GLOBAL BITCOIN MINING DATA REVIEW
Q2 2022

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45 MINING COMPANIES REPRESENTING 50.5% OF THE GLOBAL NETWORK
AGENDA

1. Introduction: Michael Saylor
2. Data Aggregation / Explanation: Taras Kulyk
3. Full BMC Q2 2022 Update: Michael Saylor
4. Power Situation In Texas: Peter Wall & Jason Les
5. The Effects of Bitcoin Price And Network Efficiency: Fred Thiel
7. Analyzing And Debunking The FUD: Ben Gagnon
8. Q & A
BITCOIN MINING COUNCIL

45 MINING COMPANIES FROM 5 CONTINENTS REPRESENTING 50.5% OF THE GLOBAL NETWORK

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EXECUTIVE SUMMARY

Bitcoin mining, in Q2 2022:

1. Uses an inconsequential amount of global energy (15bps) and generates negligible carbon emissions (9bps)

2. Bitcoin mining hashrate is up 137% YoY while energy usage is up 63% YoY, due to an increase in efficiency of 46%

3. Bitcoin is the industry leader in sustainability with a 59.5% sustainable energy mix
1. Bitcoin Mining Energy Use Vs Global Energy Use
2. Bitcoin Mining Carbon Generation Vs Global Carbon Generation
3. Global Bitcoin Mining Energy Use Is Negligible
4. Global Bitcoin Mining Has The Highest Sustainable Energy Mix
5. Global Bitcoin Mining Vs Other Industries
6. Q2-22, Mining Efficiency Increased 3% & Sustainable Electricity Increased 2%
7. YoY, Mining Efficiency Increased 46% and Sustainable Electricity Mix Increased 6%
8. Bitcoin Mining Is Technology Intensive, 58x+ In Efficiency In 8 Years
9. Conclusion: Bitcoin Mining Energy Efficiency Is Improving, Rapidly
10. Sources And Methodology
BITCOIN MINING ENERGY USE VS TOTAL GLOBAL ENERGY USE

165,317 TWh
TOTAL ENERGY UTILIZED WORLDWIDE

253 TWh
ENERGY CONSUMED BY BITCOIN MINING ON THE WORLD’S ELECTRIC GRID

GLOBAL BITCOIN MINING CONSUMES 0.15% OF THE WORLD’S ENERGY PRODUCTION

BITCOIN MINING CARBON EMISSIONS VS TOTAL GLOBAL CARBON EMISSIONS

34.8 BMt
TOTAL ESTIMATED CO² GENERATED GLOBALLY

0.03 BMt
ESTIMATED CO² GENERATED BY BITCOIN MINING ON THE WORLD'S ELECTRIC GRID

GLOBAL BITCOIN MINING IS 0.086% OF THE WORLD'S CO² PRODUCTION

SOURCES:
¹ CO² EMISSIONS ARE ESTIMATED BY EXTRAPOLATING U.S. CARBON EMISSIONS GENERATED BY ELECTRICAL GENERATION. HTTPS://WWW.EIA.GOV/TOOLS/FAQS/FAQ.PHP?ID=74&T=11
² BITCOIN MINING ESTIMATE IS DERIVED FROM THE Q2 2022 BMC ESTIMATED TWH ELECTRICITY CONSUMED GLOBALLY.
GLOBAL BITCOIN MINING ENERGY USE IS NEGLIGIBLE

BITCOIN MINING VS COUNTRIES (TWh)

BITCOIN MINING ENERGY USE IS ONLY 0.15% WHEN COMPARED TO THE WORLD’S TOTAL ENERGY

SOURCES: ¹ BMC ESTIMATED BITCOIN MINING ENERGY USE (June 30, 2022). ANNUALIZED VALUES ARE USED FOR BITCOIN MINING ENERGY & ELECTRICITY USE.
GLOBAL BITCOIN MINING HAS THE HIGHEST SUSTAINABLE ENERGY MIX

