HASHRATE INDEX

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Hashrate Index Q3-2023 Report: Wakeup Call

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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.

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Executive Summary

If Q2-2023 gave miners bull market expectations, Q3 did a great job of slapping them with a dash of reality.

In Q2, a surge in transaction fees from the inscription NFT phenomenon on Bitcoin sent hashprice higher than many miners could have hoped for in the current market environment. In Q3 – particularly, the last month of it – reminded them just how cutthroat mining can be as hashrate surged, difficulty hit a new all-time high, and hashprice faltered to the all-time low levels we saw in November and December of last year.

And that's without the impending block subsidy halving that is coming in April of next year. Bitcoin's Fourth Halving is expected to hit roughly around April 23, 2023, although it will probably be a few days sooner than that given 2023's extraordinary rate of hashrate growth. The event will cut Bitcoin's block subsidy from 6.25 BTC to 3.125 BTC at block height 840,000, and it will immediately cut hashprice in half.

The event is like a specter looming over the heads of miners around the world, and even though it's still 6 months away, it's starting to affect every aspect of the mining market, from ASIC trading to hedging strategies. As we head into the final stretch of 2023, Bitcoin miners are looking for any way they can to cut costs and maximize revenues leading up to the quadrennial event.

As we cover in this report, the halving could wreak havoc on a number of mining business in the US, everything from small-to-mid-sized hosting companies, to public miners, and everything in between. Of course, Bitcoin could rally and ballast mining margins in a 3.125 block subsidy world, but we wouldn't bet the farm on bullish hopes and dreams. Barring a bull run, some miners in the public markets may be able to stay afloat longer than others by surviving on their cash/BTC treasuries, selling equity, or raising debt, but these strategies aren't available to the vast majority of miners.

As such (and speaking to the North American context), we believe that miners will continue to look for opportunities for cheap power outside of North America, and we wouldn't be shocked if North America's share of global hashrate already saw its peak in 2022 and 2023. We don't believe that mining in the US and Canada is going away anytime soon, but we do believe that hashrate will continue to spread throughout the globe as miners seek out cheap and stranded energy to survive amid the bare-bones margins that the next Halving will create. Additionally, power efficiency and fleet optimization strategies will become crucial for navigating the coming month both before and after the Halving.

If Q2 brought miners reprieve, then Q3 acted as a liminal space between reprieve and stress. As we enter Q4, the stress is growing as miners prepare for a make or break year in 2024.

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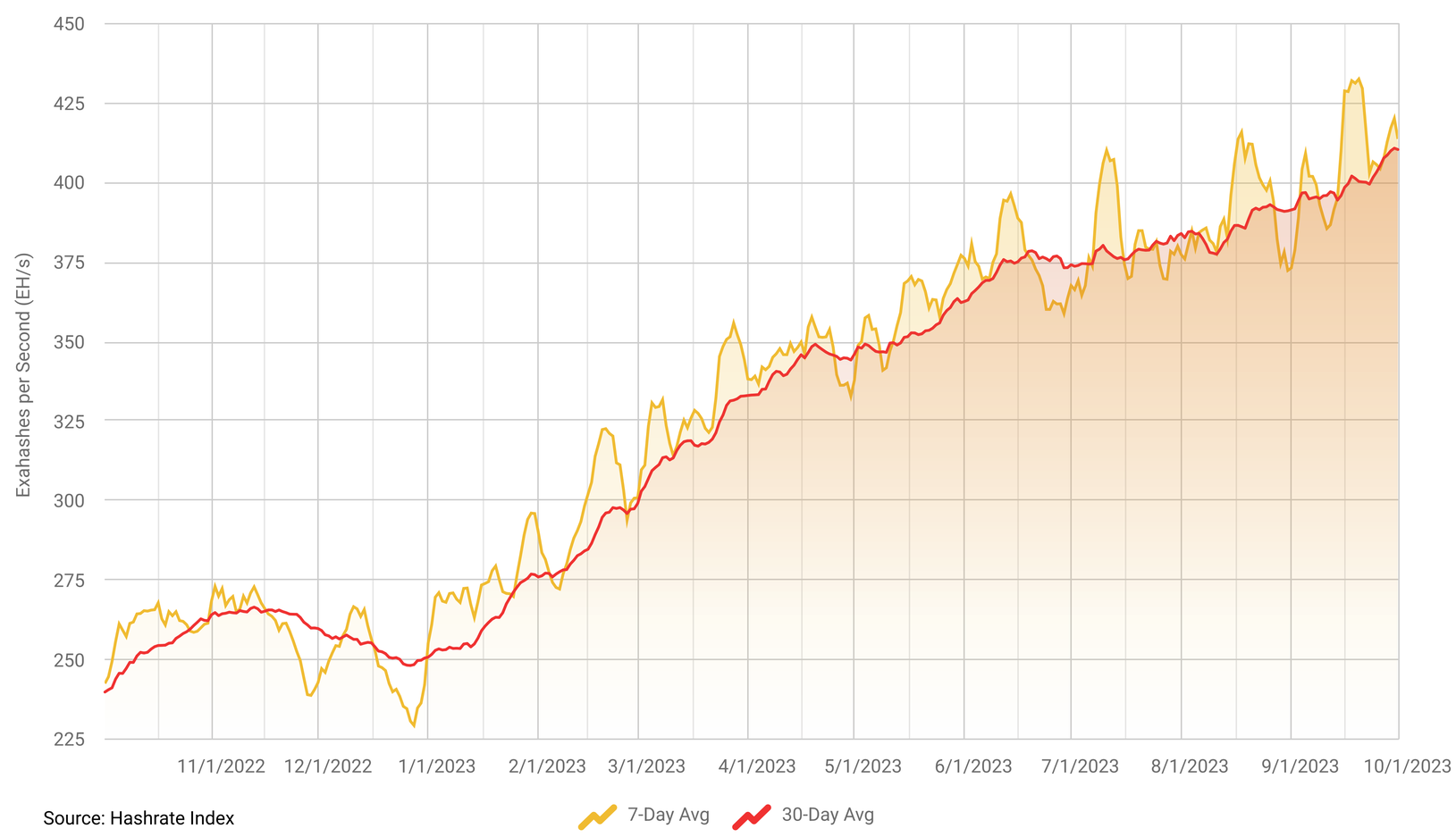
Hashprice, Hashrate, Difficulty: The Good, The Bad, The Ugly

Hashrate is Taking Off Again

Bitcoin's hashrate expanded in Q3-2023. On a percentage basis, the growth was twice as much as Q2's expansion, but it was only about half of Q1's expansion.

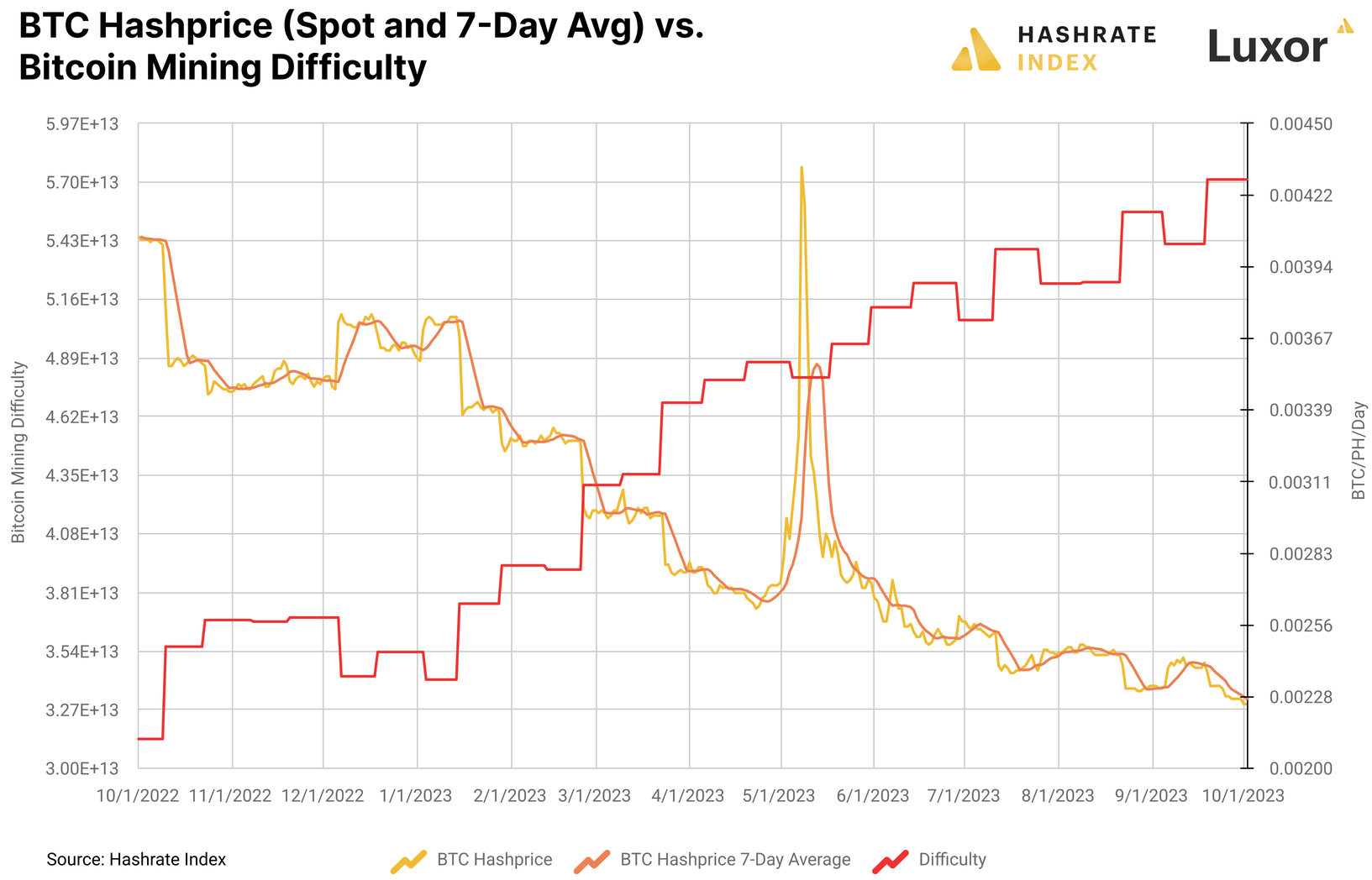
Bitcoin's 7-day average hashrate grew 16% over the course of Q3-2023; for comparison, it grew 7.5% over Q2-2023 and 35% over Q1-2023. From the start of 2023 to the end of Q3-2023, Bitcoin's hashrate grew an eye-popping 65%. Most of this growth came in September. As the summer months fade into autumn and cooler weather rolls in, miners are having fewer operational difficulties, and they aren't forced to curtail in places like Texas during power price spikes. Additionally, shipments of next-generation ASICs continue to come online around the world, contributing to the sharp uptick in hashrate that we've seen this year.



We expect Q4 to bring even greater hashrate growth as the weather, particularly in North America, grows colder. Shipments of next-generation ASICs will contribute to the growth as well. To be sure, some of the recent hashrate growth came from miners who are expanding their fleets with next-generation equipment, but 2023 has also been a testament to a new form of hashrate seasonality where summer heat in the US and Canada can stifle hashrate growth (more on this in the chapter on energy markets).

Bitcoin Mining Difficulty Hits All-Time Highs

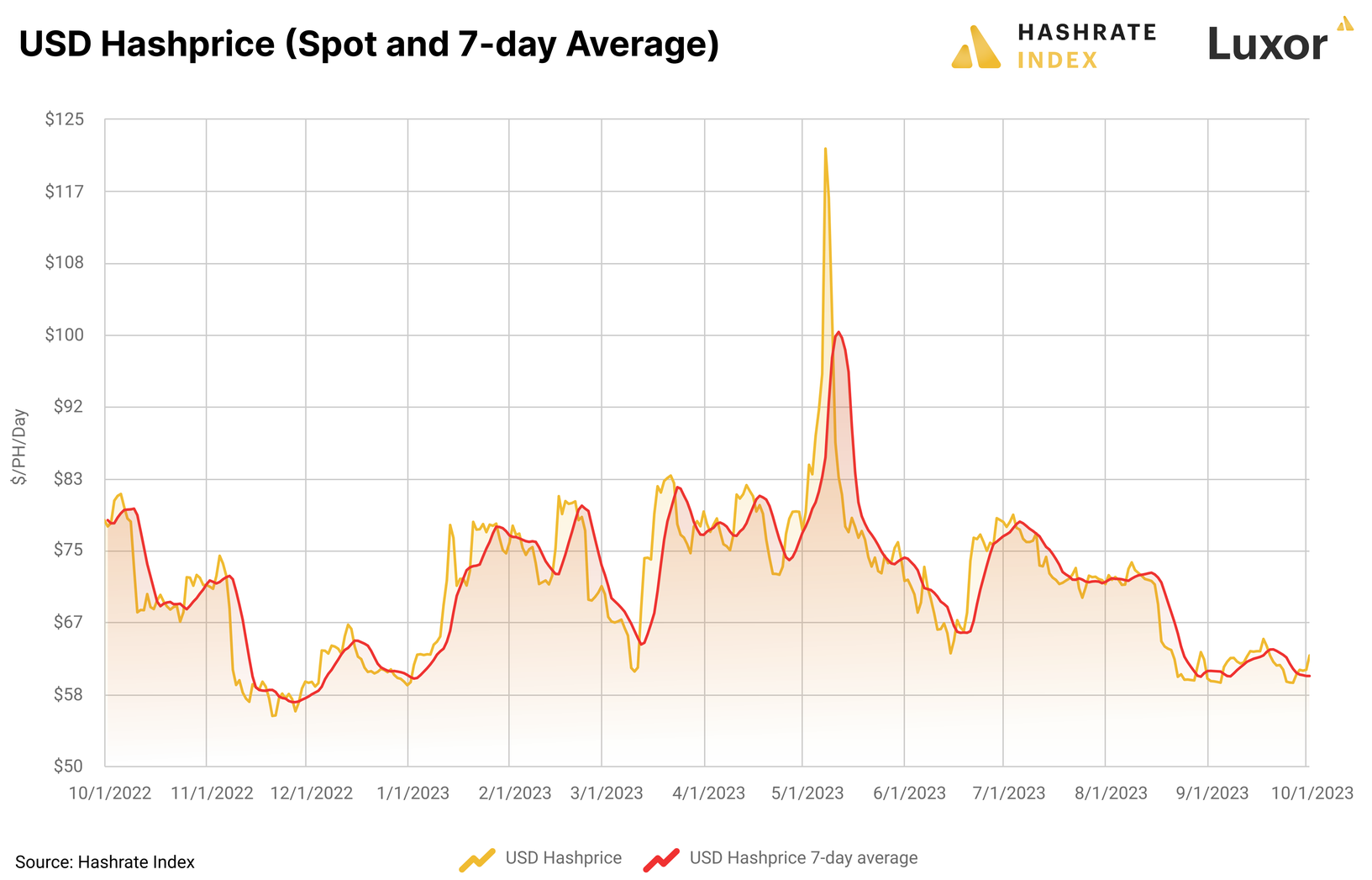
Q3's hashrate growth bumped Bitcoin's difficulty up 13% over the quarter from 50.65 T to 57.12 T, versus the 8.1% growth over Q2-2023. Year-to-date by the end of Q3-2023, Bitcoin's difficulty had surged 61.5% from 35.36 T, and despite Q3's somewhat sluggish hashrate growth, difficulty managed to hit all-time high after all-time high in Q3. The rise in difficulty has not been kind to BTC denominated hashprice, which decreased 37% from January 1 to September 30, 2023 and 8.2% over the course of Q3-2023.



USD-Hashprice Sees All-Time Low Volatility

Thankfully for USD-denominated hashprice, Bitcoin's 2023 price rally continued in Q3, with BTC reaching a yearly high just above $30,000. Bitcoin's average price in Q3-2023 was $28,100 (vs. $26,350 for the first three quarters of 2023), and this was enough to give USD hashprice some support to keep it from falling as much as it could have given the increase in Bitcoin's mining difficulty.

Still, even though hashprice was above $70/PH/day for the first half of Q3, it broke below $70/PH/day in August and has been trending toward all-time low territory ever since (in fact, at the time of writing, it's just below $60/PH/day, creeping ever closer to its all-time low of $55/PH/day). **The USD hashprice average for September was $61.71/PH/day, placing it in the unfortunate company of December and November 2022's averages of $61.94/PH/day and $61.90/PH/day, respectively – a time when Bitcoin's price was bouncing between $16,000 and $17,000.**



That said, in the grand scheme of things, 2023 (so far at least) has been a more favorable year for hashprice than otherwise. When we compare monthly and annualized returns since 2017, the current year has featured less volatility than any other year in the comparison; Bitcoin's 63% recovery over the first three quarters of 2023 has been enough to offset Bitcoin's 7-day average hashrate growth of 59% over the same time frame (in addition to Bitcoin's price recovery, hashprice has received a little nudge from transaction fees along the way, as well).

Over the time frame examined below, 2018 was the worst year yet for hashprice, followed by last year's bear market. The best year came during 2017's unprecedented bull market, followed by 2020 – which may strike some readers as surprising given the fact that this is the same year when Bitcoin's third halving cut the block subsidy from 12.5 to 6.25 BTC per block.

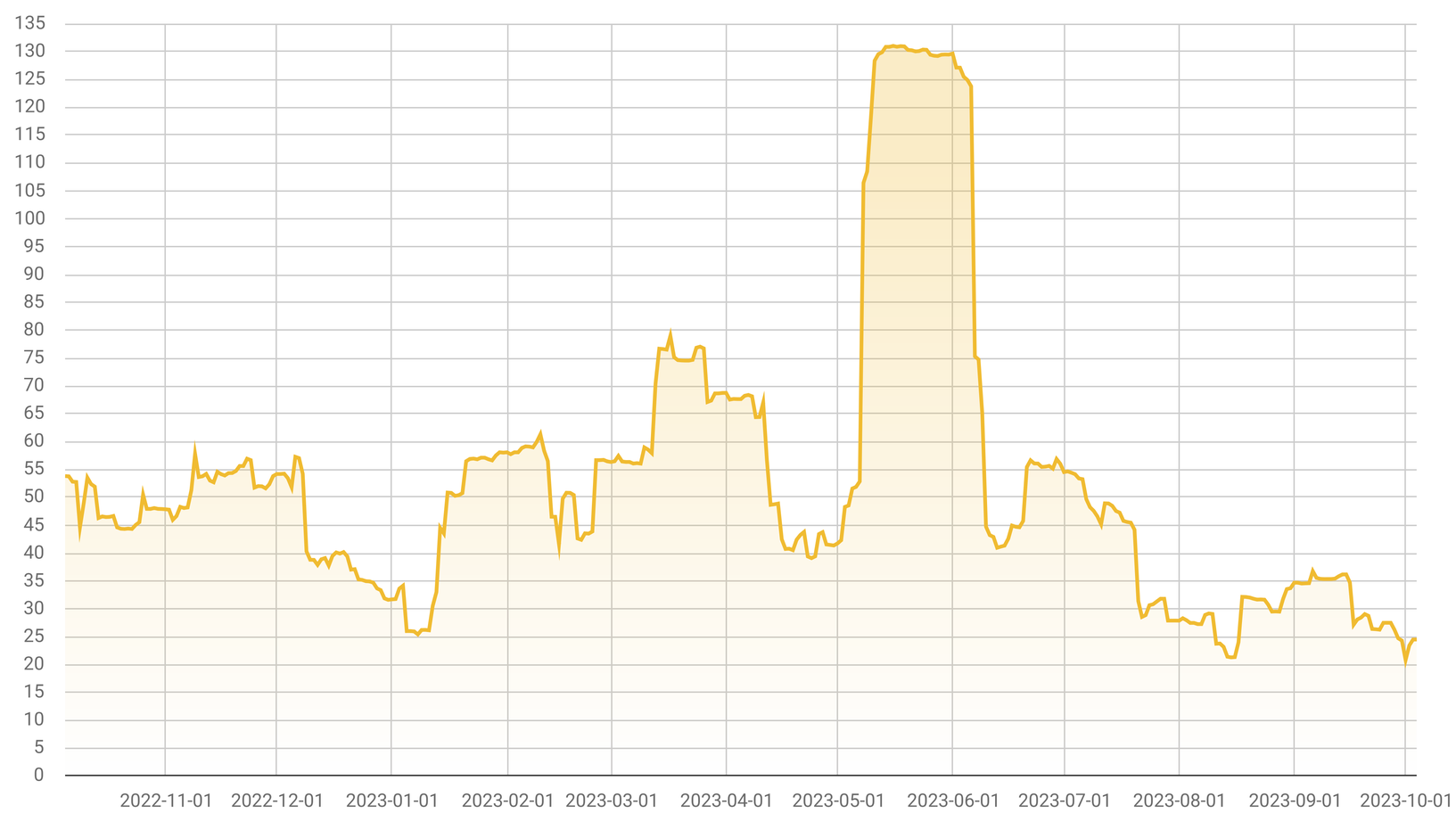
USD Hashprice Change

Month	2017	2018	2019	2020	2021	2022	2023
Jan	-17.02%	-53.51%	-9.92%	10.09%	7.94%	-25.22%	27.77%
Feb	15.70%	-9.90%	6.55%	-9.01%	33.60%	7.51%	-6.60%
Mar	-20.11%	-46.04%	4.43%	-17.44%	20.86%	2.99%	12.20%
Apr	22.71%	15.80%	30.47%	27.71%	-2.61%	-20.76%	-2.71%
May	70.66%	-22.87%	46.75%	-41.84%	-36.53%	-17.99%	-7.61%
Jun	-22.89%	-28.01%	12.30%	-9.96%	3.31%	-36.42%	9.56%
Jul	-12.03%	1.94%	-20.05%	30.46%	53.33%	26.57%	-9.20%
Aug	85.32%	-17.04%	-20.54%	-5.29%	-4.65%	-22.96%	-15.39%
Sep	-35.58%	-13.13%	-25.85%	-18.60%	-10.80%	-4.65%	1.73%
Oct	24.56%	-4.60%	1.61%	45.37%	16.56%	-9.57%	-
Nov	63.25%	-28.86%	-15.96%	26.36%	-8.57%	-15.77%	-
Dec	2.78%	5.39%	-3.33%	49.03%	-25.04%	-0.69%	-
Annualized*	171.88%	-92.36%	-16.19%	52.28%	15.94%	-75.94%	3.05%

*Annualized for each year except for 2023, which shows YTD change | Source: Hashrate Index

Zooming in to Q3-2023 specifically, the current year has witnessed the lowest period of volatility ever for Bitcoin's hashprice in the era of ASIC mining. Specifically, this all-time low came in late September, and it succeeded a spike in hashprice volatility in May that was driven by the inscription NFT activity we discuss in the next chapter. Most of Q3's low volatility comes from Bitcoin's own low volatility over the quarter, although the relatively modest growth to hashrate and difficulty kept volatility from swinging wildly, as well. (When measuring volatility, the higher the number, the more volatile an asset over the 30-day rolling period and vice versa for a low score).

USD Hashprice 30-Day Rolling Volatility



Source: Hashrate Index

3

Ordinals, Inscriptions, and Transaction Fees

Transaction Fees Stay Relatively High but Begin to Fall

In Q3-2023, transaction fees constituted 2.7% of all block rewards, which is down significantly from Q2's 8.17% figure but still higher than Q1's 2.3% figure.

Despite the reduction from Q2's transaction fee revenues, miners were still raking it in during Q3 when compared to last year's figures. **In Q3-2022, transaction fees only accounted for 1.7% of all block rewards, and the 2022 average was even less at 1.64%. So far in 2023, transaction fees have been 4.38% of block rewards.**

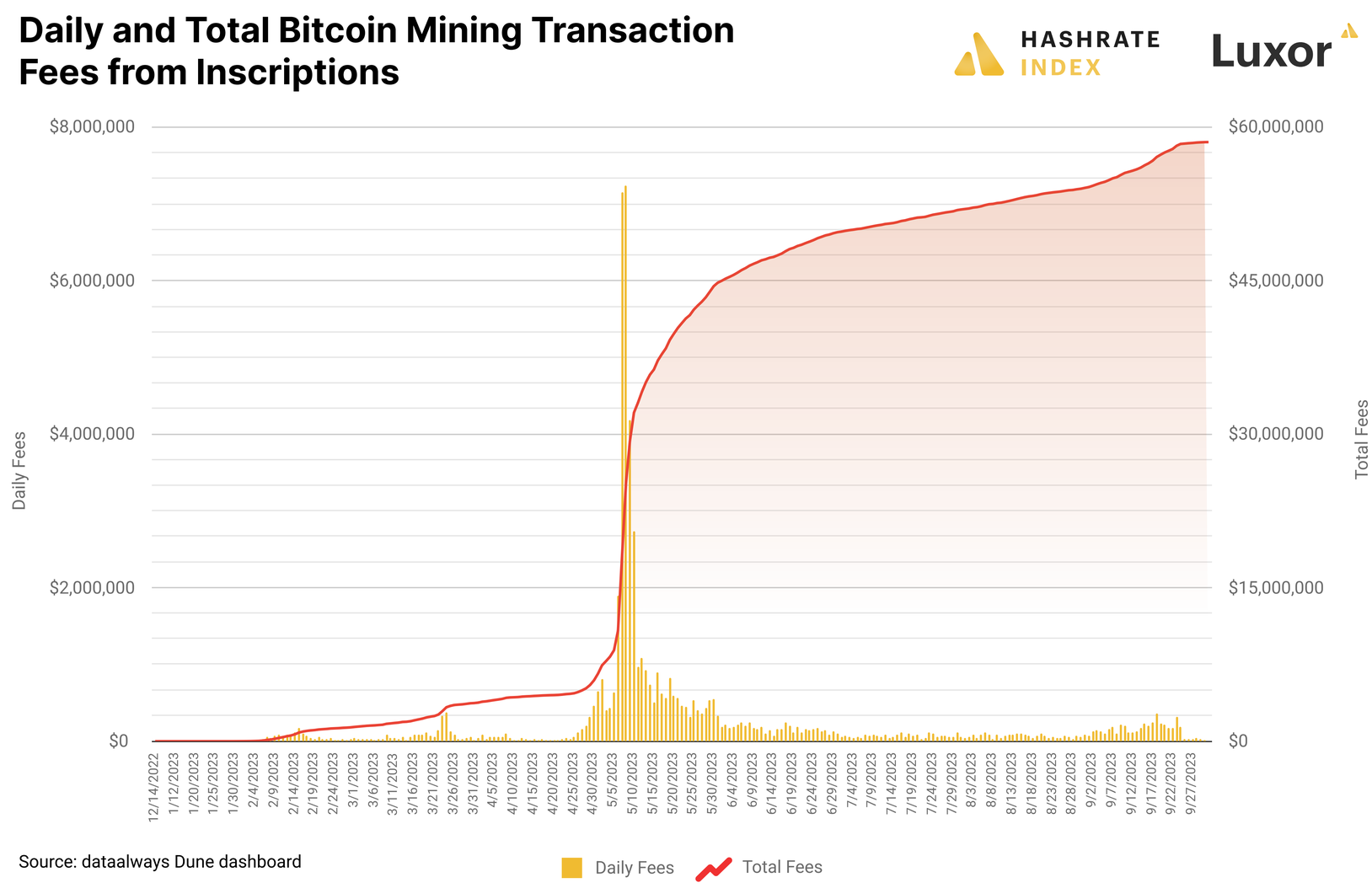
As we discussed in our Q2-2023 report, 2023's transaction fee increase stems from a paradigm shift in blockspace market dynamics from inscriptions / ordinals, a new standard for creating non-fungible tokens (NFTs) on Bitcoin. (If you need a primer, please consult this article for a 101 on inscriptions / ordinals and this article for how they have affected Bitcoin's blockspace and transaction fee markets).

