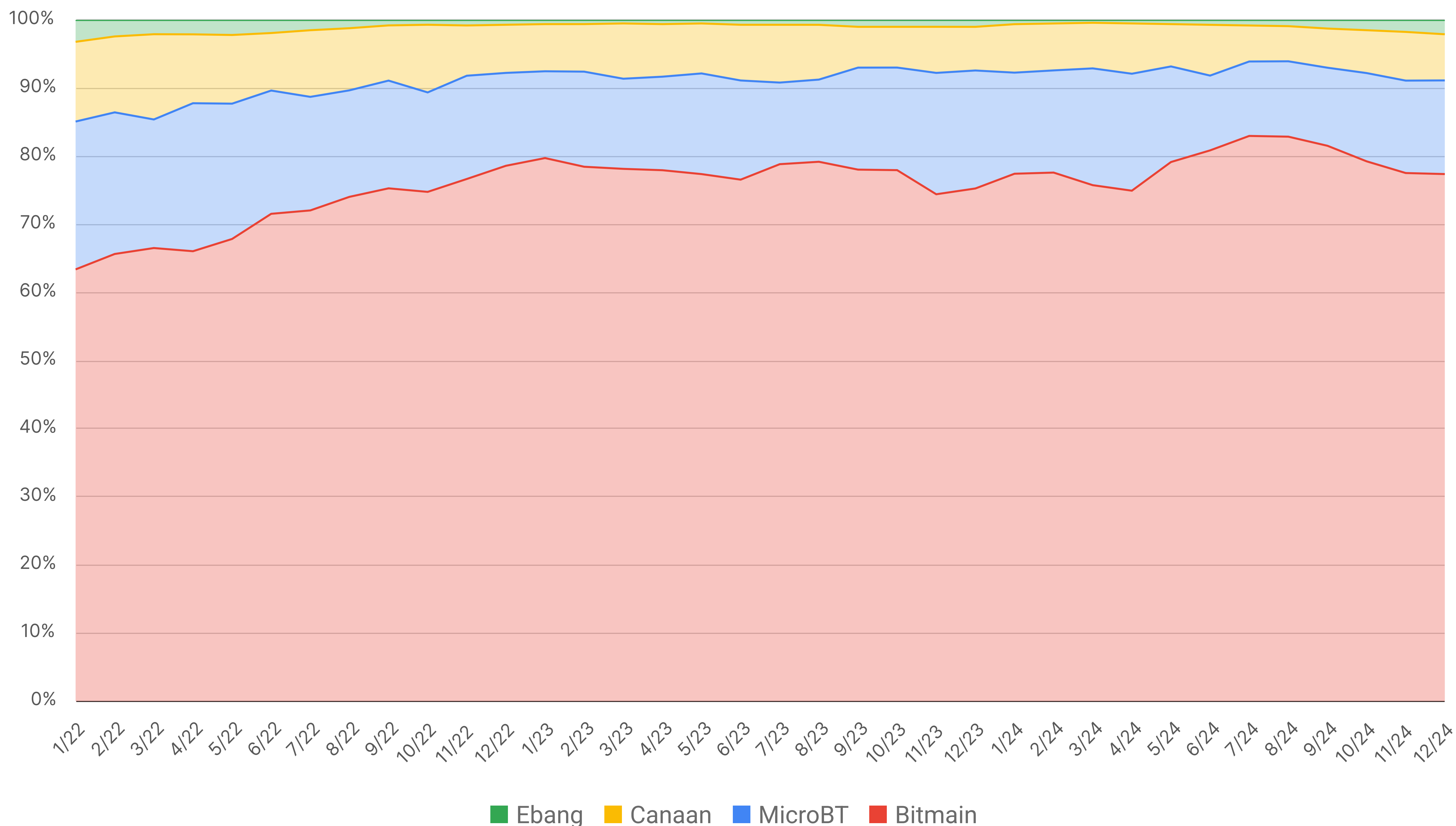
2024 also witnessed the first commercially available ASIC from the Bitdeer team — the Sealminer A2 — which comes in air-cooled and hydro models. Founded by Bitmain co-founder Jihan Wu, Bitdeer is a newcomer to the ASIC manufacturer space; as is Auradine, which released its air-cooled Teraflux 1500 and 2800 series last year and its immersion unit, the Teraflux AI3680.

Air-Cooled	Hashrate	Efficiency	Manufacturer	Hydro and Imersion Cooled	Hashrate	Efficiency	Manufacturer
S21 XP	270	13.5	Bitmain	U3S21EXPH	860	13	Bitmain
S21 Pro	234	14	Bitmain	S21 XP Hydro	473	12	Bitmain
M60S++	226	15.5	MicroBT	M63S++ (Hydro)	464	15.5	MicroBT
A2	226	16.5	Bitdeer	A2Hyd	446	16.5	Bitdeer
S21+	216	16.5	Bitmain	M63S (Hydro)	408	18	MicroBT
A15 Pro	215	16.8	Canaan	M66S++ (Immersion)	348	15.5	MicroBT
A15	203	18.8	Canaan	S21+ Hydro	319	15	Bitmain
S21	200	17.5	Bitmain	S21 XP Immersion	300	13.5	Bitmain
M60S	186	18.5	MicroBT	A13680	250	16	Auradine
A15SE	185	19.9	Canaan	A1566I (Immersion)	249	19	Canaan
AT2880	180	16	Auradine				
M60	162	19.2	MicroBT				

Market share By Manufacturer and Models

According to Coin Metric's MINE-MATCH data, Bitmain, Canaan, and Ebang gained market share over 2024, while MicroBT lost market share; Bitmain's dominance rose from 75.2% to 77.7%, MicroBT's market share fell from 17.3% to 13.8%, Canaan's market share increased from 6.4% to 6.8%, and Ebang's market share rose from 1% to 2.1%.

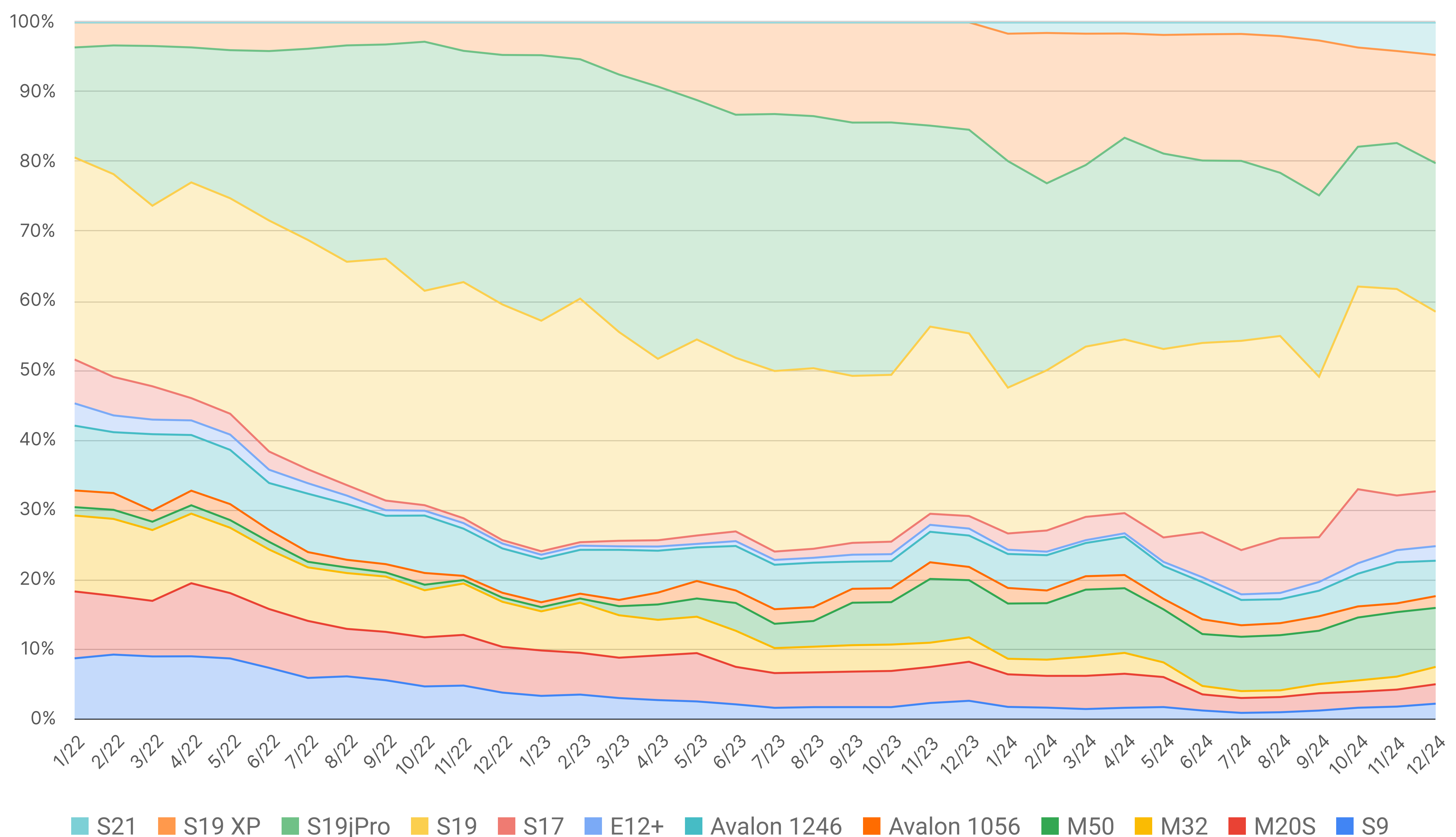
ASIC Manufacturer Marketshare (According to Coin Metric's MINE-MATCH)



The chart below shows an estimated breakdown of Bitcoin’s network hashrate per ASIC model. The S21 continues to gain marketshare, but it is still miniscule compared to the penetration of other models. In Q1-2024, the first quarter that miners started deploying S21’s en masse, it made up 1.6% of the entire Bitcoin network’s hashrate; by the end of Q2, the S21’s market share was 1.7%; by the end of Q3-2024, it was 2.6%; and by the end of Q4-2024, it was 4.7%. The S19 XP’s market share fell from 15.4% to 13.2% over 2024, while the S19j Pro’s market share fell from 29.2% to 21%.

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.

ASIC Miner Model Market Share (According to Coin Metric's MINE-MATCH)



ASIC Price Trends in 2024

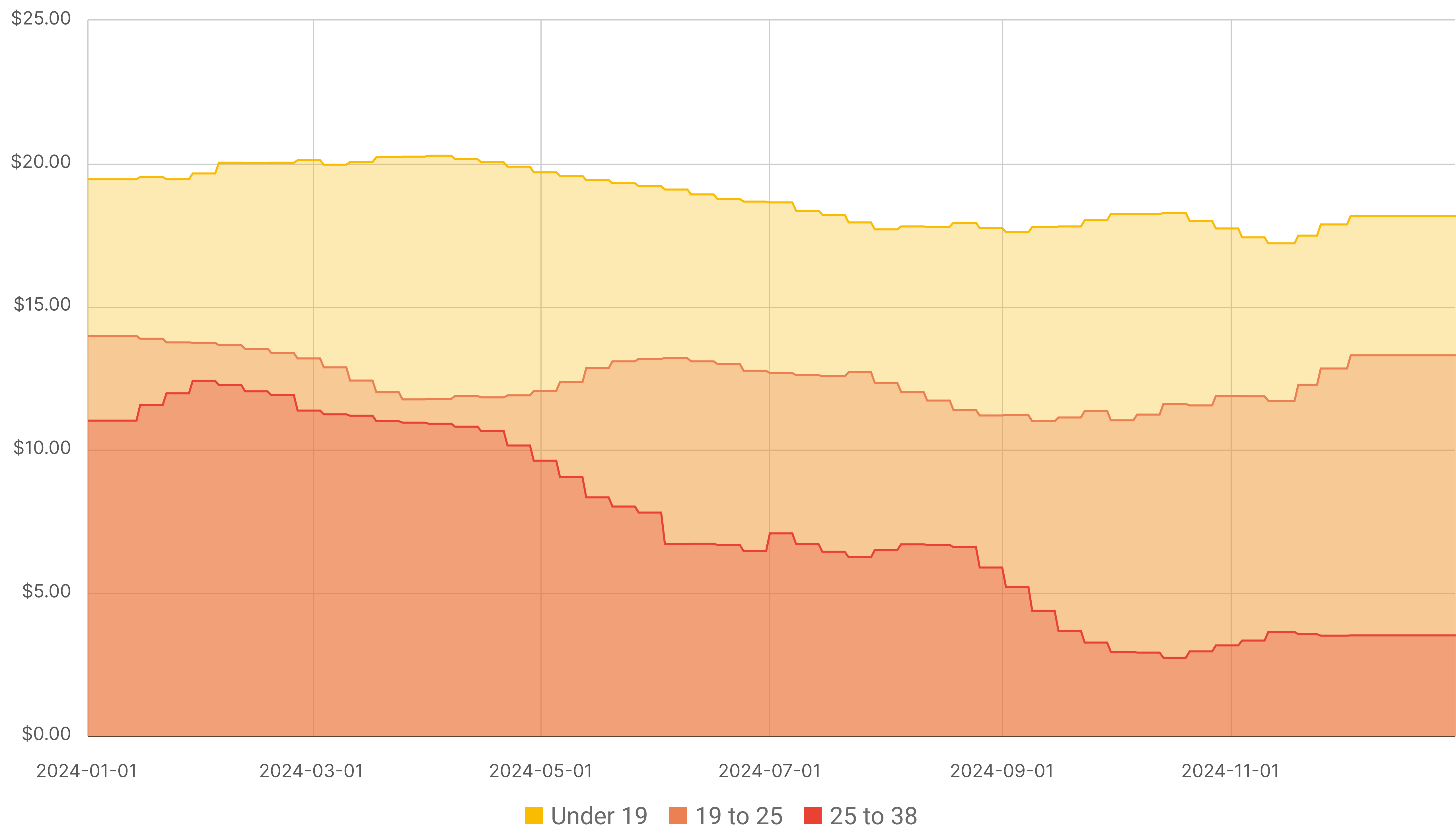
2024 was the year of next-generation ASICs like the S21.

Hashrate Index’s ASIC Price Index highlighted a significant price decline for old-generation machines over the year, indicating a gradual phase-out of relatively outdated hardware.

Mid-tier ASICs (19 to 25 J/TH) experienced a -5% annual decline, with occasional rebounds throughout Q2 and Q4, suggesting intermittent demand for these models before and after the halving.

The least efficient ASICs in the index (25 to 38 J/TH) suffered the steepest depreciation at -68% annually, with sharp drops throughout Q2 and Q3 and a dramatic -50% in September.

ASIC Price Index - 2024

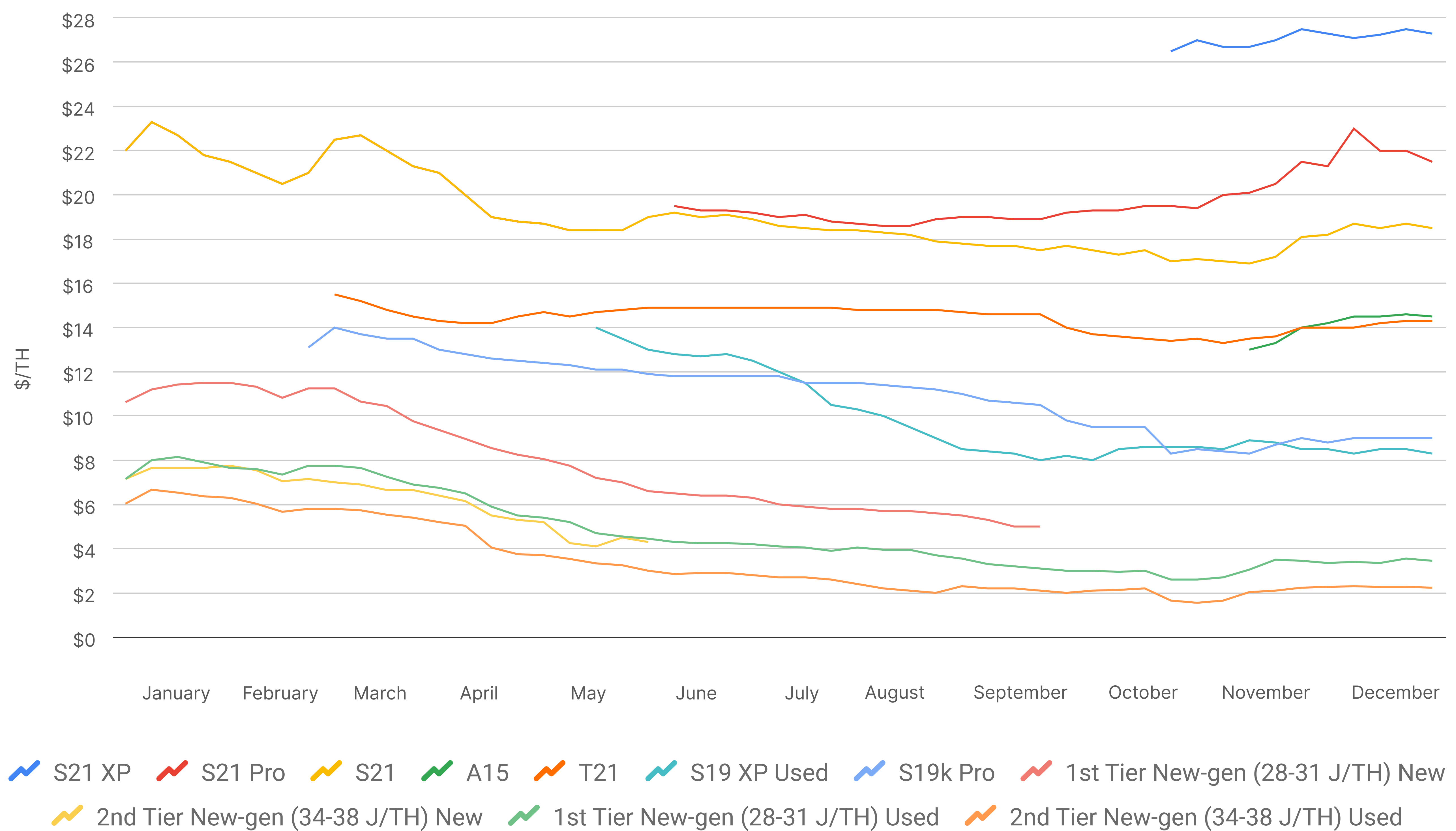


ASIC Price Index	Under 19 J/TH	19 to 25 J/TH	25 to 38 J/TH	USD Hashprice
January	1%	-2%	13%	-18%
February	2%	-4%	-8%	29%
March	1%	-11%	-4%	4%
April	-3%	2%	-12%	-55%
May	-2%	9%	-19%	25%
June	-3%	-3%	-17%	-16%
July	-5%	-3%	-8%	-1%
August	0%	-9%	-9%	-7%
September	3%	-2%	-50%	12%
October	-3%	8%	8%	17%
November	1%	8%	11%	31%
December	2%	4%	0%	-11%
Annualized	-7%	-5%	-68%	-45%

Shifting gears to asking price data from Luxor's ASIC Trading Desk, we can break down model-by-model demand with greater granularity. Prices for the vanilla model of the S21 series, which was released at the end of 2024 and first delivered in Q1-2024, fell over the course of the year as Bitmain released the S21 Pro, S21+, and S21 XP. From the introduction of the S21 Pro in this data set in June, the model increased 10% by the end of 2024, while the S21 XP increased a more modest 3% from its introduction in the data set to the year's close. Predictably, older ASICs declined over the course of the year, with their decline accelerating following the halving. Our data for new models from the S19 and M30 series drops off in May and September, as Bitmain and MicroBT no longer manufacture these units.

ASIC Asking Prices per Model / Efficiency Tier

Source: Luxor ASIC Trading Desk



S21 Series Premiums in 2024

Unsurprisingly, S21 series ASICs were the most sought after models in 2024. We can see this reflected in the premiums these ASICs carried to other models, which swelled significantly as the year wore on.

These premiums were relatively small in Q1 as orders of the flagship of the series, the S21, were still making their way into the hands of bitcoin miners. As orders were fulfilled and the miners started trickling into the secondary market, the premiums began to rise, and then they really took off after the fourth Halving in April.

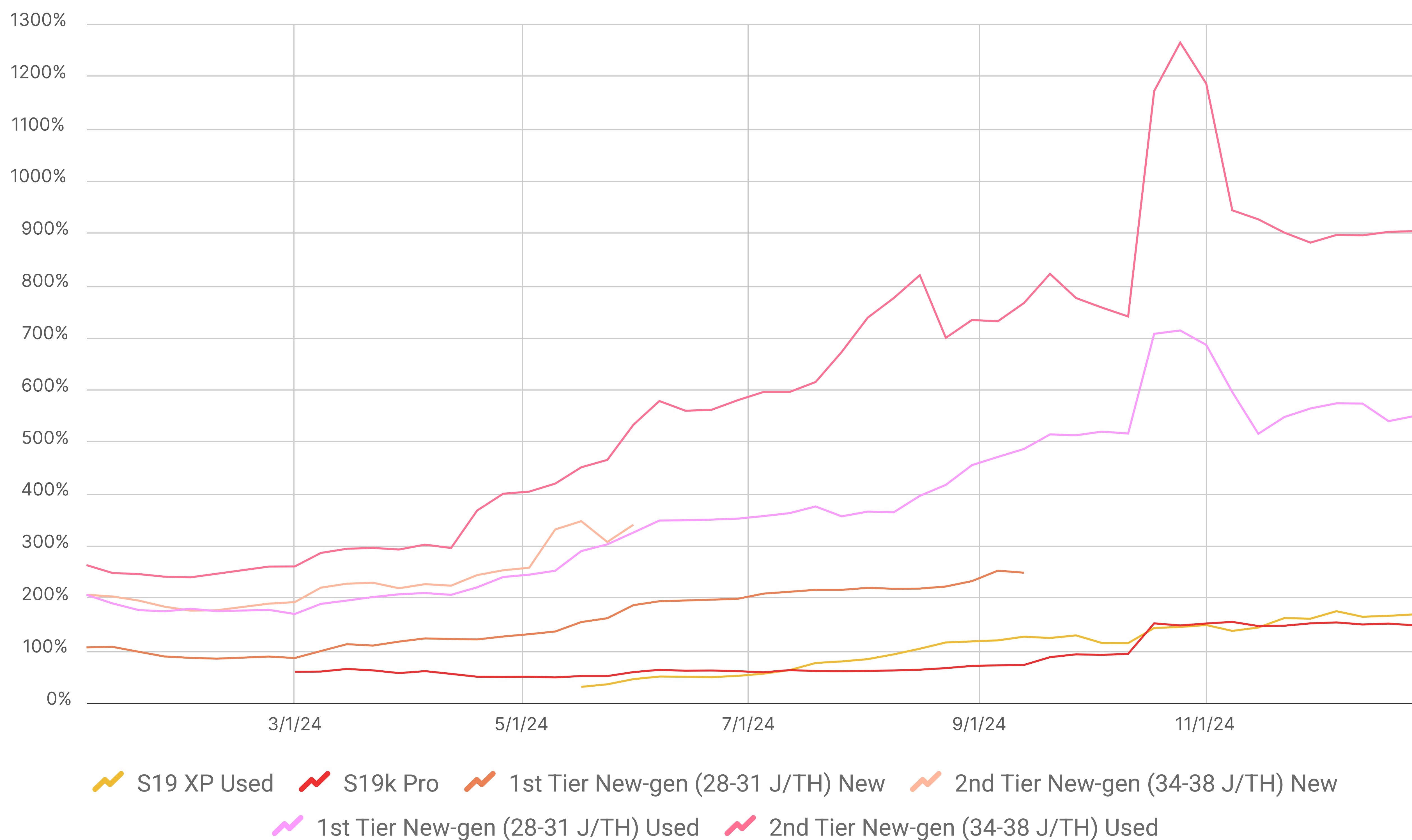
These premiums peaked in October, with S21 series ASICs fetching nearly a 1,300% premium over used older generation ASICs like the S19 and M30. As bitcoin broke above \$100,000 the premiums tapered off briefly before resuming their rise into the New Year.

The Chart below shows the \$/TH asking price difference between an average for S21 series ASICs (the S21, S21 Pro, and S21 XP) versus other popular Bitcoin mining rigs and older ASIC tiers. For older ASIC tiers, we break these out into four categories and take an average of the asking prices for ASICs in each category (as with the pricing chart on the last page).

The significant jump in October is the result of the S21 XP entering the mix, a model which holds roughly a 40-45% premium over the S21 and S21 Pro models.

S21 Price Premium vs Other ASICs and Efficiency Tiers

Source: Luxor ASIC Trading Desk



Emergence of Regional Premiums After Bitmain Imports Detain at U.S. Ports

The U.S. is currently experiencing significant import challenges concerning Bitcoin mining machines, particularly those manufactured by Bitmain. The U.S. Customs and Border Protection (CBP), reportedly at the request of the Federal Communications Commission (FCC), has been detaining shipments of Bitmain's Antminer S21 and T21 series at various ports of entry. These detentions have led to delays extending up to two months, causing substantial operational disruptions and financial burdens for mining companies based in the U.S. As a result, premiums are growing for ASICs sold in the U.S. versus other markets.

The specific reasons for these detentions have not been officially disclosed. However, industry speculation suggests that the scrutiny may be linked to the semiconductor chips used in Bitmain's latest machines. These chips, produced by the Chinese company Sophgo, are allegedly under investigation for potential U.S. sanctions violations.

