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Beyond the kWh: A Decision-making Framework for Bitcoin Miners. What various Whatsminer Models Tell Us.

distributed hash research is dedicated to studying the mining ecosystem and producing content that empowers miners of all sizes and experience levels. For project consultation, hosting, or general inquiries, please email hosting@distributedha.sh

The bitcoin mining space is rife with anecdotes, best practices and old wive's tales about ideal operating conditions for ASIC computers. Beyond this, the market is only beginning to discuss environmental factors, contracting, and alternative cooling mechanisms. For example, newer market entrants like MicroBT Whatsminers and their various M30S ASIC models are often seen as excellent hardware, but are comparatively under-studied relative to market competitors. In this paper we review empirical data generated via API query across multiple models of Whatsminer M30S to begin answering the broader ASIC question, "How do I make intelligent decisions around self mining and/or hosting my machines?"

These data should be viewed as the beginning of a conversation around ASIC optimization and not a series of hard and fast rules for operating machines or facilities.

Notes on Miner Data:

The following data were collected in a dry, Western environment at an altitude over 4,000ft, but below the manufacturer recommended maximum operating altitude of 6,561ft (2000m) for most new generation miners. Data was collected via API query in a single air-cooled datacenter across multiple weeks. Temperature conditions varied between a high of 94.3F (34.62C) midday and 41.2F (5.1C) in the evenings. Precipitation was .22in over the period of data collection with humidity between 93% and 15% (average 49%).

Miner Decision-making:
Rates, Hosting and Contracting

Bitcoin miners are taught to consider kWh as the golden number. The sacred kWh is often the single vector of decision-making when deciding when and where to mine. However, as experienced miners will attest, cheap energy is only meaningful when 100% machine uptime is assumed. Additionally, for miners who host their machines with third parties or have signed power purchasing agreements with mandatory minimums or fixed consumption agreements, these contracts are only cost-optimized when uptime is near maximized.

Considering only kWh when mining or hosting is both naive and financially reckless.

Imagine hosting a new generation miner for an agreed upon 6.5c/kW. Your bill starts at $154/month, plus most companies have additional fees that can push your your bill closer to $200/month per miner (so you're already at an effective rate of 8.6c/kW before you power up). However, that's not all that influences your effective kWh rate. The overall uptime of your machine or facility and the way those terms are contracted is, especially these days, becoming a large factor in profitability.

If you're contracted to pay a fixed $200/mo on your machine (we assume a hosting provider has a cheaper rate per kWh than 6.5c and makes money on the spread). What happens when a heatwave rolls through your state? A provider, or you, powering down your machines 50% of the time while you pay a fixed $200/mo to generate sats via your chosen pool effectively doubles your cost of Sats production to over 17c/kW.

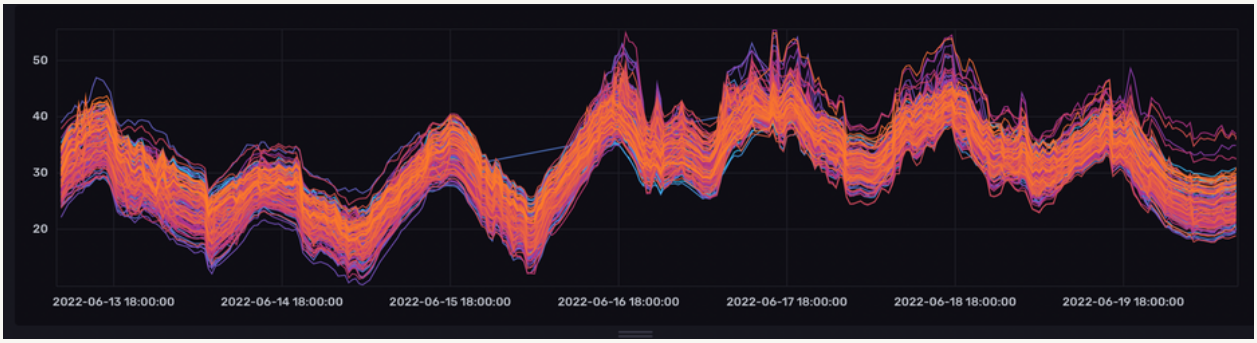
Outside of contract issues, uncontrollable factors such as environmental conditions, grid level supply issues (not to mention unexpected geopolitical upheaval) can invert even the most optimal contract for cheap kWh and leave operators hemorrhaging money with no recourse. What's more, these factors come before consideration of macro bitcoin market conditions such as difficulty and price.