So far in 2023, inscription activity peaked in Q2 and has slowly petered out since. The last week of September and the first half of October have marked the lowest levels of inscription activity since the NFT standard caught on in February of this year.

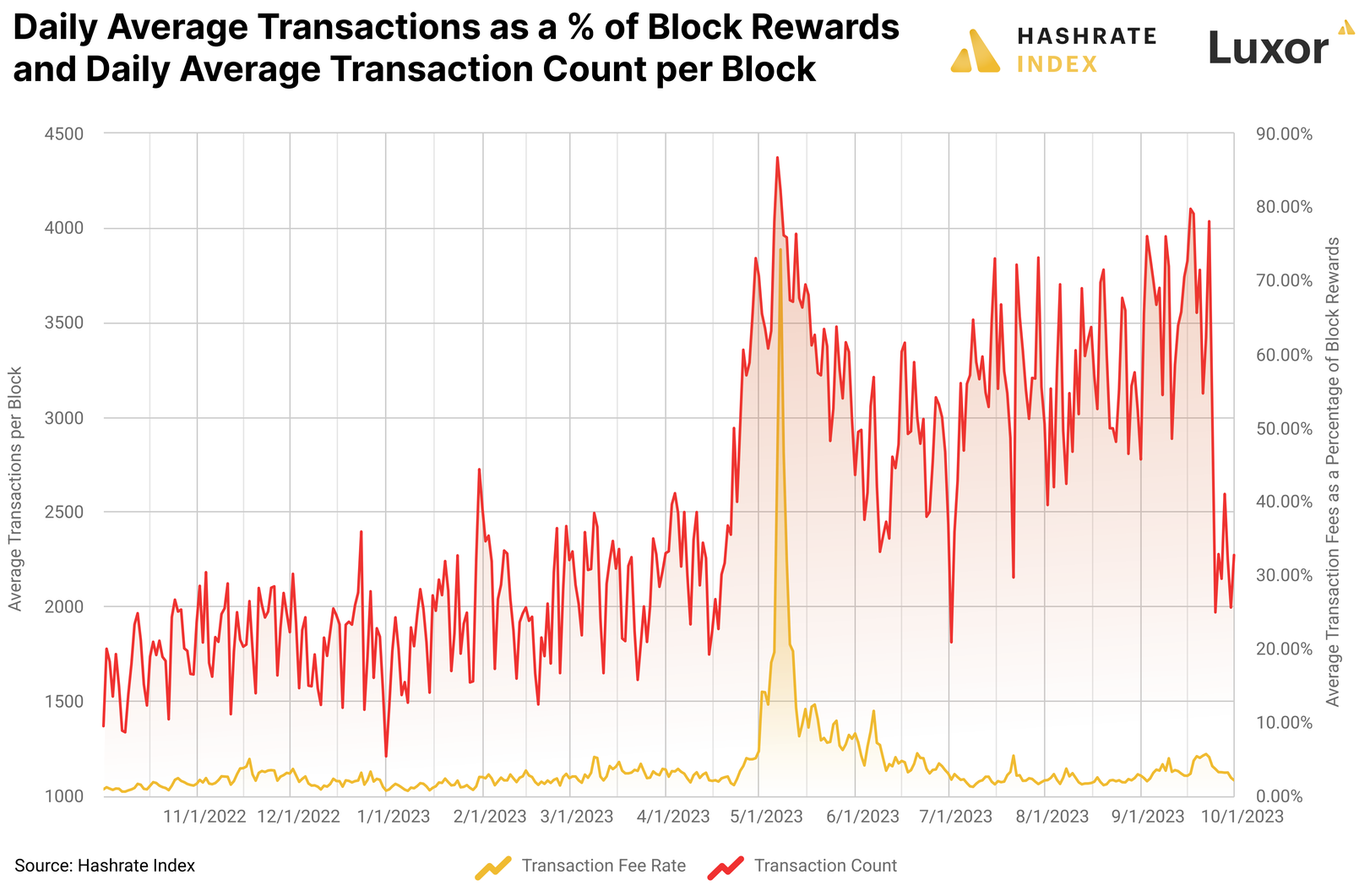
Ordy Porgy: Ordinals, Inscription Activity Still Hot, But Less So Than Q2

Inscriptions and ordinals are perhaps the most controversial development to come to Bitcoin this year, depending on who you ask. But if you ask most miners, they'll probably tell you that the development is welcomed – because it's fattening their wallets.

From their introduction in December 2022 to the end of Q3-2023, inscriptions netted Bitcoin miners 2117.31 BTC ($58,495,224) in transaction fees. In Q3-2023, inscriptions earned miners $8,793,718 in fees, versus $45,964,544 in Q2 and $3,730,164 in Q1.

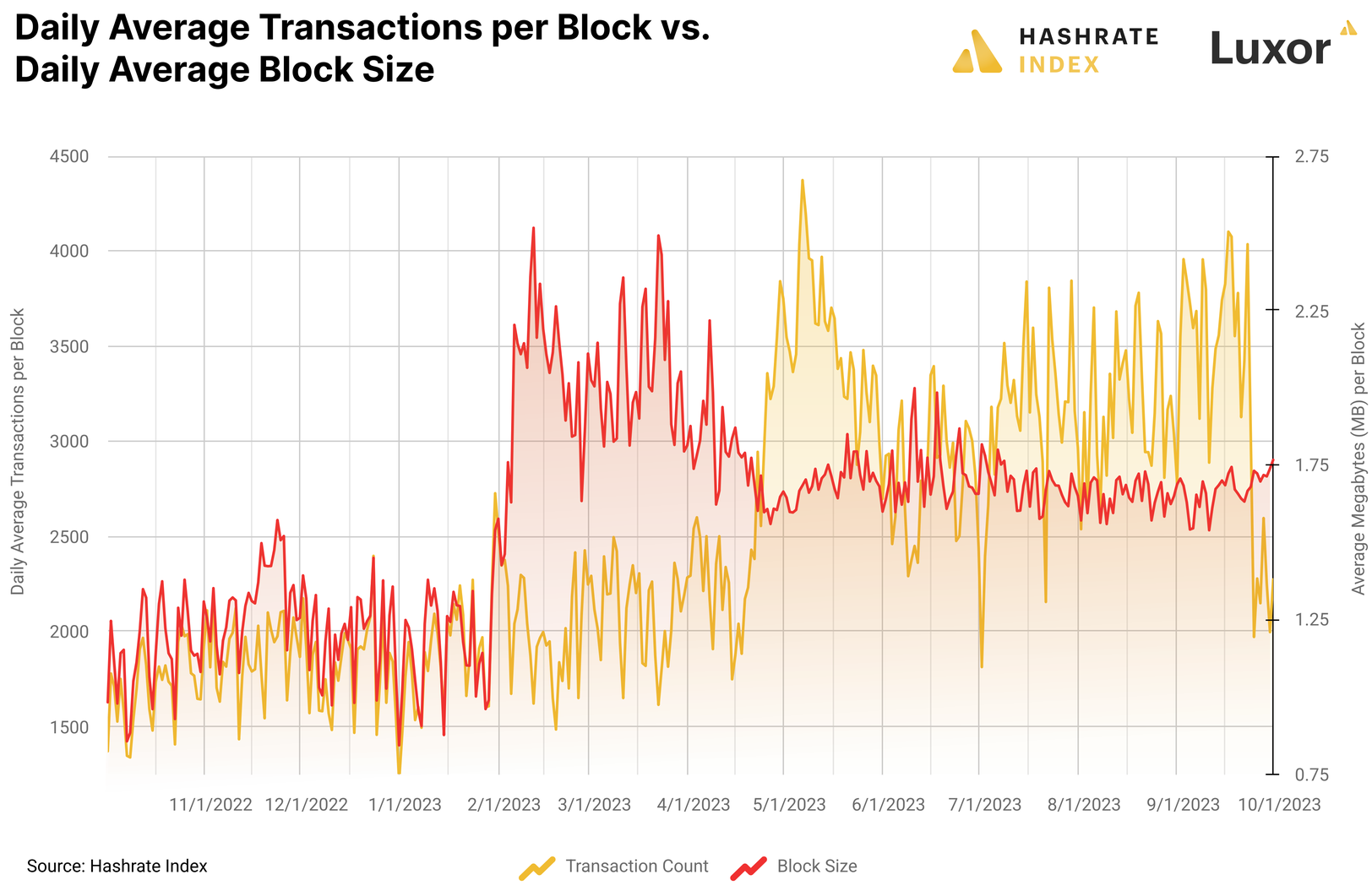


As the chart above illustrates, the supermajority of these transaction fees came during a short spurt in May. **In fact, the month of May alone netted miners 1390.89 BTC ($38,156,799), a staggering 66% of all-time inscription fees (as of Q3-2023's close)**. This revenue came from a sprint from collector and inscribers for BRC-20 tokens, a subset of inscriptions that use Bitcoin's OP_CODE function to create text-based series of inscriptions.

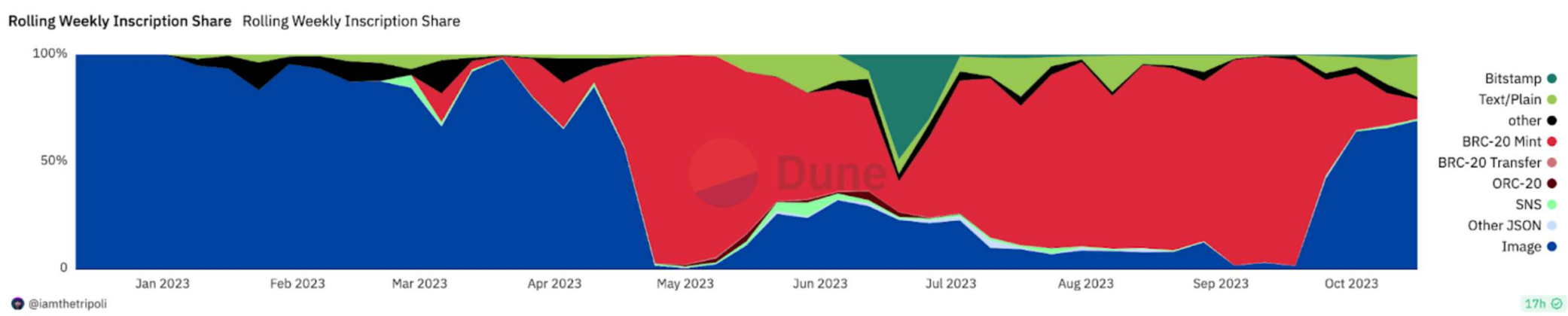


Using Bitcoin's OP_CODE field, collection creators can create a token parameter with a set supply. After they broadcast the template, anyone can mint tokens in the series if they follow the token's parameters. When BRC-20s caught fire in May, the first-come-first-mint mechanism incentivized inscribers to bid up fees to be the first to mint a new series. These minting transactions are also OP_CODE transactions, so they do not benefit as greatly from the SegWit discount that image-based inscriptions benefit from. As such, they cost more on a satoshi per byte basis. These minting incentives and the fact that BRC-20 transactions don't benefit greatly from the SegWit discount led to the transaction fee spike we see in May in the chart above.

Further, we can observe the SegWit discount in full effect in the chart below: the gap between transaction counts and block sizes from February to May best demonstrates the witness discount's impact on early inscription fee dynamics. Blocks were filling up with arbitrary inscription data like images and text, but the transaction count – increase though it did – did not increase astronomically. We see a larger increase in total transactions when text-based inscriptions capture more market share. In fact, text-based inscriptions have constituted the vast majority of inscription activity in 2023, as a chart on the next page demonstrates.



The chart below (courtesy of dataalways/iamtripoli's Dune dashboard) displays a weekly rolling average of inscription market share by type. If we compare this chart with the prior two charts on daily transactions / block sizes and daily transactions / transaction fees, we can see how the type of inscription heavily impacts blockspace dynamics: when inscription activity is high, image-based inscriptions take up more block space with fewer transactions, while text-based BRC-20 inscriptions take up less block space than their image-based counterparts even though these minting events typically entail greater transaction counts. (BRC-20s are text-based inscriptions).

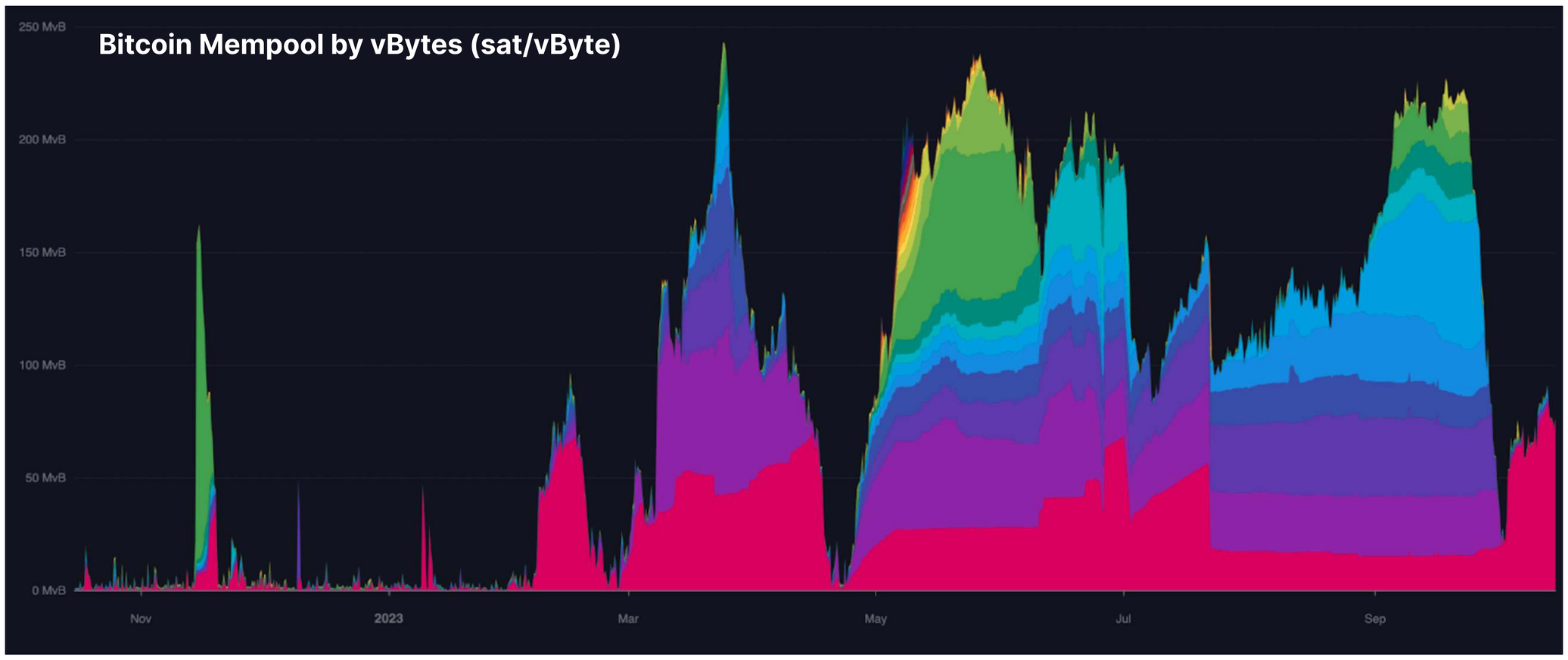


Source: dataalways/iamtripoli Dune dashboard

Understanding "Direct" and "Indirect" Fee Pressure from Ordinals / Inscriptions

To understand how inscriptions impact blockspace dynamics and Bitcoin's transaction fee market, we need to look beyond the "direct" pressure that inscriptions assert on transaction fees. We also need to understand how inscriptions assert "indirect" pressure on transaction fees by creating congestion in Bitcoin's global transaction queue.

The BRC-20 mania we saw in May was the peak of this year's inscription activity, so much so that the average transactions included in each block reached an all-time high. The mad-dash to mint these text-based inscriptions clogged Bitcoin's mempool (the queue for unconfirmed transactions). In fact, the mempool was so backlogged in Q2 and Q3, that it only recently receded to February 2023 levels.

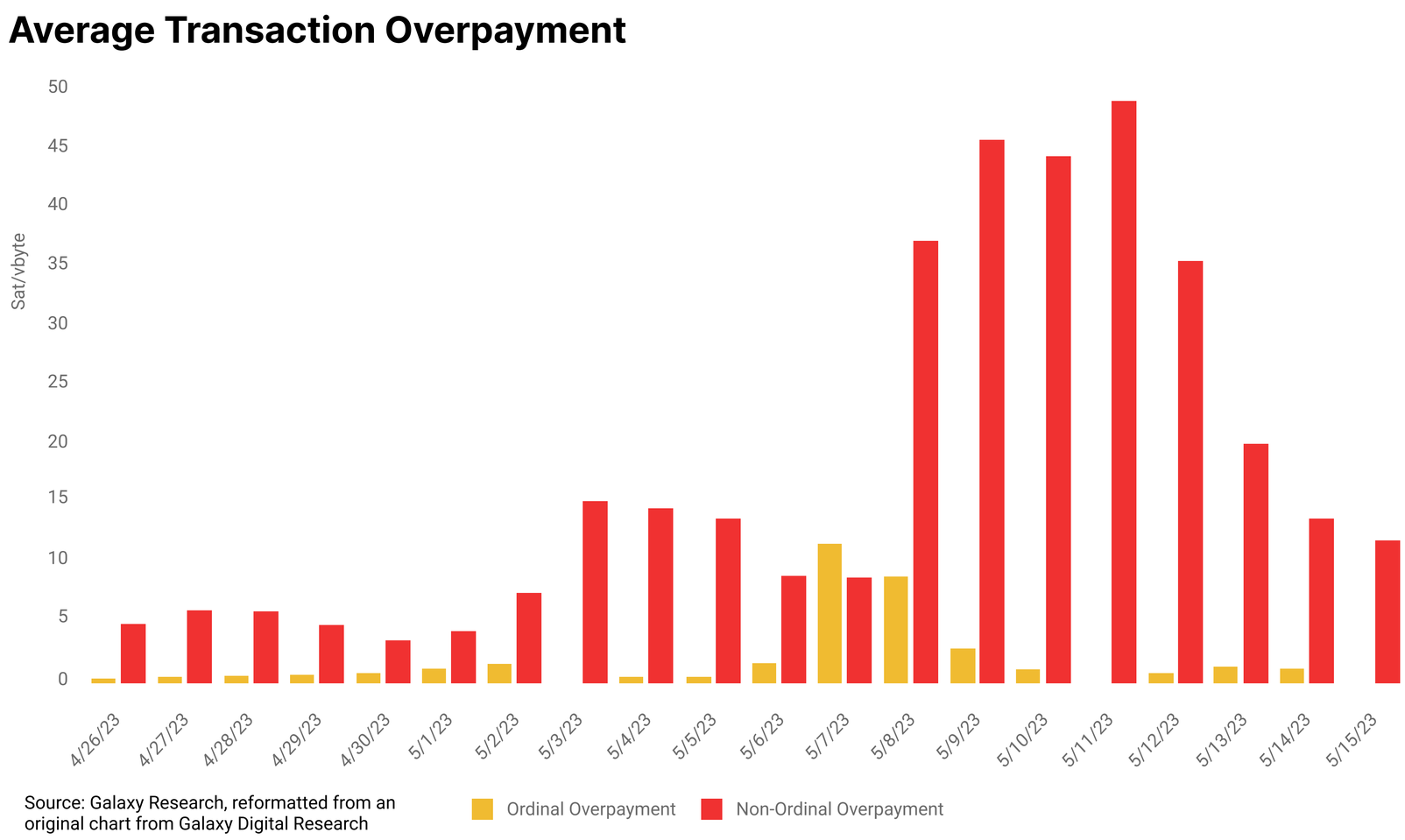


Bitcoin's mempool | Source: Mempool.space

Notably, the transaction backlog that inscription activity created in Q3 exerted roundabout pressure on transaction fees. We call this "indirect" fee pressure to differentiate between fees generated from other transactions during times of inscription-led mempool congestion and fees generated directly from inscription transactions ("direct" fee pressure); "indirect" fee pressure comes from users who pay higher fees than they normally would for normal, financial transactions because inscription activity is creating a transaction backlog in the mempool.

As Galaxy Digital points out in a recent report on inscriptions / ordinals, mempool congestion precipitated transaction fee "overpayment" from various transactors. The Galaxy Digital Research team defines overpayment as any transaction fee in a block greater than that block's median transaction fee (in sats/vbyte). For financial transactions (i.e., normal BTC transfers), this overpayment could stem from inaccurate transaction fee estimators in wallet / exchange software or from general user ignorance regarding transaction fee structure and dynamics. Additionally, some financial transactions may be time sensitive, so users overbid their fees to expedite their transactions during the mempool congestion. For inscription transactions, this so-called "voluntary overpayment" was commonplace during times of high activity and popular mints, particularly for BRC-20 tokens whose first-come-first-mint design encourages such behavior.

The chart below quantifies overpayment for inscription/ordinal transactions and all other transactions to demonstrate the dynamics discussed above. As the chart suggests, when Bitcoin's mempool became backlogged in April and May, a majority of the transaction fees during this time actually came from user overpayment for financial transactions – not inscriptions/ordinals themselves.

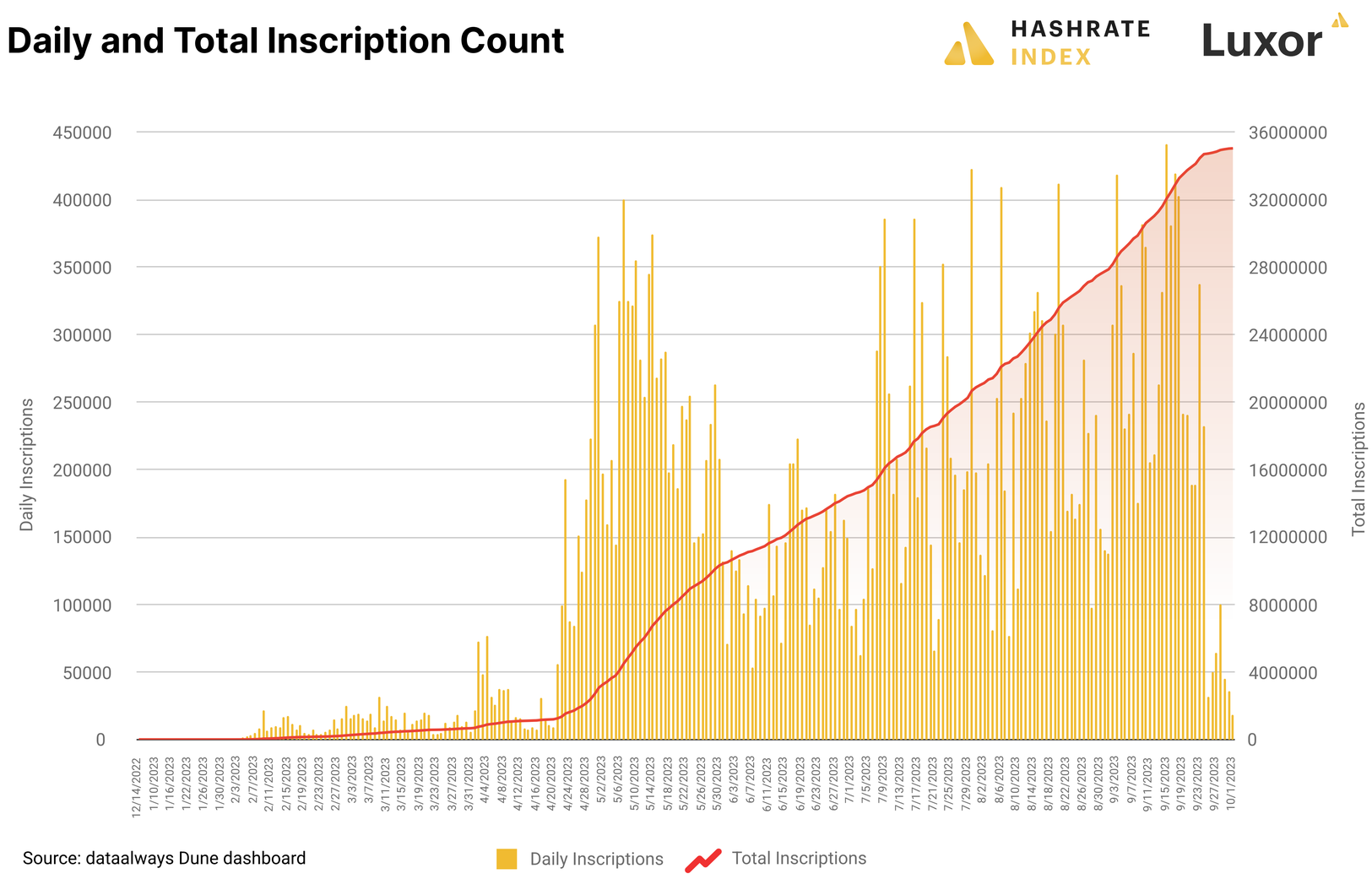


This insight is important for understanding that inscriptions create both **direct and indirect pressure** on transaction fees. Overall, indirect and direct transaction fee pressures from inscriptions are important for understanding how inscription activity can raise the transaction fee floor.