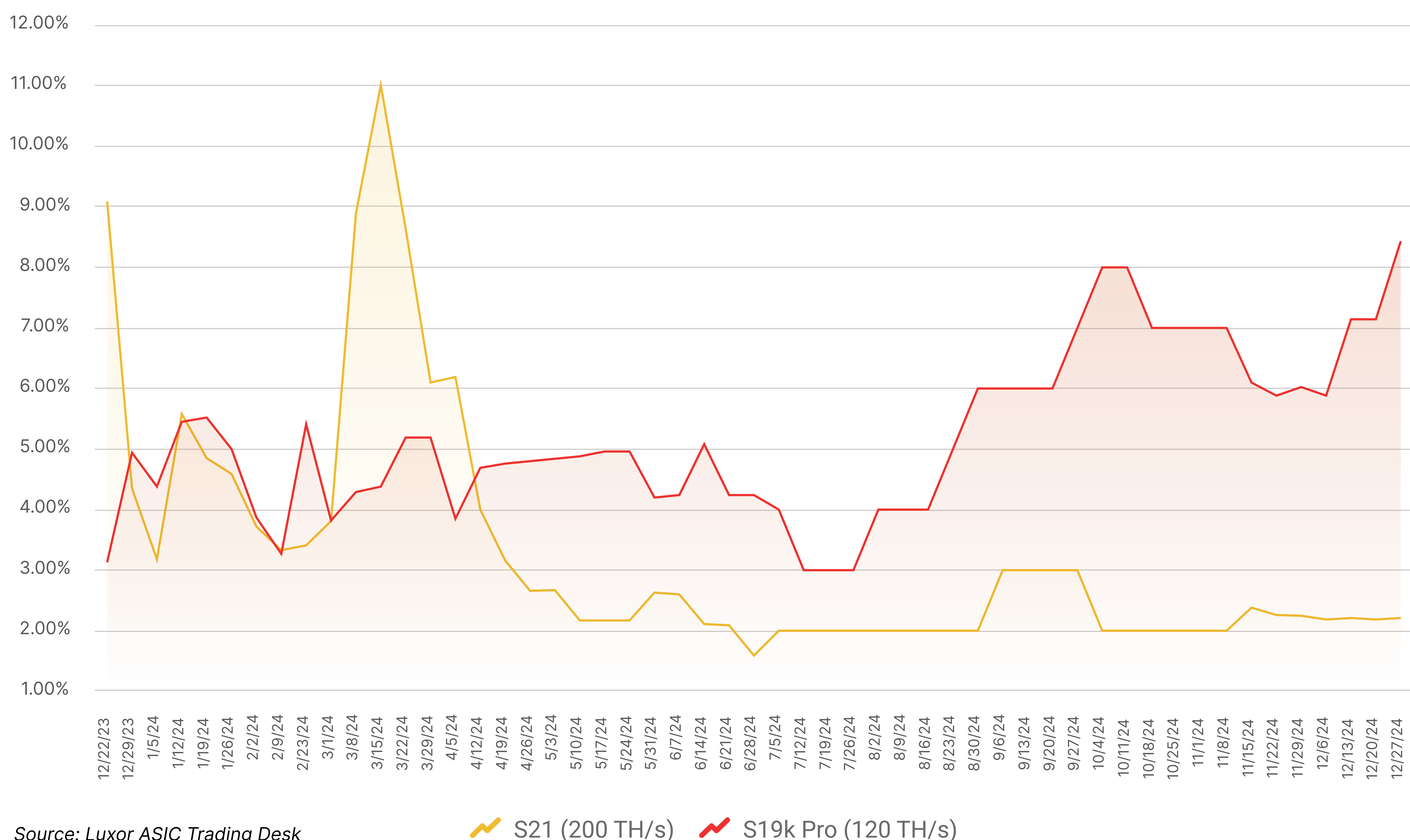
In response to these import challenges and potential tariff hikes on Chinese exports with the new administration, Bitmain has announced plans to establish a production line in the United States. This strategic move aims to provide faster response times and more efficient services to North American customers, potentially mitigating the impact of import restrictions and ensuring a more stable supply chain for their products. In the meantime, U.S. based mining machines are likely to command a regional price premium. This would reflect the reduced risks of import delays, regulatory scrutiny, and additional costs associated with tariffs or transportation. Domestic availability of mining equipment will enable U.S. mining operations to continue and grow, albeit at a higher upfront cost.

In December 2024, Luxor announced a \$93.2 million purchase agreement with MicroBT for WhatsMiner ASICs, with an option to acquire an additional \$38.2 million worth, totaling \$131.4 million. This partnership aims to ensure a stable supply chain for U.S. based miners, enhancing domestic access to advanced mining hardware.

ASIC Ask-Bid Spreads

Bitcoin mining rig ask -bid spreads (the difference between listing price and selling price) can vary drastically per model, per order quantity, and depending on mining profitability at the time of the sale, but clearing prices typically carry a discount to spot. Looking specifically at two popular models, we can see that the ask-bid spreads for the S19k Pro widen substantially in the latter half of 2024 (the spread particularly takes off after hashprice hit its yearly bottom and all-time low in August). By contrast, ask-bid spreads for the S21 peaked in Q1 while this ASIC was still out for delivery and before it became widely available on the secondary market, but they flatten later in the year as this model became increasingly desirable in a harsh hashprice environment.

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



Source: Luxor ASIC Trading Desk

— S21 (200 TH/s) — S19k Pro (120 TH/s)

The following pages show ask-bid spreads for a variety of hardware sourced from Luxor's ASIC Trading Desk data. We break up clearing price averages into buckets according to order sizes: under 200 units, 200-500 units, and over 500 units.

There are too many insights from this data to list, but if you are looking for consistent alpha on ASICs, sign up to Luxor's weekly newsletter [here](#).

ASIC Investments

Breakeven Hashprice Under Different Power Price Scenarios

Electricity is the most critical operational expense (OpEx) for bitcoin mining, as it makes up the lion's share of costs and directly impacts profitability. Mining operations strive for maximal up-time and consistently consume power, so even small differences in electricity rates can significantly affect overall margins. Those with access to cheap and reliable energy can operate at a lower cost per terahash, allowing them to remain profitable even during bear markets. A sound energy strategy is a competitive advantage, enabling low-cost miners to survive longer cycles, reinvest in incoming ASICs, and ultimately scale operations more aggressively.

The table below shows the breakeven hashprice (i.e., the hashcost) for a range of ASIC machines under power price scenarios ranging from \$0.01/kWh to \$0.12/kWh:

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

Note: calculation only incorporates power costs and excludes other direct operating expenses.

The cell value for each ASIC machine (rows) and power price (columns) indicates the daily cost associated with operating a particular machine. Comparing this value with current spot hashprice conditions allows a mining operator to ascertain whether or not running the ASIC machine is economically rational.

The table demonstrates what is perhaps obvious to most: next-generation ASICs will be instrumental to thriving in the next mining epoch. Lets assume, for instance, that hashprice continues to trend at \$50 per PH/s/Day. Under this scenario, machines with sub 20 J/TH efficiencies would be able to afford electricity costs up to 9 cents per kWh and still justify hashing. Now compare that to efficiencies between 25-30 J/TH: these machines would only be able to afford electricity costs up to 6-7 cents per kWh and still justify hashing.

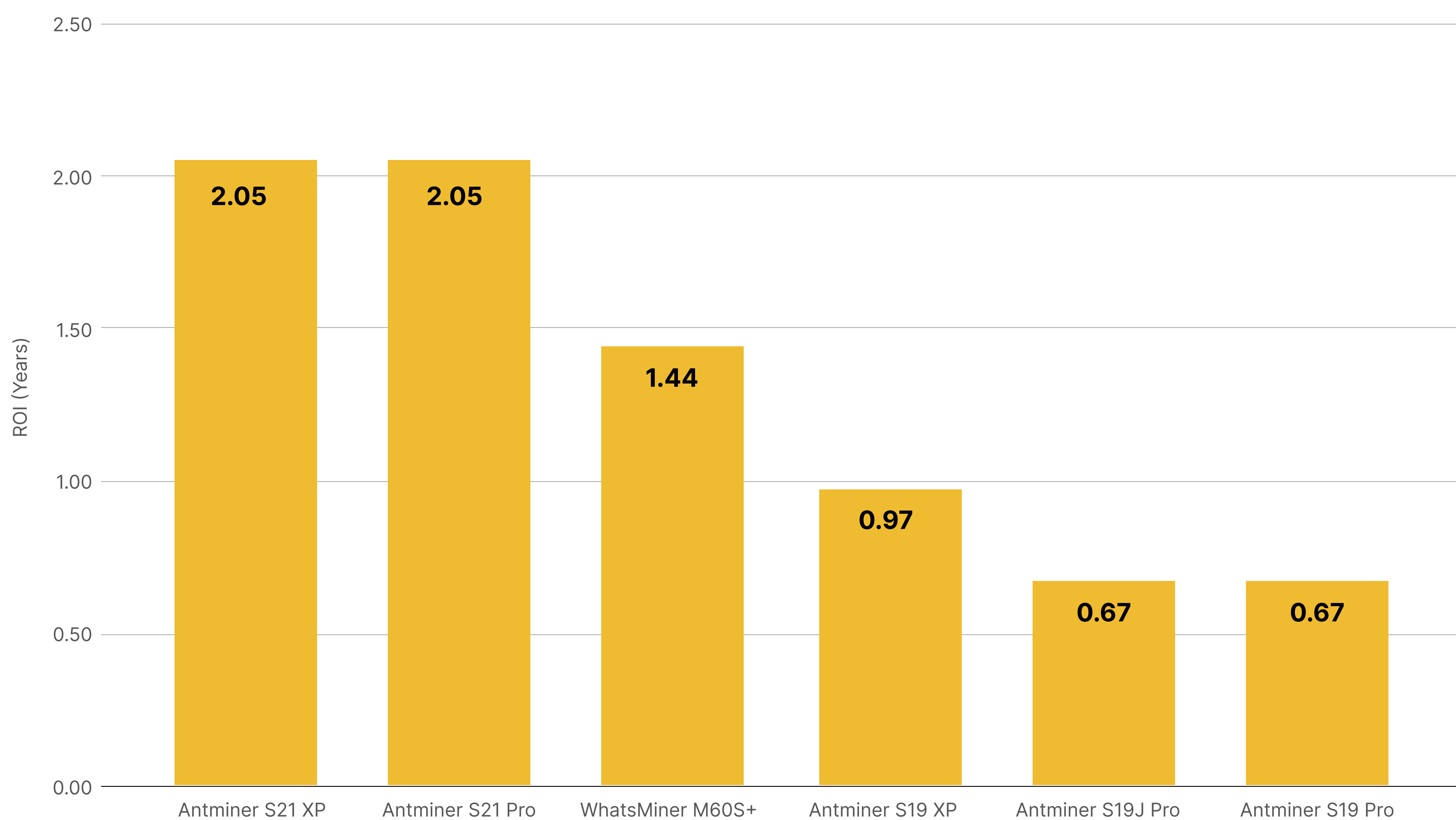
To put these breakevens into perspective, consider the average industrial power cost in the US from January through September 2024 of \$0.082/kWh and the average Bitcoin mining hosting rate of \$0.074/kWh in Q4-2024.

Returns on ASIC Investments

Payback period is a crucial ASIC investment return metric for operators. This metric measures how long it takes a miner to recoup their initial capital expenditure from the revenue generated by a machine. Since ASIC hardware depreciates quickly (due to technological innovation), miners aim to achieve payback before their ASICs become obsolete or less competitive. A shorter payback period reduces risk across the board, whereas a longer payback period increases exposure to hashprice, energy costs, or the many other variables which could render the initial investment unprofitable before full cost recovery.

In the table below, we estimate payback periods based on the current hashprice environment for popular Bitcoin mining ASICs. The calculation assumes 100% uptime and \$0.06/kWh all-in power costs. ASIC prices are based on low MOQ (1-200) prices from Luxor's ASIC Trading Desk as of the second week in January 2025, and hashprice is held constant at January 2025's daily average (month-to-date).

Payback Period - \$57.75 Hashprice, 0.060 \$/kWh Electricity Cost, 100% Uptime



At first glance, the results seem intuitive: older-generation machines pay back faster than new-generation machines. Then why would new-generation ASICs such as the S21 XP and S21 Pro carry a premium? While older-generation ASICs have faster payback periods, they come with trade-offs: particularly in terms of sensitivity to import duties, shipping costs, and (most importantly) long-term profitability. Since these machines are less efficient, they require larger unit quantity shipments to match the output of newer units, incurring higher logistical costs per terahash. This ultimately makes them more sensitive to import tariffs and transportation expenses (especially for miners operating in regions with restrictive trade policies). Since they are less efficient, they also run the risk of becoming unprofitable sooner than newer models.

In contrast, newer ASICs justify their premium pricing by offering higher efficiency, requiring fewer units to generate the same hashrate and reducing operational costs over time. This translates into lower exposure to shipping and import-related costs. Next-generation ASICs also enable future-proofing as they are more resilient to changes in network difficulty. Public miners are also valued based on fleet efficiency, which drives up new-gen prices (and reduces demand for older machines, allowing private miners to acquire them at a discount).

Despite longer payback periods, miners prioritizing long-term stability and cost efficiency across multiple halvings tend to favor newer models.

Looking Ahead

Incoming ASICs

As with last year, 2025 will bring new ASIC models into the market. Here are a few we're keeping an eye out for:

- Sealminer A3: Bitdeer will begin its chip tapeout for the A3 in Q1-2025, so testing units may be available by the end of Q4-2025. Bitdeer anticipates a 10 J/TH chip efficiency for this unit (NB: this is just the efficiency for the chip, not the entire unit).
- Block's Proto ASIC: Jack Dorsey's Block is anticipated to bring its ASIC miner chip to market this year; the company originally said that this rollout would include stand-alone chips that companies could use to build their own ASICs (similar to Intel's strategy in 2022) as well as a full unit, but it's unclear now whether Block will produce a full unit. There are no publicly available specs for this chip.
- Bitmain, MicroBT, and Canaan will also release new models this year, although there isn't any publicly available information on these models yet. Bitmain will reveal its latest model at its World Digital Mining Summit, which should occur in April or May. We should expect news about MicroBT and Canaan's new models around this time as well.

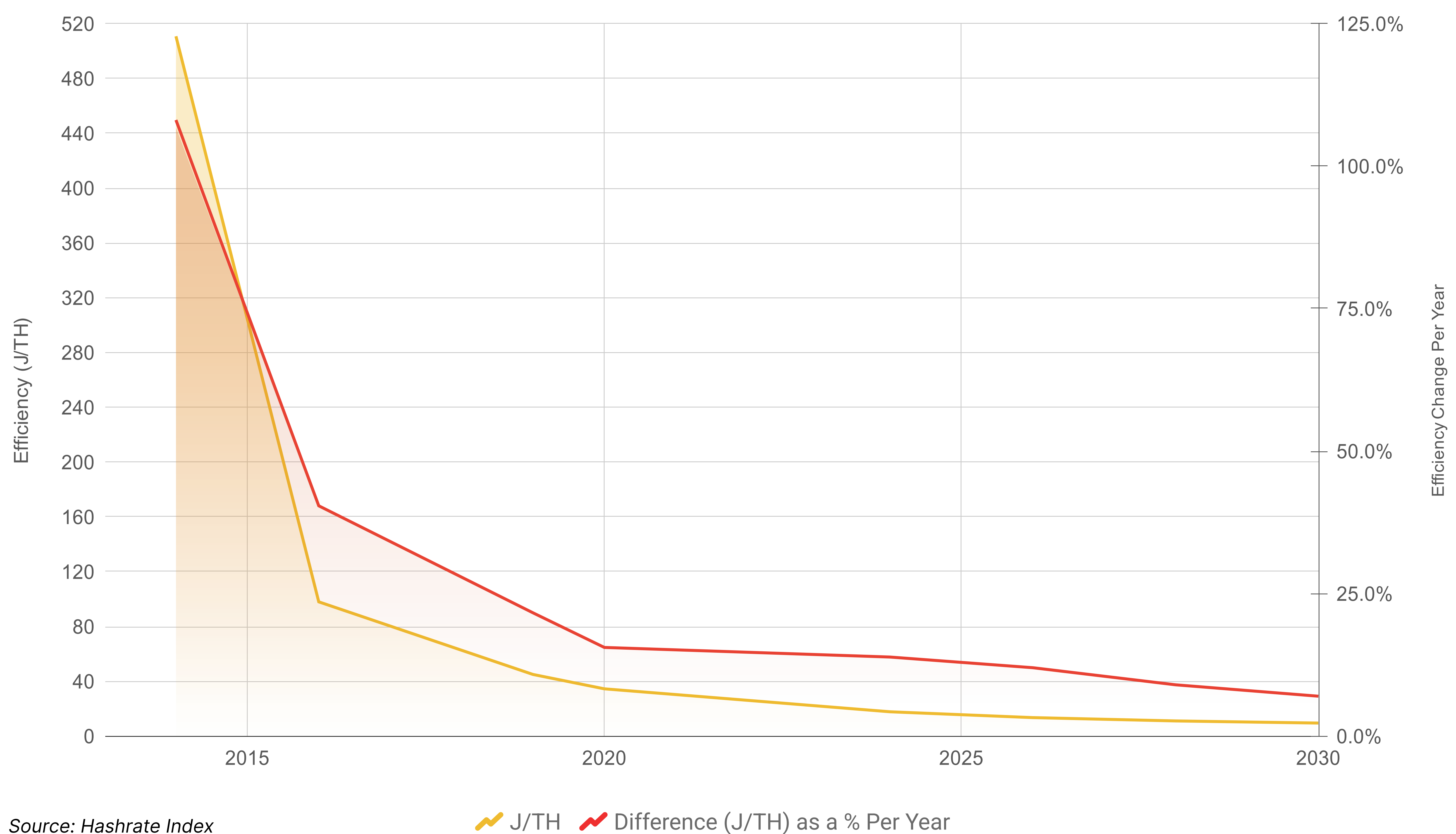
Projecting Future Efficiency Gains

Since Bitmain's first ASIC miner, the S1, mining efficiency as measured by J/TH has improved dramatically. While efficiency increases are declining every year and loosely tracking Moore's law, each new model's efficiency gains are still significant for a miner's bottom line.

Bitdeer's SEALMINER Technology Roadmap expects the SEALMINER04 to achieve 5 J/TH by Q2 2025, however, without a major technology breakthrough or some other unpredictable event, this timeline suggestion should be taken with a grain of salt.

We estimate new machines to hit ~ 10 J/TH, 8 J/TH, and under 6 J/TH over the next five years.

Leading Hardware J/TH Efficiency vs. Leading Efficiency Change from Prior Year



Using Hashrate Forwards to Finance ASICs

As miners are evaluating ASIC fleet refreshes and expansion programs, they can look to Luxor's Forward Market for financing. In exchange for upfront payment, miners have two delivery options: fixed hashrate or fixed Bitcoin repayment.

	Fixed Hashrate Delivery	Fixed Bitcoin Delivery
Purpose	Fianningc and Hedging	Financing and Leverage
Trade(s)	Sell Deliverable Forward (DF)	Sell Deliverable Forward (DF) and Buy Non-Deliverable Forward (NDF)
Upfront Funds	Deliverable Notional - Margin (incl. Unrealized Loss)	Deliverable Notional - Realized Loss
Daily Delivery Qouta (i.e., Daily Repayment)	Hashrate * Daily Hashprice	Fixed BTC Amount

Fixed hashrate repayment refers to the delivery of a specific quantity of **Bitcoin mining hashrate** to Luxor Pool, for a specific amount of time, in exchange for upfront payment. This is otherwise known as selling a Deliverable Forward (DF) contract.

The upfront capital amount Luxor will pay the miner is known as the “notional” value of the hashrate – i.e., Contract Execution Hashprice x Daily Hashrate x Contract Duration in Number of Days – less a margin requirement of 18% on the position. With each day that rolls off the contract, excess margin is returned to the miner after a daily mark-to-market. Luxor collects margin to protect against fluctuations in hashprice and ensure market integrity.

A fixed hashrate delivery locks the miner into a certain hashprice, enabling a hedged position throughout the contract term. This option may be favorable to miners looking to reduce revenue volatility or to express a relatively bearish opinion on future hashprice.

Fixed Bitcoin repayment refers to the delivery of a specific quantity of **Bitcoin** through hashrate on Luxor Pool, for a specific amount of time, in exchange for upfront payment. This is otherwise known as selling a Deliverable Forward (DF) contract and buying a Non-Deliverable Forward (NDF) contract.

The upfront capital amount Luxor will pay the miner is known as the “deliverable notional” value of the hashrate – i.e., Contract Execution Hashprice x Daily Hashrate x Contract Duration in Number of Days – less the realized loss on the spread between the Deliverable Forward (DF) and Non-deliverable Forward (NDF) contracts. The Deliverable Forward (DF) tends to trade at a discount to the Non-deliverable Forward (NDF) market because it entails upfront payment.

Since inception, the market-determined annualized spread between the DF & NDF (i.e., the realized loss or cost of capital) has decreased from 18-21% to 10-13% in favor of miners.

A fixed bitcoin delivery locks the miner into a specific bitcoin amount, enabling a leveraged position throughout the contract term. This option may be favorable for miners looking to express a relatively bullish opinion on future hashprice, i.e., an upward trend over time.

To be eligible for forward payment, miners must move to Luxor Pool for a minimum of 30 days, post margin, and complete credit profiling procedures and due diligence requirements with the Luxor Derivatives Desk. After completing onboarding and executing contracts, all settlements and mark-to-markets happen automatically in your Luxor Pool account.

On November 21, 2024, BitMine Immersion Technologies, Inc. (OTCQX:BMNR) entered into a deliverable forward contract with Luxor, selling a portion of its existing hashrate for an upfront Bitcoin payment. This capital was utilized to purchase 3,000 ASIC machines, marking one of the first long-term agreements by a publicly listed Bitcoin miner to use existing hashrate as collateral for working capital. The 365-day contract allows BitMine to hedge against hashprice volatility and enhances operational efficiency by running the new miners on LuxOS firmware, optimizing ASIC performance by approximately 10%.



4

Energy Markets

Power Price Trends in 2024

Wholesale Electricity Pricing

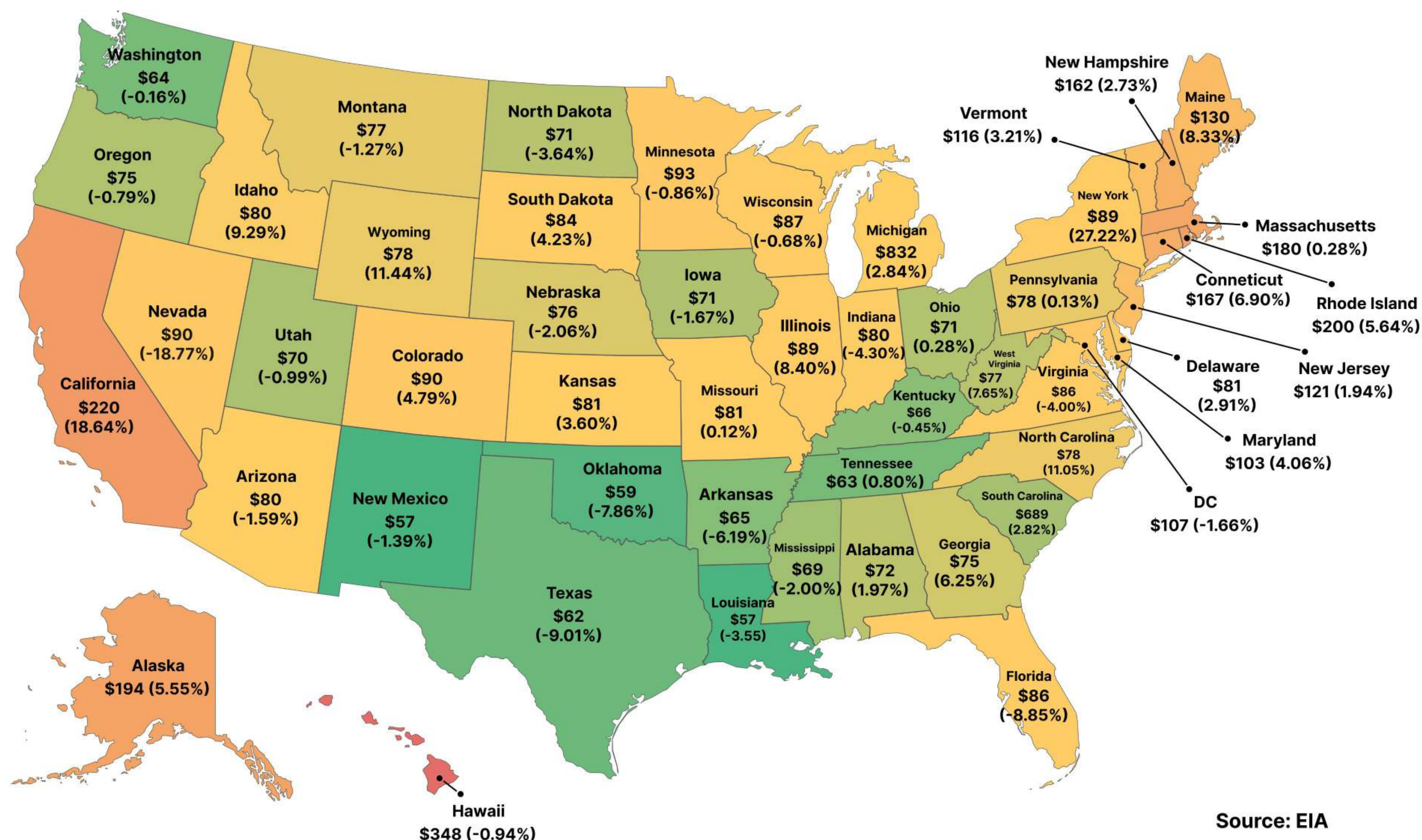
Electricity prices in the US are relatively flat year over year, with the average price of power for industrial consumers increasing 1% from \$81.2/MWh to \$82/MWh from the first nine months of 2023 to the same period in 2024, according to the EIA. If we zoom in more closely on popular mining states, we see that there's a mixed bag of changes in power prices.

Certain states in the US experienced a more mild summer in 2024 than in 2023, and this partly explains the reduction in power costs somewhat since there was less stress on the grid from use of air conditioning and the like. Texas had one of the most notable decreases in power costs, with the average price of industrial power falling from \$67.7/MWh in the first nine months of 2023 to \$61.6/MWh in 2024 over the same period – a whopping 9% decrease. Texas also added 10.7 GW of capacity between August 2023 and August 2024, which is no doubt the primary factor behind the reduction in industrial power prices in the state. This new capacity consists of 6.2 GW of solar, 2.5 GW of wind, 1 GW of natural gas, and 1 GW of battery storage.

