HCW Rational Hashprice Forecasts and Bitcoin Mining Coverage Extension

Kevin Dede, CFA
kdede@hcwresearch.com

Michael Donovan
mdonovan@hcwresearch.com

Expanding our broad bitcoin mining coverage. Complications surrounding bitcoin mining have escalated in lock step with the network hash rate this past year, as technological advances, geopolitical trauma, and macroeconomic flux each in their own way shape process and profitability. The latter point here, macroeconomic factors, in our view, exacts the greatest influence over bitcoin pricing, where past bitcoin price cycles benefited from combinations of money printing, zero interest rates, and steady economic growth promoting an aggressive, risk-on investment atmosphere. Meanwhile, the overarching crypto backdrop has evolved markedly under the new administration and the GENIUS act signed into law last week, which we think translates to a bullish second half for crypto-related assets. In conjunction with our brief update on the mining environment herein, enclosed also are two new company reports: (1) *Cango Inc.* (CANG; Buy) we view favorably in light of its aggressive hashrate add pushing it into the group of top five publicly-traded miners; and (2) *Soluna Holdings, Inc.* (SNLH; Neutral) attractive to us in its development of datacenter megawatts addressing both hosted mining and high-performance compute, but we are not quite ready to stand behind this one quite yet.

Favorable risk-on outlook. Apart from our typically optimistic perspective, we see a confluence of macro and fundamental factors that shed favorable light on bitcoin's price trajectory apparently beginning to play out, we think, as exemplified by the recent surge to $123,000. For our forecasting purposes, we choose to remain on the conservative side using a 4.5 cent/Th/s/day hash price, despite its recent rise to 6.0 cent, in driving our financial models—the combined price and network hash represents revenue generation where flourishing bitcoin price is typically and naturally offset by network hash as price gains incentivizes competition. From an asset performance perspective, we see Trump's pro-crypto stance, the change in SEC leadership, and legislation floating through Congress suggesting less regulatory ambiguity, as obvious positives for bitcoin pricing, but other fundamental aspects are important as well, including: large bitcoin ETF inflows, increases in corporate bitcoin treasury, and sovereign governments' own stockpiling. From a macro perspective, raising the debt limit through the Big Beautiful Bill and expected declining interest rates this year, lay the groundwork for greater risk appetites, also favoring bullish pricing trends. Many would argue that bitcoin is fully in price discovery mode, rising until demand exhaustion. Offered as a reality check, some of the 143 crypto treasury companies that have emerged are funded via swaps of stock for crypto to add to treasury, thus not truly inflating crypto demand.

Evolving business models. The objective to maximize the profit each megawatt contributes has arisen as common theme within the bitcoin mining community, and we have commented on it regularly. Companies such as Core Scientific and Bit Digital have become the poster children for profit optimization and outside-the-box business initiatives. Further, because we see both the business models and accorded valuation disconnected, we suspect more companies could take Bit Digital's route and separate two operating groups—ultimately two independent companies—between crypto-related and HPC datacenter related. And there are many that might slip into this grouping going forward, so stay tuned.

Too much reliance on technical analysis? An instilled, pervasive belief that past pricing cycles dictate future trends arose as fallout in the study of previous having cycles—there simply is more to it than that. Over our eight years covering the sector—estimating hashprice in building financial models—had necessitated applying of a number of tools, including all the usual suspects such as stock-to-flow and regression-based curve fitting, yet finding limited success in predicting bitcoin price. Never fans of technical analysis, there is, and continues to be, little else in the tool bin to help anticipate pricing dynamics; however, we caution investors against that thinking and reliance. Despite our track record and preaching, we do a bit more technical analysis here, using power laws in matching pricing and network hash historical data over longer durations. Ultimately, we advocate fundamental economic analysis over technical specifically in examining factors that prompt investors to the edge of the risk curve and force bitcoin price higher.

Bitcoin grades the dollar. Over the past five years The Overton Window on U.S. fiscal policy has slid from emergency stimulus toward an acceptance of funding chronic deficits near 7% of GDP through balance sheet expansion is politically easier than instituting fiscal restraint, as perhaps best characterized by DOGE's detractors. Critics such as Ray Dalio now openly warn that, absent a cut to 3%, the default outcome becomes "massive money printing." Data show that broad money, M2, expanded by more than one third in the 18 months after the pandemic began and reached a record $21.9 trillion in May 2025, even as Federal Reserve assets remain about $6.7 trillion—triple pre Covid levels. The treasury general account is routinely drained into markets and then rebuilt, while the Fed's overnight reverse-repo facility has collapsed from more than $2.5 trillion to about $148 billion—moves that expand reserves without any formal QE label. Liquidity now arrives through stealth mechanisms, and such shifts are no longer ignored; bitcoin's hard capped 21-million-coin supply is increasingly used as a hedge, and Mike Novogratz quips that bitcoin is acting as a report card on financial stewardship over the U.S. dollar.

Structural bid meets immutable cap. Bitcoin's average 60-day rolling correlation to the Nasdaq 100 fell to 0.34 in 2Q25 from 0.43 in 1Q25, suggesting that bitcoin more recently is trading on its own fundamentals rather than acting as a high beta tech proxy. Decoupling as it has been this year has coincided with a structural flow shift: U.S. spot bitcoin ETFs absorbed $14.5 billion net year to date through July 8, 2025, compared with $36.2 billion for all of 2024. Demand skews younger—73% of investors aged 24–45 now prefer bitcoin to gold for long term appreciation—and there is no supply response: issuance remains capped at 21 million. Gold's supply, by contrast, looks increasingly elastic. China mapped a 1,100 ton gold deposit, while a World Gold Council survey shows 43% of central banks plan to add bullion over the next 12 months. Physics and space technology stretch the tape measure further—CERN's ALICE collaboration has demonstrated lead-to-gold transmutation, and NASA's Psyche mission targets a metal rich asteroid whose notional value runs into the quintillions. On the energy side, bitcoin mining is proving grid accretive, not parasitic. ERCOT directed demand response cut major Texas miners' output by 12–25% in June 2025, yet that flexibility is credited with avoiding roughly $18 billion in new peaker plant costs, reframing idle electrons—not hash power—as the real waste. The flip side, however, is enlarging power demand, with high-performance compute now competing for electrons though carrying less energy price sensitivity potentially reducing bitcoin mining's relevance, or enhancing it given complementary adjustable loads. In a macro environment defined by high real rates, fiscal overhang, and an aging investor base passing assets to younger cohorts, overweight exposure to bitcoin relative to gold and other risk assets offers a clearer asymmetry—structural demand is rising, correlations are falling, and the supply curve is both visible and immovable. Collectively, we see fundamental support for higher bitcoin prices as the year progresses.

Perspectives on valuation. Costs remain the fulcrum of the mining narrative after the April 2024 halving intensified margin pressure across the sector subject to lower hashprice since the halving. Hashrate expansion has continued, fleet efficiency gains have narrowed, and regional power volatility has stretched operating cash costs. In response, capital is being triaged toward rigs that squeeze more terahash out of every joule and toward sites that harvest extra revenue from demand response or heat reuse. Meanwhile, per the table on the following page, valuation gaps have widened as business models diverge. Multiples are being set by how much bitcoin sits on the balance sheet of pure play miners, perhaps accorded a valuation benefit on digital asset treasury, but leaving their equity yoked to spot-price volatility. By contrast, mullet datacenter firms—AI hosting out front, hashboards buzzing in back—are being treated as hybrid infrastructure plays and appear to be priced more generously. Grid interconnects and low leverage are prized. The table that follows sets each company against a number of quantitative yardsticks so relative positioning can be seen at a glance.

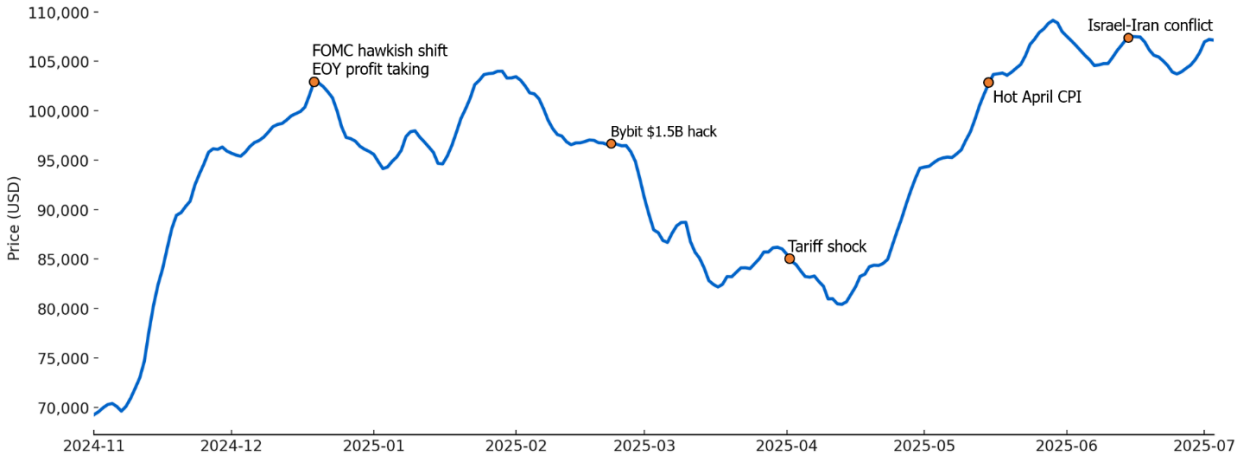
Miner Valuations and Efficiency Measures