For more analysis and data exploring inscription transaction fee dynamics, we highly recommend Galaxy Digital Research's report linked in the prior page.

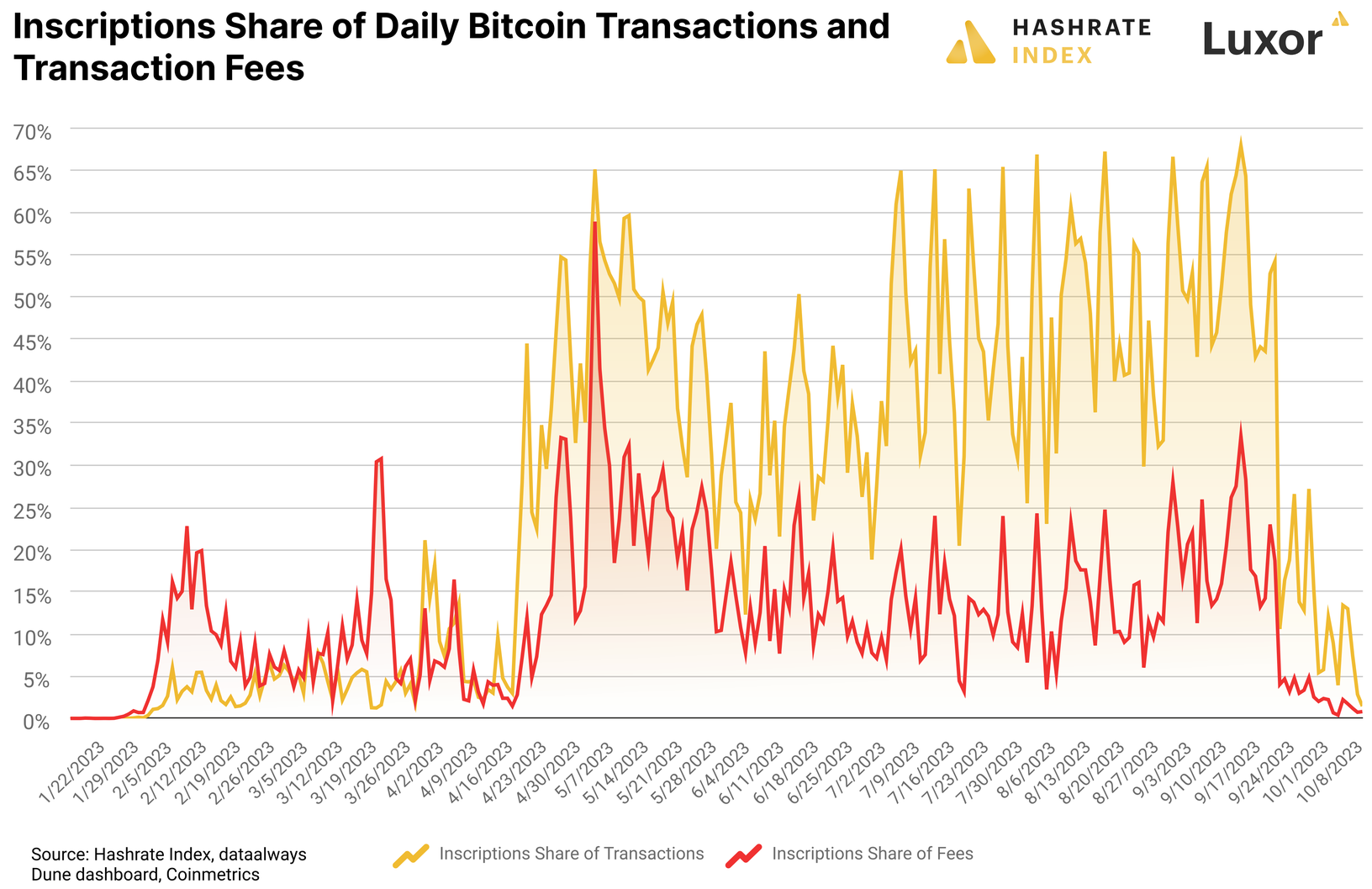
Inscription Activity is Dying Down – For Now

Inscription activity began to plateau in September, as evidenced by the total inscription count displayed in the chart below. As inscription activity has tapered off, transaction activity has fallen to levels we saw in February, March, and early April before inscription activity went parabolic.



As displayed in the chart below, inscription activity fell off a cliff at the end of September and dropped below 5% in October for the first time since April.

The chart below reinforces that inscription volume is dropping significantly. So far in October, inscriptions have seen their lowest share of both transaction fees and transaction volumes since Q1. **In Q3-2023 on average, inscriptions consisted of 45% of daily transactions and 14% of all daily transaction fees; respectively, these averages were 32% and 16% in Q2 and 3% and 8% in Q1.**



Ethereum has seen a number of NFT waves come and go. We expect that inscriptions will follow a similar trajectory, with activity ramping up or down depending on new developments and the general Bitcoin market environment. As such, even though inscription activity is dying down for now, we expect that it will resume in the future, particularly in a bull market – we just don't know exactly when.

4

ASIC Prices Hit Lows Again and Again

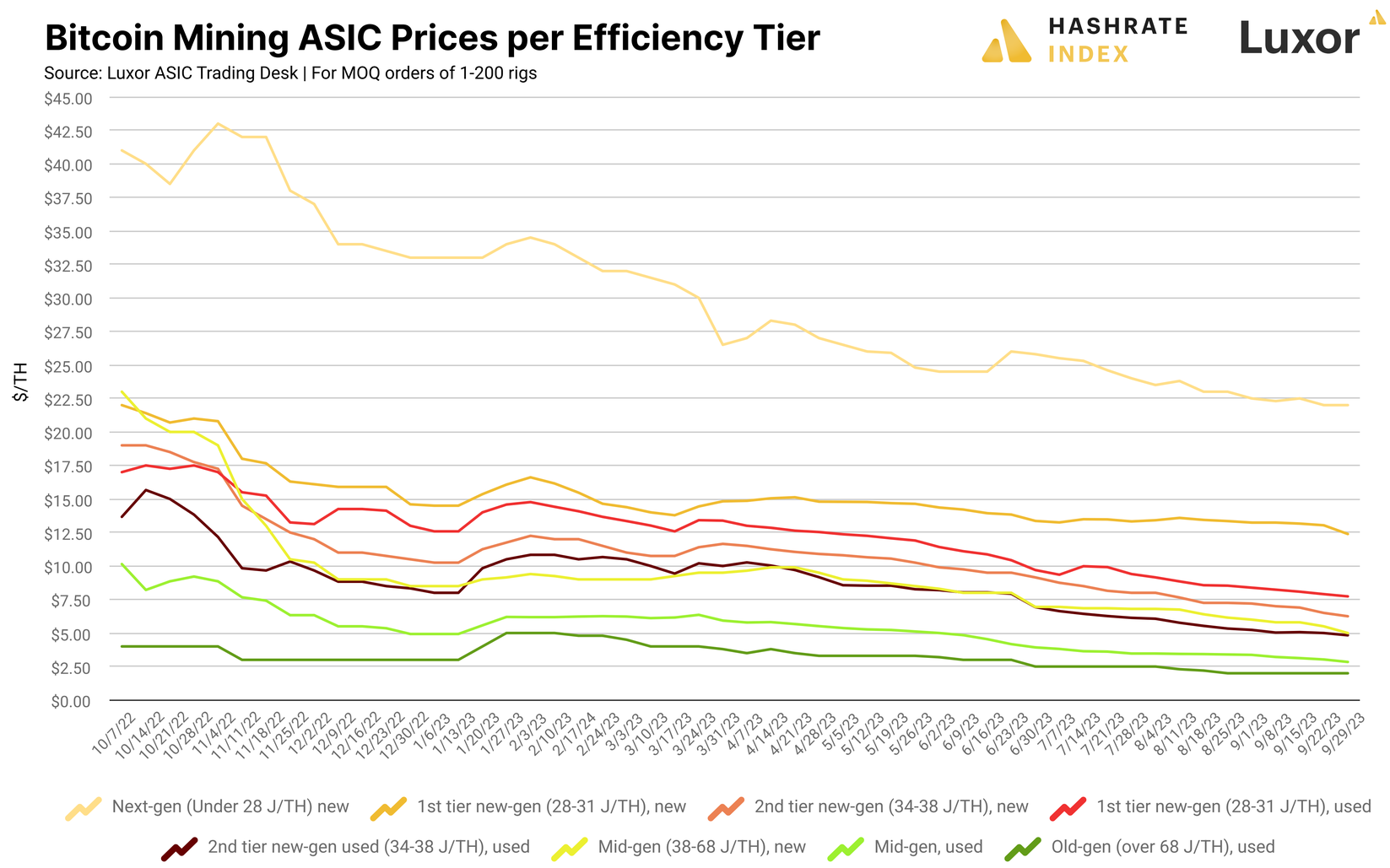
Bitcoin mining ASICs continue to slide in 2023, with models of all calibers hitting all-time lows in Q3 as mining margins continue to thin.

Buying activity in the ASIC market declined over the course of Q3 as miners continue to adopt a “wait and see” approach as the Fourth Bitcoin Halving casts questions over future mining economics. Additionally, the advent of new machines like the Antminer S21 have complicated rig acquisition strategies, something we discuss later in this chapter.

Perhaps obviously, miners are starting to prioritize leading efficiency ASICs as they stare down the barrel of Bitcoin’s Fourth Halving. Taking a look at listing prices from Luxor’s ASIC Trading Desk data, we can glean a few salient insights from the last year of buying activity.

As the chart below illustrates, what we classify as 1st tier new-gen ASICs (rigs with an efficiency of 28-31 J/TH) have gradually separated from the pack over the year; their premiums began gradually increasing over older and used models in April and the spread has increased ever since. Rigs of all tiers saw a brief bump in prices at the beginning of 2023 as hashprice rallied, and they saw another brief price bump in Q2 in response to improved hashprice economics still from inscription-fueled transaction fee revenue.

The dip we see at the end of September is likely in response to the Antminer S21’s release, and we expect this downtrend to continue for all existing models in response to market demand for the S21 and similar next-gen equipment.



Something surprising that we can glean from the chart above: **Even used 1st tier new-gen rigs are carrying a premium over NEW 2nd tier new-gens (rigs with an efficiency of 32-38 J/TH)**. Miners are thus prioritizing efficiency over condition – put differently, they would rather take a machine that is used with an efficiency of 30 J/TH than one that is new with a 34 J/TH rating. Notably, though, 2nd tier new-gen, mid-gen, and old-gen rigs of all types have lost significantly more value over 2023 as miners anticipate that many of these rigs won't be viable after the 2024 Halving.

Going further, used 2nd tier new-gen ASICs are trading at comparable prices to new mid-gen models. That may seem odd to some readers, considering that they may think of something like the Antminer S17, a commonly referenced mid-gen ASIC; however, these new mid-gen ASICs technically fit into the mid-gen classification because they have an efficiency rating greater than 38 J/TH, but they are models that have been released in the last two years so there is still manufacture-new supply available.

When we look at the change in listing prices for different ASIC efficiency tiers throughout 2023, Q1 stands out as an outlier. Thanks to the rebound in hashprice, every rig tier (except for the next-generations bucket) gained value over the first quarter; inversely, next-gen rigs like the S19 XP were somewhat oversold in Q1 as the recovery in hashprice made less efficient rigs more attractive. Q2 and Q3 were a different story as selling accelerated, especially for older and less efficient models. The table below drives home the point that miners are beginning to distinguish between 1st tier (28-31 J/TH) and 2nd tier (34-38 J/TH) new-gen ASICs.

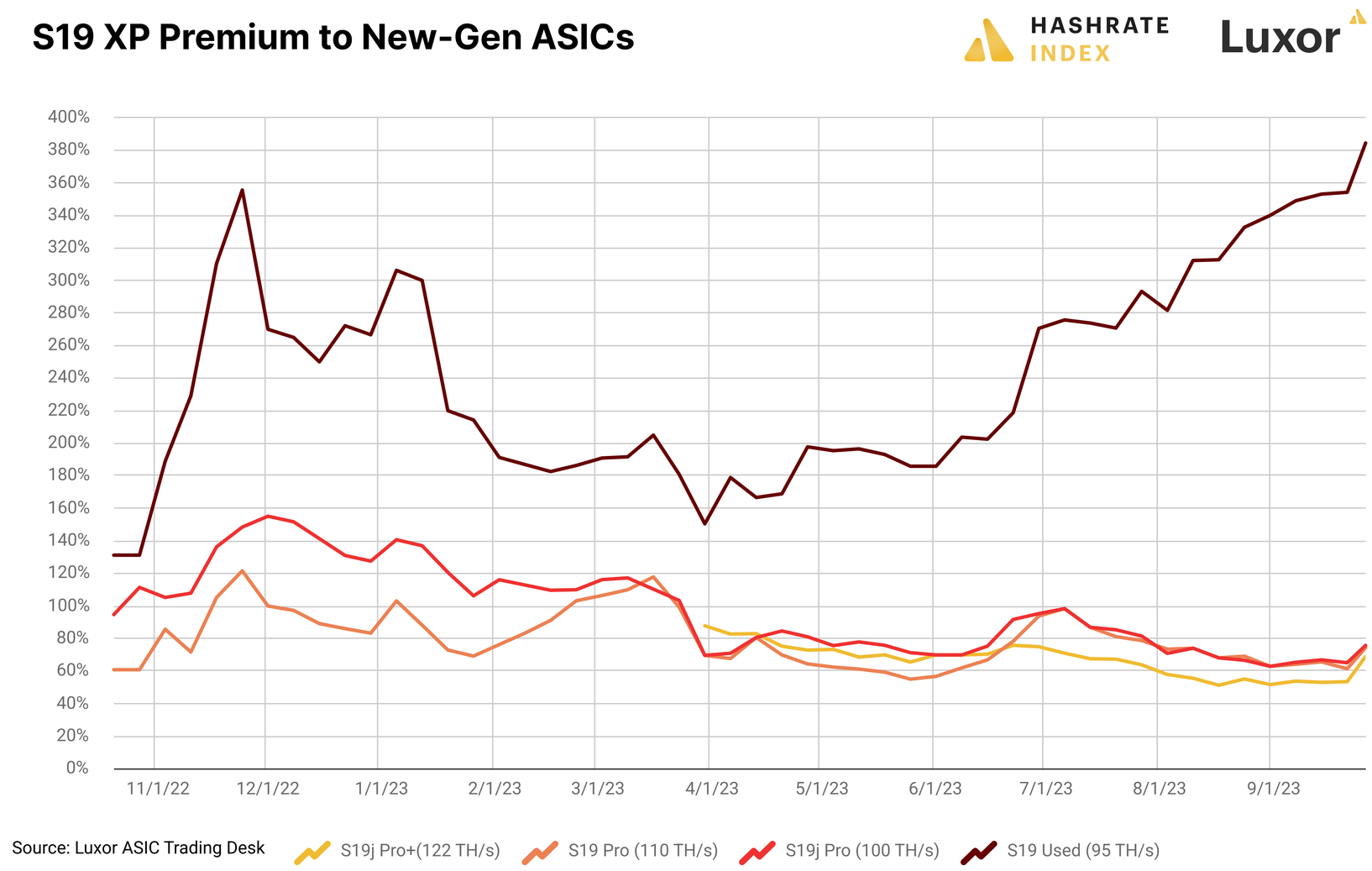
Listing Prices 2023 per Efficiency Tier	Q1 change	Q2 Change	Q3 change	YTD Change
Next-gen (Under 28 J/TH) New	-19.70%	-2.64%	-14.73%	-33.33%
1st Tier New-gen (28-31 J/TH) New	1.54%	-9.87%	-7.30%	-15.15%
2nd Tier New-gen (34-38 J/TH) New	10.95%	-21.46%	-31.69%	-40.48%
1st Tier New-gen (28-31 J/TH) Used	2.95%	-27.52%	-20.27%	-40.51%
2nd Tier New-gen (34-38 J/TH) Used	20.00%	-30.67%	-30.29%	-42.00%
Mid-gen (38-69 J/TH) New	11.76%	-26.84%	-28.06%	-41.18%
Mid-gen (38-69 J/TH) Used	20.29%	-33.73%	-27.64%	-42.32%

Source: Luxor ASIC Trading Desk

S19 XP Premiums Decrease

The Antminer S19 XP is still commanding a notable premium over new-generation rigs, but this premium has gradually decreased over 2023 for factory-new S19 models – albeit there have been bumps along the way.

Premiums increased at the end of last year in response to the market fallout that drove hashprice to all-time lows. As hashprice rallied in 2023, premiums fell, and when hashprice spiked in May in response to the inscriptions frenzy, premiums reached their lowest points for the first half of the year for the S19 Pro and S19 Pro+. Premiums climbed for a brief period in September, only to drop steadily in Q3 for the S19j Pro, S19 Pro, and S19 Pro+



The glaring exception to this premium decrease, as the chart illustrates, is the S19. The prices consulted for this data were for used S19s of course, as Bitmain no longer produces factory new versions of the S19 series' flagship design. Once again, this illustrates that older models with less efficient power consumption (the 95 TH/s S19 has a 35 J/TH efficiency) are falling out of favor.

Another takeaway from the above chart: the difference in S19 XP premiums between the S19j Pro, S19 Pro, and S19 Pro+ have decreased significantly throughout 2023. **Year-to-date (as of the end of Q3-2023), the S19 XP's premium over the S19 Pro and S19j Pro decreased 28% and 46%, respectively; over the course of Q3, these premiums for the S19j Pro+, S19 Pro, and S19j Pro fell 8%, 21%, and 20%, respectively.**

The premium spread for these rigs is in a tighter band than ever, perhaps as a result of improved hahsprice economics over the course of 2023. Another explanation could be that perhaps the market is starting to price the S19j Pro and S19 Pro similarly as they fall out of favor, given the shipments of next-gen rigs like S19 XP, S19j XP, and the S19k Pro and the advent of the Antminer S21.

Hashprice gives us one explanation for why these premiums decreased over the year, but the decrease in premiums in Q3 could also come from expectations for the Antminer S21. Indeed, new hardware like the S21 will be coming to market next year, so miners could be deprioritizing orders of the S19 XP accordingly given the S21's improvements to both hashrate and efficiency. As such, we expect new models to chip away at the Antminer S19 XP's premium to other rigs.

Enter the Antminer S21

Bitmain unveiled its latest ASIC model in September at its World Digital Mining Summit: the Antminer S21, which will come in an air-cooled and hydro-cooled version. The new model is the first-ever Bitcoin mining ASIC to achieve an efficiency under 20 J/TH.

Bitcoin mining ASICs	Hashrate	Efficiency	Wattage
Antminer S21 Hydro	355 TH/s	16 J/TH	5360 W
Antminer S21	200 TH/s	17.5 J/TH	3500 W
S19 XP Hydro	255 TH/s	20.8 J/TH	5304 W
S19j XP	151 TH/s	21.5 J/TH	3241 W
S19 XP	140 TH/s	21.5 J/TH	3010 W
S19k Pro	120 TH/s	23.0 J/TH	2760 W
S19j Pro+	122 TH/s	27.5 J/TH	27.5 W

Source: Hashrate Index

Bitmain could begin shipping units of the S21 as early as December, although a January shipping date is more plausible. The company has plans to manufacture at least 50,000 units per month for 18 months, split 50/50 between air-cooled and hydro models, but they could manufacture as many as 100,000 per month if there is enough demand, a Bitmain rep told Hashrate Index.

At its World Digital Mining Summit, Bitmain announced attractive promotional pricing for bulk pre-orders of S21. For the first phase of preorders, which requires a minimum buy of 1.2 EH/s (6,000 for air-cooled models or 3,380 hydro models) Bitmain is selling the rigs for $14/TH. This comes out to $2,800 per unit for air cooled models and $4,690 per unit for hydro models. The second phase of orders will cost $19.6/TH (per unit, $3,920 for air cooled and $6,566 for hydro cooled) and requires the same 1.2 EH/s minimum order size. It's important to note that this is promotional pricing for the launch of the Antminer S21 and that later orders will cost more than the promotional pricing. Further, secondary seller pricing has been close to this promotional pricing, with many vendors selling models in the $14-15/TH range.

	S21 (1st Batch)	S21 (2nd Batch)	S19 XP	S19k Pro	S19j Pro+	S19 Pro	S19j Pro
Hashrate	200	200	141	120	120	110	104
$/TH	$14	$18	$20.80	$12.60	$11.80	$11.50	$11.40
$/Unit	$2,800	$3,600	$2,932.80	$1,512.00	$1,416.00	$1,265.00	$1,185.60

Prices for bulk orders (1.2 EH/s or greater) as of September 29 | Source: Bitmain, Luxor ASIC Trading Desk

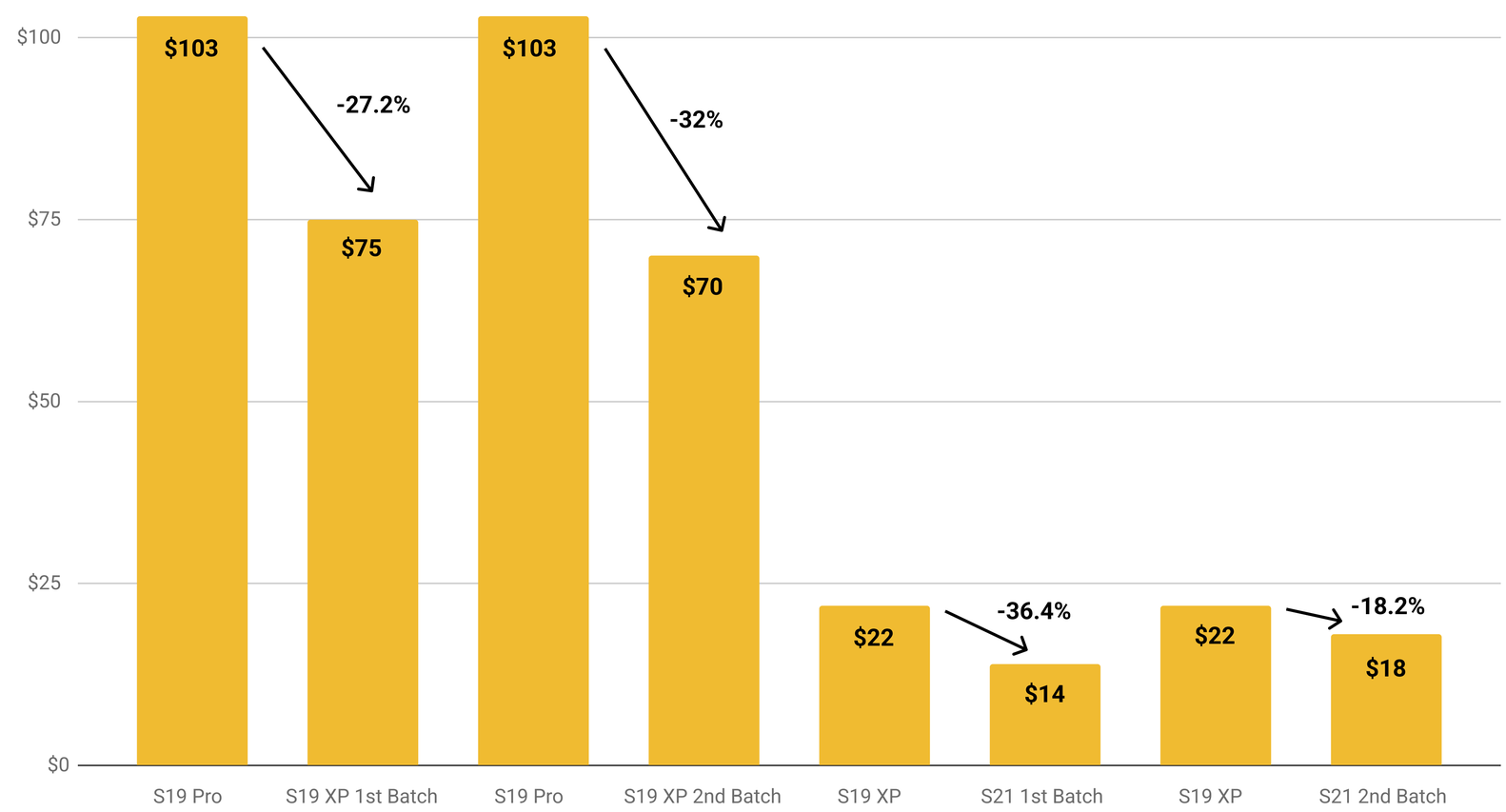
With its promotional pricing, Bitmain is undercutting the market rate for many of its other models; the asking price for a new S19j Pro+ during the last week in September, for instance, was $13.30/TH – only $0.70/TH less than the first phase of orders for the S21. Even for futures orders, this is an incredible price point for the Antminer S21 given its superior hashrate and efficiency.

We've seen Bitmain do this before. When Bitmain first released the S19 XP, it offered promotion pricing of $75/TH for the first batch of S19 XP orders and $70/TH for the second batch of orders. Additionally, during the summer of 2022, it offered coupons for previous preorders and for futures orders of the S19 XP to incentivize buying. These coupons led secondary sellers to reprice their inventory accordingly, so we expect to see prices for all rigs to change dramatically in the coming months as sellers react to Bitmain's promotional pricing for the Antminer S21.