In 2024, Texas' significant expansion in both solar photovoltaic (PV) and energy storage systems introduced more zero marginal-cost power into the grid, and enhanced its capacity to handle variability and manage the evening peak in net-load after sunset. As a result, ERCOT was able to cope with new all time record load more efficiently, leading to less scarcity pricing compared to the peak load periods of 2023.

Other notable mining hubs saw their power prices rise year-over-year for the first nine months of 2024. Georgia, for example, saw a 6.3% increase to industrial power prices from \$70/MWh to \$74.8/MWh, while New York experienced a nosebleed increase of 27% from \$70/MWh to \$89/MWh.

Average Industrial Power Cost in \$/MWh YTD Through September 2024 (w/ % Change from 2023)



Datacenter Demand and the Impact on Capacity Pricing

In 2024, PJM Interconnection experienced a dramatic increase in capacity prices, with the Base Residual Auction (BRA) for the 2025/26 delivery year reaching \$269.92/MW-day, a sharp 933% rise from \$28.92/MW-day in the prior auction. This surge in prices was influenced in part by scheduled unit retirements but also by forecasts of future demand, particularly from data centers, with expectations of a nearly 40% growth in total energy use by 2039, signaling a significant increase in grid load in what was already one of USA's largest and most established power markets.

However, the methodology for setting capacity prices based on anticipated future demand might be flawed due to the ease with which projects can enter PJM's interconnection queue. There is no significant financial barrier for adding load projects to the queue, as PJM's current rules only require a minimal application fee and do not demand upfront commitments for project development. This low entry cost encourages speculative load projects, potentially inflating future demand forecasts. Many of these projects might never come to fruition due to various reasons such as insufficient funding or shifts in business plans, yet they currently influence capacity pricing. This scenario raises the risk of overpricing capacity, as the market might be pricing in demand that could be significantly overestimated.

The 2024 auction's capacity prices strongly encourage building new generation in the region and possibly delaying or canceling plant retirements. However, it remains to be seen whether this price signal is sufficient to match the surge in demand or if the projected demand will actually occur under these elevated prices.

AI's Dirty Little Secret

In the rush to cater to the growing computational demands of AI, hyperscalers are increasingly finding workarounds for grid limitations. They're skipping the often lengthy process of grid interconnection queues and the supply chain issues related to transformers by directly sourcing natural gas and acquiring gas turbines for their data centers. This allows these companies to essentially go "off-grid," producing their own electricity to bypass the constraints of public utility infrastructure. This practice has been noted in various industry analyses and reports, indicating a significant shift towards self-reliance in energy production for tech companies.

This approach marks a significant deviation from the environmental pledges these tech giants have made over the past decade, particularly their commitment to ESG principles and initiatives like RE100, aiming for 100% renewable energy usage. The reliance on natural gas contradicts the sustainability narrative these companies have been promoting. Critics argue that this move prioritizes operational efficiency over environmental responsibility, potentially setting back the industry's progress towards more sustainable energy practices.

Tesla is the poster child of this trend, known for its commitment to sustainability, which has also opted to use natural gas turbines for its Nevada data center operations. This decision was made to circumvent the challenges of grid connection, reflecting a pragmatic yet controversial approach to meeting energy demands. Tesla's choice to install gas turbines for immediate power needs showcases how even companies with strong green credentials might resort to fossil fuels when faced with the pressure of scaling up AI operations, highlighting the tension between tech innovation and environmental impact.

Bitcoin mining companies, also voracious consumers of energy, are caught in the same competition for resources. As hyperscalers drive up demand for natural gas and power generation equipment, Bitcoin miners will likely follow suit, albeit at a higher cost for energy and the increasingly scarce electrical distribution equipment. However, Bitcoin mining has certain advantages in this scenario: miners can operate with more flexible uptime (99.999% uptime is not necessary for economic mining), they can be more easily deployed in remote locations, and they do not heavily depend on high-speed fiber optic networks.

Power Price Expectations for 2025

The EIA anticipates electricity prices to increase marginally in 2025, driven in part by record electricity demand.

According to the EIA's projections, industrial electricity prices could increase 0.4% on average across the U.S. in Q4-2025 from their projected levels in Q4-2024. The EIA anticipates the largest increase YoY in Q4-2025 will come from New England, with a 5.45% change, and it expects the West South Central region (Texas, Oklahoma, Louisiana, and Arkansas) to be the only region that experiences a decrease in power prices, with the EIA estimating electricity prices to fall 4% from Q4-2024 to Q4-2025 in this region.

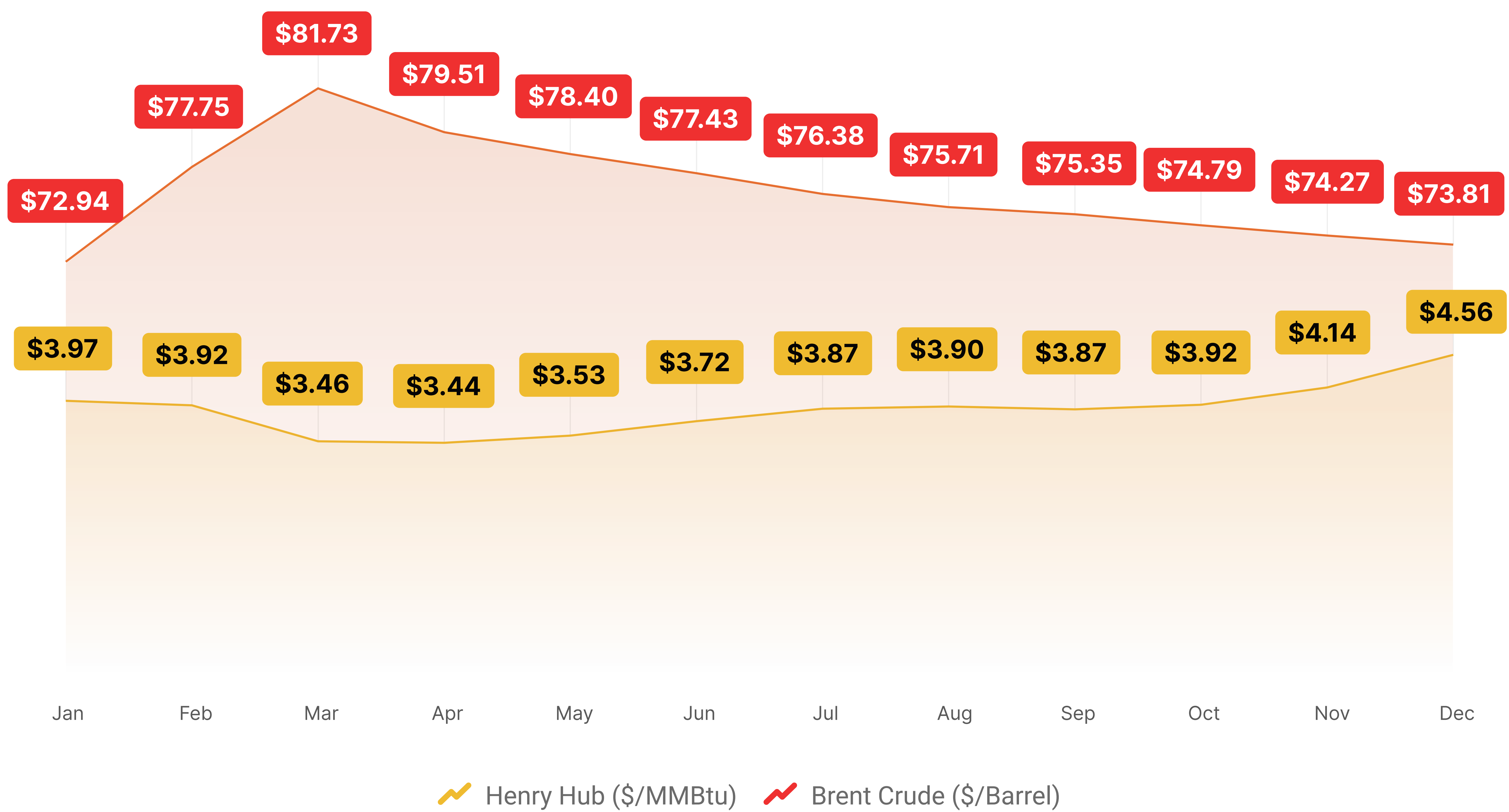
EIA Industrial Power Price Projections (in \$/MWh)



Natural Gas Prices Surge in 2024, Expected to Stabilize in 2025

The Henry Hub spot price surged 32.8% over 2024 from \$2.56/MMBtu to \$3.40/MMBtu. Many analysts are pointing toward higher natural gas prices in 2025, including analysts at the EIA, who are forecasting an average price of \$3.10/MMBtu in 2025 and \$2.90/MMBtu in Q4-2024. By contrast, the CME's Henry Hub futures most recent quotes as of January 17, 2025 average out to the following for each quarter: \$3.78/MMBtu (Q1-25), \$3.56/MMBtu (Q2-25), \$3.88/MMBtu (Q3-25), and \$4.21/MMBtu (Q4-25).

The EIA anticipates that natural gas inventories will remain above the 5-year average for the rest of the winter. for natural gas to rise in the US while supply remains stagnant. The agency forecasts that natural gas prices will average just under \$3/MMBtu for 2025 as a result of ramped up supply. Looking at Henry Hub natural gas and Brent Crude oil futures from the CME and ICE respectively, we can see that the market expects 2025 oil prices to peak in Q1 and fall throughout the year, while it expects natural gas prices to slump into Q2 before rising throughout the rest of the year.



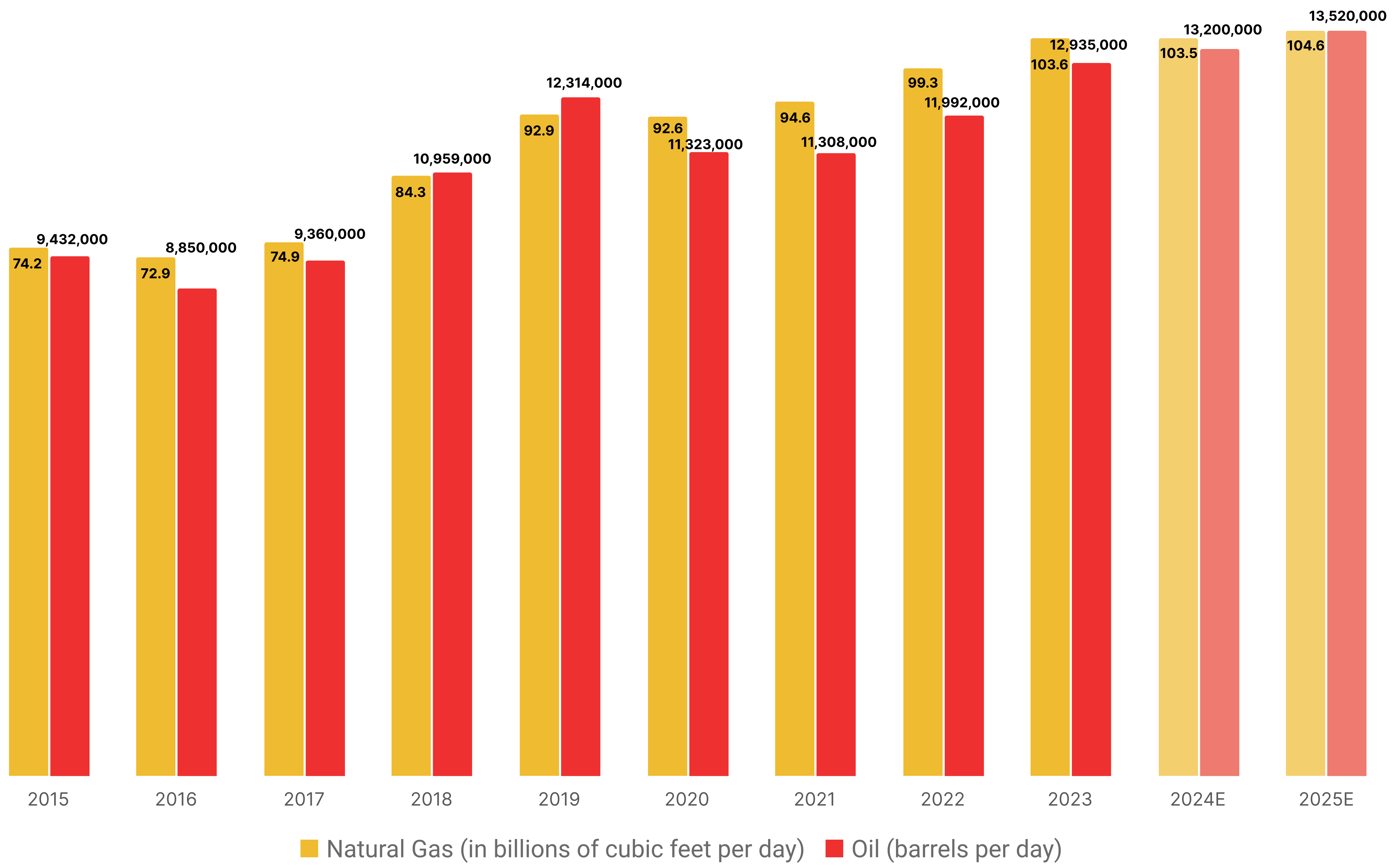
Source: CME and ICE futures quotes as of Jan 17, 2024, with Jan prices settled

Oil and Gas Production to Increase in 2025

The EIA projects that U.S. oil production will rise by 300,000 barrels per day in 2025, bringing the average daily output to 13.7 million barrels. This increase is expected to align with a global production expansion of 1.6 million barrels per day. Alongside this domestic growth, the EIA foresees U.S. oil imports declining to 1.9 million barrels per day, down from 2.5 million barrels — the lowest level observed since 1971.

For natural gas, the EIA predicts record-high demand in 2025. U.S. exports are anticipated to surge by 15%, reaching 14 billion cubic feet per day (Bcf/day), driven by the commencement of exports from the Plaquemines LNG and Corpus Christi LNG Stage 3 facilities in late December. Additionally, the EIA estimates that U.S. natural gas production will average 103 Bcf/day in the first quarter of 2025, with an overall annual increase of 1%, largely attributed to heightened output in the Permian and Eagle Ford regions.

Domestic U.S. Production per Day (w/ EIA 2024 and 2025 Estimates)



Source: EIA



5

Bitcoin Miners vs. AI/HPC In Power Markets

The United States will need to continue expanding its electricity production to adequately serve the coming wave of demand from HPC and AI data centers.

According to Electric Power Research Institute (EPRI) estimates, the electricity consumption of data centers in the U.S. could increase anywhere from 3.7% to 15% from 2023 to 2030:

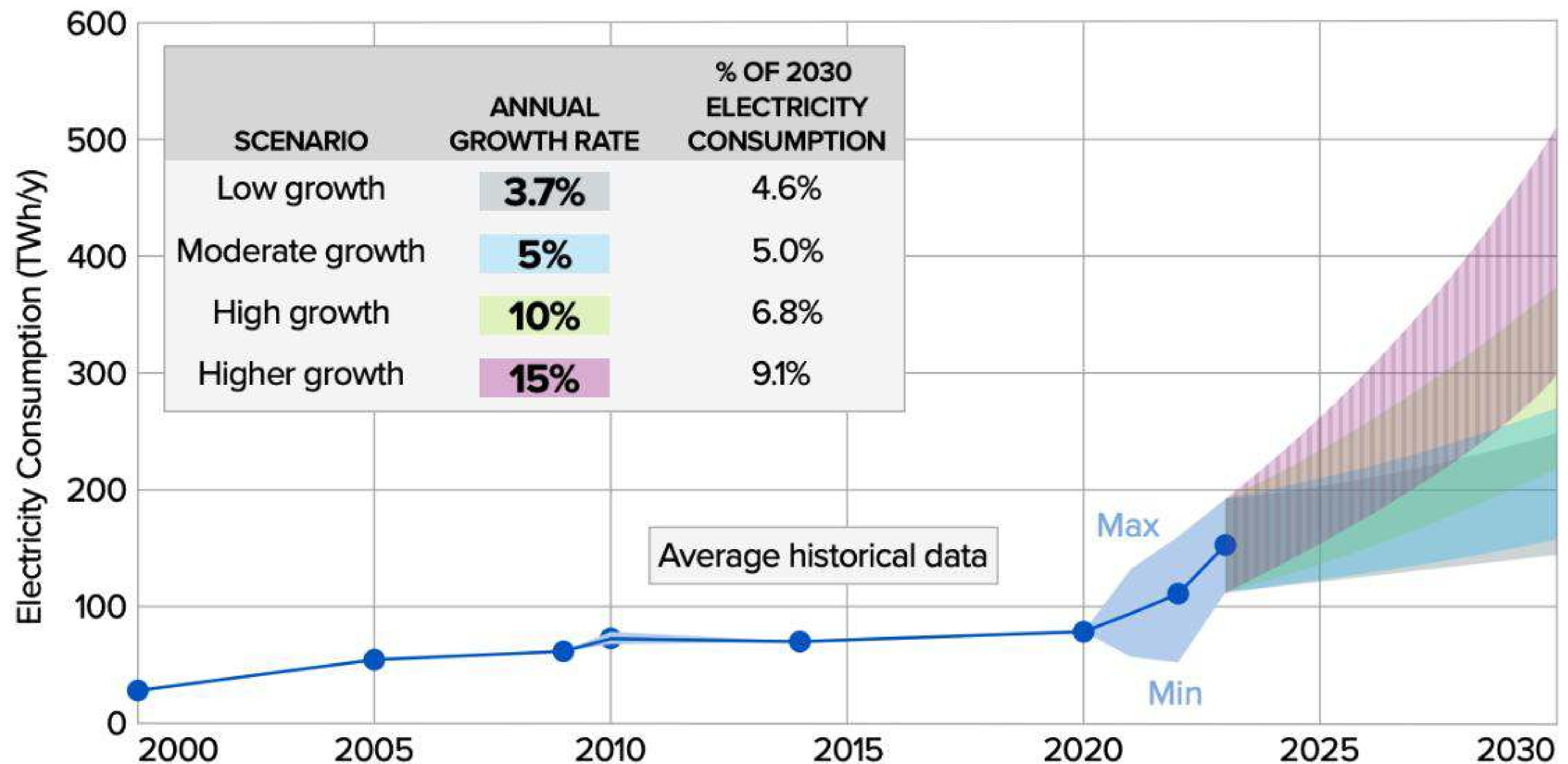


Figure ES-1. Projections of potential electricity consumption by U.S. data centers: 2023–2030. % of 2030 electricity consumption projections assume that all other (non-data center) load increases at 1% annually.

As we touched on earlier, nuclear power may serve as a long-term, environmentally friendly solution to this demand. But in the short-to-medium term, the data center industry will need power assets that have short(er) lead times. For now, natural gas is fitting that bill; as reported by Reuters, there are nearly 50 natural gas plants worth roughly 30 GW under pre or active construction across the U.S.

Datacenter CAPEX Spend Projections

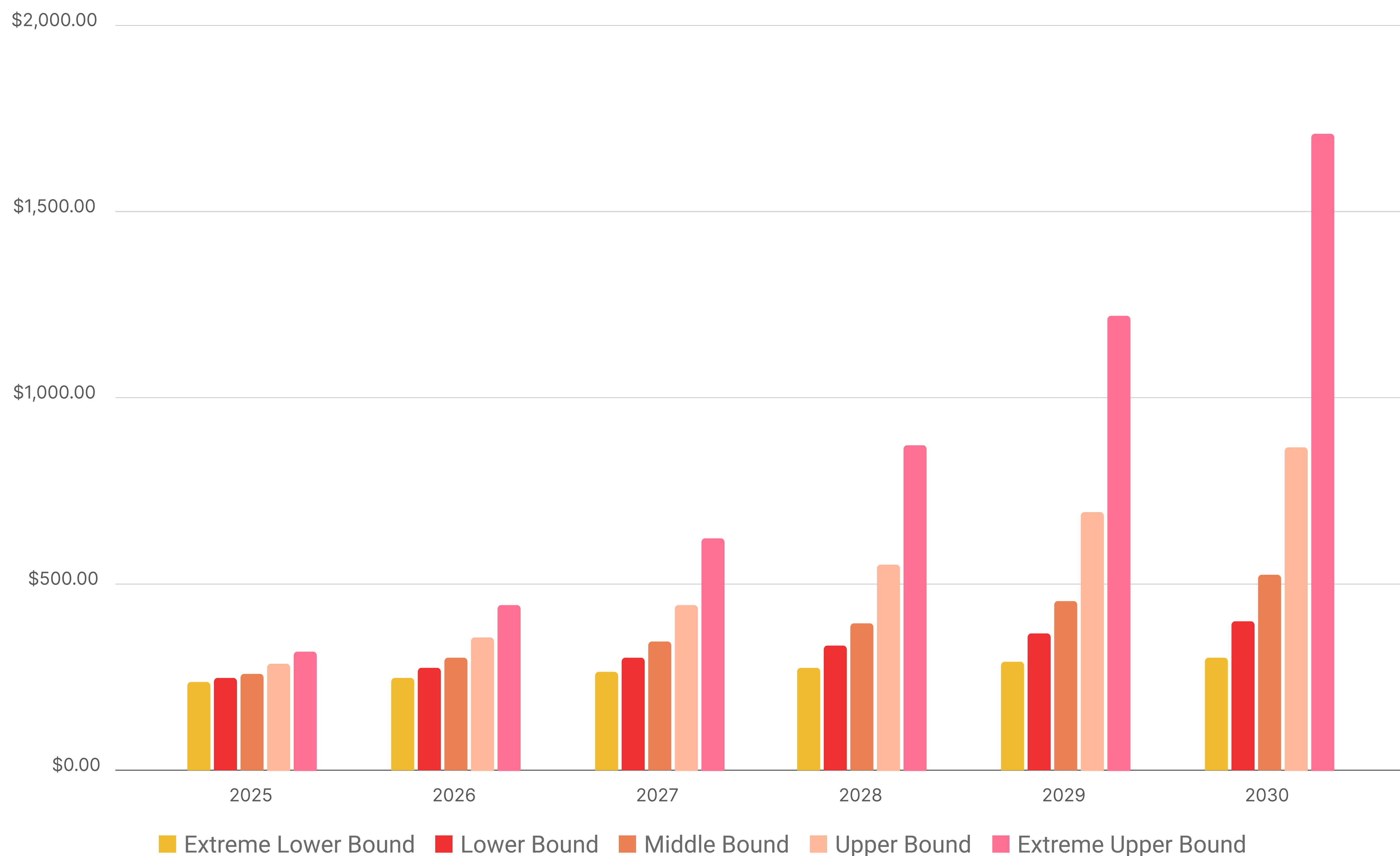
Analysts at Bank of America estimate that cloud service providers' capital expenditures hit a record \$227 billion in 2024, a 39% increase from the previous year. Over the coming decade, the data center industry will no doubt see trillions of dollars in CapEx spend on new greenfield data centers to feed the market's appetite for AI, data storage, and other forms of computation. There are a number of short-term estimates for annual CapEx spend. To cite a few notable ones:

- The Dell'Oro Group expects 24% compound annual growth rate (CAGR) to data center CapEx through 2028, and they forecast that AI infrastructure spending will exceed \$1 trillion globally over the next five years.
- Barclays analysts project that hyperscalers will increase their capital expenditures by 41.3% in 2024 and an additional 15.2% in 2025.

- Projections from New Street Research anticipate that AI-specific data center spending could increase from approximately \$90 billion in 2023 to roughly \$800 billion by 2027.

Using Bank of America’s 2024 estimate for CapEx and factoring the above projections, we’ve formulated our own forecast for annual data center CapEx. The model provides an extreme lower case, a lower case, a middle case, an upper case, and an extreme upper case, which respectively assume a 5%, 10%, 15%, 25%, and 40% CAGR.

Estimated Datacenter CAPEX Spend per Year (in Billions \$USD)



A Nuclear Renaissance is on the Horizon

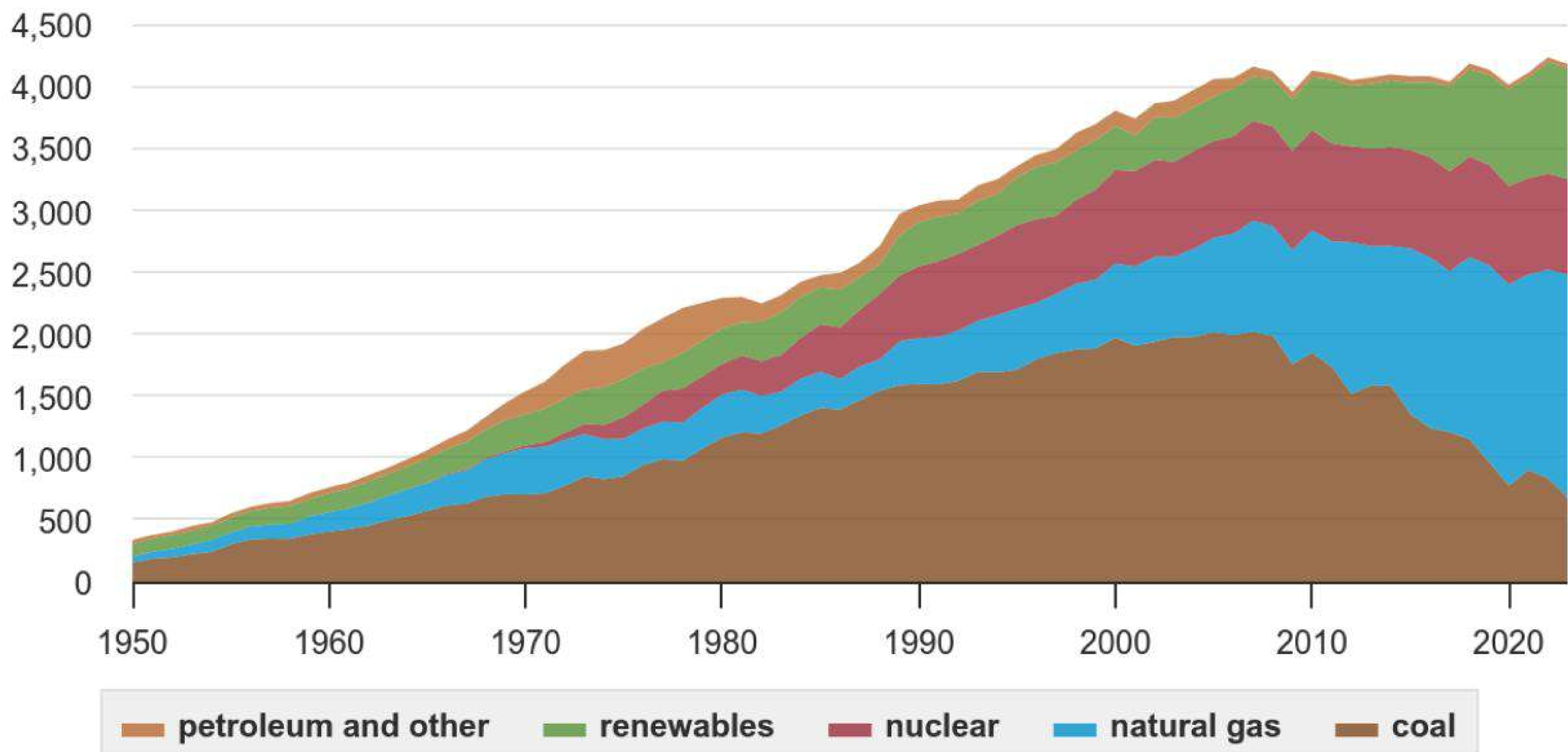
Perhaps the only industry that is more power hungry than bitcoin mining is AI/HPC, and demand for these computing resources is blowing open an inconvenient truth in the United States: the country’s grid is woefully under-equipped at present to support future AI/HPC demand.