In the future, we hope to provide additional tools for miners to better navigate their hosting agreements, facility operations, and external environmental conditions to maximize their Sats production and minimize their risks.

Heat, Modes, and Down Time in Whatsminer M30s Models

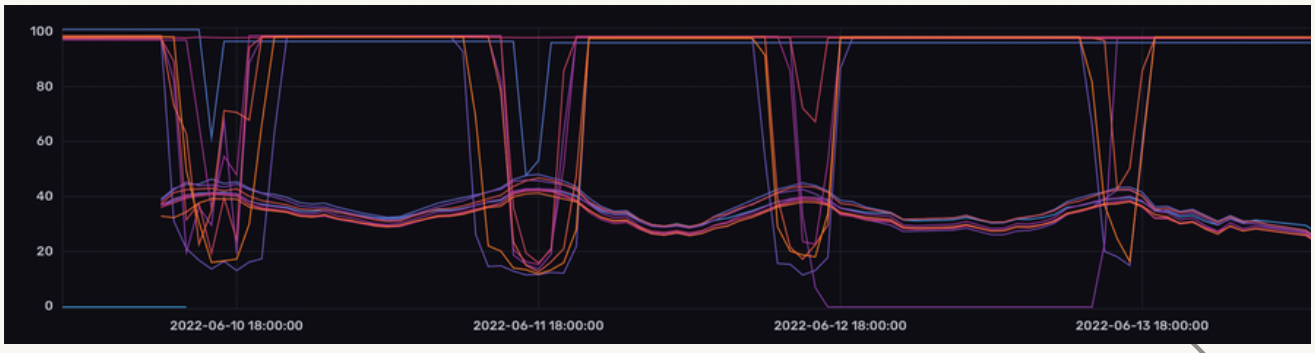
Ambient heat poses a significant challenge to current air cooled ASICs.

All miners should consider geography, altitude, humidity, and temperature when choosing which machines to purchase and operate. We look particularly in the following data at various Whatsminer M30S ASICs (M30S 86T, M30S 92T, M30S+ 102T, and M30S++ 106T) and have a few broad suggestions regarding which machines are optimal in environments that are subject to high summer heat.



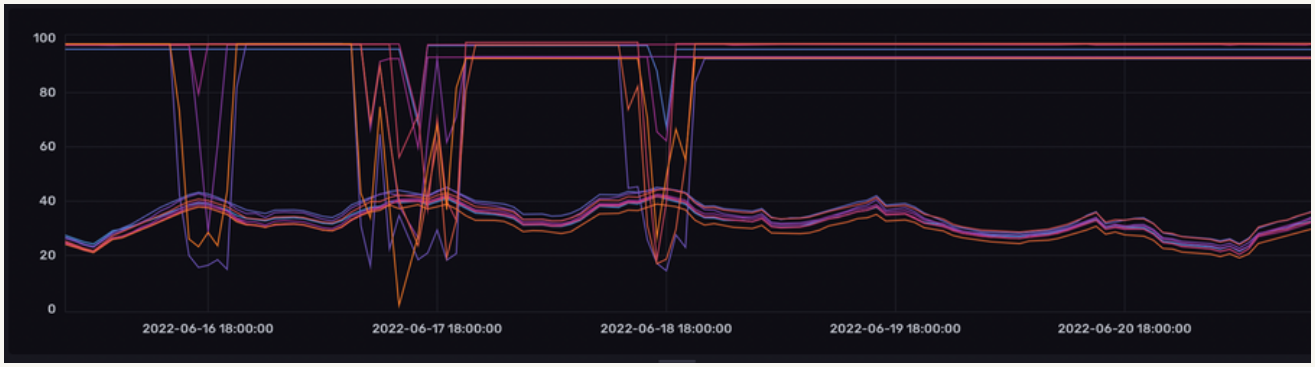
Consider the above capture of machine reported environmental temperatures over a five and a half day period. You will notice a general sine wave pattern reflecting the heat of the midday and the cool of the night. There is a more general cooling effect for the first three days, followed by a number of hot days in quick succession. Additionally, notice how machine reported environmental temperature towards the righthand side of the chart become more chaotic as ambient temperature increases overall.

A series of hot days are what pose the most serious risk to miner operation. During peak heat hours miners will automatically reset or switch to idle until the ambient temperature cools sufficiently to resume regular hashing. Consider the capture on the following page of four days of miner data with Terahash reported on the upper lines and Temperature reported on the lower lines. At roughly the same ambient temperature each day a series of machines in this subgroup will overheat and drop hash power until the ambient temperature decreases sufficiently. In the aggregate this is a substantial amount of down time with negative outcomes for miners on fixed contracts. **Note:** *This is why distributed hash chooses to bill our hosting clients only on power consumed. This protects the miner from predatory contracting and becoming massively unprofitable during tighter market conditions.*



So how can a miner maximize uptime in the most punishing midsummer environments?