Notably, Bitmain's promotional pricing for the Antminer S21 flips the script from its promotional pricing for the Antminer S19 XP: the first batch of the S21 ($14/TH) is cheaper than the second batch ($18/TH), contrary to the Antminer S19 XP's pricing, where the first batch was more expensive than the second. This indicates to us that Bitmain is trying to boost sales amid market uncertainty given bearish headwinds from both the broader economy and with the Fourth Halving looming.

At the time of its release on November 8, 2021, the S19 XP's first round of promotional pricing offered a 27.18% discount to the S19 Pro, the most efficient model at the time of its release; the S21's first round of promotional pricing offers a 36.36% discount to the S19 XP, which is currently the most efficient model available. Conversely, the discount for the S21's 2nd batch compared to the S19 XP's current pricing is less than the S19 XP's second batch discount to prices of the S19 Pro at the time.

$/TH Promotional Pricing of New Models vs. $/TH Listing Prices of Most Efficient Models at time of Release



Now, to caveat again, these S21 orders are futures orders that won't ship until Q1 and Q2 of next year, while the inventory for S19 XPs, S19j Pro+'s, and other rigs that we cite in the prior table are spot prices. Bitmain's discount is partly to compensate for multi-month lead times for the S21, but it also seems to account for the reduction in mining rewards miners will experience after the Fourth Halving. All of that said, Bitmain is likely trying to stimulate buying interest for this new rig given hashprice uncertainty leading into the Fourth Halving amid an already bearish environment.

As we saw in the past with promotional pricing and coupons for the Antminer S19 XP, we expect the Antminer S21's attractive pricing to heavily influence prices in the secondary ASIC market to the downside. Sellers have already started to bring down prices as buyers place lower bids for older Antminer models, and we anticipate ask-bid spreads to continue to widen as ASIC buyers demand lower prices going into the Halving.

ASIC Breakeven Analysis

The top anxiety for every miner currently is whether or not they have cheap enough power to survive the Fourth Bitcoin Halving. Well, we don't have a crystal ball, but we do have a power price breakeven sensitivity table.

The table below displays different breakeven electricity prices for various ASIC models according to different hashprice levels.

Breakeven Power ($/kWh) per Hashprice ($/PH/Day)	$70	$65	$60	$55	$50	$45	$40	$35	$30	$25	$20
S21 (200 TH/s)	$0.167	$0.155	$0.143	$0.131	$0.119	$0.107	$0.095	$0.083	$0.071	$0.060	$0.048
S19j XP (151 TH/s)	$0.136	$0.126	$0.116	$0.107	$0.097	$0.087	$0.078	$0.068	$0.058	$0.048	$0.039
S19 XP (134 TH/s)	$0.130	$0.121	$0.111	$0.102	$0.093	$0.083	$0.074	$0.065	$0.056	$0.046	$0.037
S19k Pro (120 TH/s)	$0.127	$0.118	$0.109	$0.100	$0.091	$0.082	$0.072	$0.063	$0.054	$0.045	$0.036
S19j Pro+ (122 TH/s)	$0.106	$0.098	$0.091	$0.083	$0.076	$0.068	$0.061	$0.053	$0.045	$0.038	$0.030
S19 Pro (110 TH/s)	$0.099	$0.092	$0.085	$0.078	$0.071	$0.063	$0.056	$0.049	$0.042	$0.035	$0.028
S19j Pro (100 TH/s)	$0.096	$0.089	$0.082	$0.075	$0.068	$0.061	$0.055	$0.048	$0.041	$0.034	$0.027
S19 (90 TH/s)	$0.085	$0.079	$0.073	$0.067	$0.061	$0.055	$0.049	$0.043	$0.037	$0.030	$0.024
S17 (53 TH/s)	$0.065	$0.060	$0.056	$0.051	$0.046	$0.042	$0.037	$0.032	$0.028	$0.023	$0.019
S9 (13 TH/s)	$0.030	$0.028	$0.025	$0.023	$0.021	$0.019	$0.017	$0.015	$0.013	$0.011	$0.008

Source: Hashrate Index

One thing that immediately stands out: if the halving happened today and hashprice dropped to $30/PH/day, even the S21 is barely scraping by with a breakeven of $0.071/kWh. In fact, given the USA's average industrial power price of $0.0845/kWh in July 2023, the S21 would be underwater, and it's barely eking out a profit at Texas' average industrial power price in July 2023 of $0.0677/kWh. (Granted, July is usually a higher-than-average month for power prices, but it still illustrates the point that some Bitcoin miners will need help from more than just best-in-class equipment to navigate the Halving).

The average power cost (as of Q2-2023 close) of the public miners we sample in the subsection "Operational Costs and ASIC Fleets" is $0.055/kWh; given this cost, only next-generation machines like the S21 and S19 XP are viable at $30/PH/day hashprice (and the S19 XP is barely viable at this hashprice).

If hashprice drops to such extreme lows, miners would do well to look at cost-cutting strategies and firmware strategies to optimize power consumption so that they can shore up costs amid thinning margins.

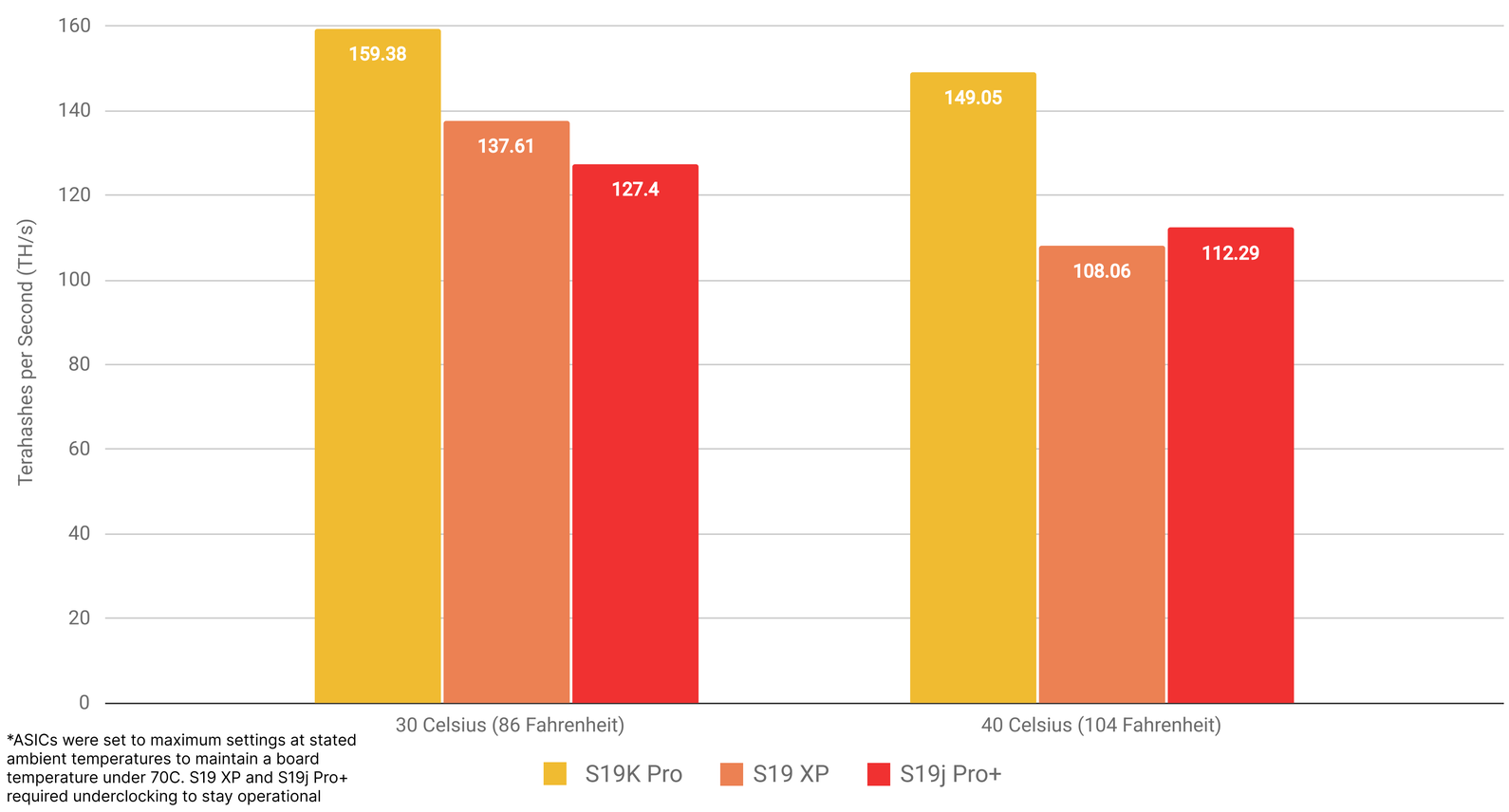
LuxOS Firmware Analysis for S19k Pro, S19 XP, and S19j Pro+

Custom firmware will continue to be an integral tool for fleet management for miners before and after the 2024 Halving. For those with cheap enough power, overclocking (increasing power consumption to maximize hashrate) could be key to squeezing every last nonce out of their hashrate, and for those with higher costs, underclocking (decreasing power consumption to maximize efficiency) will be crucial for survival in a 3.125 BTC block subsidy world. (Disclaimer: overclocking can damage hardware and users should proceed at their own risk).

In this section, we will be referring to various power profiles for each ASIC to distinguish between overclocking and underclocking scenarios. The power profiles are displayed in terms of volts and megahertz (e.g., 12V / 260 MHz). Similar to how pounds per square inch (PSI) measures pressure in a water or air system, voltage (which is measured in volts) quantifies the "pressure" in an electric system (i.e., the force of electricity from a power source); hertz is used to measure the frequency of an electrical system (i.e., the rate at which an electrical signal oscillates, where 1 Hz corresponds to a signal oscillating one time per second). Don't let the jargon bog you down: for our purposes, a higher volt/hertz rating means MORE power flowing into an ASIC miner (meaning it is being overclocked when the frequency setting exceeds the default frequency setting of a miner), and a lower volt/hertz rating means LESS power flowing into an ASIC miner (meaning it is being underclocked when the frequency settings is lower than the default frequency settings of a miner).

To test which mining rigs would be best for underclocking and overclocking in different environments, we conducted LuxOS firmware analysis on the S19k Pro, S19 XP, and S19j Pro+. When overclocking these rigs, we pushed the hashboards to their limits and set their board shutdown temperatures to 70 degrees Celsius. We ran this analysis at two different ambient temperatures of 30 degrees Celsius (86 degrees Fahrenheit) and 40 degrees Celsius (104 degrees Fahrenheit). The ASICs were run at each profile setting until their power draw and 5 minute hashrate stabilized, and then we logged 5 minute hashrate and nominal hashrate data for each rig to provide a side-by-side comparison of what each rig is capable of under high temperature conditions.

S19k Pro, S19 XP, and S19j Pro+ Hashrate at Max Setting with LuxOS at High Ambient Temperatures*



*ASICs were set to maximum settings at stated ambient temperatures to maintain a board temperature under 70C. S19 XP and S19j Pro+ required underclocking to stay operational

The S19k Pro outperformed both the S19j Pro+ and the S19 XP in both environments, and remarkably, we could have overclocked it one notch higher even at 40 degrees Celsius. Even at such a high ambient temperature, the S19k Pro remained roughly at its advertised efficiency (23 J/TH) at its default profile settings, as displayed in the table below. Notably, the S19 XP and S19j Pro+ couldn't handle the high heat in either scenario, and they were even unable to achieve their default setting hashrates; this held true at all high-voltage scenarios displayed in the tables below.

The first table shows results for high-voltage scenarios at 40 degree Celsius ambient temperature, while the second table shows results for high-voltage scenarios at 30 degree Celsius ambient temperature.

S19k Pro (120 TH/s) LuxOS Performance - 77 ASIC chips per Hashboard								
Power Profile (Voltage/Frequency)	5 Min Avg Hashrate (TH/s)	Nominal Hashrate (TH/s)	Power Consumption (W)	Efficiency (J/TH)	% Over/Under Clock	Ambient Temp °C (°F)	Inlet Board °C (HB0/HB1/HB2)	Outlet Board °C (HB0/HB1/HB2)
14.1V / 720MHz	149.05	146.85	3992	26.78	24.21%	40 (104)	51/50/51	65/66/67
13.9V / 670MHz	140.07	136.65	3564	25.44	16.73%	40 (104)	51/49/50	63/63/66
13.5V / 590MHz	123.96	120.54	2920	23.56	2.84%	40 (104)	49/47/48	58/59/61
13.4V / 545MHz	113.65	111.18	2647	23.29	-5.29%	40 (104)	45/43/45	55/55/58
S19 XP (141 TH/s) LuxOS Performance - 110 ASIC chips per Hashboard								
Power Profile (Voltage/Frequency)	5 Min Avg Hashrate (TH/s)	Nominal Hashrate	Power Consumption (W)	Efficiency (J/TH)	% Over/Under Clock	Ambient Temp °C (°F)	Inlet Board °C (HB0/HB1/HB2)	Outlet Board °C (HB0/HB1/HB2)
12.2V / 360MHz	108.06	104.91	2519	23.31	-23.36%	40 (104)	49/53/52	61/65/64
12.0V / 310MHz	92.65	90.33	2096	22.62	-34.29%	40 (104)	47/50/49	57/60/59
12.0V / 260MHz	76.95	75.75	1703	22.13	-45.43%	40 (104)	45/49/48	54/58/56
S19j Pro+ (120 TH/s) LuxOS Performance - 120 ASIC chips per Hashboard								
Power profile (Voltage/Frequency)	5 Min Avg Hashrate (TH/s)	Nominal Hashrate	Power Consumption (W)	Efficiency (J/TH)	% Over/Under Clock	Ambient Temp °C (°F)	Inlet Board °C (HB0/HB1/HB2)	Outlet Board °C (HB0/HB1/HB2)
13.2V / 610MHz	112.29	110.91	3280	29.21	-7.96%	40 (104)	49/51/51	66/69/69
13.0V / 560MHz	104.06	101.82	2885	27.72	-14.70%	40 (104)	49/51/51	65/66/65
12.8V / 510MHz	95.32	92.73	2527	26.51	-21.87%	40 (104)	43/46/46	59/63/63

S19k Pro (120 TH/s) LuxOS Performance - 77 ASIC chips per Hashboard								
Power Profile (Voltage/Frequency)	5 Min Avg Hashrate (TH/s)	Nominal Hashrate (TH/s)	Power Consumption (W)	Efficiency (J/TH)	% Over/Under Clock	Ambient Temp °C (°F)	Inlet Board °C (HB0/HB1/HB2)	Outlet Board °C (HB0/HB1/HB2)
14.5V / 770MHz	159.38	157.05	4514	28.32	32.82%	30 (86)	47/45/47	61/61/66
14.3V / 745MHz	154.25	151.95	4154	26.93	28.54%	30 (86)	46/44/45	58/58/63
14.1V / 720MHz	149.49	146.85	3895	26.06	24.58%	30 (86)	45/43/44	56/57/60
13.9V / 670MHz	139.73	136.65	3450	24.69	16.44%	30 (86)	42/44/44	55/55/59
13.5V / 590MHz	122.78	120.54	2870	23.38	2.32%	30 (86)	43/41/42	54/54/58
13.4V / 545MHz	114.5	111.18	2580	22.53	-4.58%	30 (86)	42/41/41	53/53/56
S19 XP (141 TH/s) LuxOS Performance - 110 ASIC chips per Hashboard								
Power Profile (Voltage/Frequency)	5 Min Avg Hashrate (TH/s)	Nominal Hashrate	Power Consumption (W)	Efficiency (J/TH)	% Over/Under Clock	Ambient Temp °C (°F)	Inlet Board °C (HB0/HB1/HB2)	Outlet Board °C (HB0/HB1/HB2)
12.6V / 460MHz	137.61	134.04	3230	23.47	-2.40%	30 (86)	47/50/49	64/67/66
12.4V / 410MHz	122.46	119.46	2750	22.46	-13.15%	30 (86)	45/48/47	59/62/61
12.2V / 360MHz	108.06	104.91	2519	23.31	-23.36%	30 (86)	43/45/45	55/58/57
12.0V / 310MHz	92.65	90.33	2096	22.62	-34.29%	30 (86)	42/44/44	53/55/55
12.0V / 260MHz	76.95	75.75	1703	22.13	-45.43%	30 (86)	41/43/43	51/54/53
S19j Pro+ (120 TH/s) LuxOS Performance - 120 ASIC chips per Hashboard								
Power profile (Voltage/Frequency)	5 Min Avg Hashrate (TH/s)	Nominal Hashrate	Power Consumption (W)	Efficiency (J/TH)	% Over/Under Clock	Ambient Temp °C (°F)	Inlet Board °C (HB0/HB1/HB2)	Outlet Board °C (HB0/HB1/HB2)
13.5V / 685MHz	127.4	124.53	3778	29.65	6.17%	30 (86)	43/46/46	63/68/68
13.4V / 660MHz	122.33	120	3539	28.93	1.94%	30 (86)	42/45/45	61/66/65
13.2V / 610MHz	112.29	110.91	3280	29.21	-7.96%	30 (86)	40/43/43	57/61/61
13.0V / 560MHz	104.06	101.82	2885	27.72	-14.70%	30 (86)	40/42/42	55/59/58
12.8V / 510MHz	95.32	92.73	2527	26.51	-21.87%	30 (86)	39/42/41	54/57/57

To accommodate a wide range of operating temperatures for air-cooled mining rigs, LuxOS provides a feature called Advanced Thermal Management (ATM). This feature automatically overclocks the rig when conditions are cool (or sets the rig to maximum default hashrate, depending on the user's configuration); it also automatically underclocks depending on board temperatures to keep the hardware hashing while temperatures are warm or hot. ATM can also help users optimize efficiency over a range of underclocking profiles by keeping the miner temperatures at a sweet-spot operating point even at a range of ambient temperatures.

5

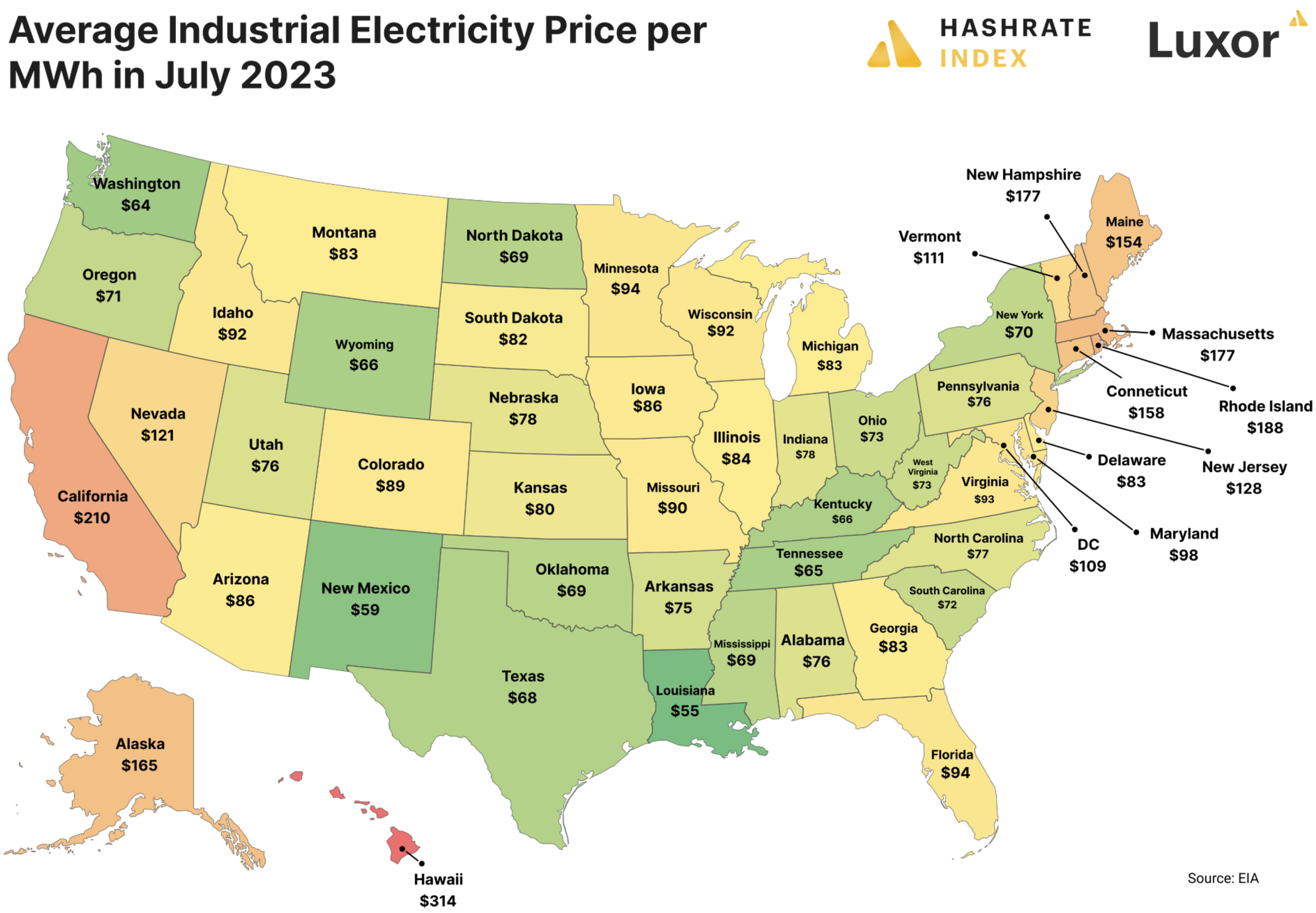
Energy Markets Are Recovering

Since electricity is their primary input cost, miners live or die by their power rates. Disruptions to power markets or changes to electricity price could smoke out some miners from the network, particularly with the 2024 Halving's effect on hashprice.

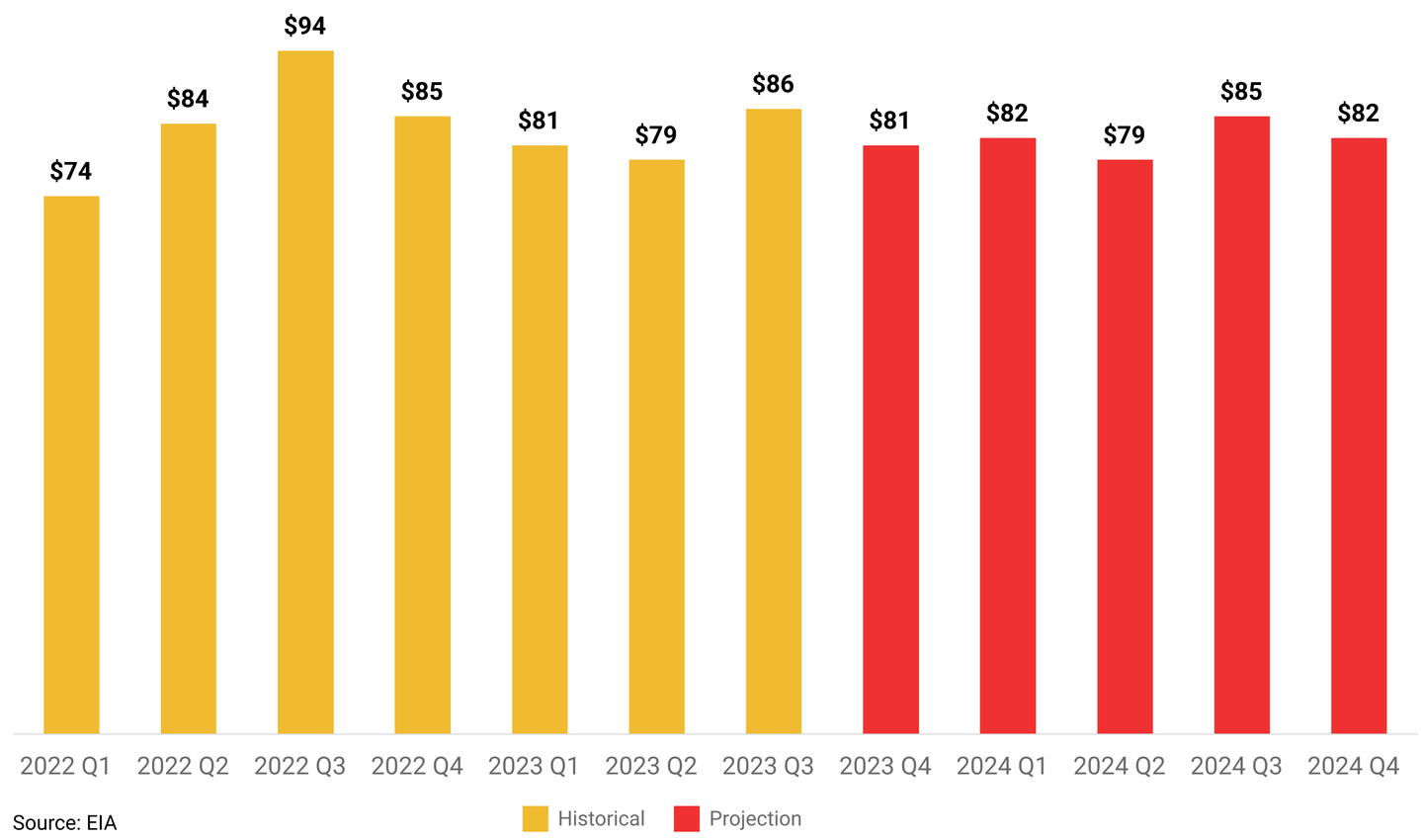
In this chapter, we will look at the current situation in energy markets, focusing on bitcoin mining markets with significant market share like the United States.

Electricity Prices in the United States Stabilize

This time last year, many miners operating in the United States struggled in a horrible market environment characterized by depressed hashprice and severe electricity price inflation. The US's average all-in industrial electricity price peaked at an unprecedented $94 per MWh in Q3-2022, which contributed to the bankruptcy of some of the largest players in the space (namely, Compute North and Core Scientific).