Goldman Sachs estimates that U.S. data centers could consume as much as 8% of all U.S. energy by 2030, while the International Data Corporation anticipates that AI data centers alone could consume up to 146.2 TWh of energy per year by 2027, which corresponds to 16.69 GW of load.

If the increase in AI/HPC load, alongside other forms of compute like bitcoin mining and data storage, aren’t to drive up power prices or crowd out other consumers, the U.S. will need to increase its electricity generation capacity. Per data from the Energy Information Association (EIA), this capacity has barely budged since the 2000s, which is largely a consequence of the mass decommissioning of coal plants.

U.S. electricity generation by major energy source, 1950-2023

billion kilowatthours



Data source: U.S. Energy Information Administration, *Monthly Energy Review* and *Electric Power Monthly*, February 2024, preliminary data for 2023
Note: Includes generation from power plants with at least 1 megawatt electric generation capacity.

The solution won't come from highly intermittent renewables sources like wind and solar, which will be insufficient to buttress AI data centers that demand uninterrupted uptime. The most likely candidates to fill in the gap will come from nuclear energy and natural gas.

One of the more eye-grabbing stories in the energy sector last quarter came from Microsoft when news broke that it signed a 20-year power purchasing agreement with Constellation Energy to restart Unit 1 of the Three Mile Island nuclear plant in Pennsylvania. Constellation plans to invest \$1.6 billion to refurbish the 835 MW plant and plans to have it up and running in 2028. Analysts project that Microsoft could pay anywhere from \$100 to \$115 per MWh for the energy.

We expect to see more efforts and dollars poured into the nuclear industry in the coming years to satisfy exponential and insatiable demand for AI/HPC compute. In addition to Three Mile Island, the Palisades plant in Covert Township, Michigan, which was shut down in 2022, is being recommissioned; the U.S. Department of Energy is lending \$1.5 billion to Holtec International to restart the 800 MW plant, which it expects to complete by the end of 2025.

In 2023, NextEra Energy Resources announced that it was looking into restarting the Duane Arnold Energy Center near Palo, Iowa, which was shut down in August 2020 following a derecho storm. This restart, however, is still in the early stages and it's unclear whether it will come to fruition.

No projects for new nuclear reactors are currently under construction. Oklo Incorporated is projected to begin construction of its first reactor, Aurora, in 2027 in Idaho, with an estimated completion in the late 2020s. The most recent plant to come online was the Vogtle plant in Georgia, with its final unit, Unit 4, coming online on April 29, 2024.

Intersection of Bitcoin Mining and AI/HPC

A [whitepaper](#) published by Galaxy Research in December 2024 explored how Bitcoin miners are positioned to play a critical role in meeting the rising demands of AI/HPC by leveraging large-scale energy infrastructure and expertise.

Hyperscalers are investing billions in AI-focused data centers, however traditional data centers are facing challenges due to limited scalability and extended construction timelines. This is where miners have a role to play.

Bitcoin mining operations are uniquely positioned to fill gaps in AI/HPC infrastructure. They often possess large-scale power-ready facilities, critical electricity infrastructure (e.g., substations, high-voltage equipment), and expertise in managing power-dense sites. Miners with the necessary assets, such as water for cooling, advanced fiber, and necessary approvals, have the potential to convert operations into AI/HPC data centers.

The economic incentives for this case are strong: AI/HPC data centers would offer wider and more predictable margins, making an attractive revenue diversification for bitcoin miners. The traditional data center industry also benefits from more favorable financing conditions and trades at significantly higher valuation multiples compared to bitcoin mining. This presents a substantial value accretion opportunity. That said, AI/HPC business lines also require business development to source a consistent buyer of this computing power. With bitcoin mining, miners can readily liquidate hashrate with a mining pool or directly to the Bitcoin network, and the market converges on a unified rate (hashprice) for hashrate. Conversely, AI/HPC computing power has a range of use cases and the market values these use cases differently; providers will need to actively build business relationships for monetizing this computing power.

Beyond economics, Bitcoin miners stand to provide a real option to AI/HPC: flexibility. AI/HPC data centers require significant levels of redundancy; these sites could be built to optimize energy management by leveraging bitcoin mining as a dynamic load-balancing mechanism. As AI workloads create fluctuating power demands, the bitcoin mining portion of the data center would scale operations up or down to stabilize power consumption and maximize efficiency. This synergy allows miners to monetize excess or stranded energy while providing hyperscalers with flexible, power-ready infrastructure, simultaneously enhancing the economic viability and resilience of both technologies.

With all that said, not all bitcoin mining facilities are suitable for AI/HPC. Significant upgrades will be required for networking, cooling, redundancy, and form factor re-design. AI/HPC data centers demand much higher capital expenditure ranging anywhere between \$5M–\$20M per MW, compared to bitcoin mining at \$300K–\$800K per MW.

We believe that some miners will be well-positioned to capitalize on the AI revolution by transitioning into hybrid data center operations, and we look forward to seeing how the complementary nature between bitcoin mining and AI/HPC infrastructure plays out.



6

Bitcoin Mining Capital Markets

Capital Markets Landscape

Capital markets play a critical role in the Bitcoin mining industry, enabling the growth and scalability of operations by providing access to funding, risk management tools, and exit liquidity. These markets have evolved significantly throughout 2024, responding to the increasing institutional adoption of Bitcoin with a diverse range of financing and hedging mechanisms. Traditionally reliant on equity and debt financing, mining companies now have a broad array of capital-raising and risk management tools. The emergence of hashrate forwards has provided miners with a sophisticated tool to hedge against future market volatility, while tokenized securities offer new avenues for fractionalized investment. Additionally, cloud mining and "buy and host" models cater to smaller-scale or retail participants, and specialized mining funds have become key vehicles for institutional capital deployment.

Equity Capital Markets

Bitcoin mining companies leverage equity markets to raise capital by issuing shares through public offerings (IPOs or secondary at-the-market offerings) or private equity placements, enabling them to finance operations, expand infrastructure, and purchase mining hardware.

In 2024, the equity markets for Bitcoin mining evolved significantly, with heightened investor interest driven by the fourth halving and the approval of Bitcoin ETFs. Public equity markets provided retail and institutional investors access to established mining firms, while private equity catered to those seeking early-stage opportunities in promising startups. Options contracts on publicly traded mining stocks allowed investors to hedge risks or speculate on price movements. Sentiment revolved around the continued institutionalization of Bitcoin and mining.

Debt Capital Markets

Bitcoin mining companies use debt markets to raise capital by instruments such as traditional loans, bonds, or convertible notes. Debt financing allows for access to immediate liquidity without diluting equity ownership, making it a strategic choice for mining operators.

Buy-side participants use these markets to invest in mining companies by purchasing bonds, lending directly, or participating in convertible note offerings. Bonds and loans provide fixed-income returns, appealing to those seeking steady cash flow, while convertible notes offer a hybrid opportunity: they provide interest payments with the option to convert into equity, enabling investors to share in potential stock price appreciation.

Bitcoin mining companies increasingly turned to debt capital markets in 2024, with a notable trend being the issuance of convertible notes. These instruments allow companies to raise capital through debt that can later convert into equity, typically at a predetermined price. This strategy offers a dual advantage: it provides immediate funding for operational expansion while offering investors upside potential if the company's stock price appreciates. This approach is especially attractive to institutional investors seeking exposure to the mining sector with reduced downside risk, further institutionalizing debt capital markets for mining.

Hashrate Forwards

Bitcoin mining companies use hashrate forwards to manage revenue predictability and hedge against market volatility. These contracts allow miners to lock in a future hashprice, mitigating the risk of changes in Bitcoin price or network difficulty.

For investors, hashrate forwards — whether traded over-the-counter (OTC) or on exchanges (futures) — offer unique opportunities to gain exposure to bitcoin mining without the hassle of directly operating hardware. OTC contracts provide custom agreements tailored to the needs of both miners and investors, offering flexibility in contract terms but requiring counterparty trust. Exchange-traded hashrate derivatives standardize contracts and reduce counterparty risk, enabling broader market participation and deeper liquidity.

Cloud Mining

Cloud mining enables individuals and organizations to participate in Bitcoin mining without owning or managing physical hardware. Mining companies offer cloud mining contracts, allowing users to lease a portion of their hashrate for a fixed period. This provides an accessible entry point for smaller investors, as it eliminates the need for upfront capital expenditure on ASICs, energy, and maintenance.

For investors, cloud mining offers a way to gain exposure to mining returns without the complexities of hardware. Contracts are typically structured to provide a share of the mined bitcoin in exchange for a fee, making it a relatively straightforward investment option. However, profitability depends on factors like Bitcoin price, network difficulty, and contract terms. Cloud mining democratizes access to bitcoin mining, broadening participation in the industry while enabling mining companies to monetize their excess capacity or scale operations efficiently.

Tokenized Securities

Tokenized hashrate securities, such as Blockstream's Mining Note 2 (BMN2), have emerged as innovative financial instruments that provide investors with direct exposure to bitcoin mining without the complexities of managing physical hardware. These securities represent a predefined amount of mining hashrate, entitling holders to a share of the bitcoin mined over a specified time period. For instance, each BMN2 token corresponds to 1 petahash per second (PH/s) of hashrate over a 48-month term, with the mined bitcoin securely stored and distributed to investors upon maturity.

Buy and Host

Buying and hosting ASICs provides a direct avenue for investors to participate in bitcoin mining by owning physical mining hardware without the burden of managing operations. In this model, investors purchase ASIC miners, which are then hosted and operated by a third-party service provider in a professional mining facility. The hosting company handles critical aspects such as installation, maintenance, cooling, and energy management, while the investor receives the bitcoin mined by their machines (minus hosting fees).

This approach appeals to those seeking direct exposure to mining profits without requiring technical expertise or access to cost-efficient energy. Hosting facilities are often located in regions with abundant and inexpensive electricity, maximizing profitability. For mining companies, offering hosting services creates an additional revenue stream by monetizing their infrastructure and excess capacity.

In 2024, the buy-and-host model gained traction as a bridge between individual investors and industrial-scale mining, democratizing access to mining while enabling efficient capital utilization across the ecosystem.

Mining Funds

Mining funds offer investors a structured way to gain exposure to bitcoin mining through professionally managed investment vehicles. These funds pool capital from multiple investors to finance large-scale mining operations, including the purchase of ASICs, infrastructure development, and energy procurement. Managed by industry experts, mining funds provide access to economies of scale and advanced operational strategies that are often out of reach for individual investors.

For investors, mining funds simplify the process of participating in bitcoin mining by offering a passive investment option with diversified risk. These funds typically generate returns through mined bitcoin, which is either distributed to investors or reinvested to grow the operation. In 2024, the appeal of mining funds grew significantly as institutional and retail investors sought exposure to mining profits without the complexities of direct hardware ownership or active management.

Estimated Capital Raises

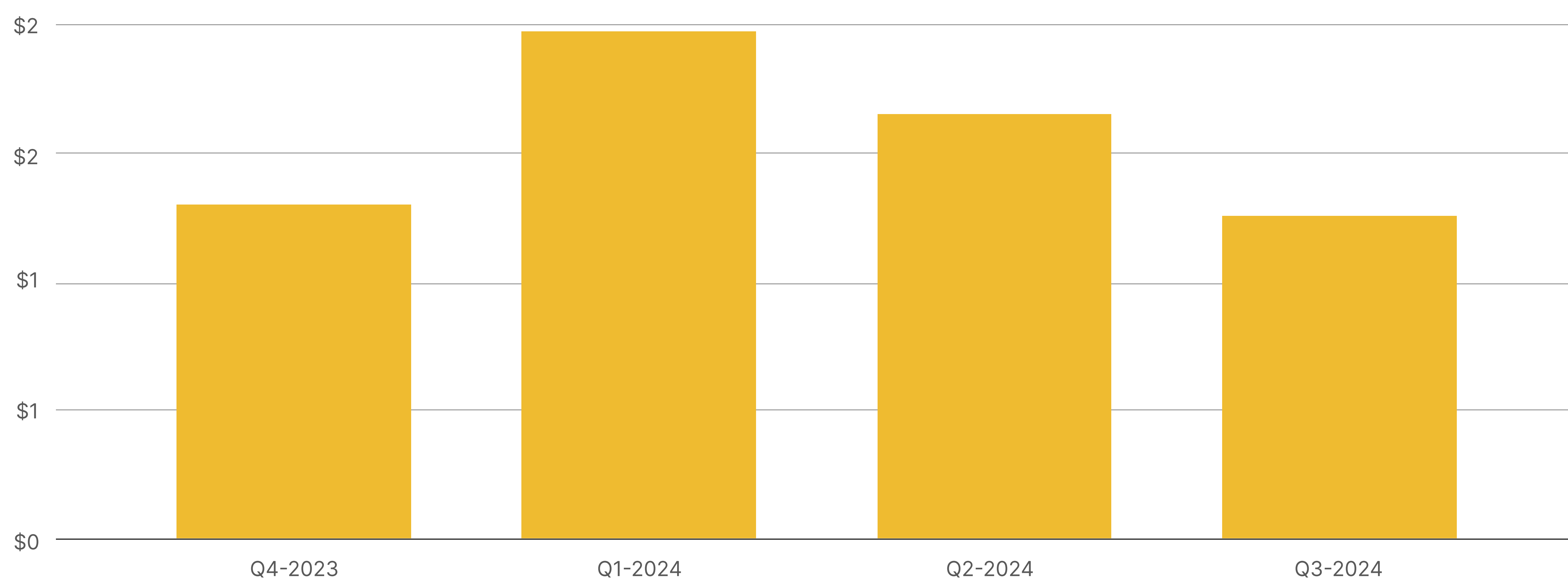
Industry Level

Overall, the Bitcoin mining industry secured over \$11 billion in 2024 through various financing methods, including equity offerings, debt instruments, and convertible notes. This influx of funds was primarily allocated toward purchasing new machines and developing infrastructure.

Product Level

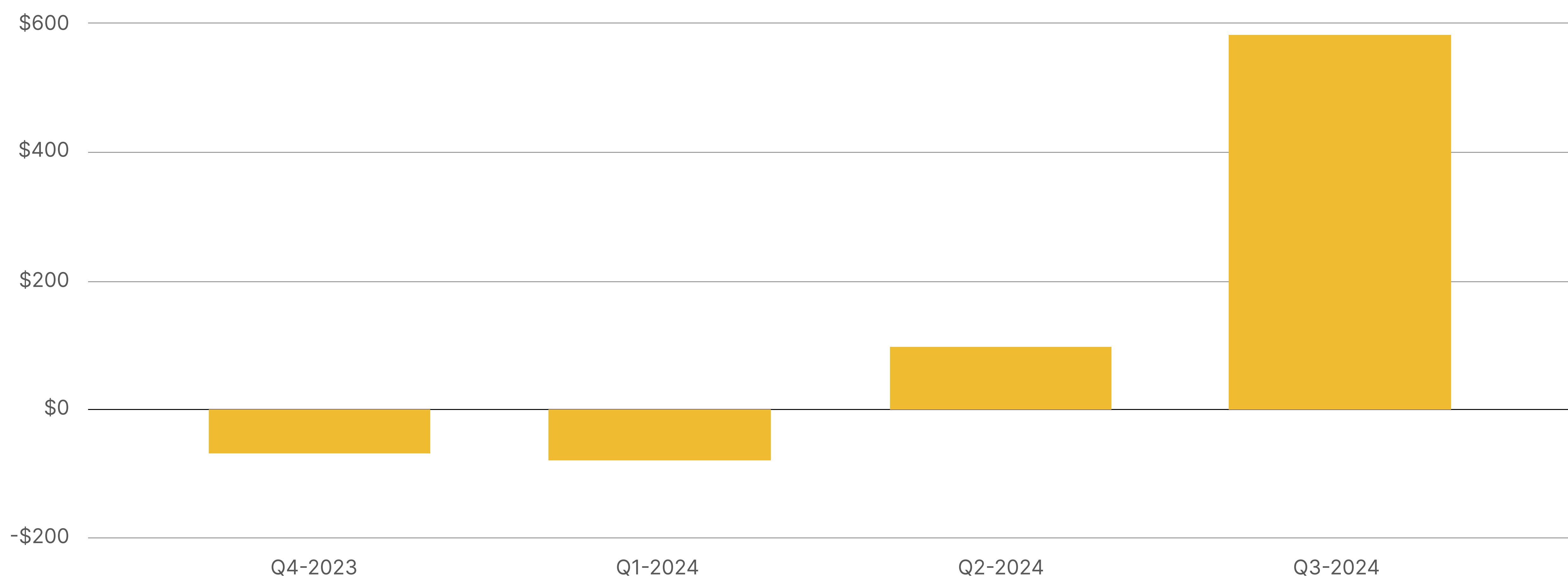
Public miners consistently tapped into At-the-Market Offerings (ATMs) throughout the year, raising over \$5 billion through equity. Having spent Q1 paying down debt, miners strategically borrowed \$700 million after the halving to continue raising capital for expansion.

Consolidated Equity Financing (\$ Billions)



Source: TheMinerMag

Consolidated Debt Financing (\$ Millions)

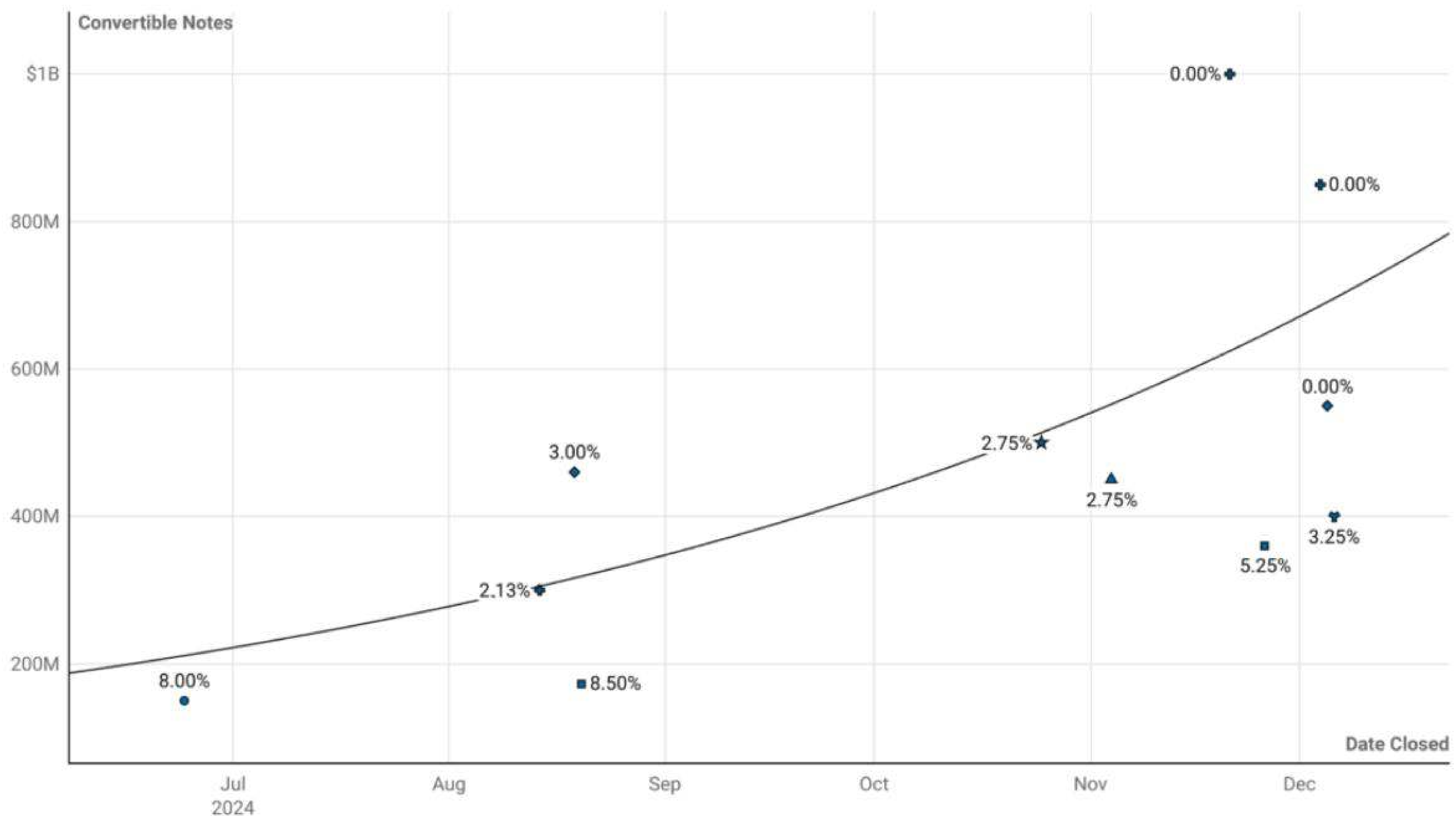


Source: TheMinerMag

In a recent [Miner Weekly](#) article, TheMinerMag reported that public miners significantly increased their use of convertible notes to raise capital in 2024, collectively securing over \$5.2 billion since June (with 70% of this amount being raised in December alone). Notably, just MARA and CORZ themselves raised over \$2.4 billion via zero-coupon convertible notes, with both companies setting conversion prices at 40% above their stock price at issuance.

Public Bitcoin Miners Raise \$5.2 Billion via Convertible Notes

Unit: U.S dollars



Of course, this playbook comes on the heels of [MicroStrategy's](#) notorious Bitcoin strategy, which ramped up to the next level during the year; the company raised a total of \$7.26 billion in convertible debt.

The security token offering (STO) for Blockstream's BMN2 was announced in Q3. This note initially provided 1,000TH/s/Day over a 48-month term and entailed a nominal token price of \$31,000 at an implied hashprice of \$21.23 per /PH/s/Day. Throughout 2024, [BMN2](#) raised \$200 million in eight tranches. Mining commenced in Q4, with Bitcoin payouts tentatively set for September 2028.

BMN2's predecessor, BMN1, had generated a 57% fiat-denominated return (~\$437,517 per note) and a 32% Bitcoin-denominated return (~294 BTC per note) for investors. Each note provided 2,000TH/s/Day over a 36-month term and entailed an initial nominal token price of \$216,000 at an implied hashprice of ~\$99 per /PH/s/Day. BMN1 produced a total of 1,242 BTC over its 3 year term between 2021-2024, resulting in net proceeds of 1,212 BTC (~7.76 BTC per note).

Mergers & Acquisitions

Bitcoin mining mergers and acquisitions (M&A) in 2024 were marked by a continued push for geographic expansion, infrastructure consolidation, and strategic energy acquisitions. Miners pursued deals that enhanced operational efficiency, energy access, and hosting capacity.

Among the cohort of 11 publicly traded miners we tracked for M&A, 7 engaged in notable deals.

Riot Platforms acquired Block Mining, Inc., a Kentucky-based Bitcoin miner, adding two operational sites with a combined 60 MW capacity outside of ERCOT. Earlier in April, Riot launched a hostile takeover bid for Bitfarms at \$2.30 per share, valuing the company at \$950 million. Bitfarms rejected the offer as undervalued, leading to a prolonged corporate battle. By September, both firms settled with Riot securing a board seat in exchange for a standstill agreement until 2026.

Bitfarms is in the process of acquiring Stronghold Digital Mining in a stock-for-stock merger valued at \$125 million, plus the assumption of \$50 million in debt (expected to close in Q1-2025).

TeraWulf sold its 25% stake in the Nautilus facility to Talen Energy Corp for \$92 million.

Cipher Mining expanded aggressively with multiple deals, including the acquisition of a 300 MW data center site in West Texas for \$68 million and signing option agreements to acquire sites from Juvo Energy.

CleanSpark pursued an aggressive inorganic growth strategy through several key acquisitions. In October, the company completed the acquisition of GRIID Infrastructure Inc., enhancing its Bitcoin mining capacity in Tennessee with plans to expand over 400 MW in the coming years. This followed the acquisition of seven mining facilities in Knoxville, Tennessee, for \$27.5 million earlier in the year, adding over 85 MW of immediately available capacity. The company also purchased a 75 MW site in Wyoming for \$19 million.

Marathon Digital Holdings acquired a 200MW data center from Applied Digital in Garden City, TX for \$87 million, securing additional hosting infrastructure.