Whatsminer machines have the option to toggle between 'Low', 'Normal', and 'High' power modes. The vast majority of the time miners will choose to run their machines in 'Normal' mode, which most closely delivers the TH listed on the machine at the stated wattage. However, during times of high heat it becomes preferable to run your machines in 'Low' mode, which, by decreasing the effective wattage of the machine, gives an additional ambient temperature buffer to the hash boards. Consider the below capture over five days showing a series of miners switching from 'Normal' to 'Low' mode on 6-18 and the subsequent elimination of machine overheating.



The effect of switching the M30S ASICs into 'Low' mode from 'Normal' mode is obvious. No machines overheat during peak temperature days as the lower wattage draw has added an ambient temperature operating buffer. This switch to 'Low' mode has proven to be an effective remedy to midday over-heating, but miners wonder how much hash they are losing by doing so. The answer is a discussion around chip manufacturing and PSU efficiency that is outside of the scope of this current paper, however, we submit the below data to open the conversation around various models of Whatsminer M30S ASIC.

M30S 86Th	Hash	Wattage	W/Th
Normal Mode	87.07	3263	37.48
Low Mode	81.78	3019	36.92
Difference	**-6.1%**	**-7.5%**	**-1.49%**
M30S 92Th	**Hash**	**Wattage**	**W/Th**
Normal Mode	94.04	3582	38.09
Low Mode	82.15	2949	35.90
Difference	**-12.6%**	**-17.7%**	**-5.76%**
M30S+ 102Th	**Hash**	**Wattage**	**W/Th**
Normal Mode	105.47	3556	33.72
Low Mode	91.33	2973	32.55
Difference	**-13.4%**	**-16.4%**	**-3.45%**
M30S++ 106Th	**Hash**	**Wattage**	**W/Th**
Normal Mode	110.57	3497	31.63
Low Mode	104.27	3265	31.31
Difference	**-5.7%**	**-6.6%**	**-1.00%**

As you can see in the above chart, when machines are switched from 'Normal' to 'Low' mode there is a general trend that goes: drop in hash power, larger drop in wattage, increase in watts per terahash. This is intuitive, as less energy is consumed by a miner the efficiency of the miner increases. Increasing heat in a system will introduce some inefficiency.

What is most intriguing is how a drop in Hash on 'Low' mode does not correlate directly with Wattage across all variations of machine. Note that the highest powered new generation machines, the M30S++ series, remain largely stable in both 'Normal' and 'Low' mode. This suggests that you can run your top end machine in 'Low' mode, gain a temperature buffer for ambient conditions, and still hash within 2T of the rating of the machine (104.27 actual vs. 106 rated). On the other end of the spectrum, the M30S machines, specifically the 92T rated M30S machines, display a substantial non-linear variation in Hash and Wattage when switched from 'Normal' to 'Low' mode. For the miner using these machines, it suggests that mode switching should be considered during competitive markets or high ambient temperatures when the efficiency gain is meaningful to Sat generation. We speculate that the differences between efficiency in the M30S 86T and M30S 92T ASICs are a consequence of the chip manufacturing process, an assertion outside of the scope of this discussion but interesting nonetheless and worth future study. Finally, the middle of the pack, the M30S+ machines, show efficiency gains that fall directly in the middle of the lower end M30S machines and the top end M30S++ machines.

The final question miners must have is when to switch between modes given certain prices and operating kWh conditions to maximize efficiency of their machines. We have prepared the larger model below, which takes into account various bitcoin price points at various electrical prices for you to determine how to run your personal machines.

Consider the below as rough data aggregation with the intention of optimizing the amount of bitcoin you're able to generate during tight markets. During clear bull markets the best option is generally to operate at the highest recommended wattage draw of your machine.