Fast forward to October 2023 and electricity prices have normalized. As the map above displays, prices in mining hubs like Texas, the Southeast, New York state, and the Rust Belt (namely Ohio and Pennsylvania) have reverted to manageable levels, although there are a few outliers (Georgia, for example, is a popular mining state which had high power costs this July 2023). The average all-in industrial electricity price in Q3-2023 was $86 per megawatt hour (MWh), an 8.5% decline from the same quarter last year. Electricity prices in the United States typically peak in the third quarter as demand for air-conditioning and other cooling is at the highest during the summer.



The EIA expects the average all-in industrial electricity price in the United States to fall slightly next quarter and stabilize between $79 and $82 per MWh, but they also expect to see a typical seasonal increase in the third quarter of 2024 to $85 per MWh.

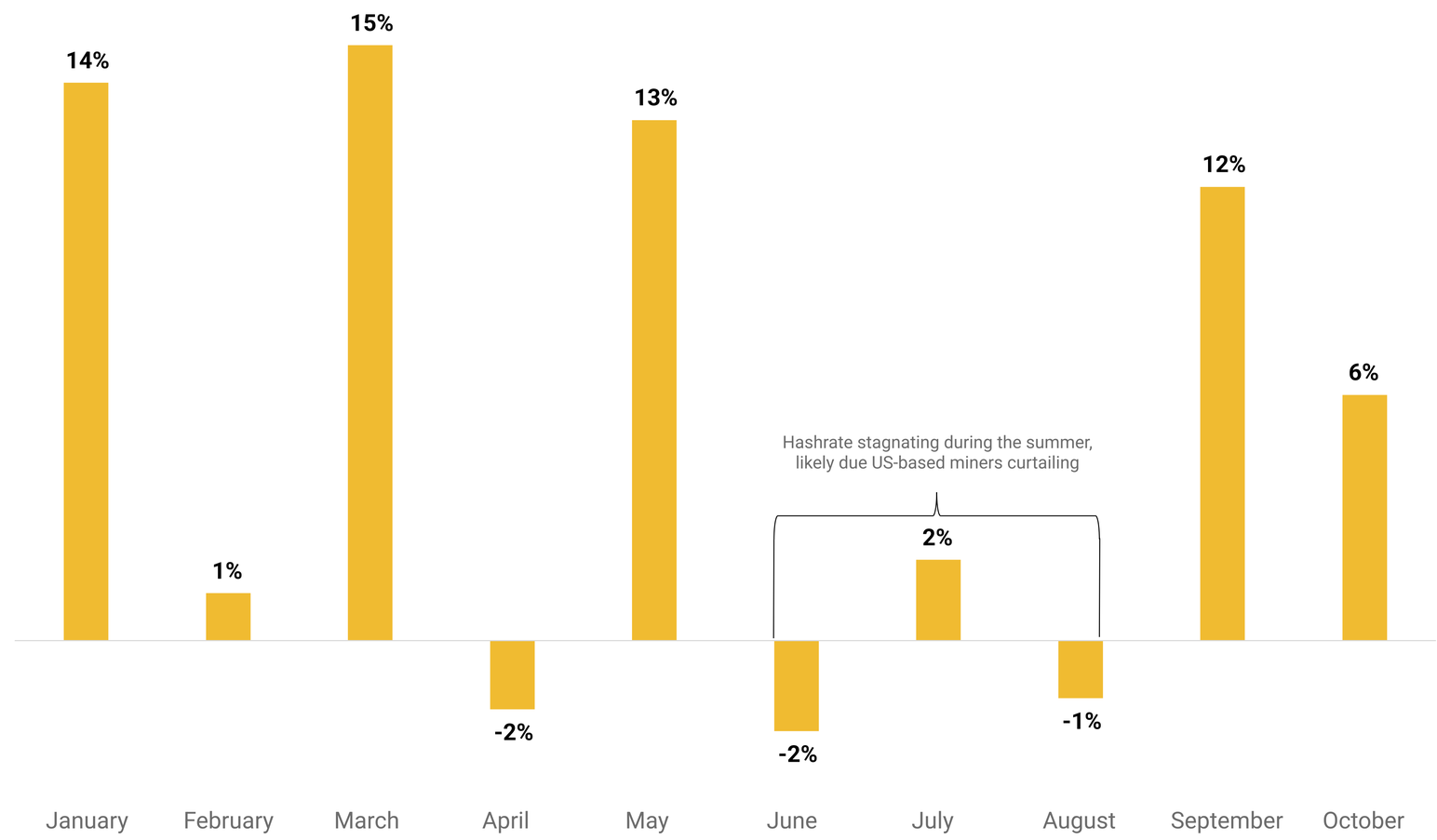
Even though electricity prices are stabilizing, there's considerable risk in electricity markets currently given geopolitical instability in Ukraine and Israel / The Middle East (more on that later in this chapter).

Bitcoin's Hashrate Continues Showing New Seasonality Patterns

Anyone paying attention to the Bitcoin mining industry has likely noticed a remarkable pattern that has repeated itself for the last three years. Bitcoin's hashrate tends to grow in an almost uncontrollable fashion from October through May, but this growth tends to slow down or even retract during the summer months. We particularly saw this pattern in Q3 this year. These seasonal patterns are most plausibly attributed to US-based miners curtailing heavily in the summer months.

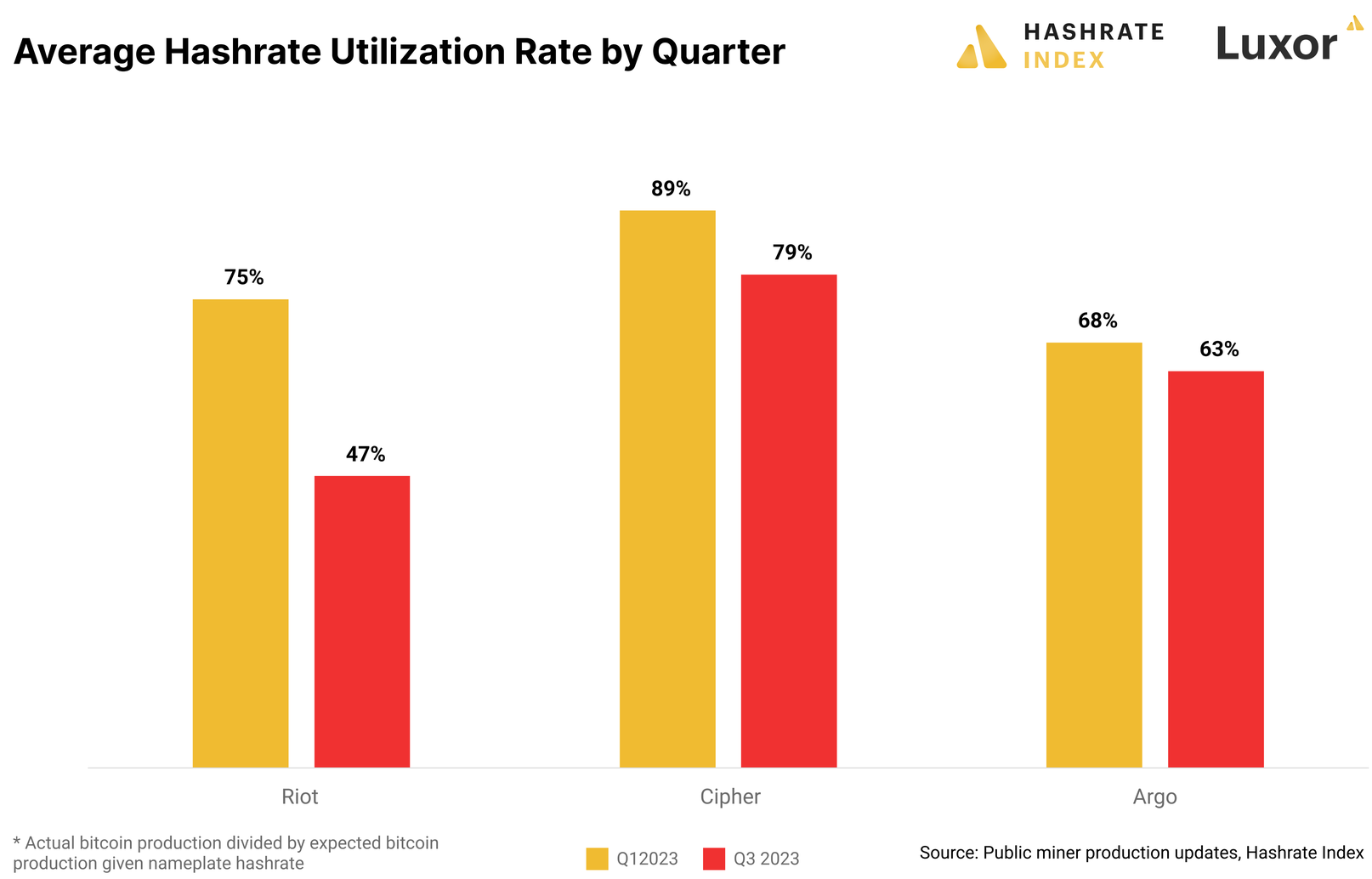
This year, Bitcoin's 7-day average hashrate grew by 56% during the first five months of the year. Then, for the three summer months of June, July, and August, Bitcoin's hashrate fell by 1.3%. In September, it suddenly increased by 12%, ultimately reaching an all-time high in mid-October after growing 6% so far this month.

Bitcoin's Hashrate (7D): Monthly Growth in 2023



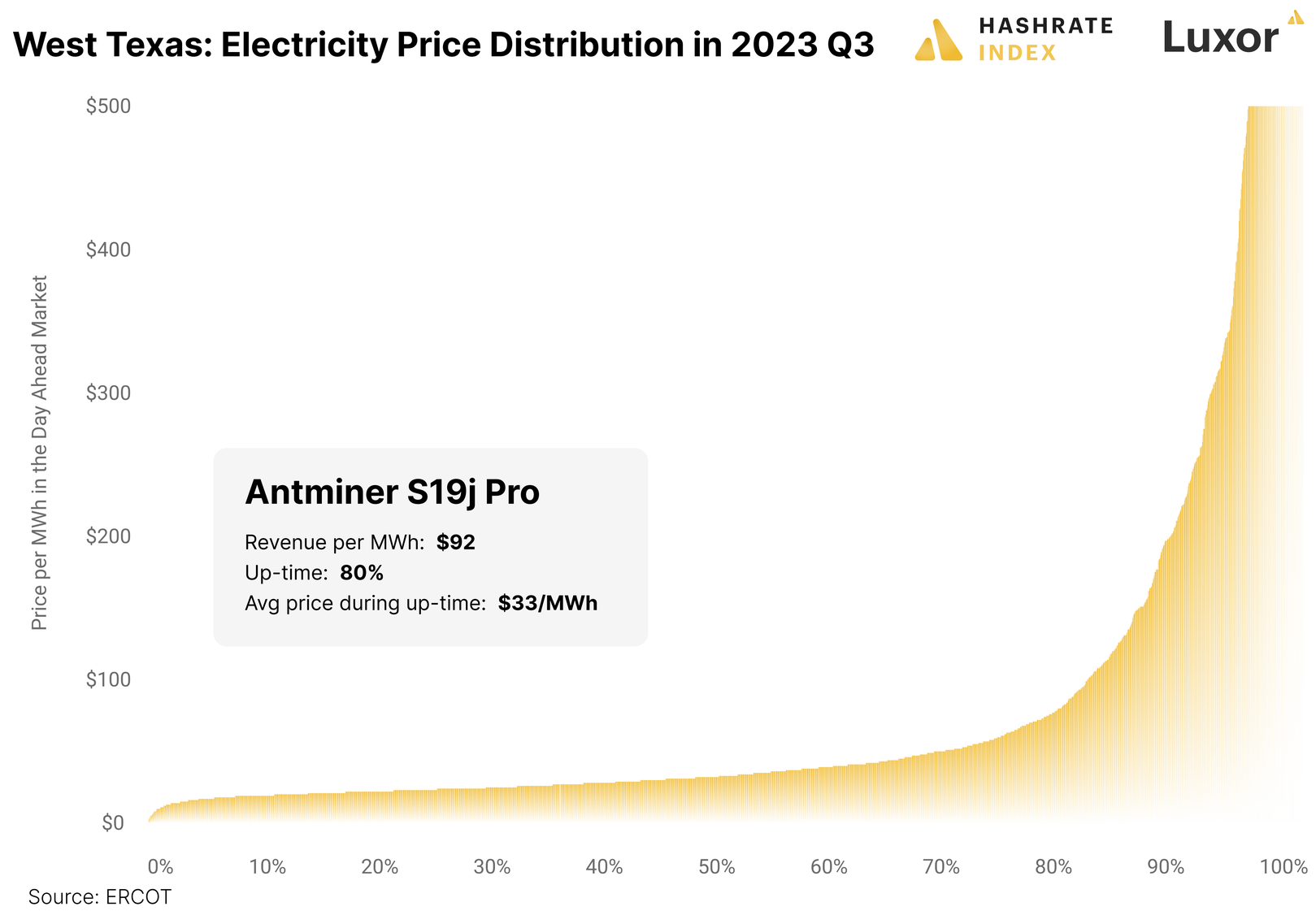
We are relatively certain that this seasonal pattern is caused by US-based miners curtailing during the summer months. The United States houses around 40% of Bitcoin's global hashrate, so any operational changes for US-based miners will ultimately have a significant effect on global hashrate. While miners all over the US are curtailing, either to escape surging spot electricity prices or as part of their participation in demand response programs (we described the different types of curtailment in detail in our Q2-2023 report), Texas-based miners are the most important factor in this phenomenon, as they make up at least 29% of US hashrate.

Indeed, Texas-based miners curtailed heavily in the third quarter, a trend that we can observe in the monthly production updates of a handful of public Bitcoin miners. In the chart below, we compare the hashrate utilization rates of three Texas-based miners in Q1 2023 versus Q3 2023. We see that all of them achieved a significantly lower hashrate utilization rate in Q3 than in Q1, indicating a massive increase in curtailment in Q3.



Riot, for example, earned power credits worth $24.2 million in August, $6.4 million in July, and $8.4 million in June. Depending on the terms of their power purchasing agreements, these are power credits Texas-based miners can earn by periodically curtailing operations during periods of elevated electricity prices.

The chart below shows the power price distribution in West Texas in Q3-2023. As you can see, there were a relatively high number of hours that were priced higher than Q3's average revenue per MWh for the S19j Pro of $92. Texas-based miners normally curtail during these hours. Given this data, a West Texas-based miner running a fleet of S19j Pros would conceivably have an up-time of 80%, and it would curtail the other 20% of the time when power prices surpassed the revenue per MWh of its S19j Pro fleet. The miner would have an average power price during its up-time of $33 per MWh.

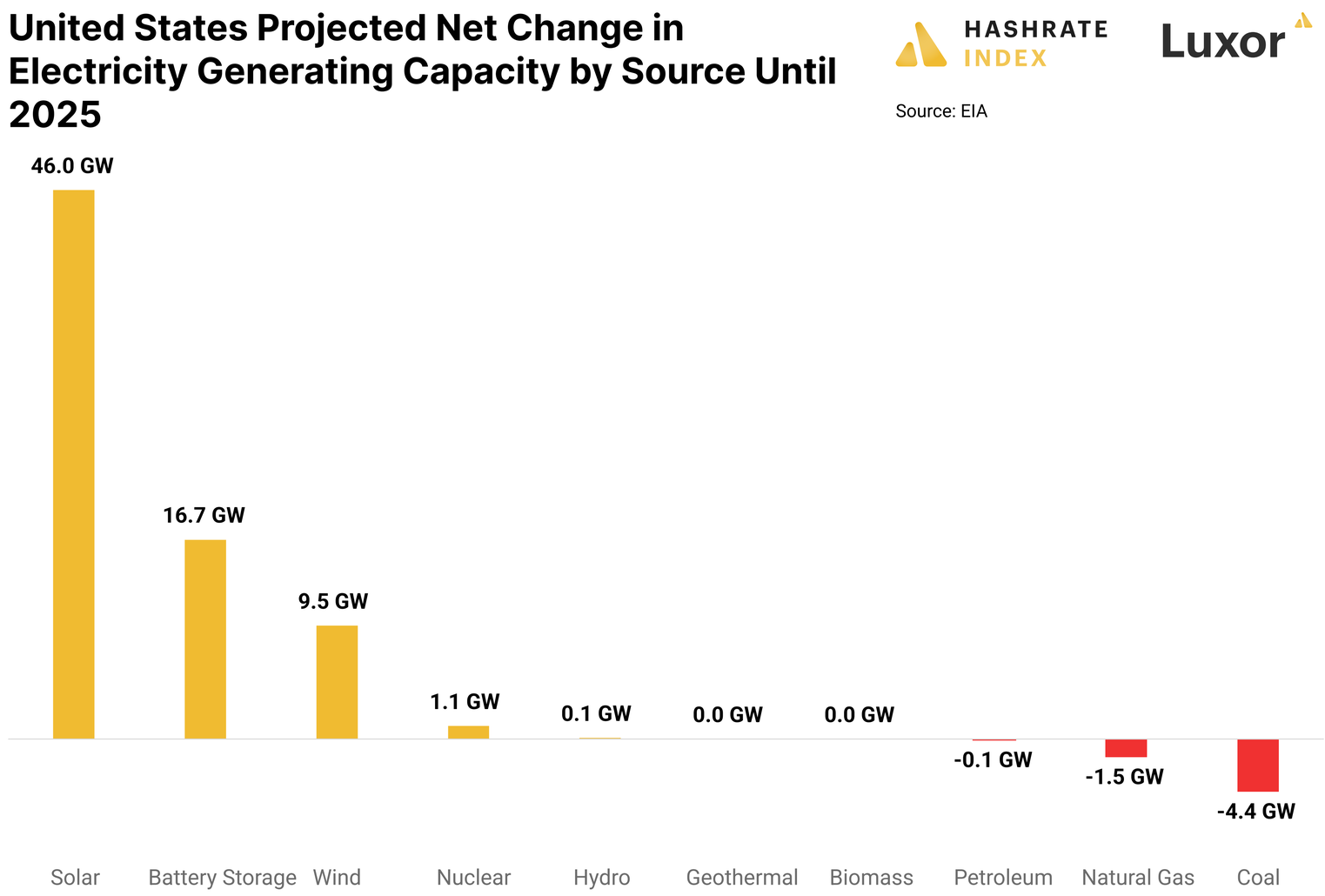


Speaking of the need for emergency demand response, this summer, ERCOT's CEO confirmed that the grid operator came incredibly close to triggering emergency operations that could have ended in rolling blackouts. The shortfall is partly due to the fact that, between 2008 and 2022, Texas' population grew by 24%, while the state added only 1.5% of dispatchable power capacity like natural gas, nuclear, or coal. Additionally, Texas had an especially hot summer, particularly in August, and its wind production, which makes up 20% of Texas energy production on a good day, periodically fell so low that the grid struggled to deliver sufficient electricity to accommodate for surging demand for air conditioning and other cooling. Due to these factors, ERCOT issued eight conservation requests in August, and bitcoin miners state-wide turned off their fleets to free up power for the grid given their exceptional operational flexibility.

All of that said, with electricity prices stabilizing in the entire United States as we move into cooler months, we will see miners curtailing significantly less; this will contribute to steady hashrate growth, as we are already seeing with Bitcoin's hashrate ripping to all-time highs in October.

US Grids Won't Add Baseload Generation Until 2025

The EIA anticipates that the United States' electricity generating capacity will increase by 67.4 GW from now until 2025. Interestingly, almost all of this growth is estimated to come from renewables like solar and wind – not from baseloads like natural gas, hydro, or nuclear.

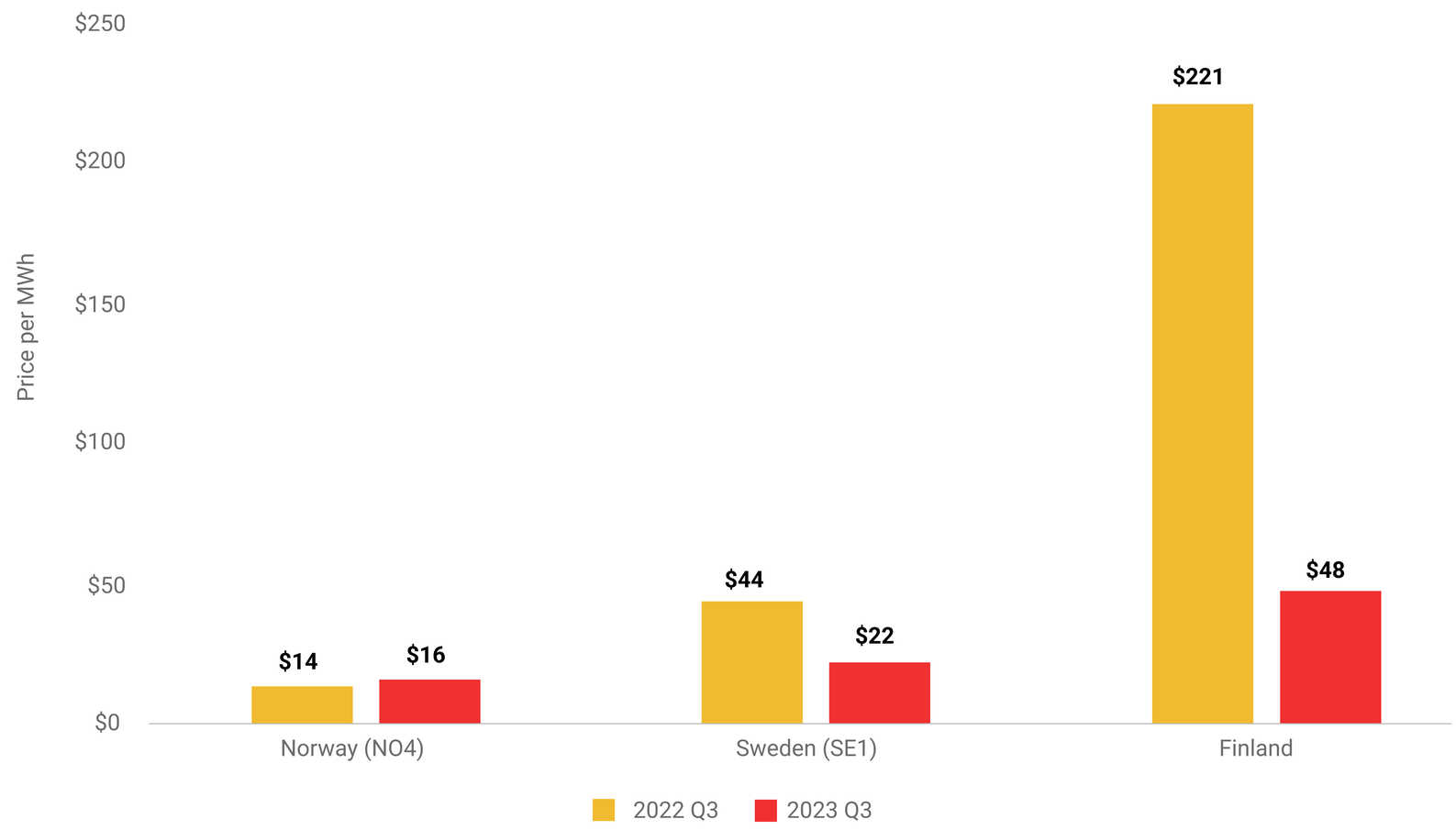


Bitcoin miners are the most flexible electricity consumers and will therefore be able to operate in electricity markets that have deep renewables penetration, as we've seen in Texas. Miners could act as flexible loads to soak up renewable energy production during off-peak hours and curtail during peak hours. However, energy grids need reliable baseloads from energy producing assets like hydro, nuclear, and fossil fuel plants to keep prices stable. As such, over-investment in intermittent and (at-times) unreliable energy sources like solar and wind does not bode well for the country's future ability to keep prices low nationwide; this, in turn, may spell trouble for the country's mining industry in the future.

Nordic Miners Continue to Feast on the Cheapest Electricity in Europe

Electricity prices in Europe have been normalizing, but mining is still only viable in the Nordic countries of Norway, Sweden, Iceland, and Finland. Finland is the newest mining hub on the block, as Finnish miners finally see bitcoin mining friendly electricity prices after getting devastated during the 2022 energy crisis. The average spot electricity price in Finland was $48 per MWh in Q3 2023, compared to the elevated $221 per MWh in the same quarter one year earlier. Finland opened a new nuclear reactor in May, and since then electricity prices have come down significantly.

The Nordics: Average Spot Electricity Price in 2023 Q2 vs 2022 Q2



Source: Nordpool

Finland might be an up-and-coming bitcoin mining stronghold, but miners in neighboring Nordic countries still have access to even cheaper electricity. **Norwegian miners have it best, paying only $16 per MWh on average in Q3 2023 and $14 per MWh in Q3 2022, illustrating the country's low and stable prices.**

Swedish miners saw a substantial decline of electricity prices year-over-year, paying only $22 per MWh in Q3 2023 compared to $44 per MWh in Q3 2022. This low electricity price is important for Swedish miners as the Swedish government increased their electricity tax substantially in July this year.