Below is a list of major Bitcoin mining M&A and capital raise transactions throughout 2024:

Date	Buyer	Target	Target Location	Deal Value (\$M)	EV / MW (\$K)
12/10/2024	Gryphon Digital Mining	Natural Gas Assets Of Erikson National Energy Inc	Northeast British Columbia, Canada	\$1	\$14
12/4/2024	Data Journey	Spartanburg Property	Spartanburg, SC	\$12	N/A
12/3/2024	BIT Mining	Ethiopian Mining Data Centers and Mining Machines	Ethiopia	\$14	\$408
12/3/2024	MARA Holdings	Wind Farm	Hansford County, TX	N/A	N/A
11/26/2024	Cipher Mining	Acquisition of New Site in West Texas called Stingray	West Texas	\$4	N/A
11/6/2024	Core Scientific	Leased a new Data Center with 11 MW of capacity	Alabama	N/A	N/A
11/5/2024	MARA Holdings	Two Operational Data Centers	Hannibal, OH and Hopedale, OH	N/A	N/A
11/5/2024	MARA Holdings	Greenfield Data Center	Findlay, OH	N/A	N/A
10/28/2024	DMG Blockchain Solutions	Acquisition of Reactor.xyz	N/A	N/A	N/A
10/22/2024	BitFuFu	Acquire a majority stake in an 80-MW Bitcoin Mining Facility	Ethiopia	N/A	N/A
10/16/2024	Iris Energy	Secured 800 additional acres of land	N/A	N/A	N/A
10/15/2024	Cipher Mining	Signed Option Agreements to Acquire three sites from Juvo Energy	West and North Texas	N/A	N/A
10/14/2024	Bit Digital	Acquired Enovum Data Centers	Montreal, Canada	\$46	N/M
10/10/2024	TeraWulf	Ground Lease at Lake Mariner Facility	Lake Ontario, Western New York (Upstate)	\$88	N/A
10/3/2024	Talen Energy Corp	TeraWulf's 25% share in Nautilus and full control on legacy PPA	Berwick, PA	\$92	\$1,840 ⁽¹⁾
9/17/2024	CleanSpark	Two Bitcoin Mining Sites and Associated Land	Clinton, MS	\$6	N/A
9/16/2024	Soluna Holdings	Power and Land Acquisition for Rosa Data Center	Texas	N/A	N/A
9/11/2024	CleanSpark	Seven Bitcoin Mining Facilities	Knoxville, TN	\$28	N/A
8/27/2024	Cipher Mining	300 MW Data Center Site in West Texas	West Texas	\$68	\$225 ⁽²⁾
8/21/2024	Bitfarms	Stronghold Digital Mining	Kennerdell, PA	\$175	\$570 ⁽³⁾
8/20/2024	Gryphon Digital Mining	2.9 MW of bitcoin mining operations	Louisiana	\$2	\$517
8/13/2024	Cipher Mining	Reveille datacenter site	Cotulla, TX	N/A	N/A
7/13/2024	HIVE Blockchain Technologies	100 MW Site in Paraguay	Paraguay	N/A	N/A
7/23/2024	Riot Platforms	Block Mining	Kentucky	\$93	\$597 ⁽⁴⁾
7/9/2024	Hut 8	205MW for a site in West Texas	West Texas	N/A	N/A
6/28/2024	Bitdeer	Monroe County Port Authority	Clarington, OH	N/A	N/A
6/27/2024	CleanSpark	GRIID Infrastructure	Cincinnati, OH	\$155	\$1,047 ⁽⁵⁾
6/18/2024	CleanSpark	Five New Bitcoin Mining Facilities in Georgia	Georgia	\$26	\$430
6/13/2024	Bitfarms	120MW site in Sharon, Pennsylvania	Sharon, PA	\$4	\$313
5/29/2024	Northern Data	Penguin Group	Asuncion, Paraguay	N/A	N/A
5/24/2024	Northern Data	300MW of data center location	Corpus Christi, TX	N/A	N/A
5/9/2024	CleanSpark	75 MW of Bitcoin Mining Sites	Wyoming	\$19	\$250
3/15/2024	Marathon Digital Holdings	200MW Data Center from Applied Digital	Garden City, TX	\$87	\$437
3/11/2024	Greenidge	Mississippi & North Dakota Sites	Mississippi, ND	N/A	N/A
3/5/2024	Undisclosed Buyer	Mirabel Facility of Argo Blockchain	Mirabel, Canada	\$6	\$1,220
2/21/2024	CleanSpark	Three Turnkey Bitcoin Mining Facilities (MS)	Mississippi	\$20	N/A
2/21/2024	CleanSpark	Bitcoin Mining Facility in Dalton, GA	Dalton, GA	\$3	N/A
2/1/2024	Ionic Digital	Bitcoin Mining Assets of Celsius Mining	Hoboken, NJ	N/A	N/A

2024 Bitcoin Mining Transactions | Source: Cohen & Company

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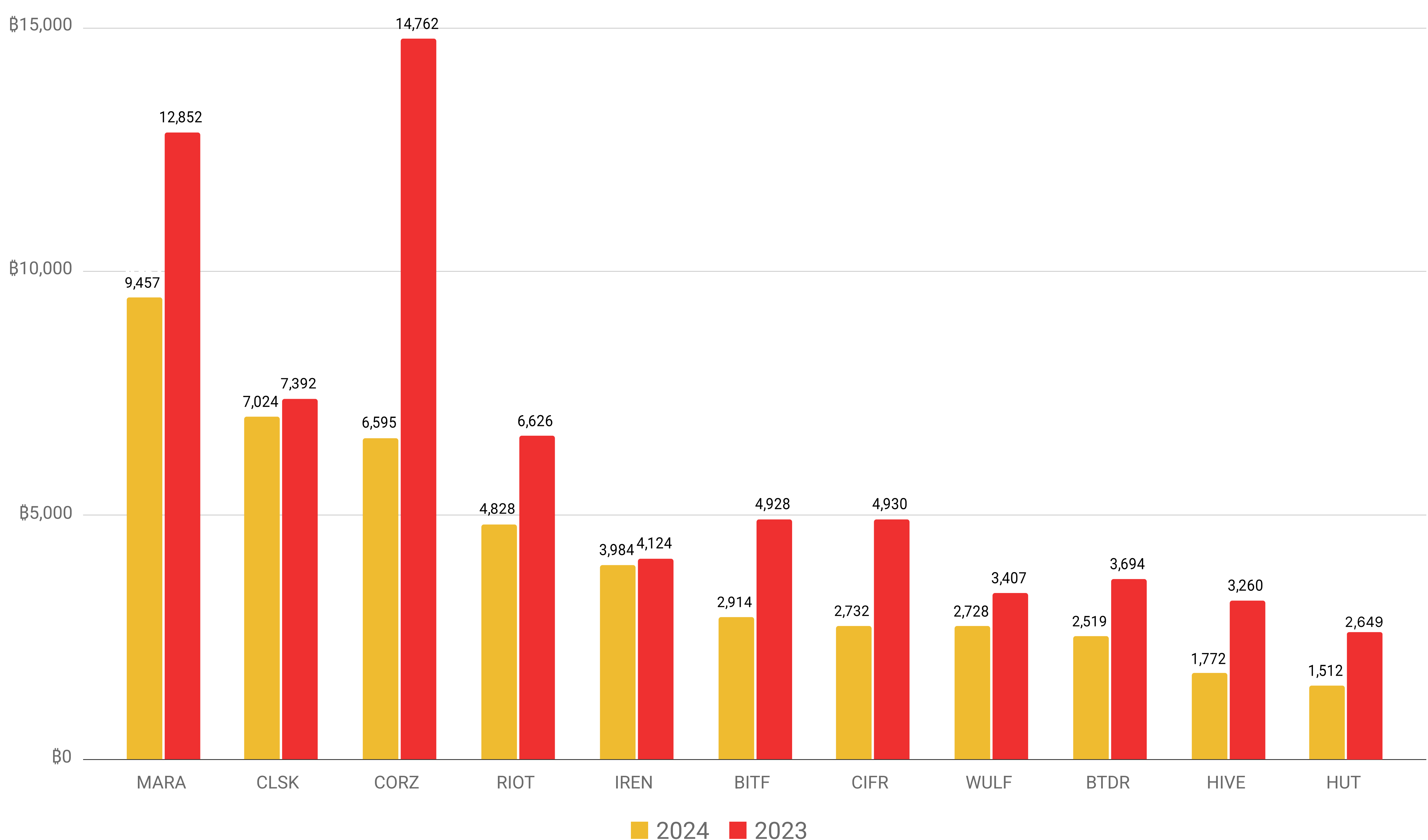
Public Bitcoin Mining Equities

As the public Bitcoin mining market continues to mature, miners have expanded their operations beyond their historical bases in North America, driven by favorable regulatory environments, energy policy synergies, and opportunities with strategic bitcoin reserves. Throughout 2024, forward-thinking regions established supportive frameworks, reducing regulatory uncertainty and implementing incentives like tax breaks or energy subsidies. Many miners are also capitalizing on access to sustainable and low-cost energy sources. Countries like El Salvador, which integrate Bitcoin mining into national strategies, provide miners with government-backed infrastructure and opportunities to collaborate in public-private partnerships.

We expect global hashrate diversification to continue throughout this mining cycle.

The cohort of 11 publicly traded miners we track collectively produced a total of 46,065 BTC in 2024.

2024 Public Miner Bitcoin Production



Source: Public miner press releases

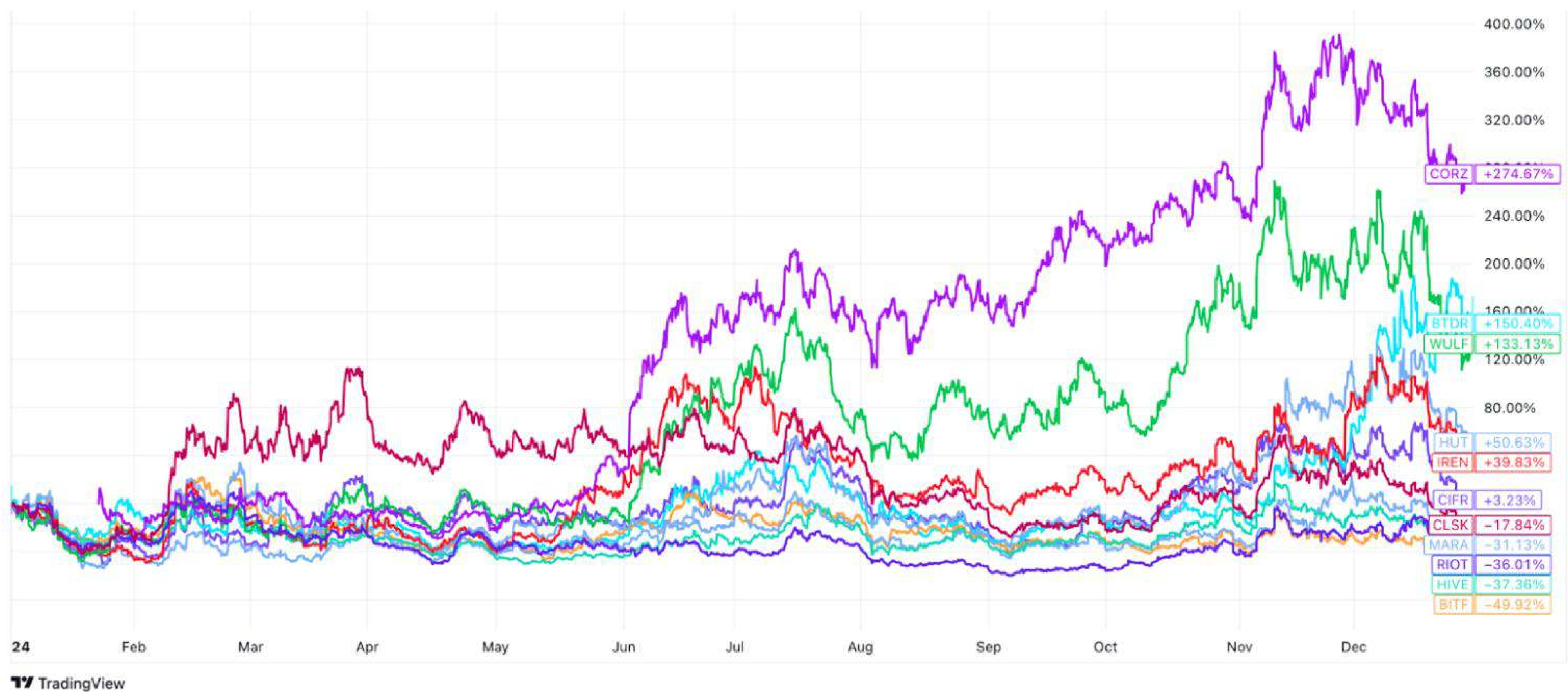
A couple of public miners were able to effectively maintain their pre-halving bitcoin production levels by expanding massively over the year. IREN and CLSK specifically stood out, with just a 3% and 5% drop respectively, whereas other miners suffered between 20% and 55% reductions in production.

MARA, CLSK, RIOT and IREN produced the most bitcoin of the public miners, ranging from 4,000 BTC to 9,500 BTC. CORZ, BITF, CIFR, and HIVE suffered the greatest losses.

Financial Performance

2024 was a stress test for Bitcoin and the mining industry, and bitcoin mining equities were certainly no exception. Investors perceive bitcoin mining equities as high-beta vehicles for Bitcoin exposure; however, with explosive Bitcoin price action, hashprice cut in half, and the advent of spot Bitcoin ETFs, bitcoin mining equities went through a shake-up in 2024.

Among the 11 publicly traded miners we track, share price performance varied significantly year-over-year. Some miners in our cohort experienced remarkable gains, while many others suffered notable declines. The market capitalizations of these companies range from under \$0.50 billion to over \$6.50 billion, highlighting the size and scale of competition in the industry.



Source: TradingView

Generally speaking, public Bitcoin miners experienced divergent fortunes in 2024.

The table below summarizes annual changes in share price and current market capitalizations for the 11 miners we track.

CORZ (+308.43%), BTDR (+144.03%), and WULF (+146.01%) achieved remarkable growth. HUT (+62.62%) and IREN (+44.41%) also delivered strong returns. BITF (-47.54%) and HIVE (-35.08%) experienced substantial declines, likely driven by post-halving pressures as they continue to work toward ongoing expansions in South America. CLSK (-15.35%) and CIFR (+12.35%) exhibited relatively stable performance compared to some peers, but still lost value over the year.

Despite being industry leaders, RIOT (-33.74%) and MARA (-26.86%) faced notable setbacks. However, these two veterans remain industry giants thanks to their massive market capitalizations, underscoring their established market positions.

Ticker	Market Capitalization (\$B), % Change (YoY)	Share Price % Change (YoY)
MARA	6.88 (+22.82%)	\$16.77 (-26.86%)
RIOT	4.45 (+43.27%)	\$10.21 (-33.74%)
CORZ	4.19 (-)	\$14.05 (+308.43%)
CLSK	3.47 (+77.83)	\$9.21 (-15.35%)
BTDR	3.08 (+245.17%)	\$21.67 (+144.03%)
IREN	2.57 (+418.30%)	\$9.82 (+44.41%)
HUT	2.52 (+129.90%)	\$20.49 (+62.62%)
WULF	2.47 (+382.29%)	\$5.66 (+146.01%)
CIFR	1.89 (+86.95%)	\$4.64 (+12.35%)
BITF	0.80 (-14.58%)	\$1.49 (-47.54%)
HIVE	0.43 (+7.54%)	\$2.85 (-35.08%)

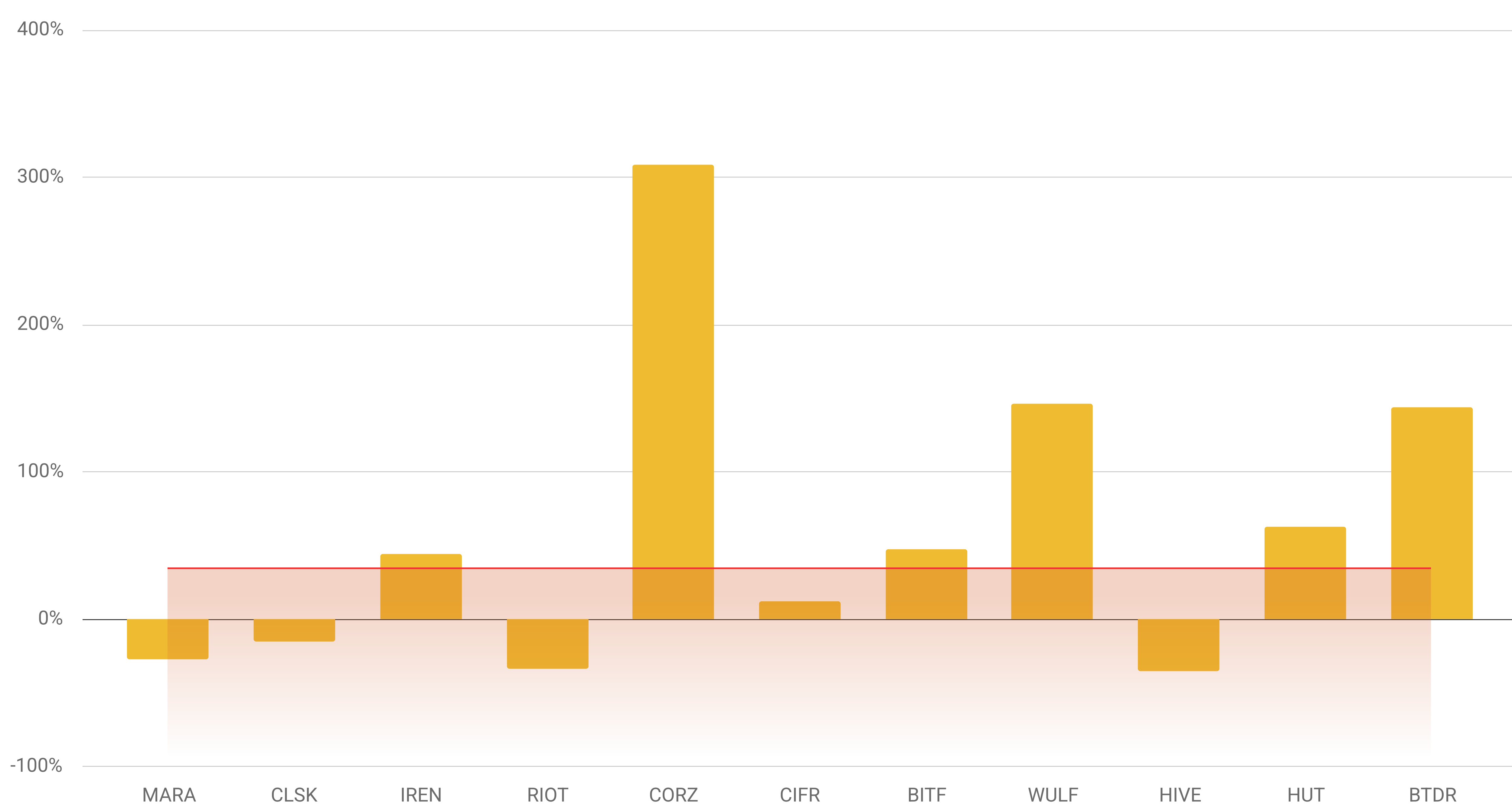
Source: TradingView

Hashrate Index Crypto Mining Index Benchmark

Hashrate Index's Crypto Mining Stock Index tracks over 60 mining companies that are traded on major exchanges and OTC, with weightings based on their market capitalization. Using this data we can benchmark individual stock price performance relative to the industry.

In 2024, 6 miners we track outperformed the index, whereas others under-performed.

Public Bitcoin Miner Performance vs. HI Crypto Mining Index



Source: TradingView, Hashrate Index

Hashrate Index's Crypto Mining Index posted a 34.59% return in 2024; the average return from our cohort was 59.49% by comparison, with a 50-50 split between over and under performance.

Correlations

Public mining equities have historically had a very strong correlation to not only the price of Bitcoin but also each other. However, in 2024 we observed a divergence between Bitcoin and mining markets, suggesting that equity market perceptions (rather than bitcoin's price) might dominate miner valuations in the years to come. Generally speaking, this analysis suggests that market participants are becoming more sophisticated when they price the value of these companies. The table below summarizes the correlation matrix between the 11 miners we track and bitcoin:

Correlations Matrix	BTDR	BITF	CIFR	CLSK	CORZ	HIVE	HUT	IREN	MARA	RIOT	WULF	Bitcoin
BTDR	1											
BITF	0.62	1										
CIFR	0.55	-0.10	1									
CLSK	0.47	-0.10	0.65	1								
CORZ	-0.05	0.17	-0.08	-0.12	1							
HIVE	0.62	-0.17	0.71	0.65	-0.11	1						
HUT	0.61	-0.13	0.69	0.58	-0.13	0.80	1					
IREN	0.62	-0.05	0.66	0.05	0.01	-0.02	-0.06	1				
MARA	0.59	-0.13	0.70	0.66	-0.03	0.73	0.68	0.65	1			
RIOT	-0.10	-0.13	-0.08	0.01	0.07	-0.09	-0.14	-0.04	-0.08	1		
WULF	0.55	-0.10	0.71	0.62	-0.10	0.73	0.71	0.68	0.69	0.73	1	
Bitcoin	0.03	-0.08	-0.03	-0.04	-0.03	0.01	0.07	0.02	-0.03	-0.03	0.01	1

Source: TradingView

Some miners exhibit strong positive correlations with others, indicating similar market or operational behavior. However, two outliers stand out.

CORZ shows weak or negative correlation with most miners, indicating distinct market or operational factors impacting its performance, which is unsurprising given that the company's AI pivot drove its price last year. Notably, BITF correlations are mostly negative, suggesting that BITF may behave counter to trends observed in the broader group.

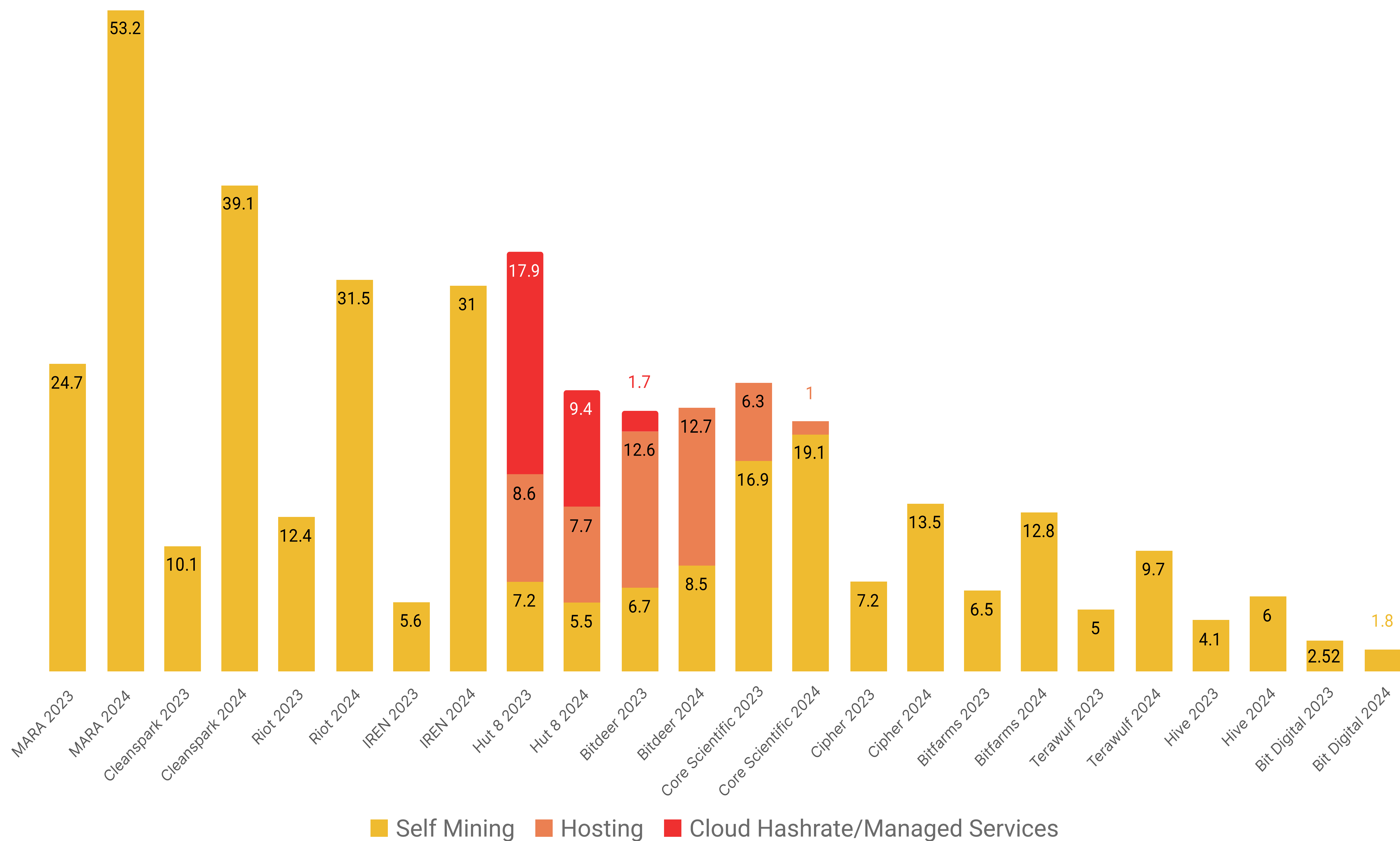
Bitcoin's correlation with most miners is close to zero, indicating a surprisingly low relationship between Bitcoin's price and miners' stock performance throughout the year. This suggests that other factors, such as operational excellence, could be playing a larger role in miner valuations.

While a few pairs of miners have strong correlations, many relationships hover around weak to moderate levels, indicating diversity in operational models, strategies, or market responses within the industry.

Operational Updates

The leading public bitcoin miners expanded their hashrate under management substantially over 2024, and some of the largest companies more than doubled this KPI.