If you would like a higher resolution version of this image, please contact us at [hosting@distributedha.sh.](mailto:hosting@distributedha.sh)

				6 c/kWh Power Cost		9 c/kWh Power Cost		12 c/kWh Power Cost	
M30S 86Th	**Hash**	**Wattage**	**W/Th**	**Monthly Cost @ 6c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 9c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 12c/kWh**	**Approximate Sats Mined**
Normal Mode	87.07	3263	37.48	$140.96	1,083,880	$211.44	1,083,880	$281.92	1,083,880
Low Mode	81.78	3019	36.92	$130.42	1,018,028	$195.63	1,018,028	$260.84	1,018,028
Difference	**-6.1%**	**-7.5%**	**-1.49%**	$10.54	**65,852**	$15.81	**65,852**	$21.08	**65,852**
		Sats @ BTC $17k		62,005	(3,847)	93,007	27,155	124,009	58,158
		Sats @ BTC $20k		52,704	(13,148)	79,056	13,204	105,408	39,556
		Sats @ BTC $25k		42,163	(23,689)	63,245	(2,607)	84,326	18,475
M30S 92Th	**Hash**	**Wattage**	**W/Th**	**Monthly Cost @ 6c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 9c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 12c/kWh**	**Approximate Sats Mined**
Normal Mode	94.04	3582	38.09	$154.75	1,170,596	$232.12	1,170,596	$309.50	1,170,596
Low Mode	82.15	2949	35.90	$127.42	1,022,689	$191.12	1,022,689	$254.83	1,022,689
Difference	**-12.6%**	**-17.7%**	**-5.76%**	$27.33	**147,906**	$41.00	**147,906**	$54.67	**147,906**
		Sats @ BTC $17k		160,791	12,884	241,186	93,280	321,581	173,675
		Sats @ BTC $20k		136,672	(11,234)	205,008	57,102	273,344	125,438
		Sats @ BTC $25k		109,338	(38,569)	164,007	16,100	218,675	70,769
M30S+ 102Th	**Hash**	**Wattage**	**W/Th**	**Monthly Cost @ 6c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 9c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 12c/kWh**	**Approximate Sats Mined**
Normal Mode	105.47	3556	33.72	$153.62	1,312,897	$230.43	1,312,897	$307.24	1,312,897
Low Mode	91.33	2973	32.55	$128.45	1,136,966	$192.67	1,136,966	$256.90	1,136,966
Difference	**-13.4%**	**-16.4%**	**-3.45%**	$25.17	**175,931**	$37.76	**175,931**	$50.34	**175,931**
		Sats @ BTC $17k		148,073	(27,857)	222,110	46,180	296,147	120,216
		Sats @ BTC $20k		125,862	(50,068)	188,794	12,863	251,725	75,794
		Sats @ BTC $25k		100,690	(75,241)	151,035	(24,896)	201,380	25,449
M30S++ 106Th	**Hash**	**Wattage**	**W/Th**	**Monthly Cost @ 6c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 9c/kWh**	**Approximate Sats Mined**	**Monthly Cost @ 12c/kWh**	**Approximate Sats Mined**
Normal Mode	110.57	3497	31.63	$151.07	1,376,364	$226.61	1,376,364	$302.15	1,376,364
Low Mode	104.27	3265	31.31	$141.05	1,298,002	$211.58	1,298,002	$282.11	1,298,002
Difference	**-5.7%**	**-6.6%**	**-1.00%**	$10.02	**78,362**	$15.03	**78,362**	$20.04	**78,362**
		Sats @ BTC $17k		58,939	(19,423)	88,408	10,047	117,878	39,516
		Sats @ BTC $20k		50,098	(28,264)	75,147	(3,215)	100,196	21,834
		Sats @ BTC $25k		40,078	(38,283)	60,118	(18,244)	80,157	1,795

Conclusions:

In summary, we began by considering the risks associated with using kWh as a single determining metric when operating ASICs. It is important to look into not only the terms of your contract with either your utility or hosting entity, but to also consider the political and geographical risks associated with hosting in certain jurisdictions or climates. There are no hard and fast rules for how to run X miners in Y location, but introducing these factors into the conversation will serve miners in making better decisions.

We continued by reviewing datacenter level data around ambient variations in temperature and how midday heat can drastically increase miner downtime. We assert that running machines in low mode is the best option to mitigate this threat and continue with an in depth analysis on a per machine level to better understand what the nominal terahash losses are versus efficiency gains measured in watts per terahash.

We found that the highest tier Whatsminer M30S++ machines demonstrate incredibly stable operation across various modes, while the higher terahash M30S machines (92T) demonstrate the highest watt per terahash efficiency gain when switched to 'Low' mode. We end our discussion by sharing a more comprehensive table of efficiency per machine across various prices per kWh and bitcoin prices to better educate miners around when to change operating modes.

We hope that you have found this data and the surrounding discussion informative and are better able to strategize around your particular mining operation. Whether you are a backyard miner or a client of a hosting facility, the more information you have around your particular operating situation, the better able you will be to navigate market conditions and advocate for yourself.

Knowledge is power.

-distributed hash team