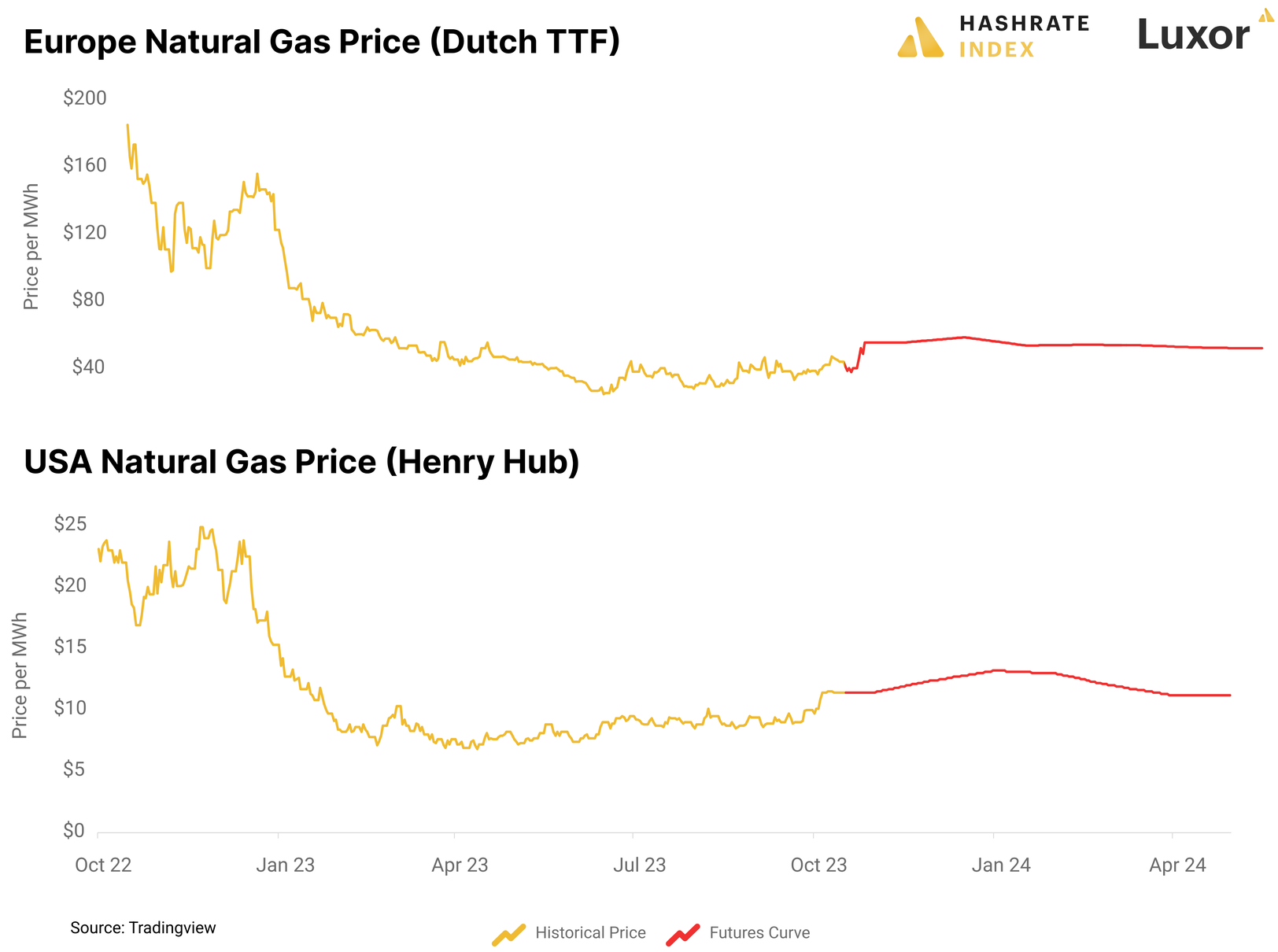
Interestingly, electricity prices in Norway and Sweden are typically substantially lower during the summer than in the winter, the exact inverse of the United States's energy markets. Miners in these countries are running at full capacity during the summer and taking advantage of the seasonality of Bitcoin's hashrate.

We don't have data on electricity prices in Iceland since the market is not deregulated and prices are not publicly available. However, we know from conversations with Icelandic miners that they have access to extremely competitive electricity rates since they can purchase non-guaranteed power that is cheap since its purchase comes with curtailment clauses. As we described in our article on Bitcoin Mining in Iceland, this access to low-cost power, along with political stability and a favorable climate, gives Iceland the highest hashrate-per-capita ratio in the world.

Geopolitical Tension Heighten the Threat of Energy Market Disruptions

While electricity prices have remained stable and the market consensus is that they will remain stable, there's still plenty of uncertainty surrounding global oil, gas, and coal markets. Global prices for fuels like natural gas and coal are highly correlated to electricity prices in most countries, so it is critical for miners to pay attention to these developments.

As you can see in the chart below, natural gas prices in Europe and the United States have increased since July 1, 2023, rising by 46% in Europe and 16% in the United States. Virtually all of these increases came as a spike in October concurrent with Hamas' invasion of Israel and a workers strike at an LNG production facility in Australia.



Recently, Europe has been the epicenter of the energy crisis as the continent is heavily dependent on Russian fuel imports for heating and electricity generation. When the Ukraine-Russia war broke out and the European Union ceased trade with Russia, natural gas prices and electricity prices soared in Europe, and these increases spilled over into the United States as Europe increasingly relied on the US for natural gas, thus bidding up the price. Thus, we should pay attention to the energy situation in Europe as it could dramatically affect global natural gas and electricity prices.

Luckily, the EU's natural gas storage is close to 100% full as a mild winter in 2022/2023 made it possible for Europe to hoard gas. This makes Europe somewhat prepared for next winter, but things could still go down the drain for the continent as the storage capacity only covers about a third of winter demand. Thus, if we see a particularly cold winter, combined with disruptions to natural gas supply due to conflict in the Middle East, Europe could be forced to bid up the price of LNG again, leading to soaring electricity prices globally. This would harm miners everywhere, particularly in the United States. (Still, natural gas inventories in the United States are also expected to be relatively high, roughly 6% higher than the five-year average for the end of October).

Even though Europe and the United States are preparing the best that they can for natural gas supply disruptions, the risk is higher now than in any other time in recent memory as a result of ongoing conflicts in Eastern Europe and the Middle East. In addition, with the 2024 Halving coming up, miners (as always) should ideally hedge electricity prices if they can.

6

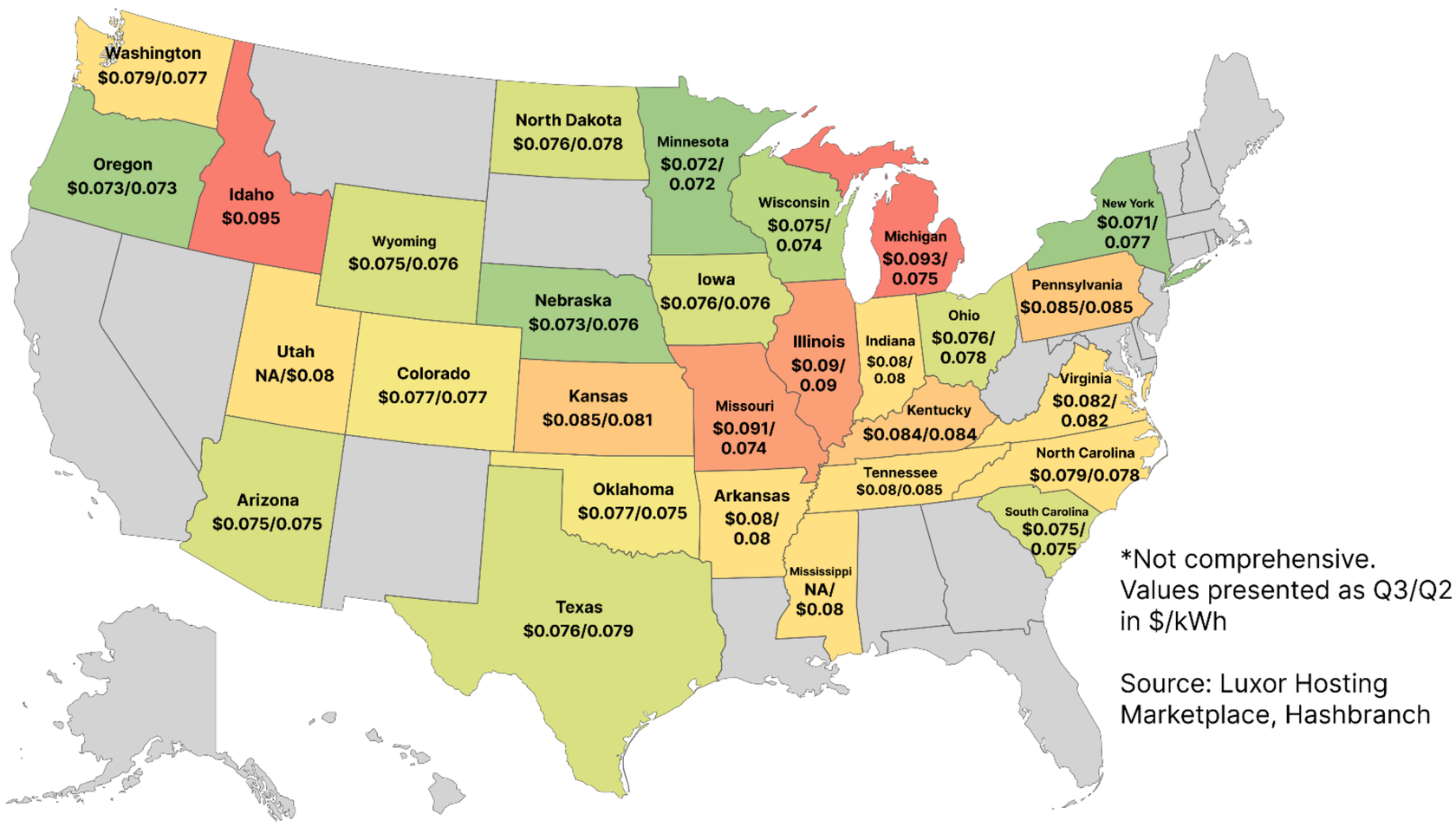
Hosting Data

Hosting Rates in the US and Canada Remain Relatively Stable

Hosting rates in the United States and Canada did not change by any meaningful degree between Q2-2023 and Q3-2023.

Per our index, which pulls numbers from Luxor business data and Hashbranch, **the national average in the United States (for all hosting sizes) was $0.0790/kWh in Q3-2023, versus $0.0787/kWh in Q2-2023; the average in Canada was $0.0725/KWh for Q3-2023, versus $0.0722/kWh in Q2-2023 (all prices are in USD).**

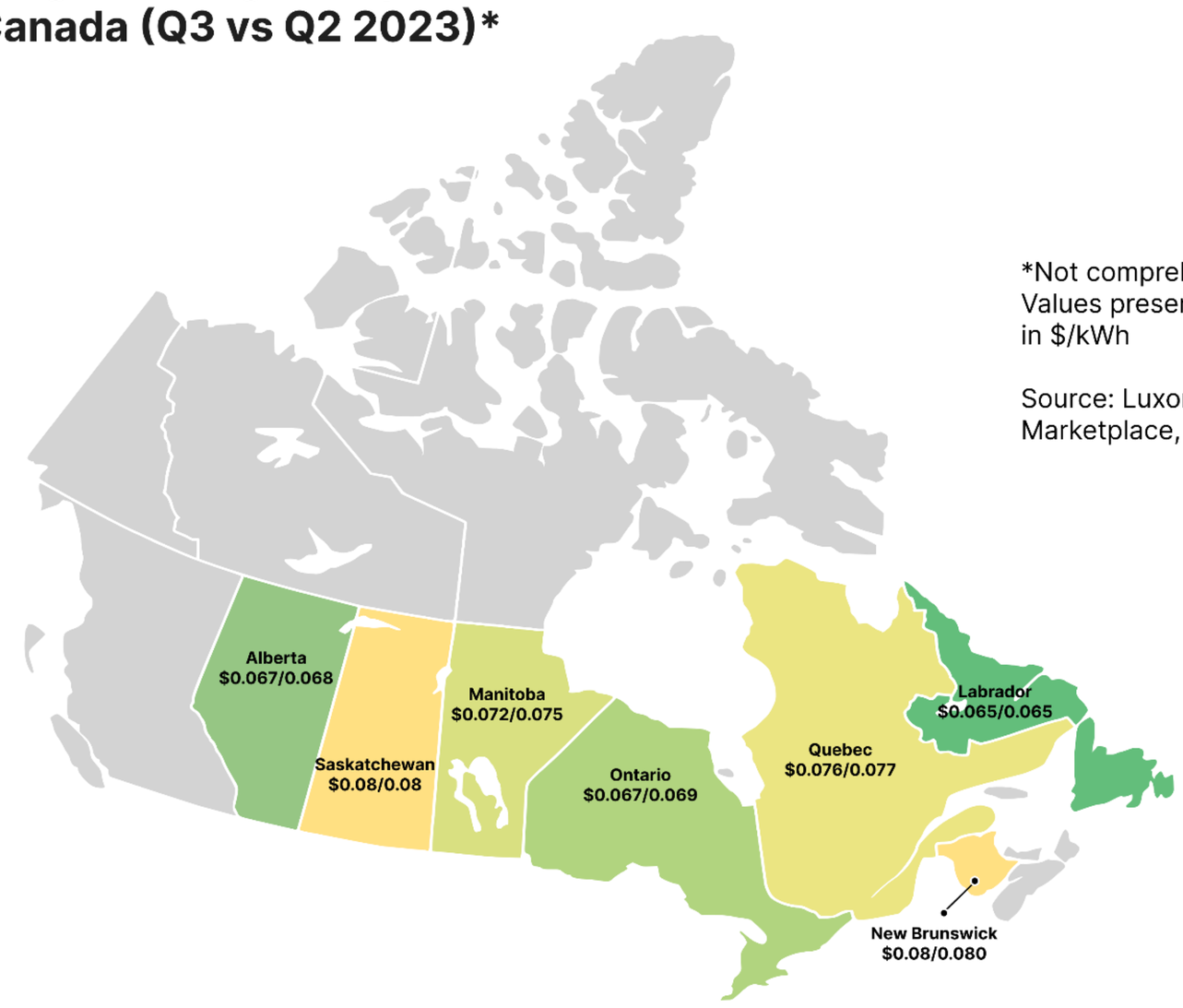
Average Hosting Cost per State in the USA (Q3 vs Q2 2023)*



*Not comprehensive.
Values presented as Q3/Q2 in $/kWh

Source: Luxor Hosting Marketplace, Hashbranch

Average Hosting Cost per Province in Canada (Q3 vs Q2 2023)*



*Not comprehensive.
Values presented as Q3/Q2 in $/kWh

Source: Luxor Hosting Marketplace, Hashbranch

In the United States, the average discount for hosting a large fleet (more than 200 ASICs) versus a small fleet (1-99 ASICs) was 8% in Q3-2023, compared to 7.5% in Q2-2023; the discount for a large hosting agreement versus a medium one (100-200 ASICs) was 6.6% in Q3-2023, compared to 5.3% in Q2-2023.

Taking a look at Canada, the discount for hosting a large fleet versus a small fleet was less drastic at 4.4% (compared to 3% in Q2-2023), although this could be a result of fewer data points. (On that note, we don't provide a discount comparison for medium hosting deployments because we only have data for Labrador and Alberta for this bucket, so the comparison would be skewed).

The discount spread for large deployments grew over Q3-2023. We could attribute this to additional data points in our index, but it could also be a sign that hosting providers have lowered rates as their own power costs have fallen, or in response to market conditions to ensure that miners stay on-site amid thinning margins.

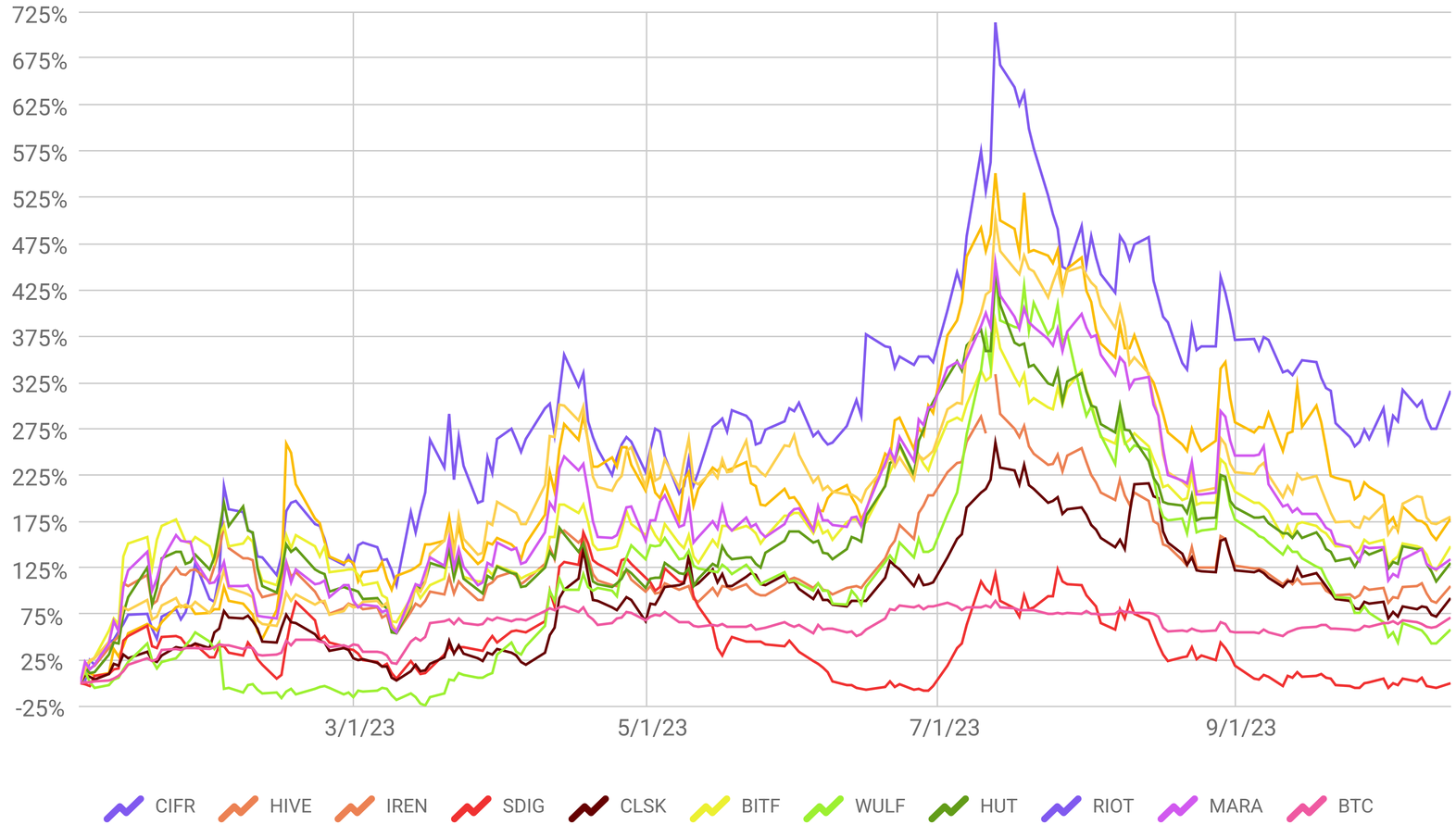
7

Bitcoin Mining Stocks

We cover 25 Bitcoin mining stocks in-depth in our 68 page H1-2023 Bitcoin Mining Stock Report, which is available to Hashrate Index Premium Silver, Gold, and Platinum subscribers. In this section, we touch on public Bitcoin mining stock prices and operational metrics to give a high-level update of data and trends from Q3-2023.

Bitcoin mining stocks started out Q3-2023 strong. Piggybacking on Bitcoin's rally to $30,000, they surged in July, only to slump throughout the rest of the quarter and erase all of the gains they experienced in the first month of Q3.

Bitcoin Mining Stocks and BTC Year-to-Date Returns



Source: Tradingview

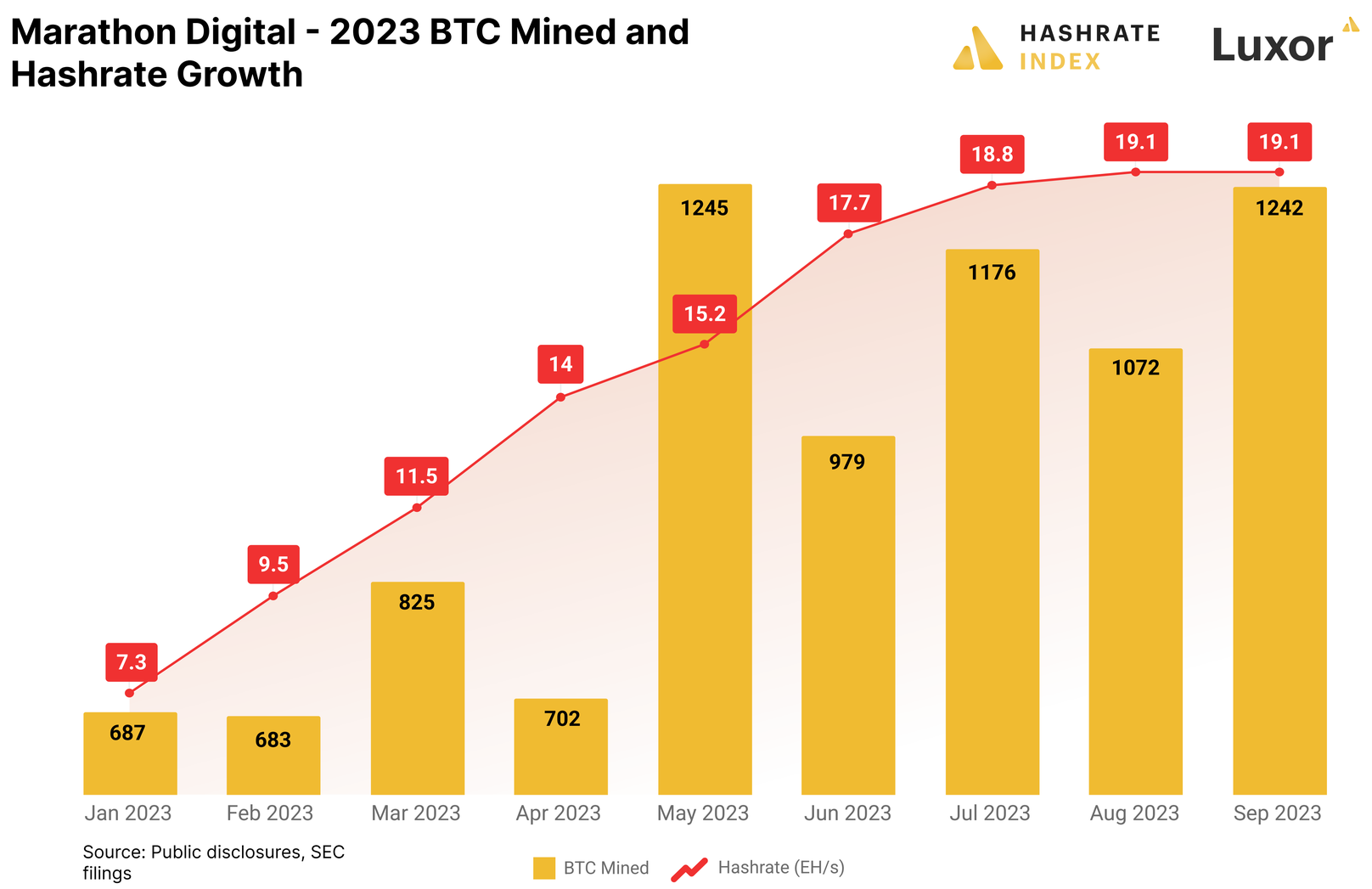
The price action is a good reminder that, generally speaking, Bitcoin mining stocks are still acting as high-beta trades in relation to Bitcoin's price. Rather than evaluating Bitcoin mining stocks based on fundamentals like fleet efficiency, power price / power trading strategies, and operational execution, the market typically values them based on Bitcoin's own price movements. When number go up, Bitcoin mining stock prices go up higher, faster, and vice versa when number go down.

Public Bitcoin Miners Rev Up Hashrate for the Halving

2023 has been a year of aggressive expansion for some public miners as they prepare for the 2024 Bitcoin Halving, although others have lagged behind their peers in their expansion strategies for various reasons.

In this section, we provide monthly hashrate growth on a year-to-date time frame for the largest public Bitcoin miners by marketcap (excluding Bitdeer, which doesn't provide consistent operational updates). We also provide monthly BTC production, and monthly BTC selling and treasury data where applicable (some miners don't provide reliable data for these). Please note, the hashrate figures cited are nameplates that companies report in their production updates and SEC filings, not realized hashrate per month.