**SUSTAINABLE POWER MIX: BITCOIN MINING VS COUNTRIES (% OF TWh)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Sustainable Power Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMC Member Data</td>
<td>66.8%</td>
</tr>
<tr>
<td>Global BTC Mining</td>
<td>59.5%</td>
</tr>
<tr>
<td>Germany</td>
<td>48.5%</td>
</tr>
<tr>
<td>EU</td>
<td>43.5%</td>
</tr>
<tr>
<td>South Korea</td>
<td>33.7%</td>
</tr>
<tr>
<td>United States</td>
<td>31.4%</td>
</tr>
<tr>
<td>Canada</td>
<td>22.5%</td>
</tr>
<tr>
<td>Brazil</td>
<td>21.7%</td>
</tr>
<tr>
<td>World</td>
<td>21.7%</td>
</tr>
<tr>
<td>Russia</td>
<td>19.6%</td>
</tr>
<tr>
<td>China</td>
<td>16.4%</td>
</tr>
<tr>
<td>Japan</td>
<td>16.3%</td>
</tr>
<tr>
<td>Poland</td>
<td>15.6%</td>
</tr>
<tr>
<td>India</td>
<td>12.6%</td>
</tr>
</tbody>
</table>

Sources:

1. Value represents data compiled from BMC Advisory Council miners. Annualized primary energy use.
2. Estimated global bitcoin network annualized power based on BMC analysis, assumptions, and extrapolation (June 30, 2022).
GLOBAL BITCOIN MINING VS OTHER INDUSTRIES

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SOURCES: ¹ BMC ESTIMATED BITCOIN MINING ENERGY USE (June 30, 2022). ANNUALIZED VALUES ARE USED FOR BITCOIN MINING ENERGY & ELECTRICITY USE.
Q2-22, MINING EFFICIENCY INCREASED 3% AND THE SUSTAINABLE ELECTRICITY MIX INCREASED TO 59.5%

FLEET ELECTRICITY CONSUMPTION (GW)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Q1-21</th>
<th>Q2-21</th>
<th>Q3-21</th>
<th>Q4-21</th>
<th>Q1-22</th>
<th>Q2-22</th>
<th>BMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption (GW)</td>
<td>13.1</td>
<td>6.2</td>
<td>7.5</td>
<td>8.8</td>
<td>9.9</td>
<td>10.1</td>
<td>4.4</td>
</tr>
</tbody>
</table>

BMC represents 43% of Global MW consumption

MINING EFFICIENCY (EH/GW)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Q1-21</th>
<th>Q2-21</th>
<th>Q3-21</th>
<th>Q4-21</th>
<th>Q1-22</th>
<th>Q2-22</th>
<th>BMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency (EH/GW)</td>
<td>12.6</td>
<td>14.4</td>
<td>17.7</td>
<td>19.3</td>
<td>20.5</td>
<td>21.1</td>
<td>24.6</td>
</tr>
</tbody>
</table>

HASHRATE (EH)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Q1-21</th>
<th>Q2-21</th>
<th>Q3-21</th>
<th>Q4-21</th>
<th>Q1-22</th>
<th>Q2-22</th>
<th>BMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hashrate (EH)</td>
<td>164.9</td>
<td>133.3</td>
<td>169.9</td>
<td>202.1</td>
<td>213.3</td>
<td>107.7</td>
<td>15%</td>
</tr>
</tbody>
</table>

BMC represents 50.5% of Global Hashrate, an increase from 37EH from the first BMC survey

SUSTAINABLE ELECTRICITY (%)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Q1-21</th>
<th>Q2-21</th>
<th>Q3-21</th>
<th>Q4-21</th>
<th>Q1-22</th>
<th>Q2-22</th>
<th>BMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage</td>
<td>36.8%</td>
<td>54.0%</td>
<td>57.7%</td>
<td>58.5%</td>
<td>58.4%</td>
<td>59.5%</td>
<td>66.8%</td>
</tr>
</tbody>
</table>

Sources:

1 DATA COMPILED FROM BMC ADVISORY COUNCIL MEMBERS. ANNUALIZED VALUES ARE USED FOR BITCOIN MINING ENERGY AND ELECTRICITY USE.
2 ESTIMATED GLOBAL BITCOIN NETWORK ANNUALIZED POWER BASED ON BMC ANALYSIS, ASSUMPTIONS AND EXTRAPOLATION.
3 As of Q4-21, BMC SUSTAINABILITY ELECTRICITY VALUE NO LONGER TAKES INTO ACCOUNT RENEWABLE ENERGY CREDITS (REC).