Hashrate Under Management by Segment 2023 vs 2024



As of the end of December, the top 12 public miners by market cap had 262.5 EH/s under management; of this figure, 231.7 EH/s were self mining hashrate, which represented 24% of Bitcoin’s total network hashrate at the end of 2024.

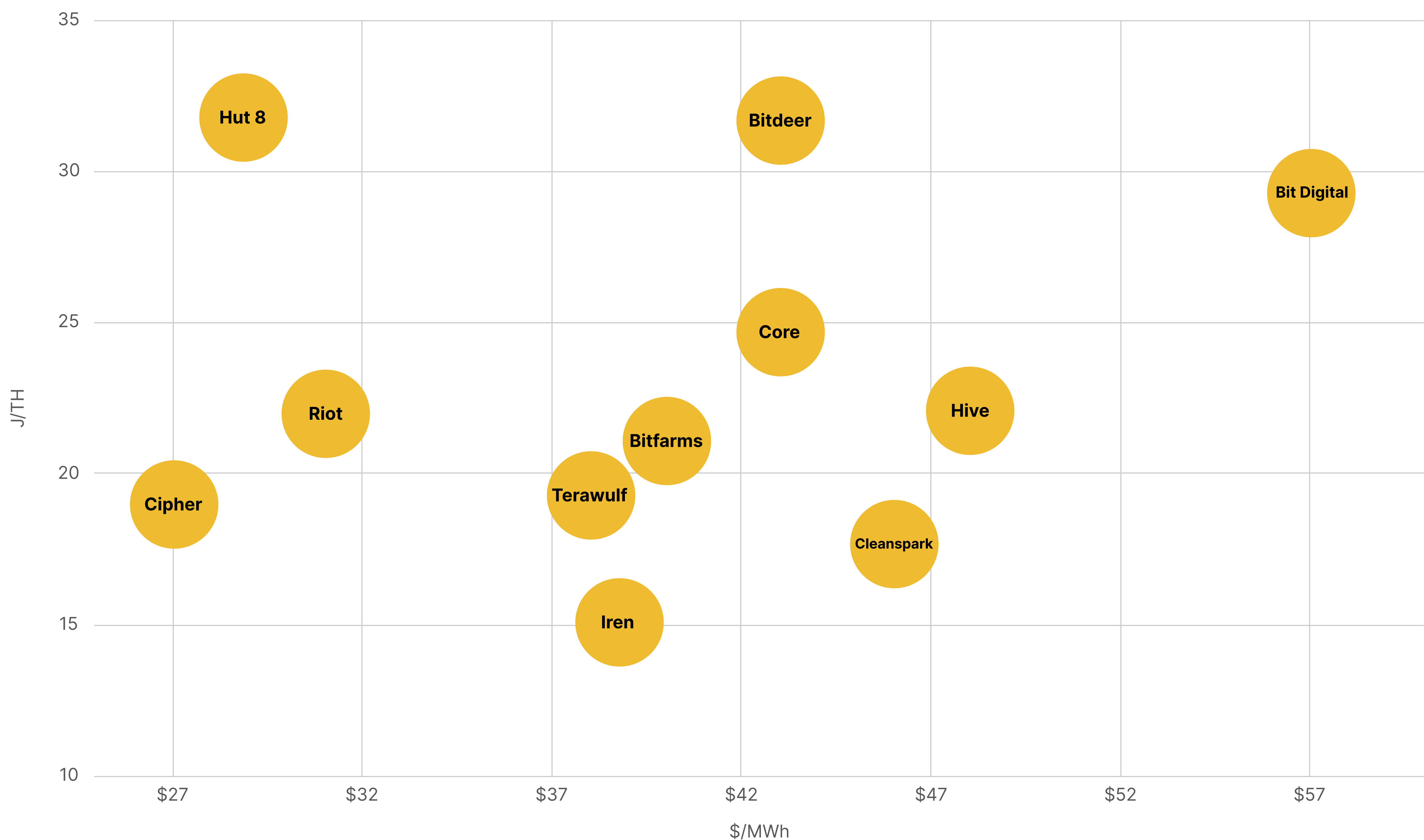
IREN expanded its self-mining hashrate more than any of the miners we track, increasing it 454% in 2024 largely thanks to the energization of its Childress, Texas site. Cleanspark takes the second spot for total self-mining hashrate expansion at 287% following its aggressive M&A strategy with GRID and multiple sites across Tennessee and two in Wyoming; Riot comes in third with 154% growth, as it energized phases of its Corsicana facility last year and acquired mining sites in Kentucky; and MARA clocks in at fourth with a 115% expansion in hashrate, boosted in part by its own acquisitions from Generate Capital and Applied Digital. Hut 8 and Bit Digital were the only miners to reduce their self-mining hashrate last year, with the latter shifting its focus to AI/HPC.

Taking a look at another miner pivoting to an AI/HPC strategy, Core Scientific significantly reduced its hosting business line, tapering it back by year-end from 6.3 EH/s in 2023 to 1 EH/s in 2024. Similarly, Hut 8’s hosting segment fell from 8.6 to 7.7 EH/s year-over-year, and its hosted services declined from 17.9 to 9.4 EH/s after MARA purchased two facilities from Generate Capital that Hut 8 managed. Bitdeer’s own hosting segment barely posted any growth in 2024, rising from 12.6 to 12.7 EH/s. Notably, Bitdeer reallocated all of its cloud mining hashrate to self-mining hashrate by the end of 2024.

Efficiency and Power Rates

In the chart below, we plot out power rates and fleet efficiencies, according to the most up-to-date data disclosed by each miner that we could find. Please note that these power prices can be variable depending on the season for each miner and that they are subject to upward and downward fluctuations accordingly. Further, please note that these values only represent reported all-in power costs, which doesn't include on-site labor, insurance, SG&A, and other costs. The chart does not include MARA, as we could find no recent disclosures for its electricity rate, but MARA reported that its efficiency as of the end of 2024 was 20 J/TH.

2024 Year-End Reported Efficiency and Most Recent Reported Power Cost



Source: Public miner SEC filings, press releases, presentations

Curtailment and Demand Response

For the miners who advertise such strategies, public bitcoin miners earned fewer power/curtailment credits in 2024 than in 2023.

Depending on their power purchase agreements and contracts with power providers / local grid operators, industrial scale miners might have the ability to curtail their operations at times when the grid experiences stress and/or when the cost of power outpaces their ability to mine profitably. Sometimes, power companies/authorities may compensate miners for this demand response, usually in the form of a credit that they can apply to future power bills, but they may also curtail without being compensated. Additionally, some miners may be granted low power prices year-round in exchange for curtailment, a practice that is common with miners in Iceland and Canada.

For those public miners who are compensated for these services, they increasingly took advantage of it in 2023, particularly in the summer months when grids experienced high demand or heatwaves created operational difficulties.

Texas has been the poster child of heatwave-induced grid stress. The state has a high penetration of renewable energy sources (wind and solar), which can be highly intermittent and unreliable at certain times of the year; for example, ERCOT – Texas’ power authority – typically budgets for wind turbines to provide 20% of Texas’ power on any given day, so if a heatwave strikes and drops wind production below this threshold, then the grid experiences disruptions and price spikes. These disruptions and price spikes have become increasingly more common, and miners have increasingly helped fill in the gap by curtailing operations to free up power for the grid.

Given the information above, it’s unsurprising that every miner except for Terawulf represented below participates in demand response programs in Texas.

Power/Curtailment Credits (in Millions \$USD)	Riot	Cipher	Argo	IREN	Terawulf
Q1-2022	\$2.60	-	-	-	\$0.10
Q2-2022	\$5.70	-	-	-	-
Q3-2022	\$13.10	-	-	-	-
Q4-2022	\$5.95	-	-	-	-
TOTAL 2022	\$27.35	-	-	-	\$0.10
Q1-2023	\$3.10	\$0.10	-	-	\$0.13
Q2-2023	\$13.50	\$5.65	\$1.10	\$0.60	\$0.59
Q3-2023	\$49.60	\$2.72	\$4.40	\$3.45	\$1.70
Q4-2023	\$5.02	\$1.57	\$1.66	\$0.52	\$1.08
TOTAL 2023	\$71.22	\$10.04	\$7.16	\$4.57	\$3.50
Q1-2024	\$5.13	\$1.17	\$0.60	\$0.10	\$1.20
Q2-2024	\$13.90	\$1.10	\$0.80	\$0.06	\$1.90
Q3-2024	\$12.42	\$1.34	-	\$0.80	\$2.91
Q4-2024	\$3.40	\$1.76	-	-	-
TOTAL 2024	\$34.85	\$5.37	\$1.40	\$0.96	\$6.01

Source: Public miner SEC filings, press releases

As the table above shows, Riot continues to rake in significantly more curtailment credits than its peers thanks to the size of its Whinstone and Corsicana facilities; Riot earned \$34.85 million in credits in 2024, a 51% decrease from 2023’s \$71.22 million. In aggregate, the miners featured in this data set earned 50% fewer credits in 2024 than 2023, with total credits earned dropping from \$96.49 million in 2023 to \$48.59 million in 2024.

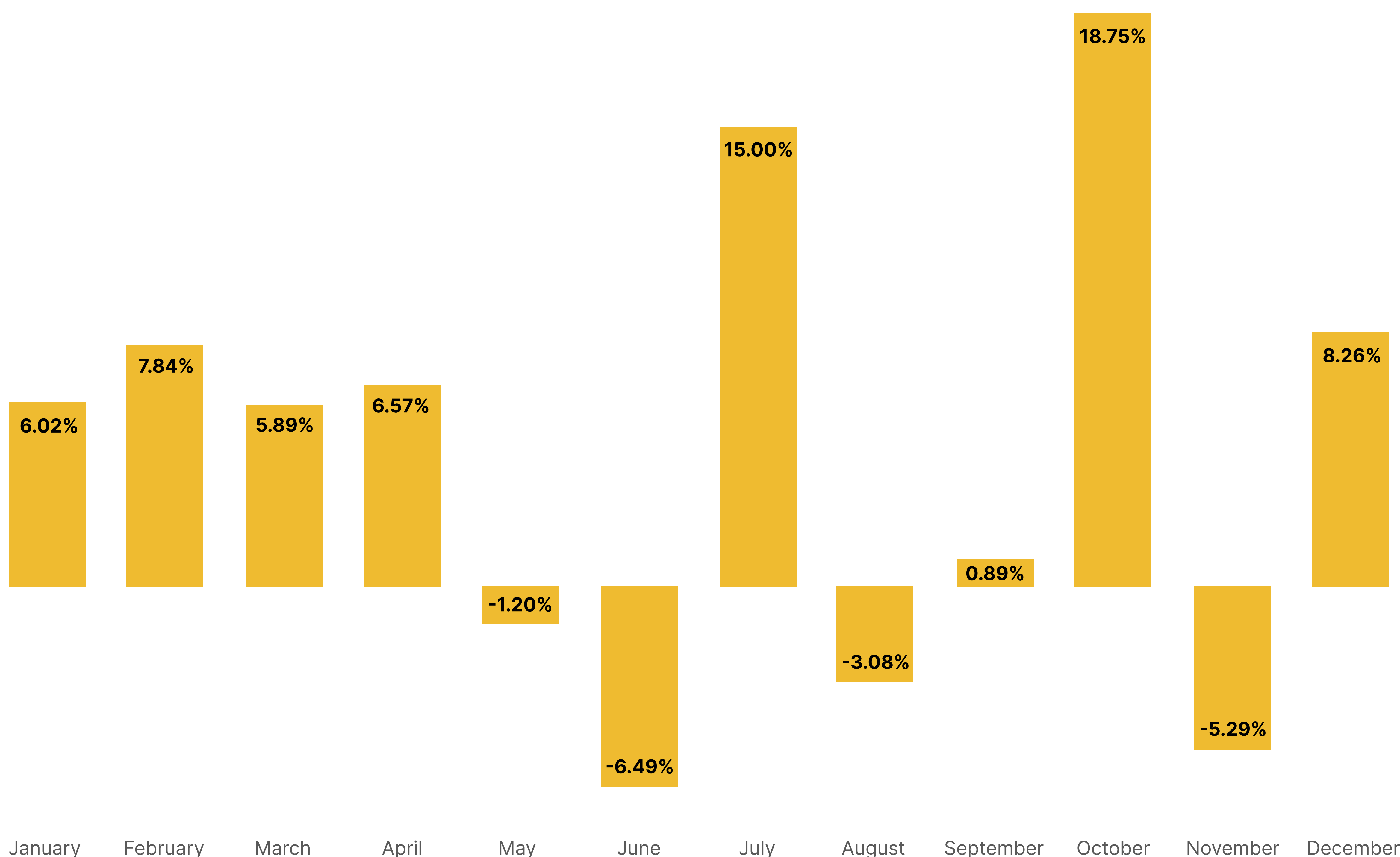
On balance, Q3 and Q4 continue to be the most lucrative periods for demand response on account of summer weather, a trend that speaks to a new pattern of hashrate seasonality for the Bitcoin network as a result of curtailment from industrial-scale bitcoin mining.

Prior to China’s mining ban, Bitcoin’s hashrate would expand during the wet season (May - September) as miners in the region of Szechuan took advantage of excess hydro-power, and it would contract temporarily in the dry season as miners unplugged and migrated to coal-rich regions like Xinjing and Inner Mongolia.

Now, Bitcoin’s hashrate is more likely to dip in the summer months as heat – primarily in North America – affects power grids and Bitcoin mining operations. When examining this trend, it’s important to note that many private miners participate in demand response as well, and that other public miners do too, but they are not as vocal about these strategies since they may not receive compensation or credits for the service.

As the chart below illustrates, Bitcoin’s hashrate contracted by 3.08% in August and 6.49% in June, although it increased significantly in July. Conversely, Bitcoin’s hashrate saw four months of consecutive growth in the colder months between January and April. It’s worth noting that, for the months of May through July, the revenue impact of the fourth halving back in April is likely adding some noise to the data set, which may explain the hard rebound in July as miners adjusted post-halving.

Bitcoin Hashrate (7-Day Avg.) Monthly Change 2024

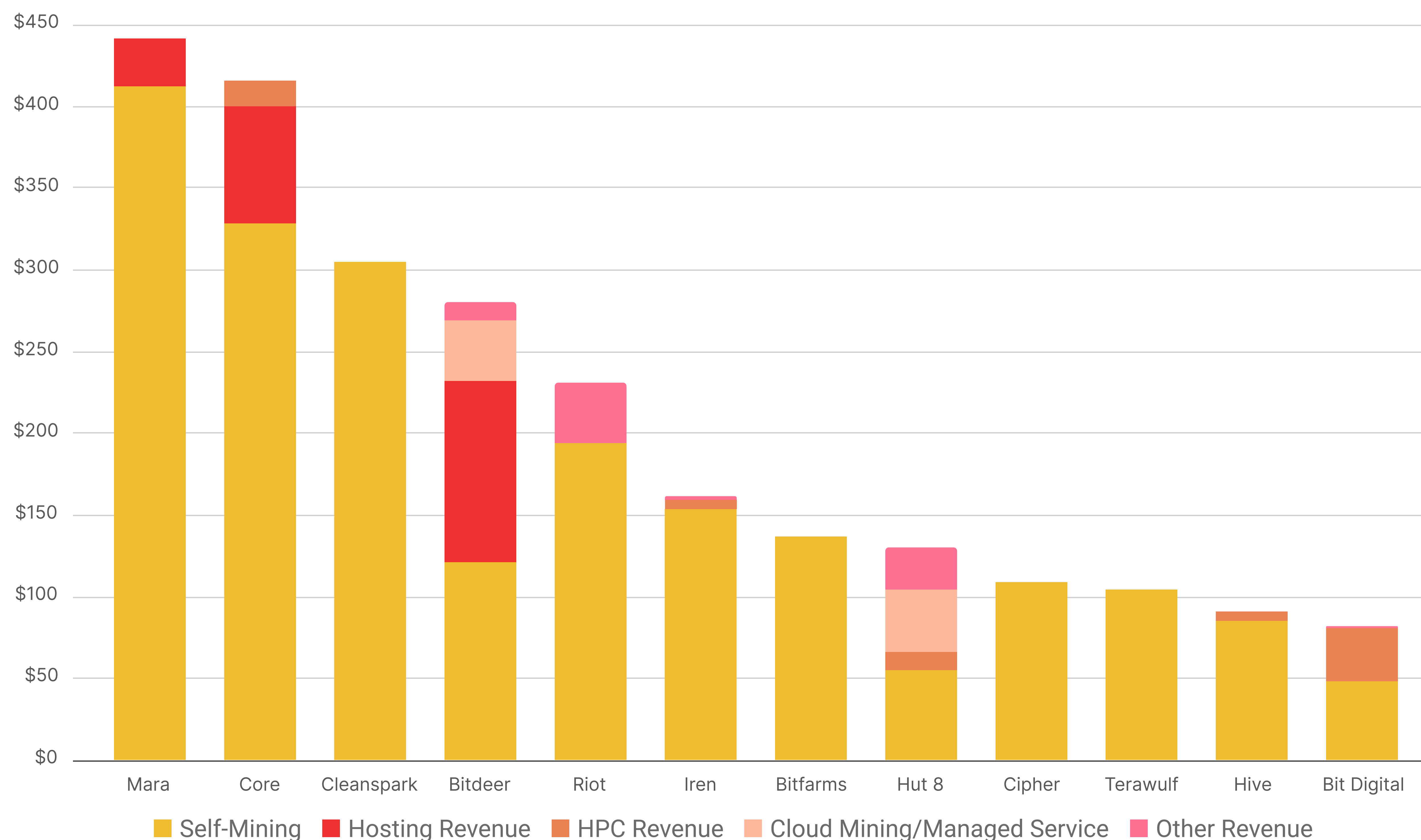


Source: Hashrate Index

Revenue by Business Line

Historically, public miners have earned their revenue primarily from proprietary mining (self-mining) and hosting. Miners have worked in recent years to diversify their revenues, but revenue from non-mining business lines still makes up a fraction of both individual miner and aggregate industry revenue.

Revenue by Business Line First 9 Months of 2024 (in Millions \$USD)



Source: Public miner SEC filings

2024 was a year of hype for AI/HPC business lines. These revenues are still slim, but miners fattened them throughout the year and they should grow in 2025 and beyond should these companies continue to execute. The only public miner to earn any AI/HPC revenue in 2023 was Hut 8 at \$9.9 million. For AI/HPC revenue in the first nine months of 2024, Bit Digital earned \$32.77 million, Core Scientific earned \$15.8 million, Hut 8 earned \$10.11 million, and Hive and IREN both earned \$6.3 million. Notably, Bit Digital's AI/HPC revenue is on track to eclipse its self-mining revenue sooner than later.

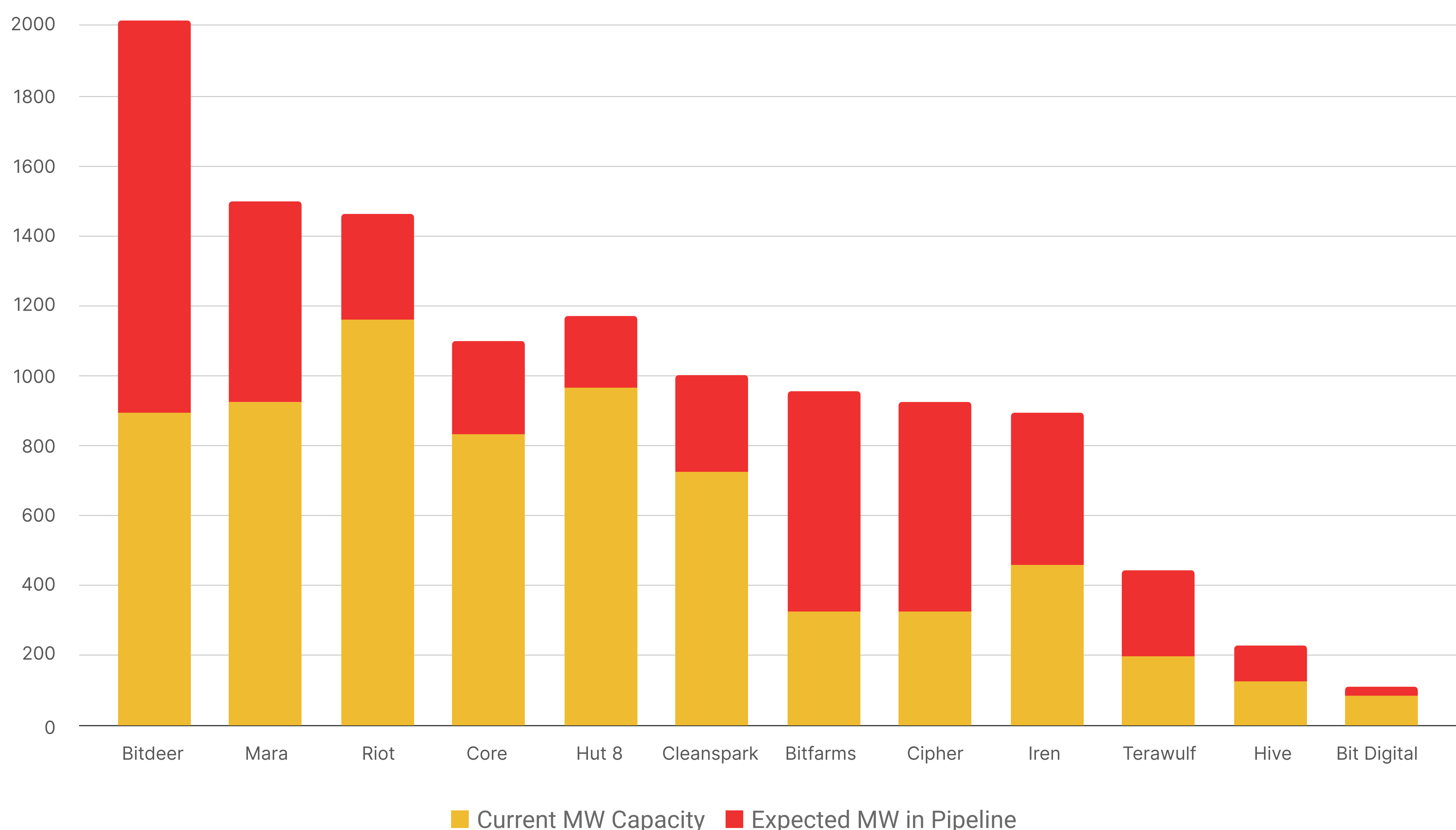
In aggregate, the public miners in our data set earned \$2.06 billion from self-mining in the first nine months of 2024, a 64% increase from \$1.25 billion in 2023 over the same period. For hosting lines in the first nine months of either year, these miners collectively earned \$211.64 million in 2024, a 23% decrease from \$260.60 million in 2023. The drop in hosting revenue is perhaps indicative of the fact that hosting as a business is less attractive after the halving's impact to hashprice; some miners are opting to fill otherwise-hosted rack space to their own machines, while Core Scientific has opted to de-prioritize hosting customers to make way for its massive AI/HPC retrofit.

One more dataset that speaks to the impact of the halving: Bitdeer's cloud mining business line shrunk significantly last year, falling 28% to \$37.3 million in the first nine months of 2024 from \$51.6 million in the same period in 2023. Most of this revenue came in the earlier months in the year, and Bitdeer reported zero cloud mining hashrate in its December update.

Expansion Plans

Major public miners have massive expansion plans for 2025. In aggregate, these public miners have collectively advertised roughly 4.8 GW of expansion plans for the new year. This figure does not include multi-year expansion plans for PPA applications that are still pending approval. Perhaps it goes without saying, but promises are easy, and delivering on those promises is another thing entirely; as such, we should take some of the more massive expansion plans with a grain of salt. Some of these plans may not come to fruition for any number of reasons, including construction delays, supply chain snafus, and other complications.

Current MW Capacity and Planned Capacity for 2025



Source: company presentations, Cohen & Company Capital Markets



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Mining Pools and Firmware

Mining Pools

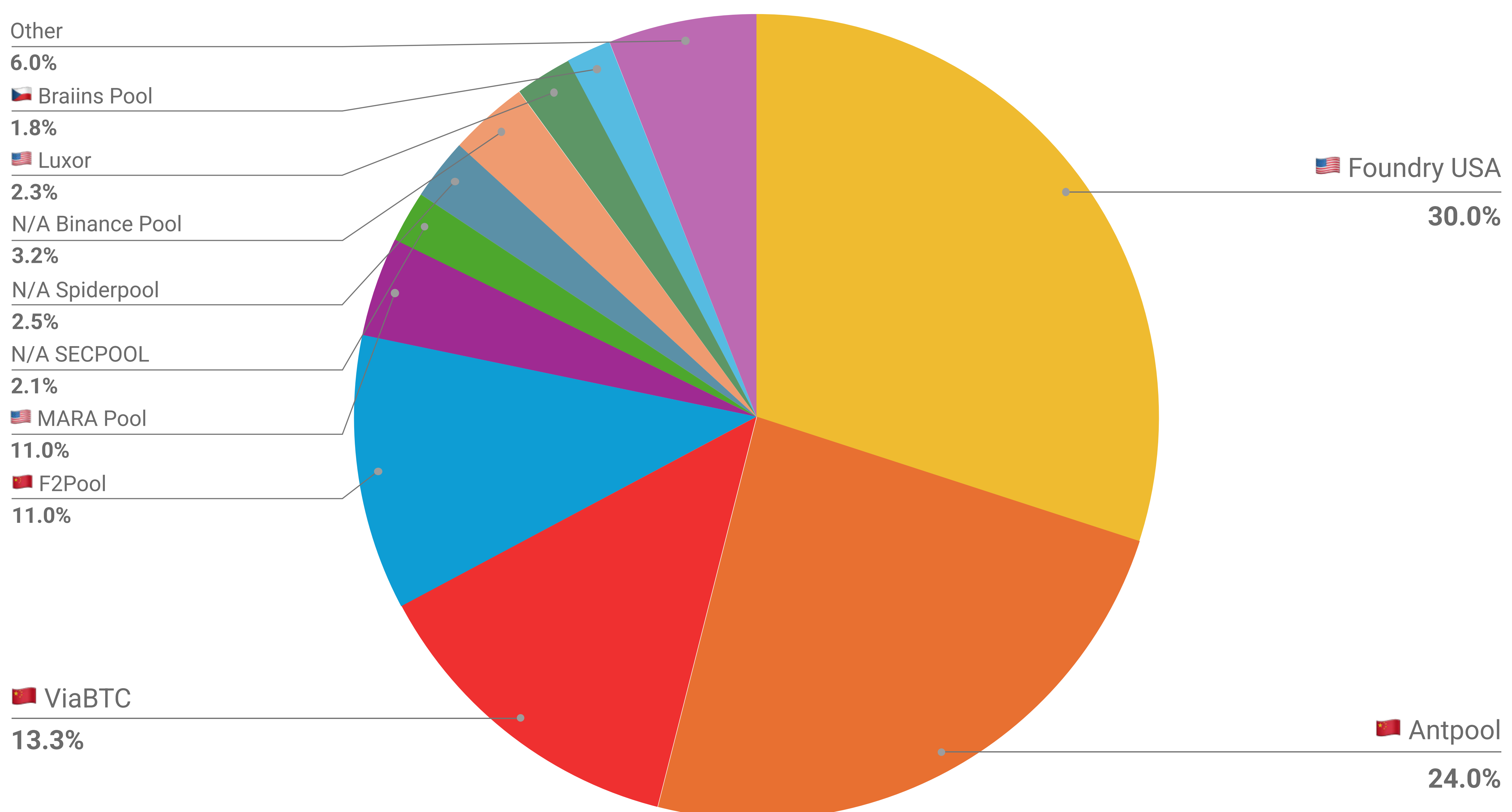
Ever since the advent of pooled mining in 2011, mining pools have been a vital piece of digital infrastructure for the bitcoin mining industry, increasing the frequency and certainty with which miners receive mining rewards. This was a direct result of fierce competition: global network hashrate increased exponentially, forcing individual miners to form groups to have a greater chance of winning any of the 144 blocks appended onto the Bitcoin blockchain per day.