		Price 7/22/25	Market Cap ($'s M)	Ent. Value ($'s M)	2024A P/S	2025E P/S	2024A MC/TH	2025E MC/TH	1Q25 EV/MW	4Q24 D/E	1Q25 D/E	Rating
Argo Blockchain PLC	ARBK	$0.03	$29	$60	5.3x	5.3x	13.1x	48.2x	2.02x	-1.4x	-1.4x	Neutral
Bitdeer Technologies Group	BTDR	$14.65	$2,705	$3,212	5.3x	5.3x	125.2x	90.2x	2.92x	1.0x	0.4x	Buy*
Bit Digital Inc.	BTBT	$3.27	$1,061	$485	9.8x	8.8x	408.1x	408.1x	10.78x	0.3x	0.3x	Buy
BitFarms Ltd.	BITF	$1.79	$628	$437	2.6x	2.6x	49.1x	31.4x	1.57x	0.4x	0.4x	Buy*
BitFuFu Inc.	FUFU	$4.19	$680	$709	1.5x	1.7x	219.4x	179.0x	4.32x	0.8x	0.9x	Buy
Cathedra Bitcoin Inc	CBIT	$0.07	$89	$32	5.3x	5.3x	222.1x	222.1x	0.34x	0.2x	0.1x	Neutral
Cipher Mining Inc.	CIFR	$6.94	$1,541	$1,644	10.2x	5.4x	127.7x	114.1x	6.45x	8.3x	7.9x	Buy*
Cleanspark Inc.	CLSK	$12.84	$3,481	$3,190	21.4x	4.3x	107.1x	69.6x	5.04x	0.3x	0.3x	Buy*
Core Scientific Inc.	CORZ	$13.48	$4,030	$5,236	7.9x	8.8x	212.1x	212.1x	11.90x	-1.3x	-6.0x	Neutral
Digi Power X Inc.	DGXX	$3.58	$135	$123	3.6x	4.0x	51.9x	33.7x	1.23x	0.9x	0.5x	Buy
DMG Blockchain Solutions Inc.	DMG	$0.26	$52	$16	2.0x	1.5x	31.8x	24.6x	0.38x	0.2x	0.2x	Buy
Gryphon Digital Mining, Inc.	GRYP	$1.27	$89	$89	4.2x	4.3x	119.6x	260.4x	2.79x	-0.8x	-0.7x	Neutral
HIVE Digital Technologies Ltd.	HIVE	$2.49	$486	$86	2.5x	1.9x	93.6x	27.0x	0.37x	0.6x	0.5x	Buy*
Hut 8 Corp.	HUT	$21.40	$2,459	$2,389	15.1x	10.7x	186.3x	163.9x	3.59x	0.4x	0.4x	Buy*
LM Funding America Inc.	LMFA	$4.93	$24	$21	2.2x	2.6x	57.9x	3.5x	1.40x	0.2x	0.2x	Neutral
IREN Limited	IREN	$18.59	$4,374	$3,964	15.7x	5.8x	141.1x	87.5x	6.01x	0.1x	0.1x	Buy*
MARA Holdings Inc.	MARA	$19.88	$6,627	$8,909	10.1x	8.1x	147.3x	114.3x	7.97x	0.6x	0.7x	Buy
Mawson Infrastructure Group Inc.	MIGI	$0.54	$12	$32	0.2x	0.2x	39.6x	2.5x	0.24x	-0.6x	-0.6x	Neutral
Phoenix Group Plc	PHX	$0.43	$2,670	$2,683	13.0x	21.6x	920.6x	404.5x	5.37x	0.4x	0.4x	Buy
Riot Platforms Inc.	RIOT	$14.27	$5,009	$4,929	13.3x	7.2x	159.0x	141.5x	6.60x	0.2x	0.2x	Buy*
SATO Technologies Corp.	SATO	$22.40	$7	$9	0.4x	0.6x	13.6x	13.6x	0.47x	0.3x	0.2x	Neutral
Sphere 3D Corp.	ANY	$0.69	$18	$10	1.1x	1.2x	22.2x	17.1x	1.22x	0.0x	0.0x	Buy
TeraWulf Inc.	WULF	$5.26	$1,919	$2,193	13.7x	9.2x	197.8x	157.3x	9.75x	2.0x	2.9x	Not rated
Group Ave.					***7.2x***	***5.5x***	***159.4x***	***122.9x***	***4.0x***	***0.6x***	***0.3x***	
Cango Inc.	CANG	$5.18	$338	$27	3.1x	0.5x	10.6x	6.8x	0.04x	0.0x	0.2x	Buy
Soluna Holdings, Inc.	SLNH	$0.64	$17	$63	0.4x	0.5x	7.1x	3.6x	0.68x	0.8x	0.8x	Neutral

Note: Asterisk (*) indicates covered by Colonnese; all others under our coverage as indicated by rating.
Source: FactSet Research (FDS; not rated), company reports, and H.C. Wainwright estimates all computed applying our price deck uniformly across the complete list of companies for comparative purposes.

Bitcoin hits its resilient stride. Year to date, bitcoin has experienced several global macro events, annotated in the chart below. Each sell-off reversed within days or a few weeks, with bitcoin repeatedly reclaiming the $105,000 level before advancing to $120,000. That pattern suggests a market whose structural bid—from spot-ETF inflows, miner balance-sheet discipline, and broader institutional acceptance—now absorbs episodic shocks seemingly more resiliently than previous cycles. Investors can treat these event-driven dips as opportunities to add exposure; the cadence of ever-higher lows implies bitcoin is building a sturdier base as 2025 progresses.

Bitcoin's Climb Amid Macro Shocks



Source: HCW Research, July 2025.

Bitcoin above $120,000: float drains, hashrate soars. Bitcoin set an intraday high above $120,000, almost doubling the post-halving price one year earlier. Assets in spot bitcoin ETFs have climbed past $150 billion after back-to-back $1.2 billion net-inflow days, shrinking the tradable float. Exchange balances slipped to roughly 2.9 million BTC—14.6% of the 19.8 million coins outstanding—by the end of 2Q25, down from about 3.1 million BTC or 15.6% at the end of 1Q25. The seven-day average hashrate now stands around 900Eh/s, 44% higher than a year ago as immersion-cooled 3nm ASIC-based fleets displace legacy rigs.

ETF inflows eclipse issuance. In 2Q25, U.S. spot bitcoin ETFs absorbed $12.4 billion of net inflows, roughly 3x the 40,950 BTC mined, versus just over $1 billion in 1Q, pushing year-to-date subscriptions to $13.8 billion on top of 2024's record $63.5 billion. SPDR S&P 500 ETF Trust (SPY) experienced $20.1 billion of redemptions in 1Q25 before a single-day $5.1 billion inflow on April 22 helped nudge 2Q flows back into positive territory. Invesco QQQ Trust (QQQ) shifted from early-year outflows to a cumulative $8 billion inflow for the first half, while SPDR Gold Shares (GLD) attracted $8.3 billion year-to-date after a flat 2024. The numbers show bitcoin funds capturing the lion's share of new money in 2Q25, eclipsing the flagship equity and gold vehicles.

Spot BTC ETFs in 2Q25 Experienced Heavy Demand

Period	Bitcoin Spot ETFs Net Inflows (est.)	SPDR S&P 500 ETF (SPY) Net Flows (est.)	Invesco QQQ (Nasdaq-100) Net Flows (est.)	SPDR Gold Shares (GLD) Net Flows (est.)
2Q 2025	$12.4B (*125K* BTC)	+$5B	+$10B	+$2.3B
1Q 2025	$1.2B (*10K* BTC)	-$20.1B	–$2B	+$6B
2024 (Full Year)	$63.5B (*900K* BTC)	+$10 B	+$27.5B	$0B (flat)

Source: FactSet, HCW Research, July 2025.