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YoY, MINING EFFICIENCY INCREASED 63% AND SUSTAINABLE ELECTRICITY MIX INCREASED 6%

FLEET ELECTRICITY CONSUMPTION (GW)  

| Quarter | Q2-21 | Q2-22 | BMC  
|---------|-------|-------|------  
| Consumption (GW) | 6.2  | 10.1 | 4.4 |

MINING EFFICIENCY (EH/GW)  

| Quarter | Q2-21 | Q2-22 | BMC  
|---------|-------|-------|------  
| Efficiency (EH/GW) | 14.4  | 21.1 | 24.6 |

HASRATE (EH)  

| Quarter | Q2-21 | Q2-22 | BMC  
|---------|-------|-------|------  
| Hashrate (EH) | 89.8  | 213.3 | 107.7 |

SUSTAINABLE ELECTRICITY (%)  

| Quarter | Q2-21 | Q2-22 | BMC  
|---------|-------|-------|------  
| Percentage | 56.0%  | 59.5% | 66.8% |

Sources:  
[i] Data compiled from BMC Advisory Council members. Annualized values are used for Bitcoin mining energy and electricity use.  
[ii] Estimated global Bitcoin network annualized power based on BMC analysis, assumptions, and extrapolation.  
[iii] BMC sustainability electricity value no longer takes into account renewable energy credits (REC).
BITCOIN MINING IS TECHNOLOGY INTENSIVE, INCREASING 58X IN EFFICIENCY OVER 8 YEARS

<table>
<thead>
<tr>
<th>Combined</th>
<th>Hardware name</th>
<th>Date</th>
<th>J/Th</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>ARM Cortex A9</td>
<td>3-Jan-09</td>
<td>877,193</td>
</tr>
<tr>
<td>GPU</td>
<td>ATI 5870M</td>
<td>23-Sep-09</td>
<td>264,550</td>
</tr>
<tr>
<td>FPGA</td>
<td>X6500 FPGA Miner</td>
<td>29-Aug-11</td>
<td>43,000</td>
</tr>
<tr>
<td>ASIC - Avalon B1</td>
<td>Canaan AvalonMiner Batch 1</td>
<td>1-Jan-13</td>
<td>9,351</td>
</tr>
<tr>
<td>ASIC - Jupiter</td>
<td>KnCMiner Jupiter</td>
<td>5-Oct-13</td>
<td>1,484</td>
</tr>
<tr>
<td>ASIC - U1</td>
<td>Antminer U1</td>
<td>1-Dec-13</td>
<td>1,250</td>
</tr>
<tr>
<td>ASIC - BF864C55</td>
<td>Bitfury BF864C55</td>
<td>3-Mar-14</td>
<td>500</td>
</tr>
<tr>
<td>ASIC - RockerBox</td>
<td>RockerBox</td>
<td>22-Jul-14</td>
<td>316</td>
</tr>
<tr>
<td>ASIC - BE3000</td>
<td>ASICMiner BE3000</td>
<td>16-Sep-14</td>
<td>187</td>
</tr>
<tr>
<td>ASIC - BM13850</td>
<td>BM1385</td>
<td>19-Aug-15</td>
<td>181</td>
</tr>
<tr>
<td>ASIC - PickAxe0</td>
<td>PickAxe</td>
<td>23-Sep-15</td>
<td>140</td>
</tr>
<tr>
<td>ASIC - S9</td>
<td>Antminer S9 - 11.5TH</td>
<td>1-Jun-16</td>
<td>98</td>
</tr>
<tr>
<td>ASIC - R4</td>
<td>Antminer R4</td>
<td>1-Feb-17</td>
<td>97</td>
</tr>
<tr>
<td>ASIC - Ebit 10</td>
<td>Ebang Ebit 10</td>
<td>15-Feb-18</td>
<td>92</td>
</tr>
<tr>
<td>ASIC - S15</td>
<td>Antminer S15</td>
<td>9-Apr-18</td>
<td>59</td>
</tr>
<tr>
<td>ASIC - S17</td>
<td>Antminer S17</td>
<td>9-Apr-19</td>
<td>39.5</td>
</tr>
<tr>
<td>ASIC - S19</td>
<td>Antminer S19 Pro</td>
<td>23-Mar-20</td>
<td>29.5</td>
</tr>
<tr>
<td>ASIC - S19 XP</td>
<td>Antminer S19 Pro</td>
<td>12-Nov-21</td>
<td>21.5</td>
</tr>
</tbody>
</table>

J/Th - Efficiency Over Time

BITCOIN MINING IS 5,814% MORE EFFICIENT OVER THE LAST 8 YEARS. IT'S ESTIMATED THAT THE GLOBAL J/TH EFFICIENCY IS 47.4.
CONCLUSION: BITCOIN MINING ENERGY EFFICIENCY IS IMPROVING, RAPIDLY

The Bitcoin Mining Council is estimating a 3x and 2x improvement in mining efficiency over the next four and following four years, respectively

Satoshi’s protocol reduces energy consumption incentives by 2x every 4 years, for the foreseeable future