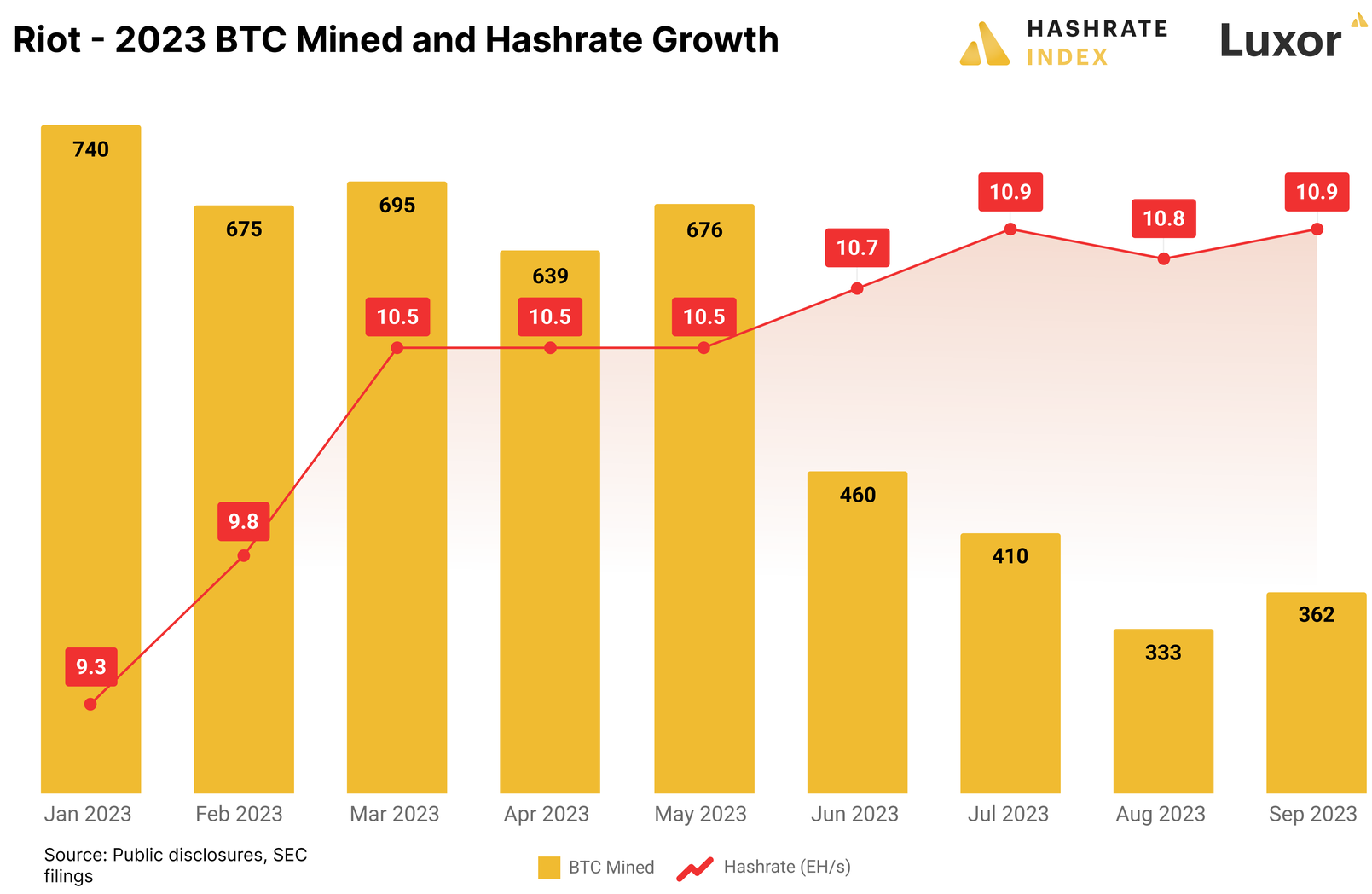
Marathon Digital



MARA	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	1501	709	751	600	554	700	750	750	800
BTC Hodl	11,418	11,392	11,466	11,568	12,259	12,538	12,964	13,286	13,726

More so than years past, Marathon Digital has been able to deliver on its promises to grow hashrate aggressively in 2023, expanding their operational hashrate from 7.3 EH/s to over 19.1 EH/s year-to-date. Marathon Digital has the largest stack of Bitcoin and the largest active hashrate among North American public Bitcoin miners. In recent months, the company's hashrate has remained flat, as energization of its Garden City, Texas facility continues to be delayed. If Marathon Digital deploys their existing stock of S19 XP rigs to replace their S19j Pros, they could reach their 23 EH/s year-end target without waiting for Garden City to be electrified.

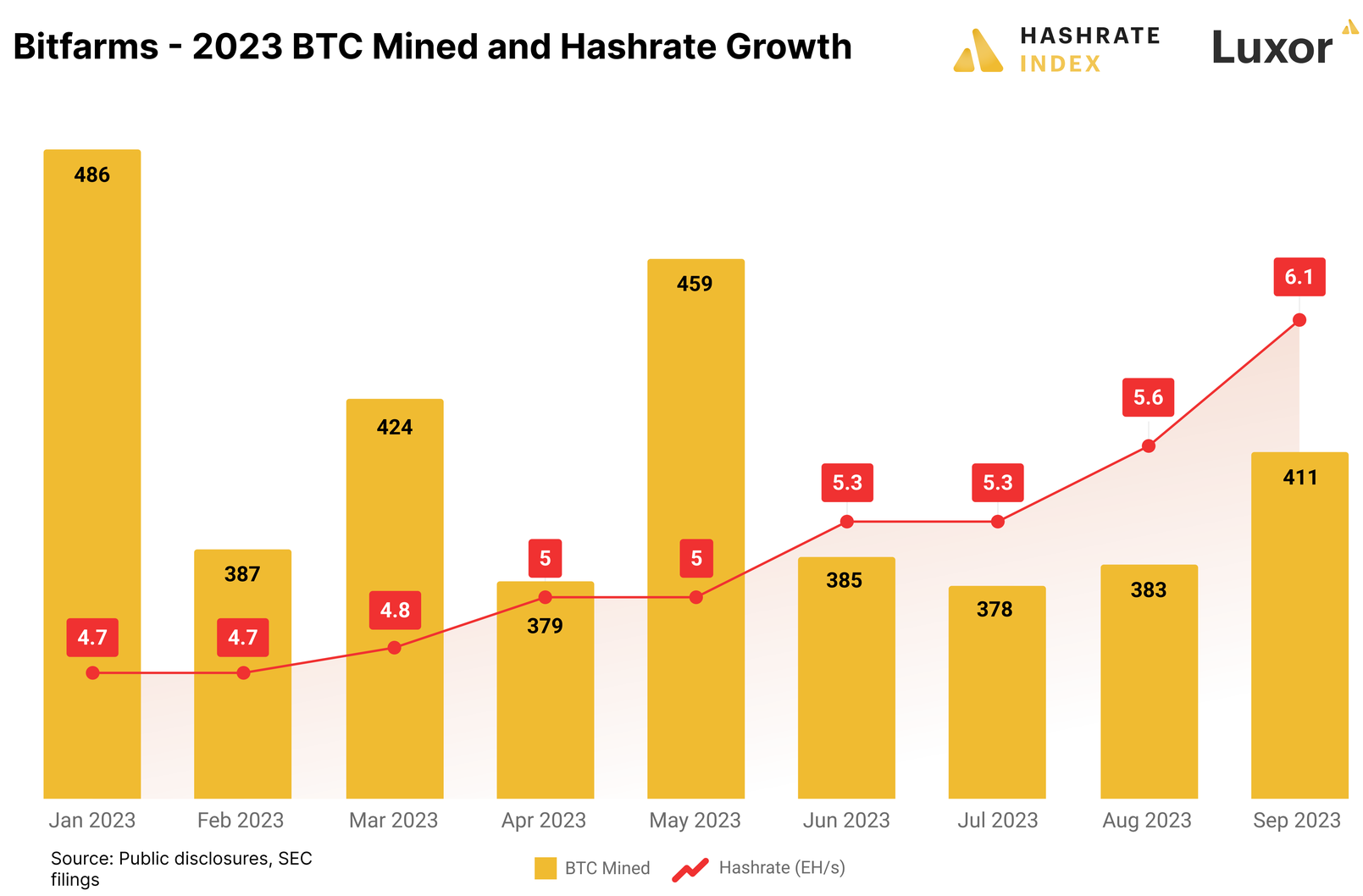
Riot Platforms



RIOT	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	714	595	681	599	600	400	400	300	340
BTC Hodl	6,978	7,058	7,072	7,112	7,190	7,250	7,265	7,309	7,327

Riot Platforms continues to consistently increase its Bitcoin stack month-to-month, even with the reduced growth in hashrate in the latter part of 2023. As we touched on earlier in this report, the primary reason that Riot's bitcoin production fell off during the summer months was due to heavy curtailment. Riot was able to earn more with energy credits during these curtailment events than running their ASICs during these months.

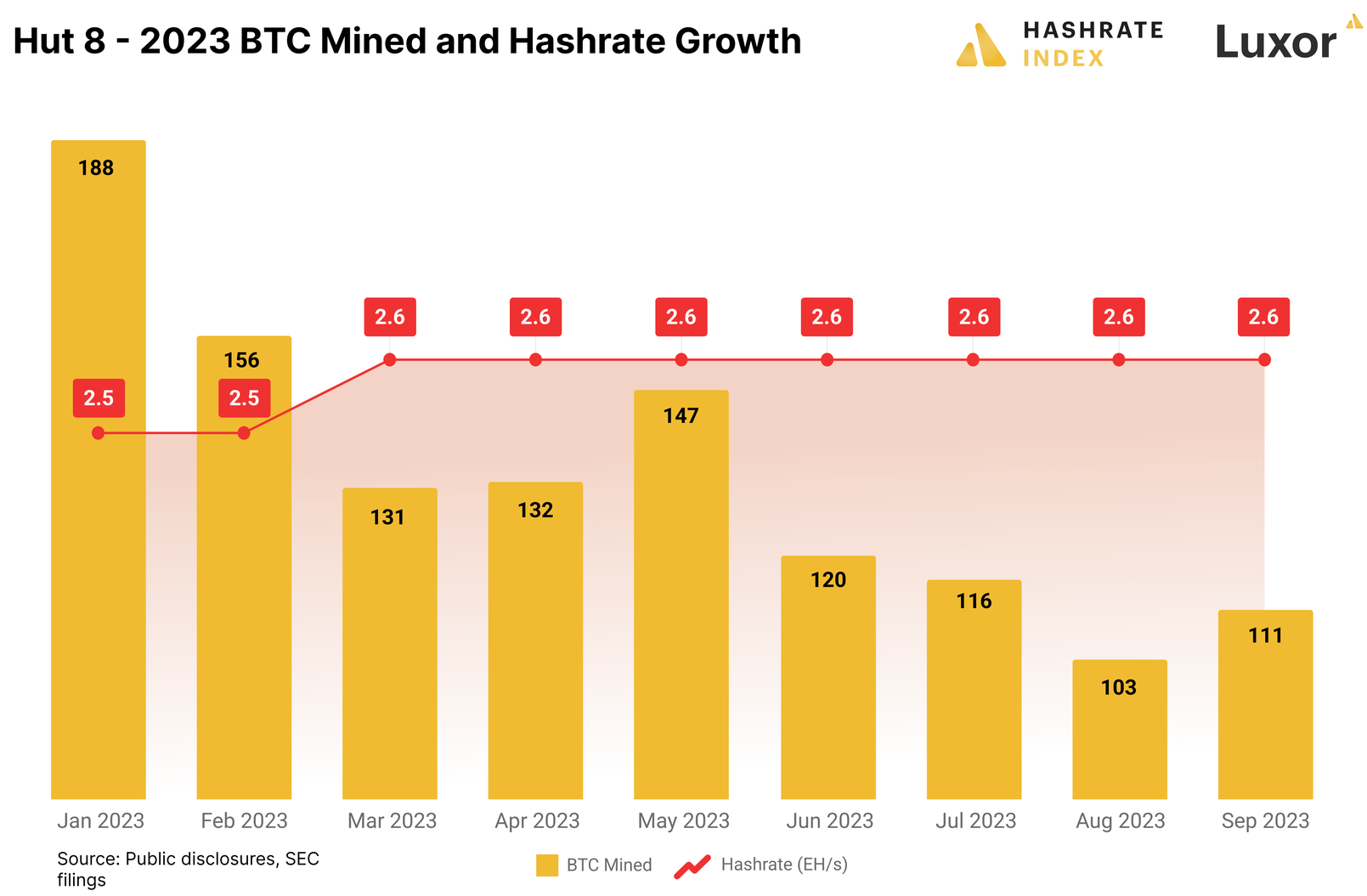
Bitfarms



BITF	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	486	387	394	349	414	346	333	323	362
BTC Hodl	405	405	435	465	510	549	594	654	703

Bitfarms continues to execute consistent hashrate growth month-to-month, growing its fleet from 4.7 EH/s at the beginning of the year to well over 6.1 EH/s today. In the later parts of this year, Bitfarms added BTC to its treasury, while reducing debt on its balance sheet. Bitfarms is certainly overlooked among its peers, perhaps due to its low Nasdaq listed share price or the age of its fleet, which is less power efficient than many of its peers. However, this is part of Bitfarms' strategy, as it employs older, less efficient machines in Paraguay and Argentina where power is cheaper; thus, it can purchase used and less-efficient machines for lower cost and speed up the return on these investments using cheap power.

Hut 8

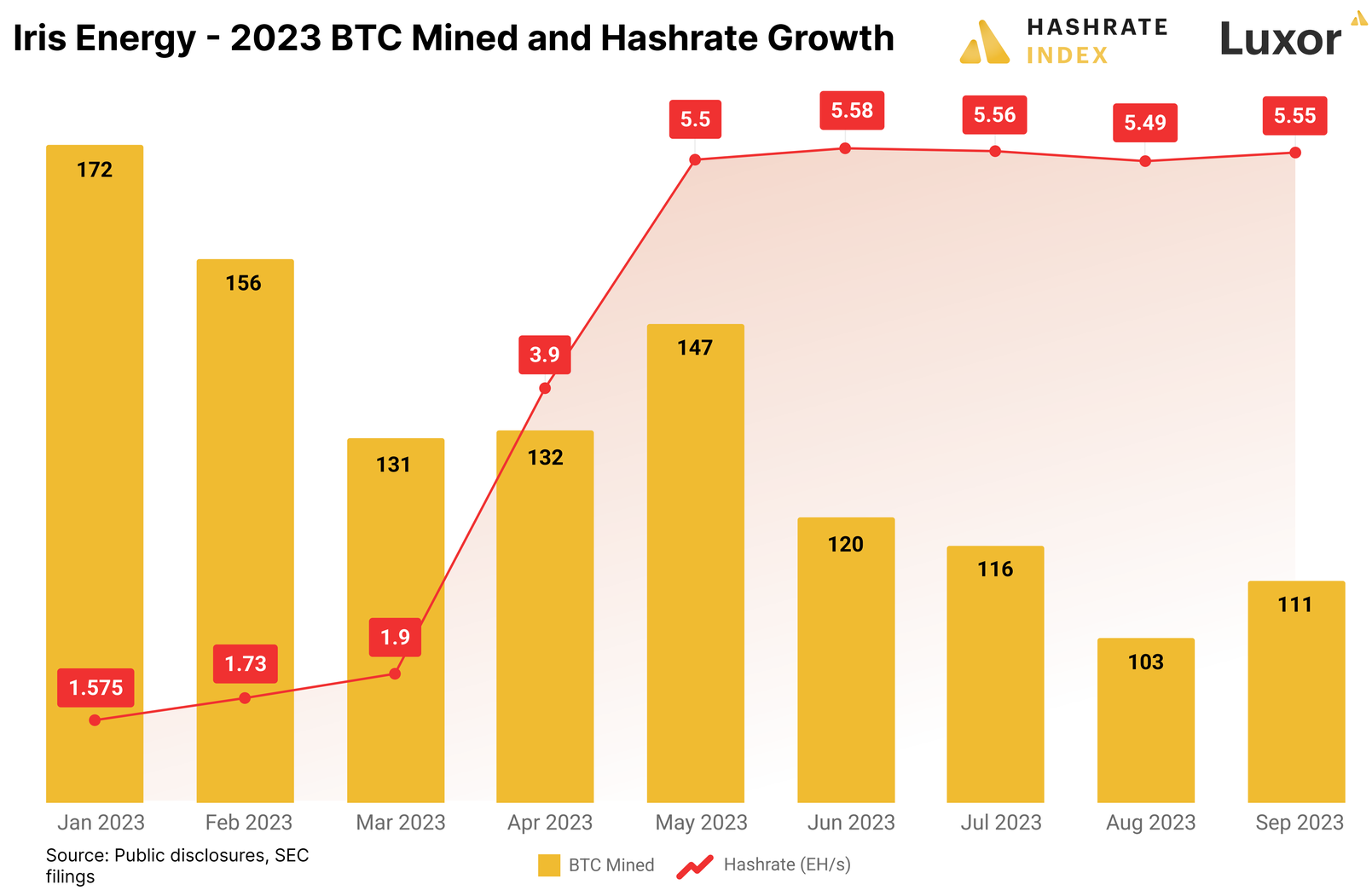


HUT	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	188	156	131	132	147	120	116	103	111
BTC Hodl	9,274	9,242	9,133	9,265	9,233	9,136	9,152	9,255	9,366

2023 has been a challenging year for Hut 8 with regards to hashrate expansion. The two main factors that have restrained its hashrate growth include the ongoing litigation with Validus Power and power damage to its mining rigs at their Drumheller facility. Even with these headwinds, Hut 8 has been able to use cash reserves in addition to the revenue from the data center business it purchased from Terago in 2022 to pay its bills, meaning that the miner has retained its impressive bitcoin treasury.

As Hut 8 approaches the 2024 Halving, most investors are crossing their fingers that litigation will wrap up with Validus Power and that its pending merger with US Bitcoin will finalize. Assuming the US Bitcoin merger finalizes, Hut 8 will have one of the largest hashrates under management of any public or private miner in North America.

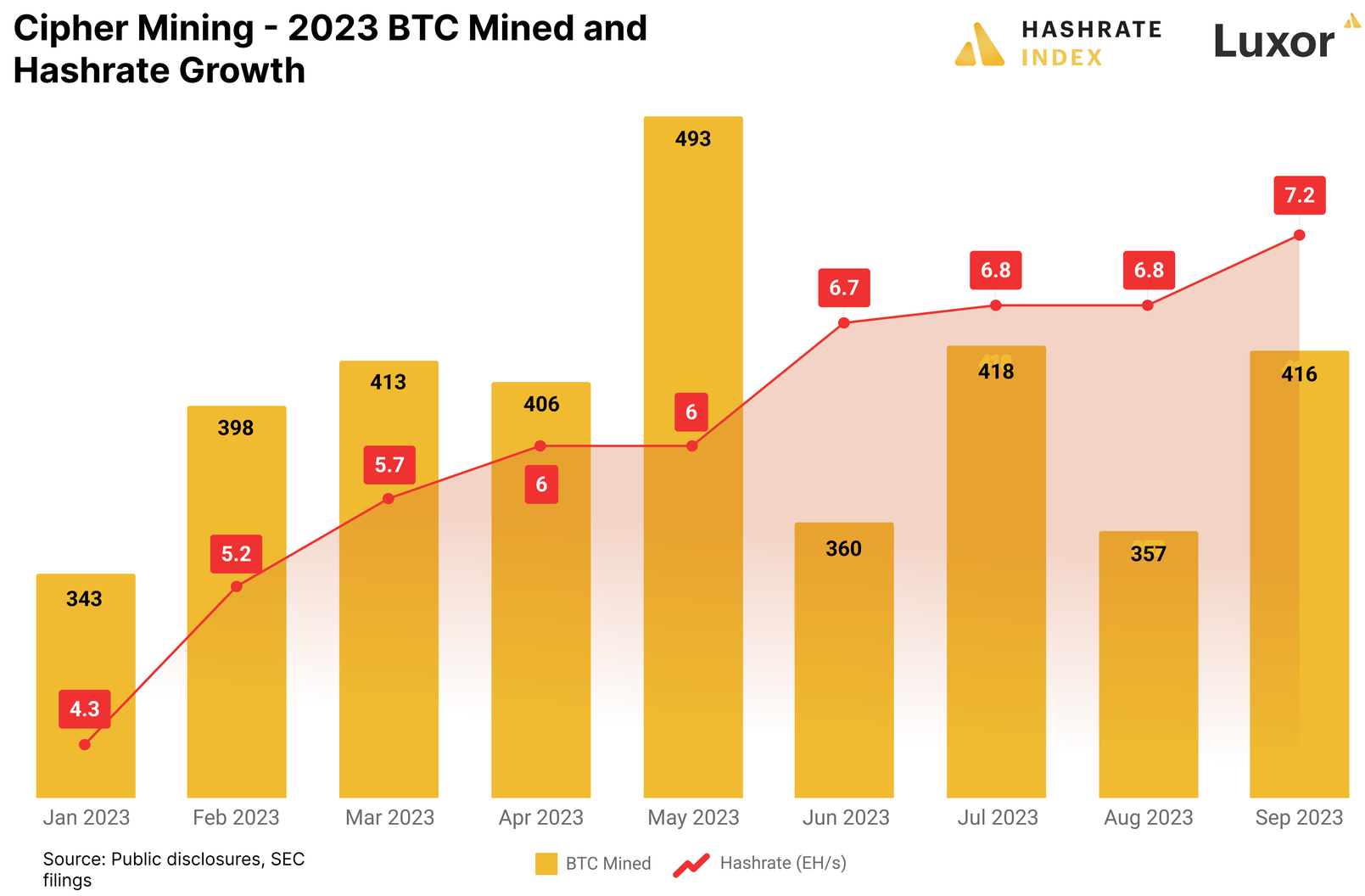
Iris Energy



Iris Energy has been able to dramatically increase mining fleet capacity from 1.57 EH/s to over 5.55 EH/s this year. The main reason for the dramatic growth is that Iris has procured new machines to replace the ASICs it lost when it defaulted on its equipment financing loan with NYDIG. Iris did not grow its fleet very much in the latter half of Q2 or in Q3, leading to a reduction in BTC production due to Bitcoin's difficulty increasing over these quarters.

Iris Energy has a lot of unused MW capacity to expand at its Childress Texas site. Assuming the company can execute on orders for next-gen machines, investors can reasonably expect Iris to grow its hashrate going into the Halving.

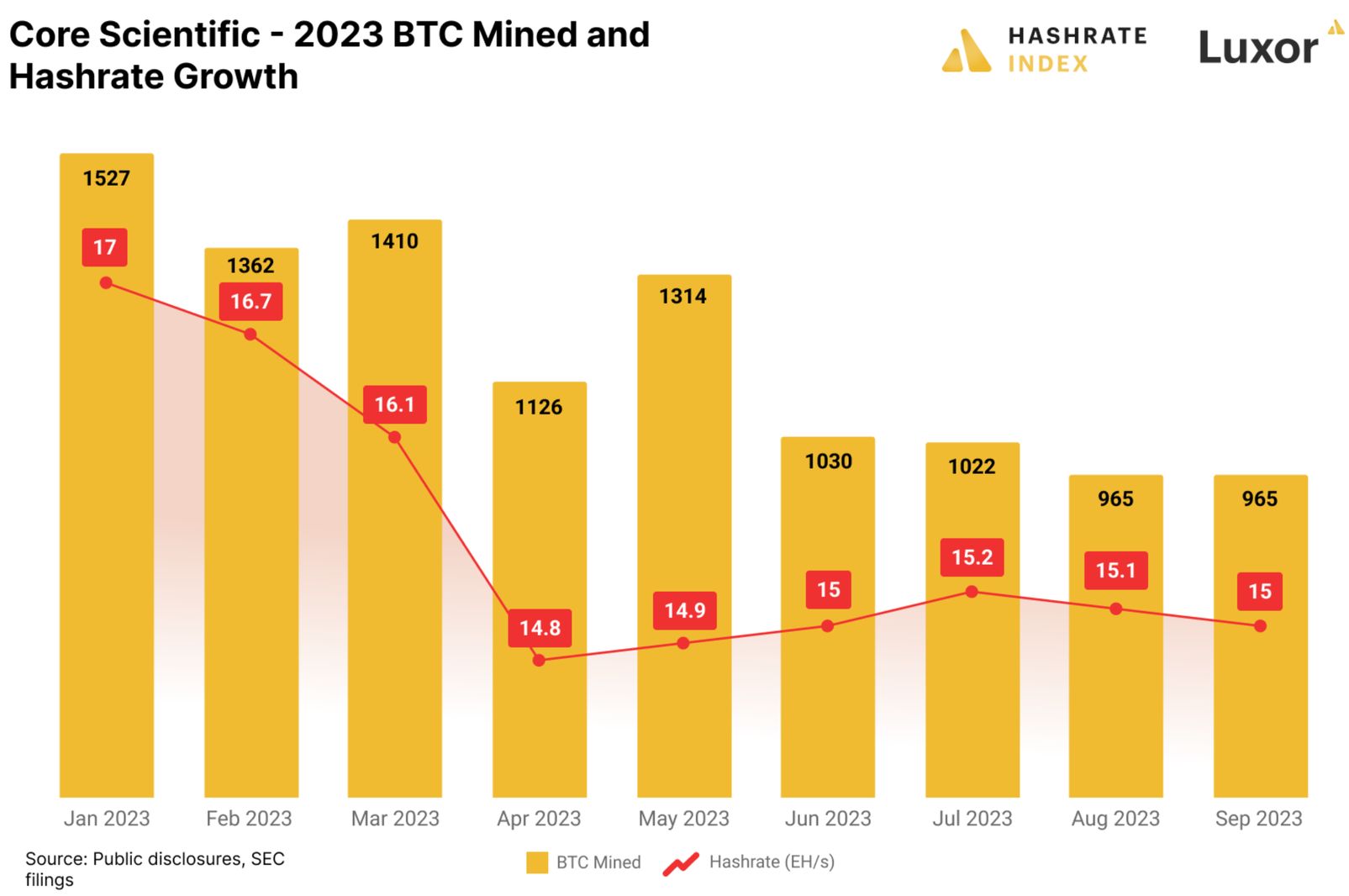
Cipher Mining



CIFR	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	314	357	450	406	513	350	318	355	382
BTC Hodl	424	465	450	427	407	417	518	519	553

Since its SPAC merger in August 2021, Cipher mining has demonstrated a good track record for expansion. It grew its fleet from 4.3 EH/s in January 2023 to over 7.2 EH/s currently. Cipher has been selling most of its mined Bitcoin, but it has slowly increased its BTC treasury this year.