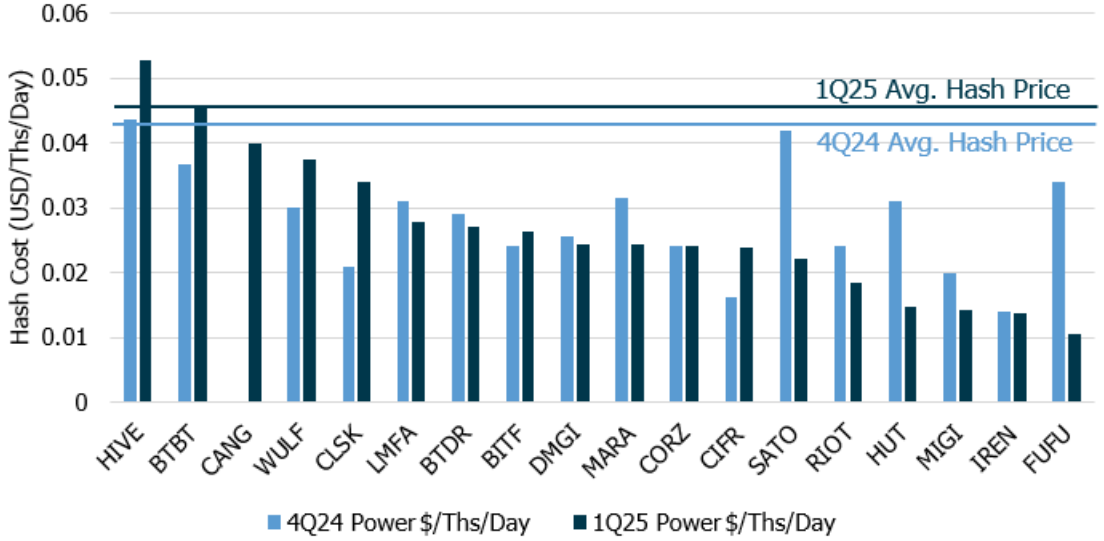
Corporate coffers outgun bitcoin ETFs in 2Q25. By the end of 2Q25, corporate bitcoin treasury companies reached new highs, with public companies alone owning about 855,000 BTC, up roughly 131,000 BTC or 18% from 724,000 at the end of 1Q25. This surge reflects the growing phenomenon of companies using Bitcoin as a treasury reserve asset – not just for passive exposure like an ETF, but as a strategic tool to hedge against inflation and boost shareholder value. The combined corporate stash, public and private firms, now stands around 1.28 million BTC, with publicly traded firms contributing the majority. Saylor leads all corporates with nearly 600,000 BTC, nearly 3% of the total supply, on its books, while other major holders include MARA with roughly 50,000 BTC. By comparison, spot bitcoin

ETFs worldwide held over 1.4 million BTC by 2Q25's end—still a larger hoard than corporations—but their 2Q25 growth of 111,000 BTC, up 8%, lagged behind the rapid accumulation by companies. U.S.-based spot ETFs make up the bulk of global ETF holdings. For instance, BlackRock's iShares Bitcoin Trust alone manages about 700,000 BTC. Second quarter 2025 marked the third straight quarter in which corporate treasuries outpaced ETFs in bitcoin accumulation, highlighting an accelerating institutional shift toward holding bitcoin as a strategic asset on corporate balance sheets.

Zettahash migration: cheap electrons help draw mining's world map. Miners pushed bitcoin's network hashrate to roughly 1.0–1.1Zh/s in 2Q25 from the low-800Eh/s range in 1Q25, a near-25% leap that followed the energization of next-generation rigs and several large campuses. U.S. operators kept about 36% of global capacity, yet new power emerged abroad: Ethiopian developers added over 100MW of hydropower—and nudged the nation above a 1% global slice. Paraguay's Itaipú and Yguazú lured further capital. In the Gulf, Oman advanced a 1.2GW pipeline aiming at up to 7% of global hashrate, while Phoenix Group's Abu Dhabi venture outlined plans to double its datacenter footprint beyond 1GW. Meanwhile, reports show Russian and Chinese fleets continue to expand. Taken together, these moves show miners actively chasing the cheapest or stranded electrons—hydro in the Paraguay River Basin, the Grand Ethiopian Renaissance Dam, Argentinian and Siberian gas fields, and subsidized solar in the Gulf—so political frictions shift projects' coordinates rather than slow network growth, and, for now, the security curve continues its upward tilt even as the geographic mix stays fluid. Geographic hash movement could become a greater concern over the next couple of having cycles as mining economics weaken but pressure to protect sovereign mining and bitcoin reserves increases.

Mixed hash cost moves in 1Q25. The bar plot below stacks each miner's pure power hash cost—dollars spent per terahash per second per day (USD/Ths/day) in 4Q24 (light blue) against 1Q25 (dark blue)—beside the average network hash price lines that mark revenue per unit of hashrate. Hash cost is simply electricity price times machine efficiency; lower figures come from locking in cheaper kilowatt-hours or running newer, more efficient rigs. In 1Q25 the average hash price rose to roughly $0.053 from $0.050 in 4Q24, then eased to about $0.048 in 2Q25, so every cent shaved off power cost feeds directly into margin. Operators like SATO (to $0.022 from $0.025) widened their spreads, while ultra-lean Mawson and BitFuFu sit near $0.015–0.020 thanks to cheap power contracts, high-efficiency fleets and demand-response deals that throttle usage when rates spike.

Coupling Economically Viable Power Deals With Efficient Fleet Remains Critical

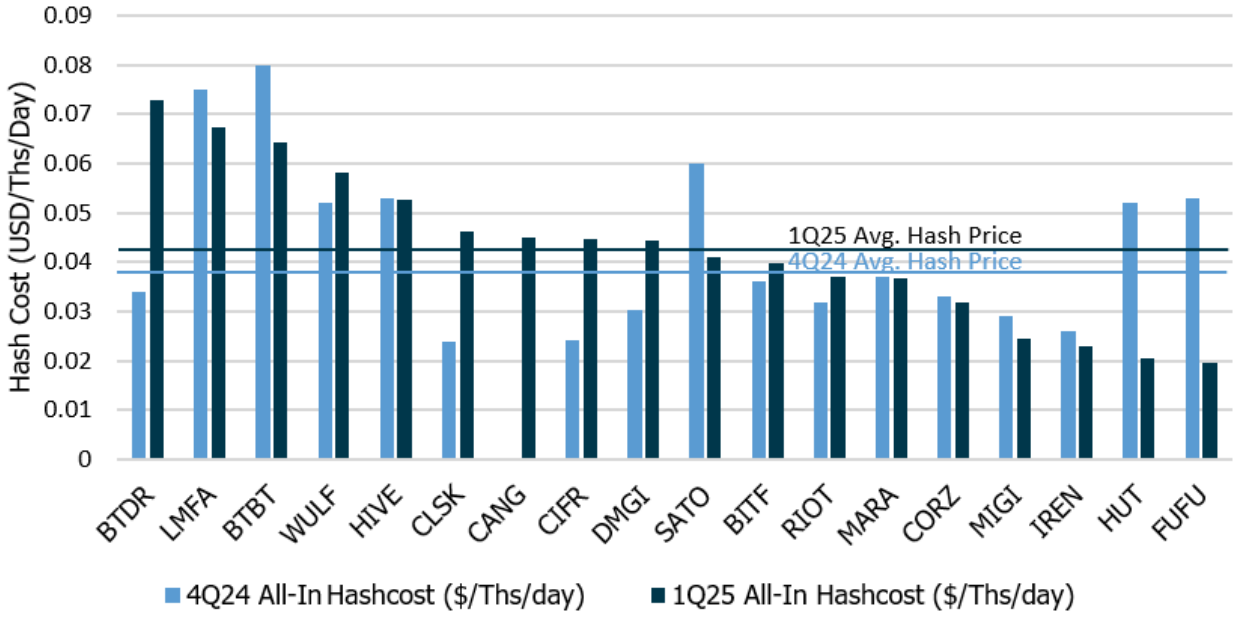


Source: Company filings, HCW Research.

All-in arithmetic crowns miners with cost discipline. The lower chart adds salaries, hosting, repairs and overhead, exposing full hash costs. Because revenue per terahash is universal, the profit battle is won or lost here. After costs were loaded, LMFA's all-in figure sits near $0.075/Th/s/day, leaving it barely afloat with the hash price drifting to $0.048 in 2Q25 from $0.053 in 1Q25. Conversely, Mawson and BitFuFu compressed total outlay to about $0.020 – 0.025 (down from $0.030–0.035 in 4Q24), keeping breakeven less than half of current revenue. Low all-in hash cost stems from the same electricity edge plus tight staffing, in-house infrastructure and balance sheets light on interest and depreciation.

When the hash price slips, those that keep both their power meter and their overhead lean remain solidly profitable, while higher-cost peers scramble just to break even.

Miners Earn the Difference Between Hash Price and Hash Cost



Source: Company filings, HCW Research.

Next-gen miners push sub-15J/Th, lowering hash cost. Working with a hypothetical electricity rate of $0.05/kWh, daily power cost equals 0.0012 × efficiency (J/Th)—each extra joule adds 0.12¢ per Th-day. Sub-15 J/Th hardware stays below 2¢ per Th-day: Bitmain's S23 Hydro leads at 1.14 ¢, the prototype A3 trails at 1.16¢, and the taped-out A4 targets 0.66¢. Mid-pack units such as Auradine's AH3880 (1.74¢) and Bitmain's S21+ Hydro (1.80¢) remain workable, but rigs above 18J/Th creep above 2¢ and face margin compression whenever network hash price hovers near 4¢.