Since then, there has been a lot of innovation in mining pools, ranging from payment methodologies to technical features and enterprise-grade solutions. Major mining pools such as Luxor have achieved SOC2 compliance to keep up with growing demand from institutional miners, in addition to finding new revenue streams such as ordinals and merge mining. We expect new frontiers for mining pools in 2025 and beyond regarding Maximal Extractable Value (sequencing transactions in ways that can maximize the collection of transaction fees).

Leaderboard

We present below the top 10 mining pools in 2024, ranked by number of blocks mined throughout the year. All together, these pools represented 94% of the global network hashrate, having mined over 50,250 blocks over the year.

Pool Market Share



Source: Hashrate Index

Rank	Dec-17	Dec-18	Dec-19	Dec-20	Dec-21	Dec-22	Dec-23	Dec-24
1	ANTPOOL	BTC.com	BTC.com	f2pool	f2pool	foundry	foundry	foundry
2	BTC.TOP MINING POOL	ANTPOOL	f2pool	Poolin	ANTPOOL	ANTPOOL	ANTPOOL	ANTPOOL
3	f2pool	SLUSH POOL	Poolin	BTC.com	Poolin	f2pool	f2pool	ViaBTC
4	BTC.com	ViaBTC	ANTPOOL	ANTPOOL	ViaBTC	BINANCE POOL	ViaBTC	f2pool
5	ViaBTC	BTC.TOP MINING POOL	SLUSH POOL	Huobi	BINANCE POOL	ViaBTC	BINANCE POOL	MARATHON
6	BTCC	f2pool	ViaBTC	ViaBTC	BTC.com	Poolin	MARATHON	BINANCE POOL
7	BITFURY	Unknown	BTC.TOP MINING POOL	58COIN&1THash	foundry	BTC.com	Luxor	SpiderPool
8	SLUSH POOL	Poolin	Unknown	OKEX	SLUSH POOL	SLUSH POOL	BTC.com	Luxor
9	BIXIN	DPOOL	Huobi	BINANCE POOL	Huobi	Luxor	BRAINS POOL	SECPool
10	BWPool	BITCLUB	BITFURY	SLUSH POOL	Luxor	SBI Crypto	Poolin	BRAINS POOL

Source: Hashrate Index

Payout Methods

In 2024, we saw an uptick in Pay Per Share Plus (PPS+) take some market share away from Full Pay Per Share (FPPS), indicating that transaction fees are becoming a relatively more material part of the overall mining reward.

PPS+ is a variant of the traditional Pay Per Share (PPS), which provides payouts based on the number of valid shares miners contribute, irrespective of whether their pool successfully mines a block. Miners are paid for their shares based on a fixed rate (calculated using network difficulty and expected block rewards) in addition to a share of transaction fees collected from mined blocks. By factoring in transaction fees, PPS+ enables miners to benefit from exposure to the transaction fee market.

FPPS also provides predictable payouts but incorporates both block rewards and an average estimate of transaction fees across a set period. The main difference lies in how transaction fees are handled: FPPS pays evenly distributed transaction fees based on historical data, whereas PPS+ pays transaction fees directly based on the real-time fees from mined blocks.

All in all, the convergence on full pay-per-share (FPPS) pools still stands as miners continue to show a preference for more stable and consistent payout structures. This indicates a preference for low payout variance and an aversion to mining luck.

Payout Method	Dec-17	Dec-18	Dec-19	Dec-20	Dec-21	Dec-22	Dec-23	Dec-24
FPPS	0%	28%	54%	67%	66%	67%	87%	69%
PPS+	22%	23%	24%	27%	30%	29%	10%	25%
PPLNS	59%	49%	22%	6%	5%	5%	3%	4%
PPS	19%	0%	0%	0%	0%	0%	0%	0%

Source: Hashrate Index

Pool Innovations

Stratum V2 is a Bitcoin mining protocol designed to enhance security, efficiency, and decentralization in the mining process. It introduces several features such as end-to-end encryption to prevent man-in-the-middle attacks, reduces data transmission to optimize performance, and notably, adds the ability for miners to select their own transaction sets in an effort to mitigate centralization risks associated with mining pools building block templates.

Throughout 2024, significant progress was made in the development and adoption of Stratum V2. In Q1, the Stratum Reference Implementation (SRI) 1.0.0 was released, providing an open-source framework for testing and integration. This release enabled miners using both Stratum V1 and V2 firmware to connect to Stratum V2 pools, facilitating a smoother transition to the upgraded protocol. By Q4, the focus shifted towards broader adoption, with the SRI project outlining a roadmap aimed at supporting early adopters in launching Stratum V2 pools by 2025. We generally remain optimistic about the development of Stratum V2 but skeptical of its adoption, given miners' focus on payment methodologies and fees as the primary criterion for selecting a pool.

Firmware Market

Firmware is specialized software embedded in Bitcoin mining ASIC machines, serving as an operating system which manages and optimizes fleet performance. As an intermediary between hardware and software, firmware dictates how efficiently a mining fleet operates, influencing hash rate, energy consumption, and overall profitability. Its importance lies in its ability to maximize mining margins by fine tuning performance parameters, reducing downtime, and enabling greater control over operational efficiency.

Over time, mining firmware has evolved from manufacturer-provided, standardized “stock” systems into a more flexible and customizable landscape, with third-party firmware providers offering advanced features like overclocking, power optimization, and better thermal management. This shift toward firmware flexibility empowers miners to dynamically adapt to changing market conditions and rising competition in the industry.

Landscape

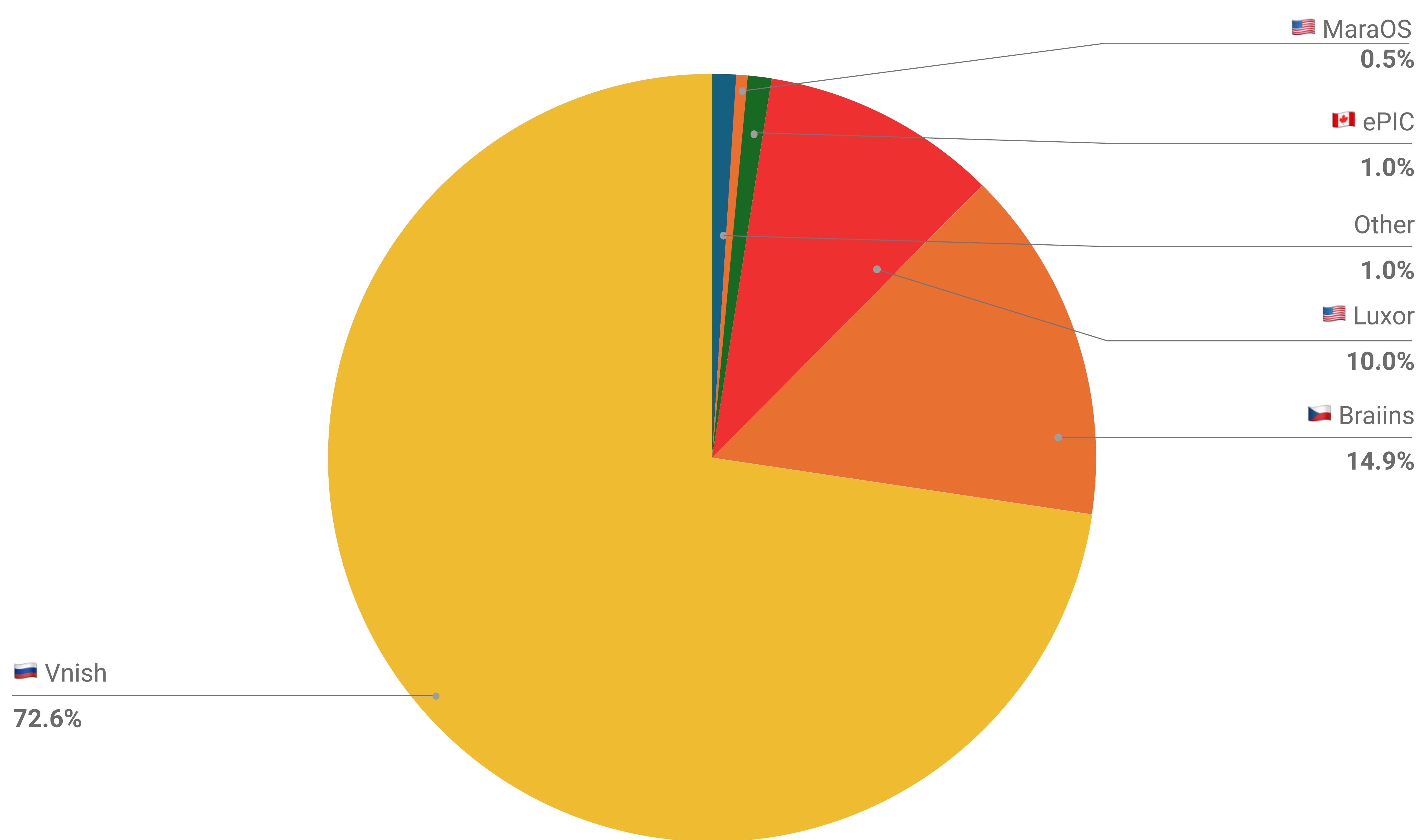
The third-party ASIC firmware landscape continues to evolve. Well-established incumbents have been developing custom firmware since 2018, whereas recent years have seen new entrants into this space, namely Luxor (LuxOS) and ePIC Blockchain (ePIC UMC) in 2023 and MARA (MaraOS) in 2024.

Company	Domiciled	Released	Firmware Type	Model	NAND / Control Board
MaraOS	USA	2024	Proprietary	Subscription	NAND
ePIC UMC	Canada	2023	Proprietary	Purchase	Control Board
Luxor Firmware	USA	2023	Proprietary	Subscription	NAND
Braiins OS	Czechia	2018	Proprietary	Subscription	NAND
Vnish*	Russia	2018	Proprietary	Subscription	NAND

*Includes partner brands and whitelabels (ASIC.to) | Source: Luxor business data

Luxor launched its Antminer firmware — LuxOS — in Q2 2023, marking the first and only Bitcoin ASIC firmware developed, owned, and maintained by a U.S. based company and the first-ever firmware to achieve SOC 2 Type II certification.

Custom Firmware Market Share



Source: Luxor business data

LuxOS firmware introduced several enhancements to improve Bitcoin ASIC miner performance and user experience over the year:

- **Advanced Tuning and Optimization:** Luxor implemented a new autotuning algorithm, optimizing voltage and frequency tuning for better efficiency and stability. The LuxOS Tuner was overhauled to enhance performance, enabling miners to adjust operations in real-time based on market conditions.

- **Stability and Performance Improvements:** The initialization process for miners in cold environments was improved, and the autotuner was enabled by default to ensure optimal performance. Persistent logs were introduced to survive reboots and power loss, aiding troubleshooting and maintenance.
- **Expanded Hardware Support:** support was added for various Antminer models, including S19j XP, T21, S21, S21 Pro, S21 XP and S19 XP Hydro, broadening compatibility across different hardware configurations.

Miner Model	Hashboard Model	"S19 generation" control boards, 120mm wide machines				S21 generation, 140mm wide machines	Hydro, long control board form factor	Notes:
		Xilinx	BeagleBone	Amlogic	CVITEK	Amlogic "Ctrl_Board_A113D_AAP4_ENIG"	Xilinx "Ctrlboard_Hydro"	
S19 "vanilla"	SN starts with "S19" SN contains "YI4B" SN starts with "NBS1902"	✓	✗	✗	✗	✗	✗	76 ASIC chips per hashboard
T19	SN starts with "T19" SN contains "YJ0B" SN contains "YN3B" SN starts with "NBT1903"	✓	✗	✗	✗	✗	✗	76 ASIC chips per hashboard
S19 Pro	SN starts with "S19P" SN contains "YI3B"	✓	✗	✗	✗	✗	✗	114 ASIC chips per hashboard
S19a	SN starts with "S19a" SN contains "YN8B"	✓	✗	✗	✗	✗	✗	72 ASIC chips per hashboard
S19a Pro	BHB28501	✓	✗	✗	✗	✗	✗	100 ASIC chips per hashboard
S19 / S19 Pro "88"	BHB42801 BHB42821 BHB42831	✓	✓	✓	✓	✗	✗	88 ASIC chips per hashboard
S19 "126"	BHB42841	✓	✓	✓	✓	✗	✗	126 ASIC chips per hashboard
S19j Pro	BHB42601 BHB42621 BHB42631 BHB42641 BHB42603	✓	✓	✓	✓	✗	✗	126 ASIC chips per hashboard
S19j Pro+	BHB42612	✓	✓	✓	✓	✗	✗	120 ASIC chips per hashboard
S19k Pro	BHB56902 BHB56903	✓	✓	✓	✓	✗	✗	77 ASIC chips per hashboard
S19 XP	BHB56801 BHB56802	✓	✓	✓	✓	✗	✗	110 ASIC chips per hashboard
S19j XP	BHB56804	✓	✓	✓	✓	✗	✗	110 ASIC chips per hashboard
S21	BHB68601 BHB68603 BHB68606	✓	✓	✓	✓	✗	✗	108 ASIC chips per hashboard
T21	BHB68701 BHB68703	✓	✓	✓	✓	✗	✗	108 ASIC chips per hashboard
S21 Pro	A3HB70601	✗	✗	✗	✗	✓	✗	65 ASIC chips per hashboard
S21 XP	A3HB70501	✗	✗	✗	✗	✓	✗	91 ASIC chips per hashboard
S19 Pro+ Hydro	HHB42631	✗	✗	✗	✗	✗	✓	180 ASIC chips per hashboard 4 hashboard Support coming soon...
S19 XP Hydro	HHB56601	✗	✗	✗	✗	✗	✓	204 ASIC chips per hashboard

- **Curtailment and Power Management:** LuxOS introduced customizable curtailment capabilities, allowing miners to reduce power consumption to approximately 25W in under 5 seconds and restore to normal levels in under 10 seconds, facilitating seamless integration with demand response programs.

These updates reflected Luxor's commitment to providing miners with feedback-driven tools to enhance efficiency, adaptability, and profitability in the evolving Bitcoin mining landscape.

In 2024, MARA (formerly Marathon Digital Holdings) introduced MaraOS, its proprietary Bitcoin mining firmware. Originally acquired from Kingdra for an undisclosed sum and subsequently rebranded, MaraOS was designed to optimize mining efficiency and performance. Its key features include enhanced control over mining hardware, fine-tuning capabilities for chip overclocking and underclocking, and robust thermal protection. MaraOS is compatible with various mining control boards, including MARA's proprietary UCB 2100.

In 2023, ePIC Blockchain, based in Toronto, Canada, introduced its proprietary firmware compatible with S19, M30, and M50 series ASIC miners. This firmware is distributed through their Universal Mining Controller (UMC) boards, offering an alternative to the traditional subscription-based developer fee model. By purchasing and installing the UMC control board, miners gain access to ePIC's firmware without ongoing subscription fees.

In 2024, ePIC unveiled a modular version of their UMC product line, featuring a carrier board and System-On-Modules (SOMs) to enhance compatibility across mining rigs and simplify inventory management. They also expanded support to include the Antminer S19 XP, S21, T21, and Whatsminer M30 and M50 series, enabling miners to standardize fleets and maintain efficiency amid evolving hardware.

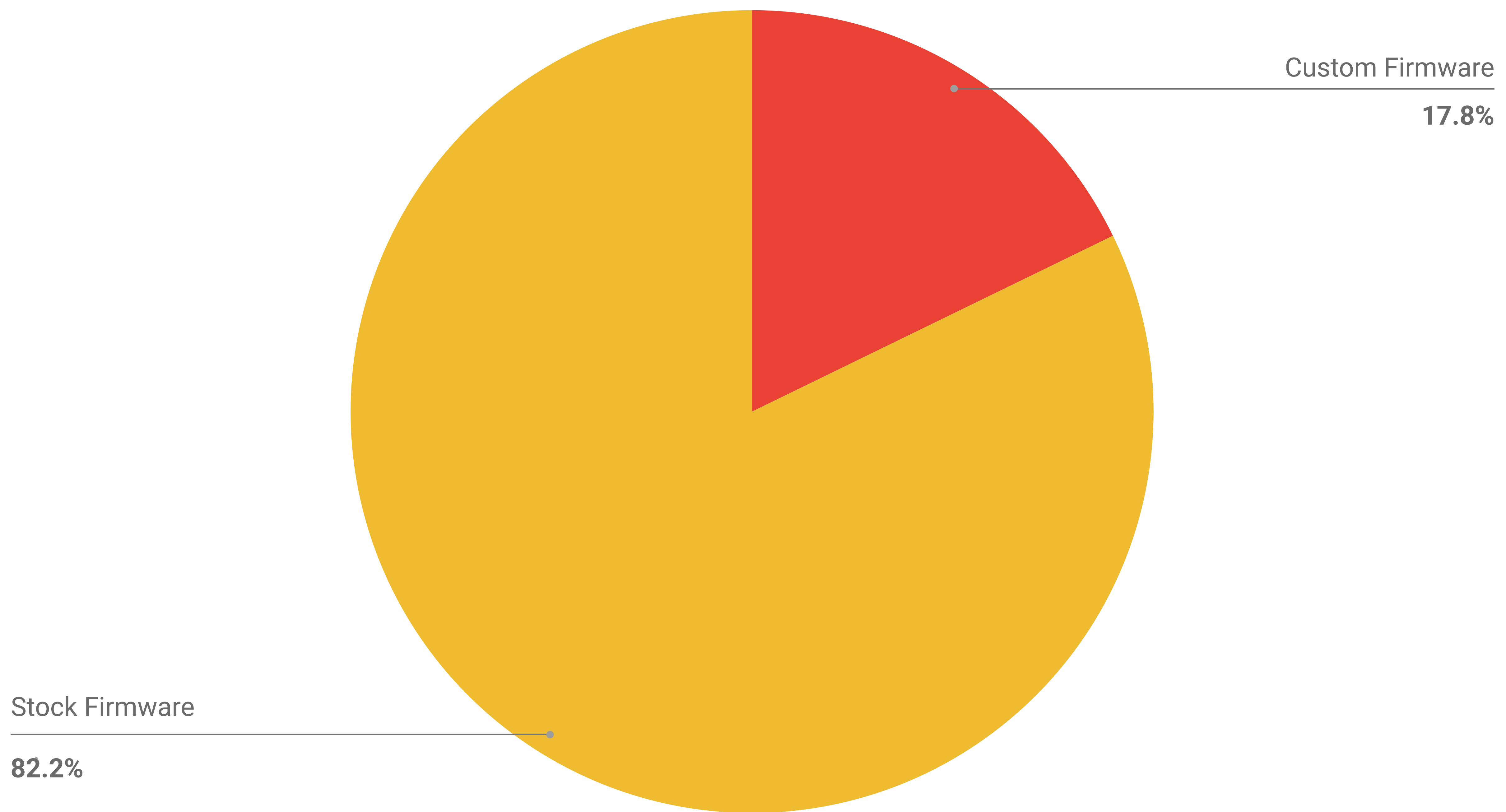
Braiins, headquartered in Prague, Czechia, has been a pioneer in Bitcoin mining firmware since mid-2018. Recognizing the potential for efficiency improvements following revelations about Bitmain's overt ASICBoost in 2017, Braiins developed BraiinsOS, their custom firmware. In Q1 2020, they launched BraiinsOS+, introducing an autotuning feature. Since then, Braiins has consistently added new features, including dynamic power scaling, and various support tools to assist miners with batch configurations and operational management.

In 2024, Braiins introduced several key innovations in Bitcoin mining. They became the first mining pool to offer Lightning Network payouts, enabling instant Bitcoin rewards with no minimum thresholds or fees. In March, they launched Braiins Manager, a rebranded mining management platform with features like API-based curtailment and farm automation. In June, Braiins debuted their first hardware, the BMM 100 Mini Miner, a 1 TH/s device targeted toward retail/hobbyists miners, followed later by the upgraded BMM 101 with Wi-Fi capabilities. Additionally, the company released Braiins Toolbox last year, streamlining large-scale mining operations with batch updates, optimization tools, and configuration management.

Founded in 2016 in Russia, Vnish has become a prominent player in the mining industry, known for pioneering features and model support that are now standard among firmware providers. They operate globally, with a strong presence in Russia, Eastern Europe, Asia, and North America through their white-label partners, such as Asic.to. Their white-label approach, which allows clients to share subscription fees (DevFee), has promoted widespread adoption but raised concerns about fee transparency. Despite growing competition, Vnish continues to expand its market share.

Overall, 2024 has seen significant developments in the firmware space, underscoring providers' commitments to delivering advanced, customizable solutions for the mining industry. We believe that custom firmware adoption will play a major role in maintaining competitiveness and unlocking the next wave of innovation in the mining landscape throughout this epoch.

Est. Custom Firmware Adoption - 2024



Source: Luxor business data

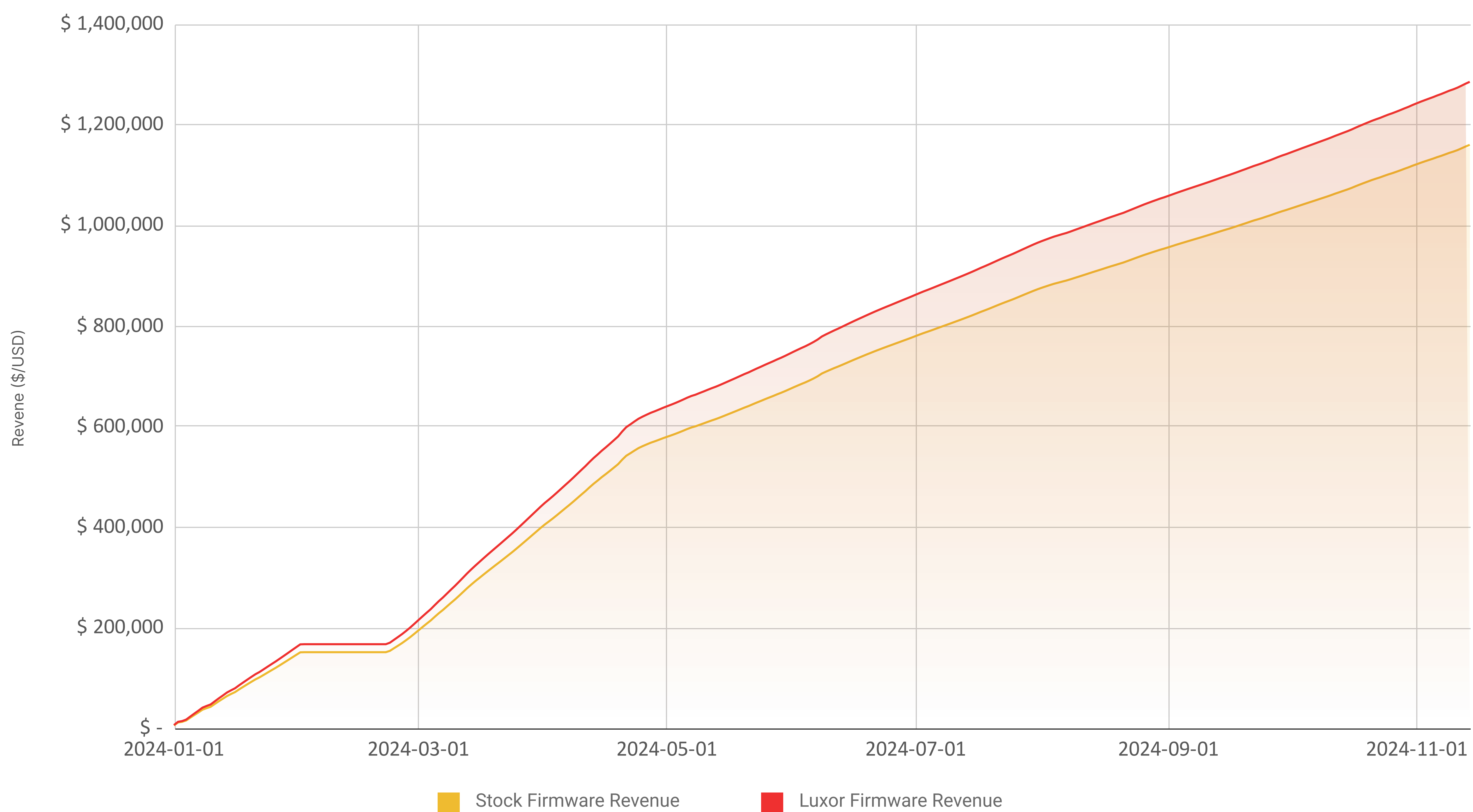
Firmware Performance

Aftermarket firmware allows users to optimize a mining machine's performance by adjusting factory-set operating parameters, specifically voltage and frequency. This enables underclocking and overclocking. Underclocking lowers voltage and frequency to reduce power consumption, which improves efficiency (J/TH) at the cost of lower hashrate. Conversely, overclocking raises voltage and frequency to increase power consumption, which increases hashrate at the expense of efficiency. By unlocking these dynamic adjustments, aftermarket firmware unlocks a broader range of performance compared to stock settings.