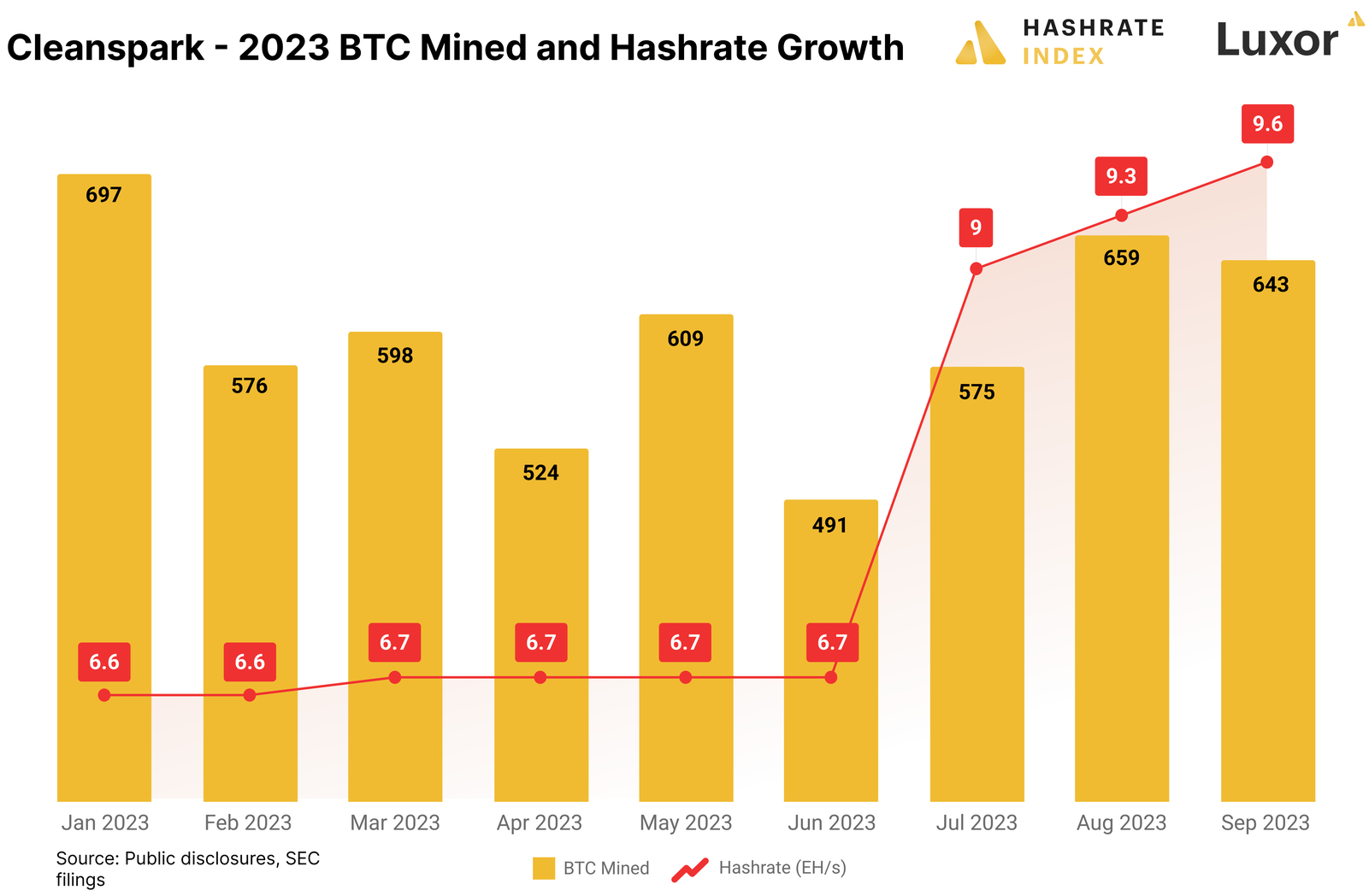
Core Scientific



CORZ	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	1527	1362	1410	1126	1314	1030	1022	1022	1040

Core Scientific has seen a large decrease in its hashrate capacity due to its restructuring during its Chapter 11 bankruptcy. Based on recent 8-K filings from Core Scientific, it appears that the miner could soon emerge from its bankruptcy proceedings. As the company moves out of bankruptcy, they will have more ability to increase hashrate capacity going into the halving. During its Chapter 11 proceedings, Core Scientific sold all of its BTC to pay creditors and cover operational and bankruptcy costs.

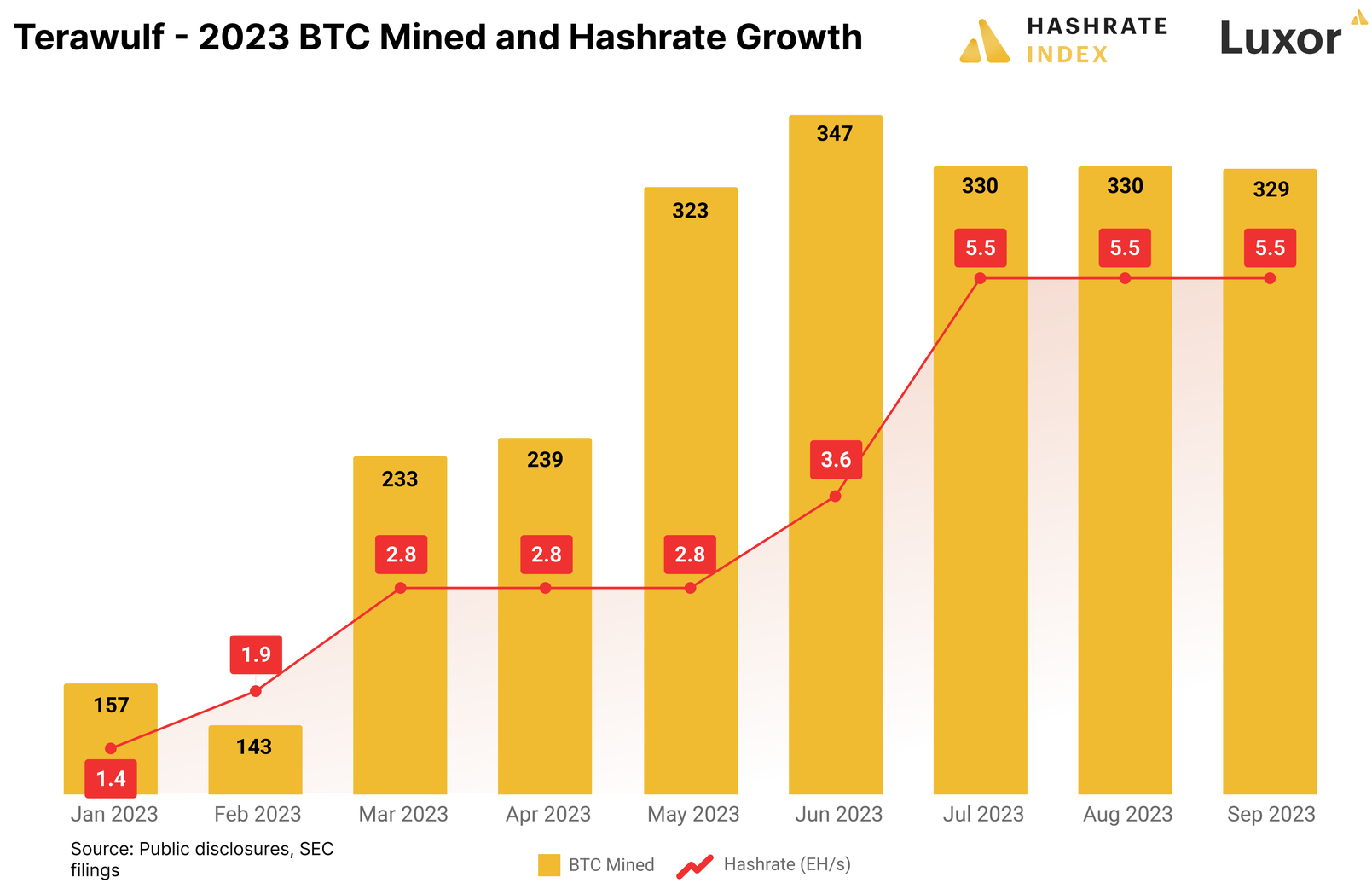
Cleanspark



CLSK	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023
BTC Sold	624	777	502	407	471	413	43	43	80
BTC Hodl	301	100	196	407	451	529	1,061	1,677	2,240

Cleanspark has been able to deliver extraordinary growth in the latter half of 2023. They started the year at 6.6 EH/s and are now well over 9.6 EH/s. Cleanspark recently announced that it secured additional rack space and power capacity to support up to 20 EH/s. To bankroll its fleet expansion, in the early part of 2023, Cleanspark sold most of its BTC production and issued new equity through an at-the-market offering.

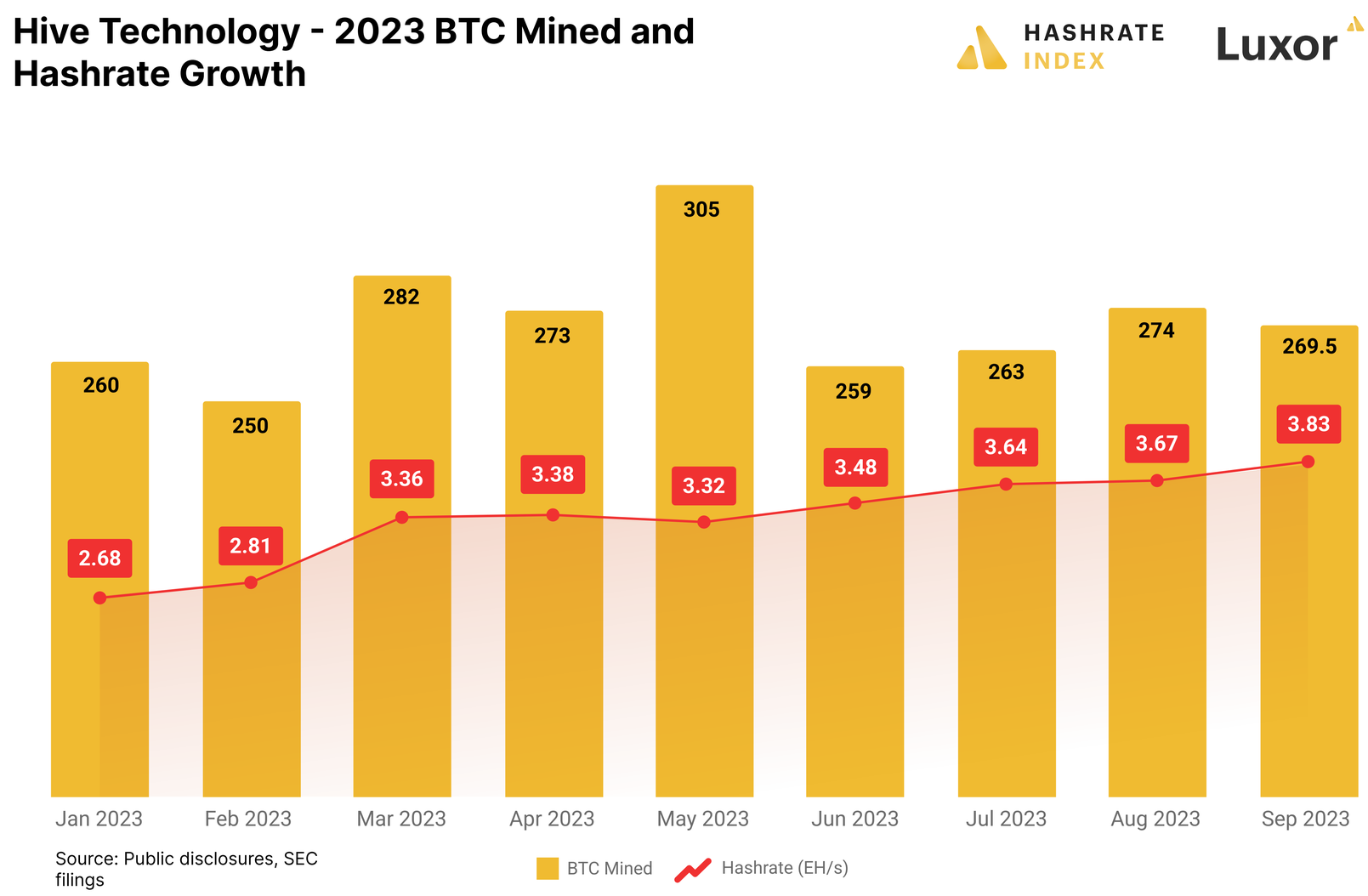
Terawulf



WULF	Jan 2023	Feb 2023	Mar 2023	Apr 2023	May 2023	Jun 2023	Jul 2023
BTC Sold	157	143	233	239	323	347	330

TeraWulf has quickly grown its young fleet this year. At the beginning of the year, the relatively new public miner had 1.4 EH/s of mining capacity online; by spring, their Lake Mariner facility came online, expanding the company's hashrate capacity to 5.5 EH/s, although this growth stagnated in Q3. With a high debt load, Terawulf has sold all of its mined Bitcoin in 2023 to pay its bills. More capacity will continue to be built into 2024, so investors can reasonably expect to see positive growth in Terawulf's fleet.

Hive Technology



Hive started the year with 2.68 EH/s of mining capacity and has experienced slower growth than some of its peers, with its current capacity clocking in at about 3.83 EH/s. That said, Hive leveraged its strong balance sheet in September to purchase next-gen Antminer S19k Pros in a bid to update its fleet. Hive seems keen to upgrade its existing fleet into the halving, as they have not yet expanded into new mining facilities this year. We have not included Hive's BTC selling data and BTC treasury because the company has not been consistent with its reporting in these areas.

Public Bitcoin Miner Geographic Presence

The United States still retains the most hashrate out of any country, both from publicly traded and private mining companies. Looking at Canada as well, more hashrate resides in North America than any other continent, roughly 45% of global hashrate, but that could change after the 2024 Bitcoin Halving.

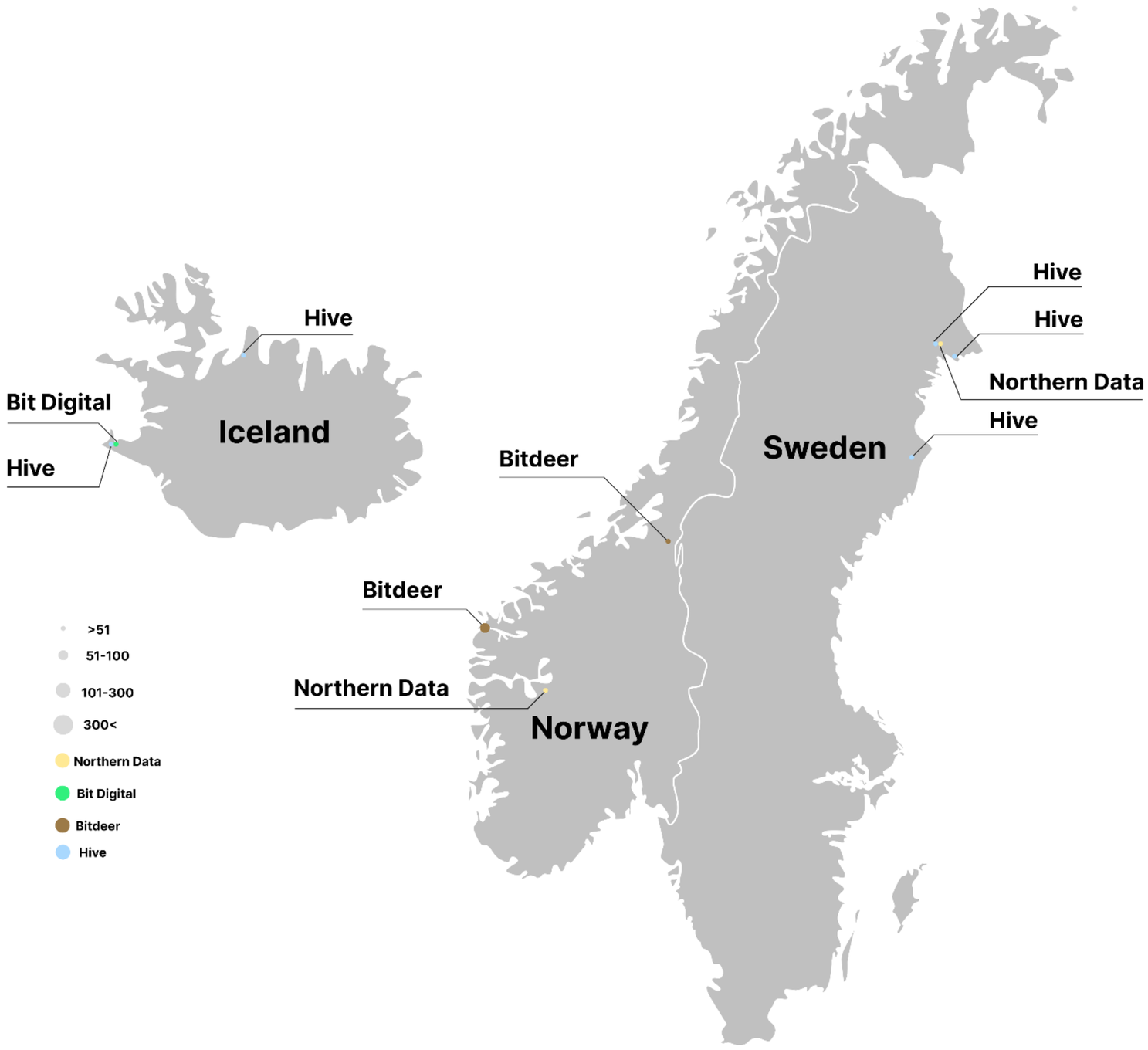
Public Bitcoin Miner Operations (Q2-2023 Close)

Indeed, looking specifically at public Bitcoin miners, geographic diversification has been one of the more notable operational trends in 2022 and 2023. Historically, public Bitcoin miners have concentrated their hashrate in the US and Canada but they've increasingly looked beyond the North American market to expand their operations. The table below gives an overview of other locations where public miners have set up shop (these numbers, like the charts above, are as of Q2 close, so they don't include forthcoming expansions like Marathon's move into the Middle East, to name one example).

Mining Ops (at Q2-2023 Close)	Country	Active MW Capacity
Bitdeer	Bhutan	100
Bitfarms	Argentina	29
Bitfarms	Paraguay	10

Europe has become a more popular destination for public Bitcoin miners than we anticipated – or perhaps more accurately, Europe's Nordic countries have become a popular spot for Bitcoin miners. Norther Data has operated in Norway for quite some time, but others have since set up shop in Norway too, as well as neighboring Sweden and Iceland. Hive, for example, expanded into Iceland in 2020 and made moves into Norway and Sweden shortly thereafter. More recently, Bit Digital expanded to Iceland, and the newly-public Bitdeer set up operations in Norway, as well. We anticipate that this geographic makeup will look much different at the end of 2024 as public miners expand to new geographic locations in search of cheaper power.

Public Bitcoin Miner Operations (Q2-2023 Close)



8

Bitcoin Mining Around the World: Notable Developments

In this section, we breakdown any notable developments in mining hubs around the world, including any relevant legislative action, regulation, and developments with mining working groups / coalitions.

USA

Kentucky

The Kentucky Public Service Commission rejected a contract proposed in October 2022 for a 10-year PPA between the Kentucky Power Company and Ebon International LLC. Per the proposed contract, Ebon would build a $50 million Bitcoin mining site adjacent to Kentucky Power's Big Sandy power plant in Louisa, KY. Ebon's planned site would draw 100 MW for the first two years of the PPA and then 250 MW for the following 8 years. (The PPA's power price was redacted from the commission's order that rejected the contract).

The Kentucky Public Service Commission, which retains "exclusive jurisdiction over the regulation of rates and service of utilities in Kentucky," according to an order from the commission, rejected the contract on August 28, 2023. The commission raised concerns about the Kentucky Power Company's ability to profit from the contract given potential future increases in cost of power generation, as well as its ability to expand quickly enough to accommodate Ebon's capacity. Additionally, the commission took issue with curtailment and interruptibility clauses in the PPA.

Kazakhstan

Kazakhstan introduced new regulations and a new Bitcoin mining tax structure beginning in 2022. The new law has four consequences for miners. First, miners need to obtain licenses to operate. Secondly, miners can only use licensed crypto exchanges and mining pools. Thirdly, miners will be last in line for electricity supplies. Fourth, a mining-specific electricity tax is introduced.

Now, a coalition of Kazakh mining firms are pushing back against these regulations, and their opening blow comes in the form of an open letter to the government.

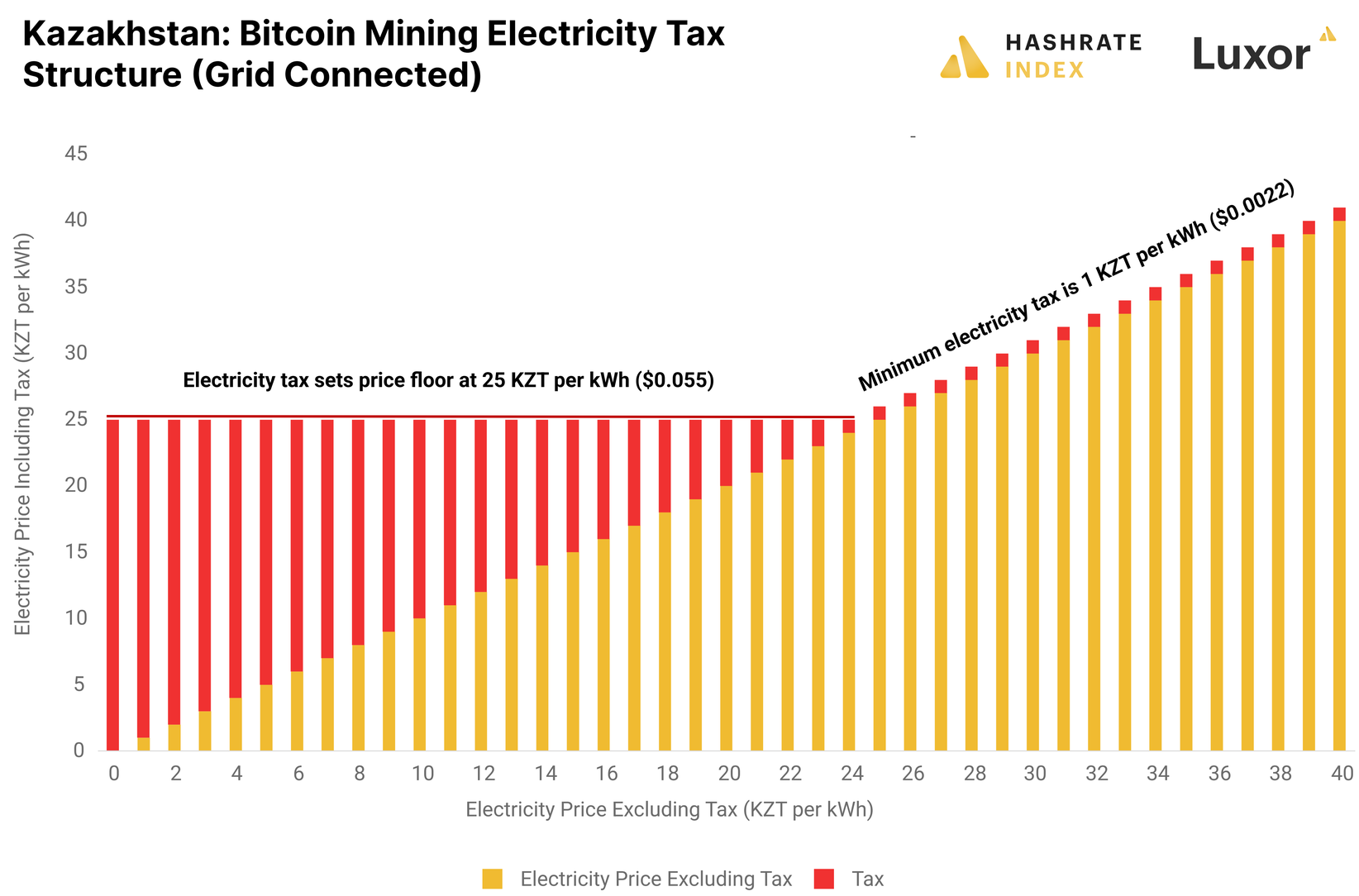
The coalition calls itself the Association of Blockchain and Data Center Industry in Kazakhstan and consists of 8 licensed mining companies: BCD Company LLP, TT TECH Limited Private Limited Company, KZ Systems LLP, AI Solutions LLP, Zhambyl branch of Kinur LLC, Green Power Solution Ltd. Private Limited Company, VerCom LLP and KINUR INVEST LLP. In its letter to the government, the coalition argues that the government's new tax scheme has been detrimental to the country's mining sector and threatens to dismantle it entirely:

[O]ur country lost its share of the global volume of digital mining from 14.03% in 2022 to 4% in 2023. Without understanding the specifics and economic issues, as well as the cost of digital mining, a differentiated a fee rate of up to 26 KZT/kWh [$0.055/kWh], the detrimental effect of which essentially destroys the industry and does not allow digital miners to optimize their activities in order to reduce costs. Up to 80% of the cost of digital assets is the cost of electrical energy.

The regulation's tax scheme has three different tiers:

- For miners purchasing through Kazakhstan's KOREM auction system or importing energy from Russia: A tax up-to 26 KZT/kWh ($0.055/kWh) proportional to a miner's power cost, which effectively sets the minimum power cost to 26 KZT/kWh ($0.055/kWh) – more on this below.
- For off-grid miners using non-renewable energy: A flat tax of 10 KZT ($0.022/kWh).
- For off-grid miners using renewable energy: A flat tax of 1 KZT ($0.0022/kWh)

The first tax bracket is a sliding scale: your tax is the difference between the 26 KZT/kWh ($0.055/kWh) maximum tariff and your power cost. Let's say there is a period with massive excess electricity in the KOREM auction system, and a miner buys electricity for only 6 KZT ($0.011) per kWh. Under this scenario, the electricity tax will be 20 KZT ($0.045) per kWh, driving the total price to 26 KZT ($0.055) per kWh. If a miner's costs are already higher than 26 KZT/kWh, then they pay a flat tax of 1 KZT/kWh in addition.



China

There have not been any publicized developments regarding China's prohibition of Bitcoin mining, but we wanted to provide some commentary regarding the Bitcoin mining industry in the country, particularly with the Fourth halving approaching. (The following commentary is based on conversations with Chinese Bitcoin mining professionals).

Despite the ban, there's a remnant of Bitcoin miners in China who are mostly concentrated in the Northwest in the coal-rich region of Xinjiang. These operations are usually smaller scale, typically anywhere from 10-20 MW, although they can be as large as 50 MW. These miners are operating older hardware, a mixture of mid-gen (e.g., S17 series) and new-gen (e.g., S19 series) rigs, but they do not have access to next-gen machines like the S19 XP, the S19k Pro, or the forthcoming S21. It's illegal to import ASIC miners into China, so both the miner and the ASIC vendor would be taking a huge risk if they did business inside the country.

As such, we expect the country's hashrate share to gradually decline over the coming years as other geographies scale up operations with the latest generation machines. Of course, this could all change if the Communist Chinese Party (CCP) reverses course on its ban – but the miners we talked to don't believe this will happen.

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