Efficiency Boundaries

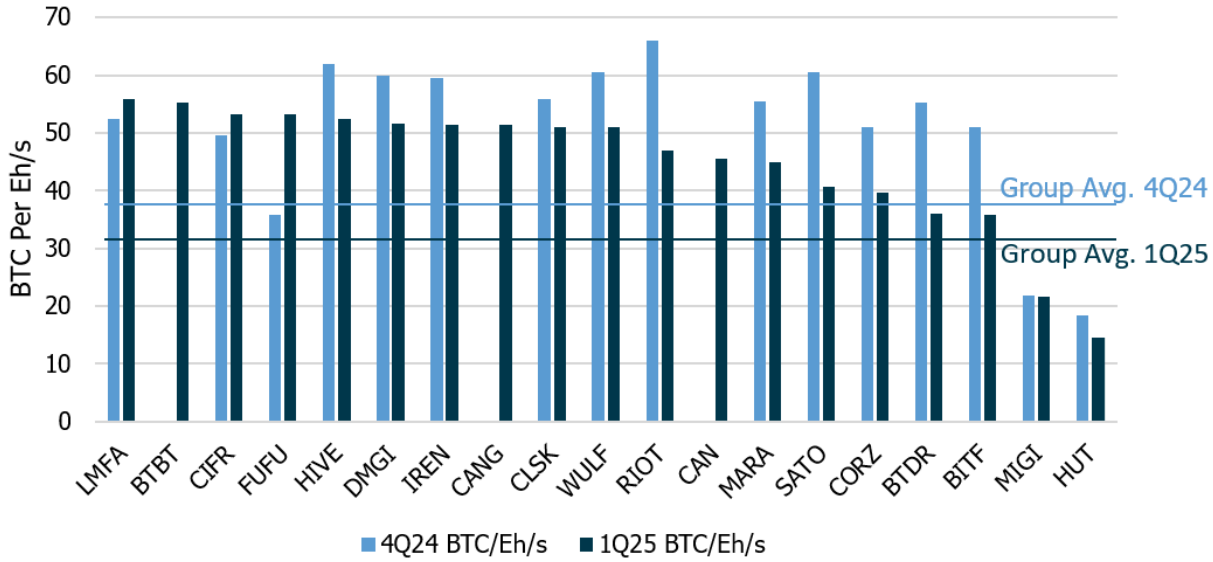
Miner	Efficiency (J/Th)	Hashcost ($/Th-day)
Antminer S23 Hydro (Bitmain)	9.5	0.0114
Antminer S23 Air (Bitmain)	11	0.0132
SEALMINER A3 (Bitdeer, prototype)	9.7	0.0116
Antminer S21 XP Hydro (Bitmain)	12	0.0144
Antminer S21 XP Immersion (Bitmain)	13.5	0.0162
Teraflux AH3880 Hydro (Auradine)	14.5	0.0174
Antminer S21+ Hydro (Bitmain)	15	0.018
SEALMINER A2 Air (Bitdeer)	16.5	0.0198
Avalon A15 Air (Canaan)	17.5	0.021
WhatsMiner M60S (MicroBT)	18.5	0.0222
Avalon A1466I Immersion (Canaan)	19.5	0.0234
SEALMINER A4 (Bitdeer, taped-out ?)	5.5	0.0066

Source: HCW Research, July 12, 2025.

Compression continues for BTC mined per exahash. The average realized output for public miners in our peer group in the chart below declined to roughly 43 BTC per Eh/s in 1Q25 from 56 BTC per Eh/s in 4Q24. This directionally aligns with the theoretical output where the ceiling for a rig running 24/7 with zero pool fees would have earned 52 BTC per Eh/s per day in 1Q25, down 60 BTC per Eh/s in 4Q24. We saw compression continue in 2Q25 as well with the theoretical ceiling coming in around 47 BTC per Eh/s. Miners captured about 93% of the theoretical maximum in

4Q24 and slipped to roughly 83% in 1Q25. In short, every new exahash is yielding fewer coins as the network hashrate climbs, so sustaining margins now hinges less on raw production growth and more on lowering power costs, deploying next-gen rigs, and exploiting fee spikes.

Production Squeeze Deepens



Source: Company filings, HCW Research.

Uptime is becoming a less-meaningful yardstick for miners. As hash price remains low while electricity markets grow more volatile, miners increasingly encounter stretches when the revenue a rig earns per kilowatt-hour drops below spot power costs; during these windows—often triggered by peak-demand price spikes, weather-driven grid stress, rising network difficulty, or post-halving reward cuts—shutting machines off preserves margins, unlocks demand-response payments, and can even generate more cash by reselling contracted power back to the grid. Frequent cycling, however, punishes air-cooled rigs: every restart swings chips from ambient to full-load temperatures, accelerating fatigue and failure. Operators that house their mining rigs in single- or two-phase immersion baths avoid this thermal shock—fluid keeps chips at a stable temperature, eliminates fan vibration and dust, and can extend ASIC service life by several years—making dynamic "on-when-profitable" dispatch both economically and mechanically sustainable.

The 50Eh/s, individual-corporate network benchmark. June production updates confirm an unprecedented concentration of hashing power in the public sphere. Four miners now sit at—or just above—the 50Eh/s mark, while MARA retains first place at 57.4Eh/s. Newcomer Cango vaulted to 50Eh/s from sub-40Eh/s footprints only months ago, compressing the gap between first and fifth faster than the network difficulty can adjust. Yet equity values remain anything but uniform. The table below details the eight largest public miners by energized hashrate and their corresponding market caps as of July 2025.

New Contenders Enter the Ranks

Rank	Company (Ticker)	Energized Hashrate (Eh/s)	Market Cap ($B) July 11, 2025
1	MARA Holdings (MARA)	57.4	6.7
2	CleanSpark (CLSK)	50.0	3.6
2	Iris Energy Ltd (IREN)	50.0	3.9
2	Cango Inc. (CANG)	50.0	0.6
5	BitFuFu Inc. (FUFU)	36.2	0.6
6	Riot Platforms (RIOT)	35.5	4.4
7	Bitfarms Ltd. (BITF)	19.5	0.6
8	Bitdeer Tech. Group (BTDR)	16.5	2.6

Source: Company filings, HCW Research, July 2025.

The powers that be. Diving into sixteen years of on-chain data—flagged in our industry note two years ago *here*—keeps pointing to a triad of power laws: cumulative addresses grow roughly as t^3, price tracks at t^6, and hashrate rises near t^{12}. Plot those series on log–log axes and every blow-off top and brutal winter still falls back onto the same straight lines. The pattern looks less like a typical asset chart and more like the metabolic scaling curves we see in cities or living organisms, which is why physicist and advocate of applying power laws to bitcoin's growth, Giovanni Santostasi, argues that bitcoin should be studied as a complex physical system rather than a speculative coin. CoinShares' research head, James Butterfield, also has given credence to bitcoin following the power law. At its core is a self-reinforcing loop—more users lift price, a higher price bankrolls more mining, extra hash power boosts perceived security, and that credibility brings in the next wave of users—so adoption, value, and computational muscle keep compounding one another in fixed proportions. That scale invariance has made the model remarkably resilient: even the 2024 spot-ETF flood was an event bitcoin needed to stay on track, not a force that bent the curve. A larger money pipe by itself should not alter the exponents; the power law cares about ratios, not raw dollar totals. Yet, the relationship is not carved in granite. If a global liquidity wave or drought were big and persistent enough to push price far outside the historical corridor before wallets and hashrate could respond, the straight line would kink and the model would be falsified. In short, the power law has been an elegant description of bitcoin's long arc, but it remains a contingent one: extraordinary, sustained distortions in capital or policy could still force the network onto a new scaling regime.