With the ability to augment their machine's performance using firmware, operators can select settings that maximize margins given their operating cost profile and current hashprice conditions. To demonstrate the case, we conducted testing throughout 2024, comparing LuxOS performance vs. stock with an R&D fleet of S19 and S21 series models.

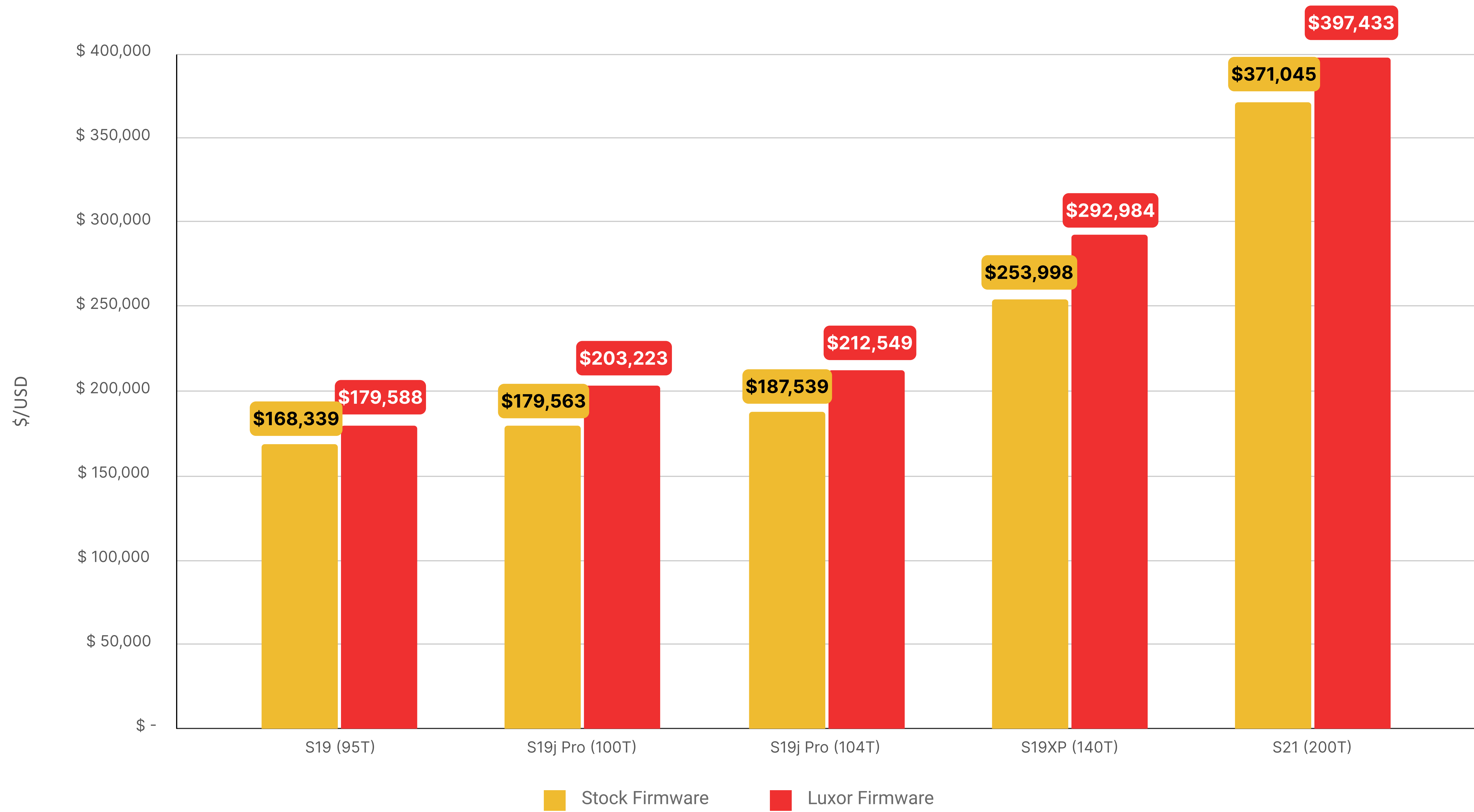
The chart below summarizes the results, highlighting that miners who adopt a dynamic operating strategy are able to optimize operating conditions in real-time based on the profitability environment, yielding ~10% higher returns:

Year-to-Date Revenue on Mining Fleet of S19 and S21 ASICs



Source: Luxor business data

How was this achieved? Firmware enabled the miner's fleet to produce **11% more hashrate through overclocking**, specifically during high hashprice periods. Second, the fleet was able to consume **11% more electricity**, specifically during low power cost periods.



Source: Luxor business data

In summary, using firmware enabled the mining fleet to dynamically adjust its fleet settings and maximize returns. By utilizing firmware and adjusting settings based on market conditions, miners with an actively-managed firmware strategy stand to outperform their counterparts who rely solely on manufacturer-default firmware.

Network Resiliency Post-Halving

Throughout 2024, miners were heavily focused on enhancing their operational efficiency amid a new hashprice regime. Despite Q4’s relative hashprice recovery, miners are likely to shift focus on efficiency as we graduate past the fourth halving.

We believe that the next phase of Bitcoin mining demands active fleet management. In an increasingly competitive environment, staying ahead requires smarter tools and strategies. Firmware empowers miners to do just that — optimize operations, extend hardware life, and maximize returns. Operators who manage their fleet actively and adapt to the ever-changing dynamics of mining economics stand to thrive throughout the next mining epoch.

Currently, the proportion of the global network utilizing aftermarket firmware is relatively modest, however we expect adoption to increase in the coming years, which may significantly lower both the overall efficiency of the global network and the industry-wide breakeven hashprice. Consequently, this could enable Bitcoin’s network hashrate to continue strengthening, even in the face of a hashprice decline.

9

Hosting

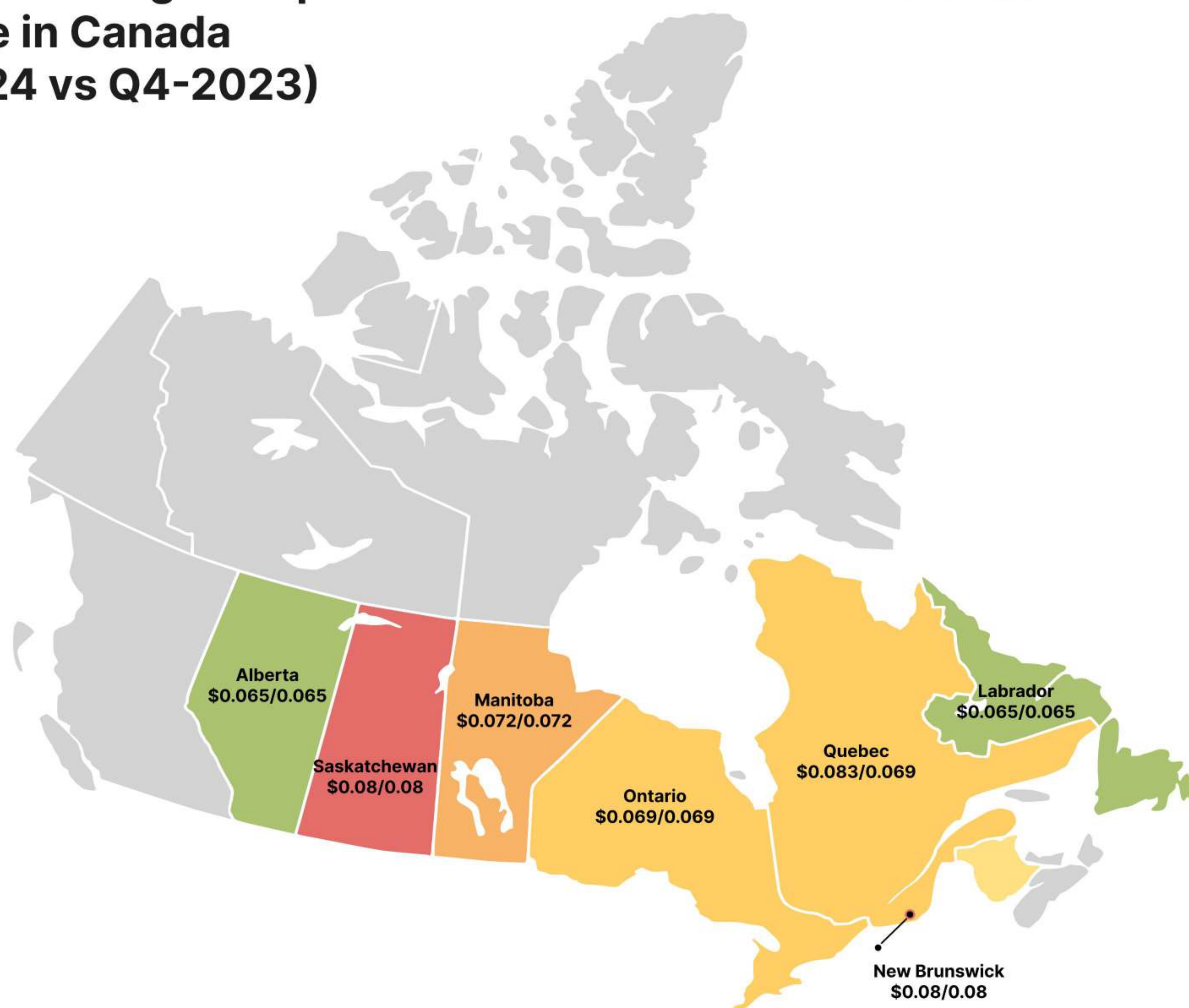
Hosting Data

In aggregate, Bitcoin mining hosting rates fell in the United States over 2024, and they remained essentially unchanged in Canada.

Looking back at time with elevated hosting rates, we saw hosting rates balloon in 2022 as energy and electricity prices surged; the average all-in hosting rate in the United States for the states we tracked in 2022 was \$0.080/kWh in Q4 according to our Hosting Index. Hashprice was range bound between \$55-62/PH/day at the time, so this average hosting rate would have put all but next generation equipment underwater. In Canada, the average all-hosting cost for the provinces featured in our data set for Q4-2022 was \$0.077/kWh according to the index (all prices in \$USD).

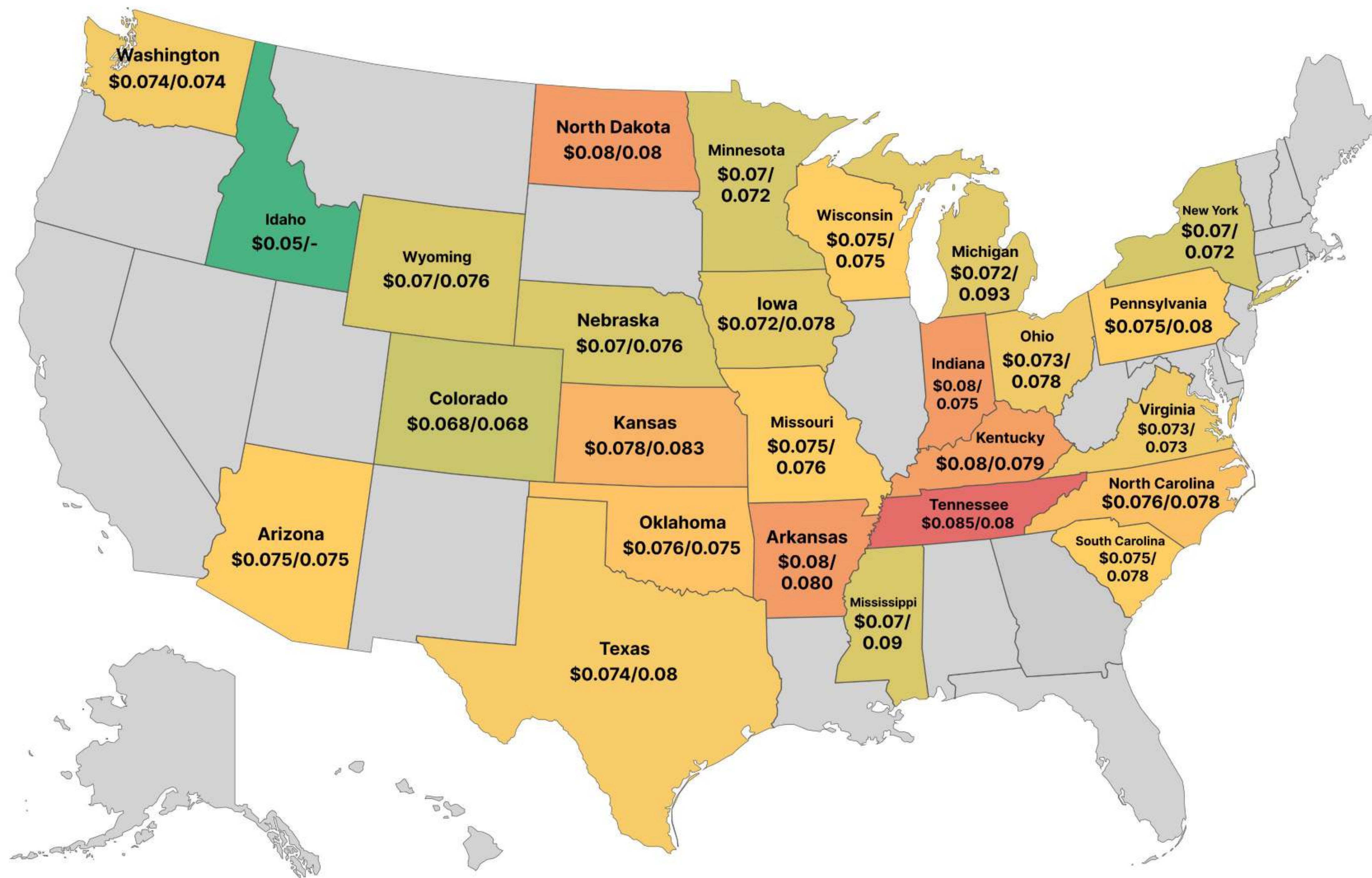
Now, let's compare those rates to 2023's and 2024's.

Average Hosting Cost per Province in Canada (Q4-2024 vs Q4-2023)



Source: Luxor Bitcoin Mining Hosting Index

Average Hosting Cost per State in the USA (Q4-2024 vs Q4-2023)



Source: Luxor Bitcoin Mining Hosting Index

In Q4-2023, the average all-in hosting rate for the sampled states/provinces was \$0.078/kWh in the US and \$0.071/kWh in Canada; in Q4-2024, the average rate was \$0.074/kWh in the United States and \$0.073/kWh in Canada. For U.S. miners, the decrease wasn't much to write home about, but every penny counts in the fallout of the Fourth Halving.

Canada \$/kWh Hosting Rates	1-100MOQ	101-200 MOQ	200+ MOQ	Q4-2024 Average	Q4-2023 Avg.	Q4-2022 Avg.
Alberta	\$0.065	\$0.065	-	\$0.065	\$0.065	\$0.072
Labrador	-	\$0.065	-	\$0.065	\$0.065	\$0.080
Manitoba	-	-	\$0.072	\$0.072	\$0.072	\$0.072
New Brunswick	\$0.080	-	-	\$0.080	\$0.080	-
Ontario	-	-	\$0.069	\$0.069	\$0.069	-
Quebec	\$0.090	-	\$0.075	\$0.083	\$0.069	\$0.079
Saskatchewan	\$0.080	-	-	\$0.080	\$0.080	\$0.080
Country Average	\$0.079	\$0.065	\$0.072	\$0.073	\$0.071	\$0.077

USA \$/kWh Hosting Rates	1-100MOQ	101-200 MOQ	200+ MOQ	Q4-2024 Average	Q4-2023 Avg.	Q4-2022 Avg.
Arizona	-	-	\$0.075	\$0.075	\$0.075	\$0.072
Arkansas	-	-	\$0.080	\$0.080	\$0.080	\$0.080
Colorado	-	-	\$0.068	\$0.068	\$0.068	-
Idaho	-	-	\$0.050	\$0.050	-	\$0.090
Indiana	-	\$0.080	-	\$0.080	\$0.075	-
Iowa	\$0.071	\$0.071	\$0.073	\$0.072	\$0.078	\$0.074
Kansas	\$0.078	-	-	\$0.078	\$0.083	\$0.080
Kentucky	\$0.080	-	-	\$0.080	\$0.079	\$0.087
Michigan	\$0.072	-	-	\$0.072	\$0.093	\$0.093
Minnesota	\$0.071	\$0.069	-	\$0.070	\$0.072	\$0.072
Mississippi	\$0.070	\$0.070	\$0.070	\$0.070	\$0.090	\$0.080
Missouri	-	-	\$0.075	\$0.075	\$0.076	-
Nebraska	\$0.070	\$0.070	\$0.070	\$0.070	\$0.076	\$0.077
New York	-	\$0.077	\$0.063	\$0.070	\$0.072	\$0.072
North Carolina	\$0.078	-	\$0.075	\$0.076	\$0.078	\$0.083
North Dakota	-	-	\$0.080	\$0.080	\$0.080	\$0.075
Ohio	-	-	\$0.073	\$0.073	\$0.078	\$0.072
Oklahoma	\$0.080	-	\$0.072	\$0.076	\$0.075	\$0.080
Pennsylvania	\$0.075	-	-	\$0.075	\$0.080	\$0.086
South Carolina	-	-	\$0.075	\$0.075	\$0.078	-
Tennessee	\$0.085	-	-	\$0.085	\$0.080	\$0.085
Texas	\$0.078	-	\$0.070	\$0.074	\$0.080	\$0.080
Virginia	-	-	\$0.073	\$0.073	\$0.073	-
Washington	\$0.074	-	-	\$0.074	\$0.074	\$0.082
Wisconsin	\$0.075	-	-	\$0.075	\$0.075	\$0.080
Wyoming	\$0.070	-	\$0.070	\$0.070	\$0.076	\$0.075
Country Average	\$0.075	\$0.073	\$0.071	\$0.074	\$0.078	\$0.080

South America \$/kWh Hosting Rates	1-100MOQ	101-200 MOQ	200+ MOQ	Q4-2024 Avg.
Asuncion, Paraguay	\$0.060	-	-	\$0.060
San José, Costa Rica	\$0.085	-	-	\$0.085
Pichincha, Ecuador	\$0.075	-	-	\$0.075
Montevideo, Uruguay	\$0.075	-	-	\$0.075

Europe \$/kWh Hosting Rates	1-100MOQ	101-200 MOQ	200+ MOQ	Q4-2024 Avg.
Alta, Norway	\$0.085	-	-	\$0.085
Bodø, Norway	-	-	\$0.075	0.075
Mo i Rana, Norway	\$0.107	-	-	\$0.107
Sweden (Northern Region)	-	-	Spot + \$0.024	-

Middle East/CIS \$/kWh Hosting Rates	1-100MOQ	101-200 MOQ	200+ MOQ	Q4-2024 Avg.
Kuwait	\$0.060	\$0.060	-	\$0.060
Kyrgyzstan	\$0.050	-	-	\$0.050
Abu Dhabi, UAE	\$0.069	-	-	\$0.069

Asia/Africa \$/kWh Hosting Rates	1-100MOQ	101-200 MOQ	200+ MOQ	Q4-2024 Avg.
Vientiane, Laos	\$0.098	-	-	\$0.098
Indonesia	-	-	\$0.06	\$0.06
Nigeria	\$0.06	-	-	\$0.06

Hosting rates have declined in both the U.S. and Canada since 2022, and a number of factors could have precipitated this change. For starters, 2022 was a year of eye-popping energy price inflation, with many mining hotspots like Texas experiencing a dramatic increase in power rates. Energy prices have come down since, which could explain falling hosting rates as well.

Additionally, hosting providers have had to lower rates since the Halving in order to retain customers who might otherwise unplug their ASICs due to unprofitability; as margins thinned after the April Halving, hosting operators became more flexible with their terms and have been increasingly offering revenue/profit sharing agreements.

Margins are still thin-to-nonexistent for certain miners in higher cost areas who are running older ASICs, so they will need to upgrade in the next year to remain competitive.

10

Significant Regulatory and Legislative Action in 2024

In 2024, Bitcoin experienced significant regulatory and legislative developments worldwide, reflecting its growing integration into the global financial system. Driven by themes of traditional finance integration, nation-state mining, and political alignment, Bitcoin regulation and adoption reached new heights.

The approval of spot bitcoin exchange-traded funds (ETFs) by the U.S. SEC marked a pivotal moment for institutional adoption, solidifying Bitcoin's role in mainstream finance. Governments explored strategic Bitcoin reserves, with Wyoming Senator Cynthia Lummis drafting a bill for a Strategic Bitcoin Reserve in the United States and similar initiatives emerging in Germany and Switzerland. El Salvador renegotiated its Bitcoin strategy with the IMF, balancing innovation with economic support from the international organization. Politically, Bitcoin gained traction as a policy tool, exemplified by Donald Trump's pro-crypto administration and global debates about national mining strategies and digital sovereignty. Here's an overview of key actions:

January: The U.S. The Securities and Exchange Commission (SEC) approved the first spot bitcoin ETFs, marking a significant milestone in bitcoin's integration into mainstream finance.

February: Texas Blockchain Council Lawsuit Against the Federal Government: Texas successfully sued the Energy Information Administration (EIA) for unlawfully mandating private energy usage disclosures from bitcoin miners. This victory marked a strong precedent for miners' rights against overreach in the United States.

March: Former German Finance Minister Christian Lindner proposed that the European Central Bank (ECB) and the Bundesbank include bitcoin in their reserves to prevent Europe from lagging behind the U.S. in cryptocurrency adoption.

April: China intensified its crackdown on cryptocurrencies, implementing stricter regulations to curb illegal capital flight and promote the use of its state-backed digital currency, the digital yuan.

April: Studies revealed the Texas electrical grid would likely double in size by 2030, driven by increased energy demands from AI and Bitcoin mining. These findings set the stage for debates about fair cost distribution for energy-intensive industries.

July: Senator Cynthia Lummis introduced the Boosting Innovation, Technology, and Competitiveness through Optimized Investment Nationwide (BITCOIN) Act, proposing the establishment of a strategic Bitcoin reserve via the U.S. Treasury and codifying the right to bitcoin self custody for U.S. citizens.

August: Hong Kong and Australia launch bitcoin ETFs, providing easier access for investors in Asia-Pacific markets, particularly for Chinese investors through Hong Kong.

September: A citizen-led initiative in Switzerland proposed that the Swiss National Bank (SNB) hold part of its reserves in bitcoin. Efforts commenced to gather the required 100,000 signatures to qualify for a public referendum.

October: Multiple U.S. states, including Texas, Pennsylvania, and Ohio, proposed or passed legislation to accept bitcoin for taxes or create state-level Bitcoin reserves. Vancouver, Canada, also moved to position itself as a Bitcoin-friendly city.

November: Following the U.S. presidential election, President-elect Donald Trump's administration announced a pro-crypto stance, including plans to establish a strategic bitcoin stockpile and create a national crypto advisory council.

December: Accounting rules change as FASB's new guidelines enter into effect, allowing fair-value accounting for Bitcoin and enabling companies to accurately report asset appreciation on their earnings statements.

December: El Salvador reached a \$1.4 billion loan agreement with the International Monetary Fund (IMF). As part of the deal, El Salvador agreed to make concessions regarding its Bitcoin Law, including not requiring businesses to accept bitcoin as payment and reducing government bitcoin purchases.



11

Conclusions and Predictions

In our 2023 Bitcoin Mining Year in Review report, we expressed our belief that the 2024-2028 epoch would bring about great change, potentially redistributing hashrate into new geographies.

We also made the following predictions:

- North America's hashrate dominance would wane as miners would increasingly look elsewhere for cheaper electricity such as South America, Africa, and other under-explored areas.
- Retail hosting-as-a-service would begin to decline due to tight mining margins.
- Mergers, acquisitions, and distressed asset sales would pick up throughout 2024-2025.
- Bitcoin mining stocks would lose some investment premium as vehicles for bitcoin exposure, given the availability of direct exposure through spot Bitcoin ETFs.

2024 was a turning point for the industry as institutional adoption and regulatory clarity continue to increase. Looking ahead, 2025 promises to be a transformative year for Bitcoin mining.

For 2025 and the coming years, we (loosely) predict the following:

- Global hashrate market shares will change. The East will grow, whereas growth in the West will slow down; Europe and the Middle East will decline.
- Hashprice will hit a yearly low of \$30 per /PH/s/Day. Miners will be forced to sell BTC.
- Transaction fee activity will increase, settling higher than in 2024. NFT trading volumes on traditional non-Bitcoin L1s will drive attention to ordinals and push fees up.
- At least one public miner will be acquired by a Hyperscaler.
- Tariffs on ASICs produced in China will increase significantly.
- Bitcoin ETFs will be integrated into major TradFi platforms, setting the stage for the next phase of major institutional adoption and corporate investment.
- Bitcoin and Bitcoin mining tax treatment will become more favorable. Miners will be given the option to realize mined coins as revenue immediately or defer the taxable income until the coins are sold. Capital gains on digital assets may be treated separately from traditional investments, up to and including a 0% rate.

- Real-world asset tokenization goes mainstream and a miner will be the first to offer a securitized token offering (STO).
- A Bitcoin miner offers a Bitcoin dividend yield.
- One of the mainstay stablecoin issuers will offer a bridge to Bitcoin-settled stablecoins.

Here's to another year in the beautiful game.

Happy hashing!