Power-law quantile framework. For each series, the network hashrate (H), bitcoin price (P), and hash-price (HP), we observe a similar log-log relationship:

$$\boldsymbol{lnY_t = m\, lnt + b}$$
$$\boldsymbol{Y_t = e^b t^m}$$

Where:

Symbol	Meaning
t	Days elapsed since the January 1, 2013
m	Power-law slope (elasticity)
b	Intercept in log-space
Yt	Level of the series at day *t*

Quantile bands. After fitting the median line, residuals are ranked:

$$r_t = lnY_t - (mlnt + b)$$

Shifting the intercept by each empirical percentile $Quantile_q(r)$ produces a fan of parallel curves:

$$Y_{t,q} = e^{b+Quantile_q(r)} t^m$$

These bands capture historical dispersion:

Q25-Q25: statistically "cheap" zone
Q50: long-run central tendency
Q55-Q70: moderately rich territory
Beyond Q90: extreme over-performance

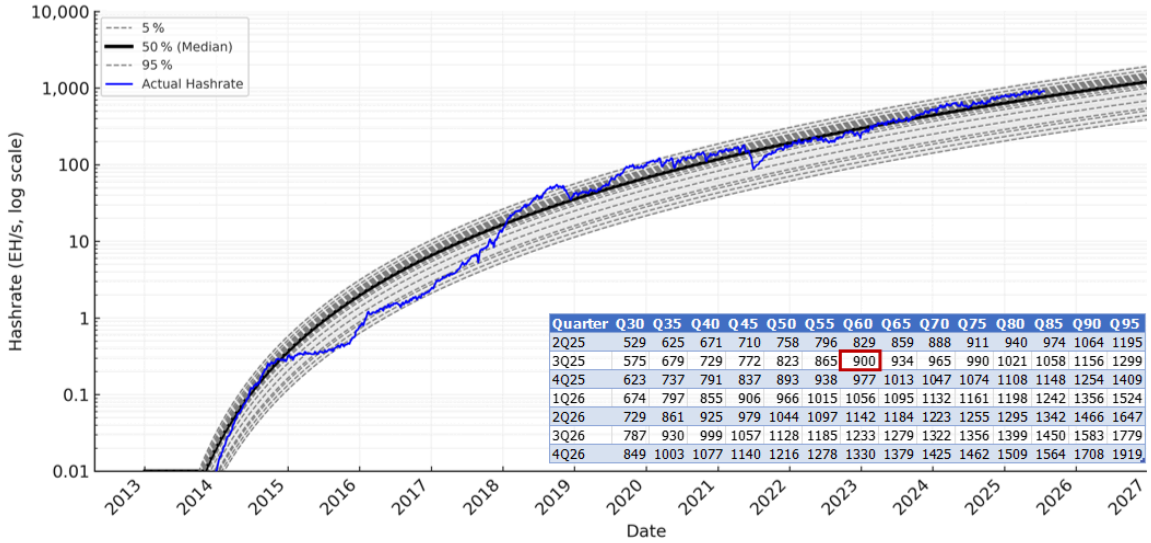
Model-by-model parameters for daily observations from January 2013 through July 2025.

Model	Slope *m*	Intercept b	R^2	Typical dispersion (1σ in log-space)
Hashrate	4.17	-0.43	0.96	±0.36
Price	2.32	-3.86	0.82	±0.38
Hash price	-3.02	3.63	0.94	±0.27

Bitcoin Network Hashrate Power-Law Quantile Model

The chart below shows the blue Eh/s line rising along the Q70–Q75 track — two to three bands above the median—across the full 2013-to-present window. Today's 900Eh/s output maps cleanly into the Q60 cell of the matrix. Staying in that percentile projects close to 1Zh/s at 4Q25 and 1.3Zh/s by 4Q26; re-joining the median Q50 would imply roughly 900Eh/s and 1.2Zh/s respectively. The network's muscle likely finishes 2025 slightly below its long-run median curve.

Hashrate Sits Above the Median



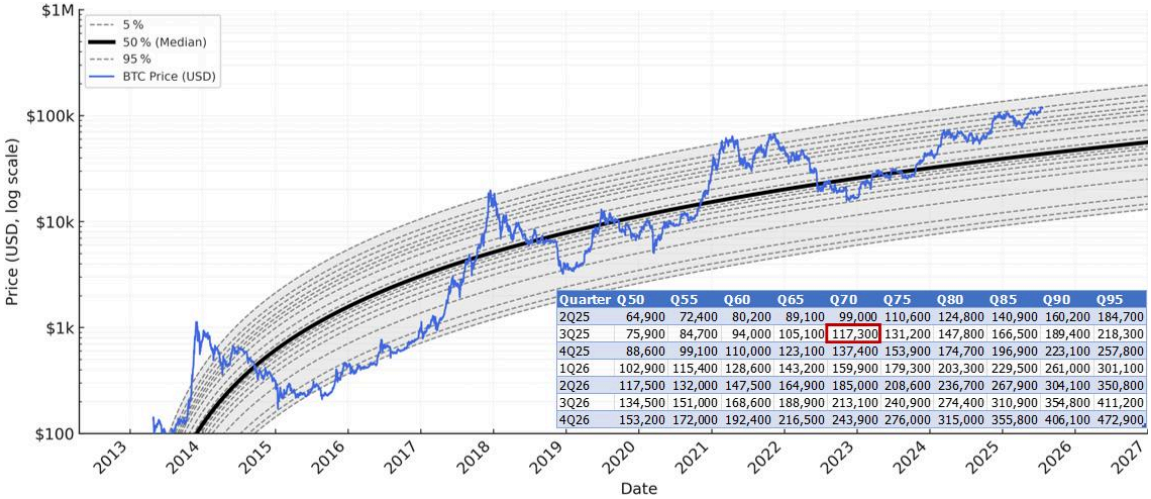
Quarter	Q30	Q35	Q40	Q45	Q50	Q55	Q60	Q65	Q70	Q75	Q80	Q85	Q90	Q95
2Q25	529	625	671	710	758	796	829	859	888	911	940	974	1064	1195
3Q25	575	679	729	772	823	865	900	934	965	990	1021	1058	1156	1299
4Q25	623	737	791	837	893	938	977	1013	1047	1074	1108	1148	1254	1409
1Q26	674	797	855	906	966	1015	1056	1095	1132	1161	1198	1242	1356	1524
2Q26	729	861	925	979	1044	1097	1142	1184	1223	1255	1295	1342	1466	1647
3Q26	787	930	999	1057	1128	1185	1233	1279	1322	1356	1399	1450	1583	1779
4Q26	849	1003	1077	1140	1216	1278	1330	1379	1425	1462	1509	1564	1708	1919

Source: HCW Research, July 2025.

Bitcoin Price Power-Law Quantile Model

At a spot price of $119,700, bitcoin now sits near the Q70 band for 3Q25. Holding that percentile points to $137,400 by 4Q25 and $243,900 by 4Q26, whereas the long-run Q50 median lies lower—$88,600 at 4Q25 and $153,200 at 4Q26. Unless fresh inflows are large enough to lift the series, the model argues for a measured grind higher rather than a sprint toward $200,000.

Bitcoin Still Has Room to Grow Before Entering "Overheated" Zone



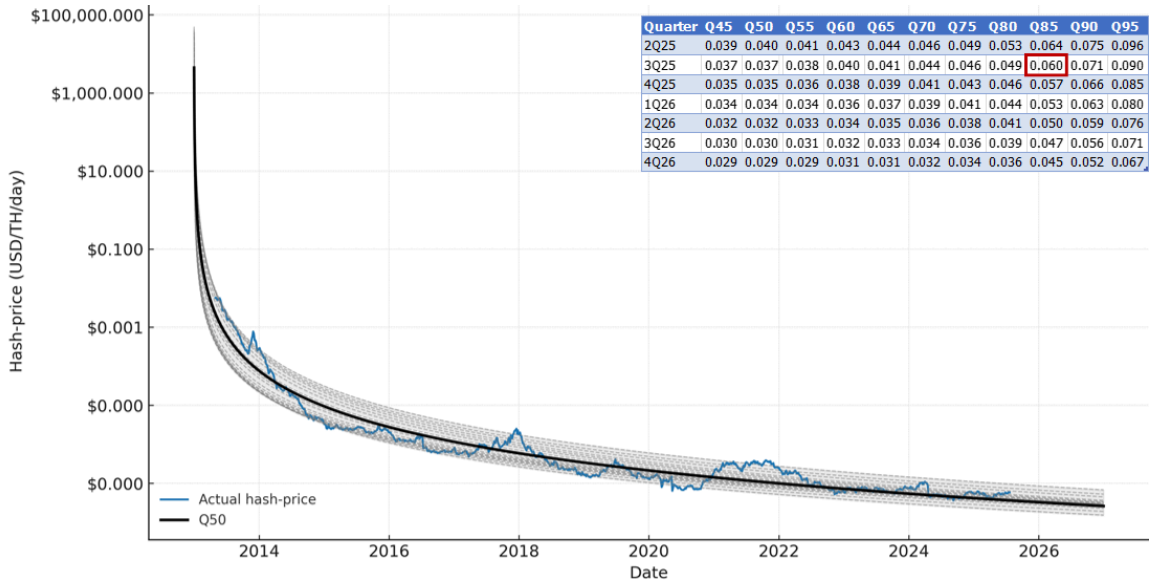
Quarter	Q50	Q55	Q60	Q65	Q70	Q75	Q80	Q85	Q90	Q95
2Q25	64,900	72,400	80,200	89,100	99,000	110,600	124,800	140,900	160,200	184,700
3Q25	75,900	84,700	94,000	105,100	117,300	131,200	147,800	166,500	189,400	218,300
4Q25	88,600	99,100	110,000	123,100	137,400	153,900	174,700	196,900	223,100	257,800
1Q26	102,900	115,400	128,600	143,200	159,900	179,300	203,300	229,500	261,000	301,100
2Q26	117,500	132,000	147,500	164,900	185,000	208,600	236,700	267,900	304,100	350,800
3Q26	134,500	151,000	168,600	188,900	213,100	240,900	274,400	310,900	354,800	411,200
4Q26	153,200	172,000	192,400	216,500	243,900	276,000	315,000	355,800	406,100	472,900

Source: HCW Research, July 2025.

Bitcoin Hash Price Power-Law Quantile Model

Miner revenue per Th/s per day rides a downward-sloping power curve. The blue trace has climbed into the Q85 band at $0.060 USD/Th/day as of July 2025. The matrix converts each band into quarter-end dollars: in the Q85 column hash-price steps from $0.057 for 3Q25 to $0.052 for 4Q25, decaying toward $0.045 by 4Q26 as time compounds along the same elastic path. Holding its current percentile would leave miners finishing 2025 at a healthy $0.05 per Th/s—well above the long-run median of $0.036 yet trending lower at the constant logarithmic pace the model dictates unless fee pressure or a fresh price surge pushes the series into even higher quantiles.

Hash Price Trends Lower

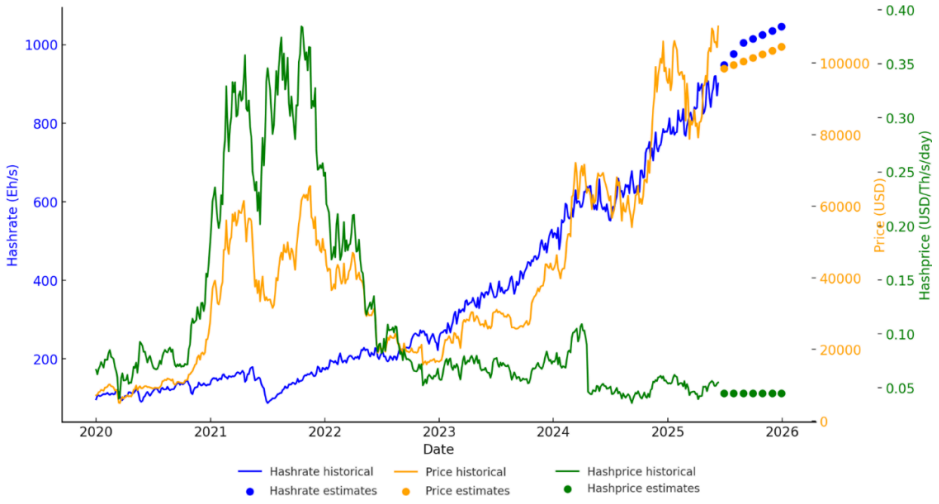


Quarter	Q45	Q50	Q55	Q60	Q65	Q70	Q75	Q80	Q85	Q90	Q95
2Q25	0.039	0.040	0.041	0.043	0.044	0.046	0.049	0.053	0.064	0.075	0.096
3Q25	0.037	0.037	0.038	0.040	0.041	0.044	0.046	0.049	0.060	0.071	0.090
4Q25	0.035	0.035	0.036	0.038	0.039	0.041	0.043	0.046	0.057	0.066	0.085
1Q26	0.034	0.034	0.034	0.036	0.037	0.039	0.041	0.044	0.053	0.063	0.080
2Q26	0.032	0.032	0.033	0.034	0.035	0.036	0.038	0.041	0.050	0.059	0.076
3Q26	0.030	0.030	0.031	0.032	0.033	0.034	0.036	0.039	0.047	0.056	0.071
4Q26	0.029	0.029	0.029	0.031	0.031	0.032	0.034	0.036	0.045	0.052	0.067

Source: HCW Research, July 2025.

Our revenue forecasts are based exclusively on hash price. Now spanning two bitcoin having cycles of formal research coverage, our experience suggests the power law fits data to the best of our knowledge, the most robust model to stand the test of time, yet we concede that we are in the early stages of hyperbitcoinization and crypto adoption. It is our practice to take a conservative stance when forecasting and focus more on the hash price. Therefore, we maintain conservative growth in bitcoin's price and network hashrate while forecasting a flat hash price of $0.045Th/s/day. Current levels are topping $0.06, but we are more comfortable offering the conservative view.

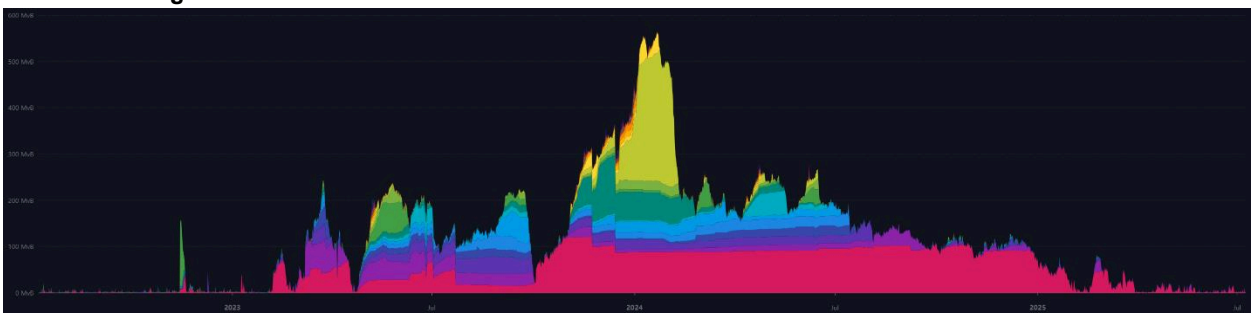
Hash Price Drives Our Conservative Universal Forecasts



Source: HCW Research, July 2025.

Fee fragility is a measured long-term concern. Bitcoin miners captured only 420BTC or $46 million in transaction fees during 2Q25, effectively flat versus the 400 BTC, $43 million earned in 1Q25. The quarter's fees translated to barely 1–1.3% of block-reward revenue, as daily fee share drifted toward a record-low 1% in June and sat near 1.25% in March. By contrast, the last fee-rich epoch saw miners pocket $247 million—about 4,300BTC at a $58,000 spot price—in April 2021 alone, when fees briefly made up 14.5% of rewards. The spread raises a structural question rather than an imminent crisis: block subsidies halve every four years, so the security budget ultimately needs a robust fee stream unless bitcoin's price continues to make up the shortfall. Lightning and other off-chain rails reduce routine on-chain demand, while one-off spikes such as 2024's Ordinals have proved ephemeral. Miner cash-flow resilience now hinges on either a durable fee renaissance or sustained price appreciation; without one of those engines, margins compress incrementally, leaving the network's long-run incentive model thin but not yet in jeopardy. As shown in the chart below, the mempool remained chronically lean throughout 2Q25—backlogs stayed under 50MB versus the 500MB peaks of the 2024 Ordinals craze—and fee rates hovered at the 1 sat/vB floor, exposing fee fragility; yet even this sparse congestion can see momentary spikes when urgent, high-value transfers outbid the baseline.

Bitcoin Backlog Shrinks



Source: Mempool.space, July 2025.

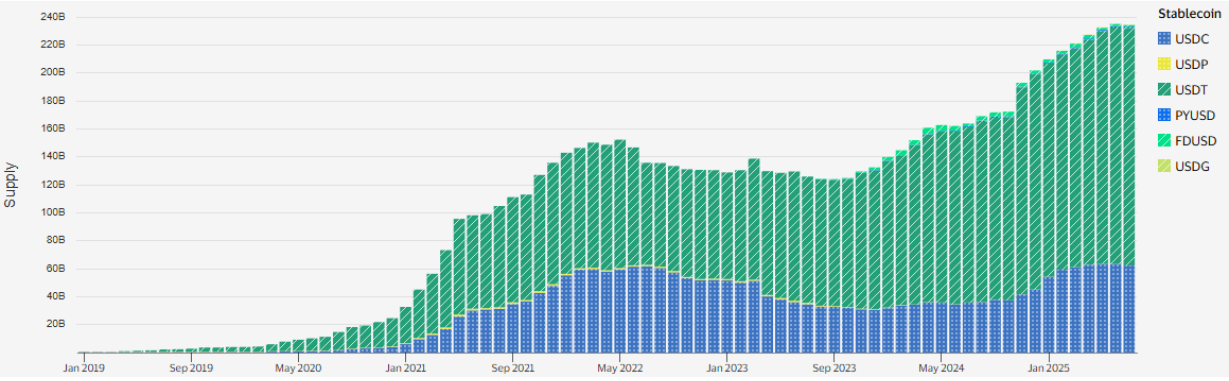
Bitcoin dominates as Ethereum gains ground. Bitcoin's crypto market share rose to roughly 65% in 2Q25 from 63% in 1Q25, keeping the oft promised alt season on pause, per the chart below. Its price was driven down 11.7% in the first quarter and then carried up 30.7% in the second, leaving most smaller tokens stranded. Ether, by contrast, was propelled about 36% higher during the same three months and now settles more than $140 billion in dollar pegged stablecoins—over half the industry float—while protocol staking is paying near 3%. Those cash flows were cited when Bit Digital converted its entire bitcoin treasury into roughly 100,603 ETH. Altcoin believers contend that Ethereum may lead any coming rotation, yet bitcoin retains most of the spotlight as it blasted past its all-time high and Ethereum works its way back above $3,700. As bullish as we are and have been on bitcoin, Ethereum's use case supporting a broad array of crypto-centric services, furthered by its native staking yield, place the token in a similarly favorable light.

Altcoin Season on Pause as Bitcoin Absorbs Capital

Source: Tradingview, July 2025.

Trojan dollars become bitcoin's quiet catalyst. Stablecoins stand as the crypto market's on-ramp—their future appears to include displacing legacy global money transfer systems. Stablecoin aggregate capitalization recently reached roughly $252 billion, up 22 percent in 2025 alone, as Tether and USDC together command more than 80% of the float. In 2024, users moved an astonishing $27.6 trillion through these dollar-pegged tokens—7% more than the combined purchase volumes of Visa and Mastercard—affirming their utility as a global payments rail. Activity is broad-based: more than 251 million unique addresses now interact with stablecoins, and circulating supply has expanded about 28 percent year-over-year. Large financial players have noticed; firms from PayPal to Standard Chartered are launching their own coins or settlement services, widening acceptance inside banking and fintech channels. As Exodus CEO JP Richardson presented to the Bitcoin 2025 audience, these tokens act as a "Trojan horse." People look to crypto to hold digital dollars, then graduate to bitcoin once they trust the rails and seek harder money. Every new digital dollar that lands on-chain seeds future demand for bitcoin, making stablecoins and bitcoin increasingly symbiotic.

Stablecoin Growth Should Lead to Greater Bitcoin Demand



Source: Visa On-Chain Analytics, July 2025.

Bitcoin's compounding network effect is accelerating, not plateauing. In 2Q25 the number of addresses holding any bitcoin rose to 55.26 million from 54.80 million at the end of 1Q25, plus 0.8% QoQ, and from 54.22 million in 2Q24, plus 1.9% YoY, extending thirteen years of uninterrupted growth. While Lightning Network capacity held steady at roughly 5,358 BTC, bitcoin's price appreciation drove USD-channel liquidity to about $575 million—up 30% from $442 million at 1Q-end. Independent processor data show Lightning's share of all bitcoin payments more than doubled in the past 12 months, topping 18% by late-2Q24 and trending beyond 20% in 2Q25. Parallel surges in Lightning-enabled wallet downloads and monthly active users are onboarding millions of new participants. In one quarter, bitcoin added hundreds of thousands of new holders and routed roughly one-third more value through its layer-2 rails. Bitcoin's user-driven base is accelerating; demand stokes price.

Bitcoin yield menu expands. While bitcoiners may insist there is no second best, many still crave income, and a growing suite of structures now coaxes coupons from otherwise inert coins. MARA led a $20 million investment and parked 2,000BTC valued at an approximate $240 million in Two Prime, an institutional investment advisor managing $1.7 billion, to build bitcoin-based yield strategies. BitBonds lace short-dated Treasuries with a 10% BTC sleeve, handing bond buyers controlled upside on sovereign paper without self-custody headaches. At the institutional level, over-collateralized, tri-party BTC loans clear roughly 400–600 basis points above equivalent Treasuries—spread that compensates lenders for counterparty, rehypothecation, and liquidity risk rather than anything native to bitcoin itself. Luxor provides another avenue by letting investors supply liquidity to its regulated hashrate-derivatives marketplace and "generate steady returns on your BTC," effectively transforming block-reward volatility into a predictable coupon. Finally, dual-currency deposits from desks such as Matrixport promise double-digit annualized yields so long as bitcoin stays above a preset strike—because savers are being paid to write puts on price direction. Every extra basis point in these offerings maps to someone else's risk stack; no yield emerges from bitcoin itself. Investment returns on bitcoin treasury holdings could inspire greater adoption and with it, higher prices.

Washington pivots from enforcement to a rulebook, yet keeps guardrails raised. Since January 2025, the United States has traded piecemeal enforcement for a coordinated rule-making drive that invites mainstream capital into bitcoin while still policing the on-ramps. President Trump's January 23 executive order revoked the 2022 directive and told a

new inter-agency working group to craft “technology-neutral” rules, protect self-custody, and bar any U.S. central-bank digital currency. The Senate followed on June 17 by passing the bipartisan GENIUS Act to license stablecoin issuers, while the House is gearing up for “Crypto Week” votes on that bill, the CLARITY Act, splitting oversight between the SEC and CFTC, and a separate anti-CBDC measure. July 17 turned out to be a landmark day in the progress of crypto regulation, with the House passing both GENIUS and CLARITY—GENIUS was signed into law by the President July 19 while CLARITY goes to the Senate. The SEC has also shifted its stance. On July 7, it issued ETF-disclosure guidance and formed a crypto task force, signaling an end to its litigation-first strategy.

Strategic bitcoin reserves in the United States. At the federal level, the U.S. made a landmark move by creating a Strategic Bitcoin Reserve in March 2025. President Trump’s executive order established this reserve using Bitcoin seized by federal agencies, which should be retained as a long-term reserve asset instead of being sold off. The order centralized all forfeited bitcoin into one national reserve, ensuring the government holds these digital assets much like a strategic stockpile. This federal strategy positions bitcoin as “digital gold” for the country, aiming to bolster financial resilience and keep the U.S. at the forefront of crypto adoption.

Embracing versus rejecting bitcoin reserves at the state level. State governments have responded in mixed ways over recent months. Some have moved to embrace bitcoin reserves as part of their financial strategy, while others have decisively ruled out holding crypto in public funds. As of mid-2025, over two dozen states had considered bitcoin treasury bills, but only a few have approved them, and at least 8 states officially said “no” via failed bills or vetoes. The legislative flurry is ongoing: for instance, North Carolina and Alabama have reserve bills advancing through committees, indicating the debate is far from over. To date, however, the outcome is mixed, but the discussion continues to raise awareness and thought, both bullish for pricing trends. Notable state decisions include:

New Hampshire, Adopted a Reserve: New Hampshire became the first state to enact a bitcoin reserve fund, passing a law (HB 302) that allows the state treasurer to purchase bitcoin and top-tier digital assets. This law caps crypto holdings at 5% of the state’s total funds, treating bitcoin as a small but strategic complement to traditional reserves.

Texas, Adopted a Reserve: Texas emerged as another early adopter. In 2025, Governor Greg Abbott signed the Texas Strategic Bitcoin Reserve Act (SB 21), making Texas the third state with a bitcoin treasury. This established a state-managed fund to hold bitcoin long-term outside the usual state treasury accounts. The Texas reserve is meant to hedge inflation and position the state as a leader in the digital economy.

Florida, Rejected Reserve Plans: Florida, by contrast, withdrew its bitcoin reserve legislation in May 2025, effectively deciding not to pursue a crypto reserve. Bills that would have allocated up to 10% of certain public funds into bitcoin were indefinitely postponed and died at session’s end. Florida’s retreat aligns it with several other states (Wyoming, South Dakota, North Dakota, Pennsylvania, Montana, and Oklahoma) that saw similar bitcoin reserve bills fail or get shelved this year.

Arizona, Vetoed Reserve Bills: Arizona’s legislature twice passed Bitcoin reserve proposals, but Governor Katie Hobbs vetoed each attempt, citing concerns. She argued that public funds and retirements are “not the place for the state to try untested investments like virtual currency.” Even a scaled-down bill to create a reserve using seized crypto assets (avoiding taxpayer money) was rejected in July 2025—Hobbs warned it could hamper law enforcement cooperation on forfeitures. Arizona did enact a narrower law allowing a small digital asset reserve from unclaimed property and staking rewards, but the governor’s repeated vetoes show a cautious stance.

Connecticut, Banned Crypto Investments: In a further sign of skepticism, Connecticut’s government banned state agencies from investing in cryptocurrencies altogether. This law, passed unanimously and signed by Gov. Ned Lamont, exemplifies states proactively prohibiting any strategic crypto reserve in public coffers due to risk concerns.

Global regulators clarify the rules, yet IMF loans still chill nation-state adoption. Elsewhere, 2025 is the year tentative guidelines became hard law. The EU’s Markets in Crypto-Assets (MiCA) regulation has been fully operative for six months, and national supervisors have already granted more than 40 licenses that give exchanges and custodians a single regulatory passport across the bloc. The United Arab Emirates is on a similar timeline. When a

grace period ends in August 2025, merchants may accept only dirham-backed stablecoins or other licensed tokens, with compliance channels split among agencies. Brazil chose clarity of a different kind, replacing its tiered levy with a flat 17.5% crypto-capital-gains tax on June 12 and closing long-standing loopholes. Yet the International Monetary Fund still slows sovereign adoption. El Salvador's new $3.5 billion loan bars further accumulation of bitcoin and made acceptance voluntary; similar conditions stalled projects in the Central African Republic and other loan-dependent states. In short, clear national rulebooks are accelerating corporate and retail uptake of bitcoin, but the IMF's lending leverage keeps many emerging economies on the sidelines.

Public Companies Mentioned in This Report

Argo Blockchain PLC (ARBK; Neutral)
Bitdeer Technologies Group (BTDR; Buy; Colonnese)
Bit Digital, Inc. (BTBT; Buy)
BitFarms Ltd. (BITF; Buy; Colonnese)
BitFuFu, Inc. (FUFU; Buy)
BlackRock, Inc. (BLK; not rated)
Cathedra Bitcoin Inc. (CBIT; Neutral)
Cango Inc. (CANG; Buy)
Cipher Mining Inc. (CIFR; Buy; Colonnese)
CleanSpark Inc. (CLSK; Buy; Colonnese)
CoinShares Intl. Limited (CS.ST; Buy)
Core Scientific Inc. (CORZ; Neutral)
Digi Power X Inc. (DGXX; Buy)
DMG Blockchain Solutions Inc. (DMG; Buy)
Exodus Movement, Inc. (EXOD; Buy)
FactSet Research Systems Inc. (FDS; not rated)
Gryphon Digital Mining, Inc. (GRYP; Neutral)
HIVE Digital Technologies Ltd. (HIVE; Buy; Colonnese)
Hut 8 Corp. (HUT; Buy)
Invesco Ltd. (IVZ; not rated)
IREN Limited (IREN; Buy; Colonnese)
LM Funding America Inc. (LMFA; Neutral)
MARA Holdings, Inc. (MARA; Buy)
Mastercard Inc. (MA; not rated)
Mawson Infrastructure Group Inc. (MIGI; Neutral)
PayPal Holdings, Inc. (PYPL; not rated)
Phoenix Group Plc (PHX; Buy)
Riot Platforms Inc. (RIOT; Buy; Colonnese)
SATO Technologies Corp. (SATO.TS; Neutral)
Soluna Holdings, Inc. (SLNH; Neutral)
Sphere 3D Corp. (ANY; Buy)
Standard Chartered PLC (STAN.GN; not rated)
TeraWulf Inc. (WULF; not rated)
Visa Inc. (V; not rated)

Important Disclaimers

This material is confidential and intended for use by Institutional Accounts as defined in FINRA Rule 4512(c). It may also be privileged or otherwise protected by work product immunity or other legal rules. If you have received it by mistake, please let us know by e-mail reply to unsubscribe@hcwresearch.com and delete it from your system; you may not copy this message or disclose its contents to anyone. The integrity and security of this message cannot be guaranteed on the Internet.

H.C. WAINWRIGHT & CO, LLC RATING SYSTEM: H.C. Wainwright employs a three tier rating system for evaluating both the potential return and risk associated with owning common equity shares of rated firms. The expected return of any given equity is measured on a RELATIVE basis of other companies in the same sector. The price objective is calculated to estimate the potential movements in price that a given equity could reach provided certain targets are met over a defined time horizon. Price objectives are subject to external factors including industry events and market volatility.

RETURN ASSESSMENT

Market Outperform (Buy): The common stock of the company is expected to outperform a passive index comprised of all the common stock of companies within the same sector.

Market Perform (Neutral): The common stock of the company is expected to mimic the performance of a passive index comprised of all the common stock of companies within the same sector.

Market Underperform (Sell): The common stock of the company is expected to underperform a passive index comprised of all the common stock of companies within the same sector.

Related Companies Mentioned in this Report as of July/21/2025

Company	Ticker	H.C. Wainwright Rating	12 Month Price Target	Price	Market Cap
Sphere 3D Corp.	ANY	Buy	$3.00	$0.69	$18
Argo Blockchain plc	ARBK	Neutral	$NA	$0.39	$28
Bitfarms Ltd.	BITF	Buy	$4.00	$1.32	$734
Bit Digital, Inc.	BTBT	Buy	$7.00	$3.27	$1045
Bitdeer Technologies Group	BTDR	Buy	$17.50	$14.65	$2232
Cango Inc.	CANG	Buy	$8.00	$5.18	
Cathedra Bitcoin Inc.	CBIT.V	Neutral	C$NA	C$0.07	C$16
Cipher Mining Inc.	CIFR	Buy	$6.75	$6.94	$2327
CleanSpark, Inc.	CLSK	Buy	$25.00	$12.84	$3607
Core Scientific, Inc.	CORZ	Neutral	$NA	$13.48	$4094
CoinShares International Limited	CS.ST	Buy	SEK110.00	SEK118.40	7890 SEK
Digi Power X Inc.	DGXX	Buy	$2.50	$3.58	$130
DMG Blockchain Solutions Inc.	DMGI.V	Buy	C$1.00	C$0.36	C$72
Exodus Movement, Inc.	EXOD	Buy	$65.00	$34.73	$327
BitFuFu Inc.	FUFU	Buy	$7.00	$4.19	$118
Gryphon Digital Mining, Inc.	GRYP	Neutral	$NA	$1.27	$92
HIVE Blockchain Technologies Ltd.	HIVE	Buy	$6.00	$2.50	$536
Hut 8 Mining Corp.	HUT	Buy	$25.00	$21.40	$2466
Iris Energy Limited	IREN	Buy	$21.00	$18.59	$4496
LM Funding America, Inc.	LMFA	Neutral	$NA	$4.93	$25
MARA Holdings, Inc.	MARA	Buy	$28.00	$19.88	$6996
Mawson Infrastructure Group Inc.	MIGI	Neutral	$NA	$0.54	$11
Phoenix Group PLC	PHX-AE	Buy	AED3.00	AED1.59	9618 AED
Riot Platforms, Inc.	RIOT	Buy	$15.00	$14.27	$5098
SATO Technologies Corp.	SATO.V	Neutral	C$NA	C$0.16	C$8
Soluna Holdings, Inc.	SLNH	Neutral	$NA	$0.64	

Investment Banking Services include, but are not limited to, acting as a manager/co-manager in the underwriting or placement of securities, acting as financial advisor, and/or providing corporate finance or capital markets-related services to a company or one of its affiliates or subsidiaries within the past 12 months.

Distribution of Ratings Table as of July 21, 2025				
			IB Service/Past 12 Months	
Ratings	Count	Percent	Count	Percent
Buy	536	80.48%	109	20.34%
Neutral	72	10.81%	12	16.67%
Sell	2	0.30%	0	0.00%
Under Review	56	8.41%	14	25.00%

H.C. Wainwright & Co, LLC (the “Firm”) is a member of FINRA and SIPC and a registered U.S. Broker-Dealer.

I, Kevin Dede, CFA and Michael Donovan , certify that 1) all of the views expressed in this report accurately reflect my personal views about any and all subject securities or issuers discussed; and 2) no part of my compensation was, is, or will be directly or indirectly related to the specific recommendation or views expressed in this research report; and 3) neither myself nor any members of my household is an officer, director or advisory board member of these companies.

The research analyst principally responsible for preparation of the report does not receive compensation that is based upon any specific investment banking services or transaction but is compensated based on factors including total revenue and profitability of the Firm, a substantial portion of which is derived from investment banking services.

Important disclosures and charts can be found on our disclaimer website: https://hcwco.bluematrix.com/sellside/Disclosures.action

The securities of the company discussed in this report may be unsuitable for investors depending on their specific investment objectives and financial position. Past performance is no guarantee of future results. This report is offered for informational purposes only, and does not constitute an offer or solicitation to buy or sell any securities discussed herein in any jurisdiction where such would be prohibited. This research report is not intended to provide tax advice or to be used to provide tax advice to any person. Electronic versions of H.C. Wainwright & Co., LLC research reports are made available to all clients simultaneously. No part of this report may be reproduced in any form without the expressed permission of H.C. Wainwright & Co., LLC. Additional information available upon request.

H.C. Wainwright & Co., LLC does not provide individually tailored investment advice in research reports. This research report is not intended to provide personal investment advice and it does not take into account the specific investment objectives, financial situation and the particular needs of any specific person. Investors should seek financial advice regarding the appropriateness of investing in financial instruments and implementing investment strategies discussed or recommended in this research report.

H.C. Wainwright & Co., LLC’s and its affiliates’ salespeople, traders, and other professionals may provide oral or written market commentary or trading strategies that reflect opinions that are contrary to the opinions expressed in this research report.

H.C. Wainwright & Co., LLC and its affiliates, officers, directors, and employees, excluding its analysts, will from time to time have long or short positions in, act as principal in, and buy or sell, the securities or derivatives (including options and warrants) thereof of covered companies referred to in this research report.

The information contained herein is based on sources which we believe to be reliable but is not guaranteed by us as being accurate and does not purport to be a complete statement or summary of the available data on the company, industry or security discussed in the report. All opinions and estimates included in this report constitute the analyst’s judgment as of the date of this report and are subject to change without notice.

Securities and other financial instruments discussed in this research report: may lose value; are not insured by the Federal Deposit Insurance Corporation; and are subject to investment risks, including possible loss of the principal amount invested.