6x + 4x = Bitcoin mining is guaranteed to be dramatically more energy efficient in the next eight years.
SOURCES & METHODOLOGY

BMC SURVEY METHODOLOGY:

THE BMC SURVEYED BITCOIN MINERS AROUND THE WORLD ASKING THREE QUESTIONS:
1.) HOW MUCH ELECTRICITY DOES YOUR TOTAL FLEET CONSUME TODAY?;
2.) WHAT IS THE TOTAL % OF SUSTAINABLE ELECTRICITY* WITHIN YOUR FLEET’S POWER GENERATION MIX TODAY?;
3.) WHAT IS THE TOTAL AGGREGATE HASHRATE OF YOUR FLEET TODAY?

*THE ANNOTATED TERM “SUSTAINABLE ELECTRICITY” WAS DEFINED AS ELECTRICITY GENERATED BY: HYDRO, WIND, SOLAR, NUCLEAR, GEOTHERMAL.

THE Q2 2022 BMC SUSTAINABILITY ELECTRICITY VALUE NO LONGER TAKES INTO ACCOUNT RENEWABLE ENERGY CREDITS (REC).

SOURCES:

   BMC ESTIMATED BITCOIN MINING ENERGY USE (June 30, 2022).
2. CO2 EMISSIONS ARE ESTIMATED BY EXTRAPOLATING U.S. CARBON EMISSIONS GENERATED BY ELECTRICAL GENERATION. HTTPS://WWW.EIA.GOV/TOOLS/FAQS/FAQ.PHP?ID=74&T=1
   BITCOIN MINING ESTIMATE IS DERIVED FROM THE Q2 2022 BMC ESTIMATED TWH ELECTRICITY CONSUMED GLOBALLY.
6 & 7 DATA COLLECTED FROM BMC ADVISORY COUNCIL MEMBERS. ANNUALIZED VALUES ARE USED FOR BITCOIN MINING ENERGY AND ELECTRICITY USE. ESTIMATED GLOBAL BITCOIN NETWORK ANNUALIZED POWER BASED ON BMC ANALYSIS, ASSUMPTIONS AND EXTRAPOLATION. As of Q4-21, BMC SUSTAINABILITY ELECTRICITY VALUE NO LONGER TAKES INTO ACCOUNT RENEWABLE ENERGY CREDITS (REC).
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Curtailment: Generation

In electric grid power generators, curtailment is the deliberate reduction in output below what could have been produced in order to balance energy supply and demand or due to transmission or demand constraints.

Curtailment: Load

Load curtailment is the removal or reduction of electrical loads for a limited period of time from a utility grid system in response to a request from the utility or electrical grid system operator.
Last week in Texas
July 11th & 13th

“Bitcoin miners collectively shut down over 1,000 MW”
- Texas Blockchain Council
Bitcoin Miners RESPONDED

16 FIRMS CURTAILED OPERATIONS

~1,006 MWS WORTH OF POWER
Miners shut down in Texas *voluntarily* (like last week) and also for *economic incentives*.

**Voluntarily**
- The right thing to do to support the grid

**Economic Incentives**
- Self-curtailment, when prices are high and miners aren’t hedged / locked-in PPA
- Ancillary services - demand response
Demand Response in ERCOT

These 3 primary tools make Bitcoin miners a **dynamic** and **responsive** participant to the energy market.

**4CP – Four Coincident Peak**
- Loads that respond to alerts to curtail demand during peak periods, save on transmission charges in subsequent year.

**Load Response (LR/CLR)**
- Committing volume of load to participate in ERCOT’s Ancillary Services.

**Economic Curtailment**
- Selling secured blocks of power in response to surges in spot prices.
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Innovation has improved efficiency over time

**Estimated Distribution of Global Hashrate by ASIC Class**

- GPU
- S1, S3
- S5, S7
- S9
- S15
- S17
- S19

**Estimated Average Network Efficiency**

Source: Blockware Solutions, MARA Analysis
Efficiency continues to improve over time

Network Hashrate & Efficiency Projections

Source: Blockware Solutions, MARA Analysis
Bitcoin Price drives Network Energy Efficiency

1. Bitcoin price increases
2. Demand for ASIC machines increase
3. Manufacturers develop more efficient ASICs
4. Best capitalized miners upgrade to the latest machines
5. Less profitable machines forced to drop out
6. Global Network becomes more energy efficient
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AXIOMS OF BITCOIN MINING

• ASIC MINERS ARE RATED IN **JOULES PER TERAHASH**
  • THE AMOUNT OF ENERGY (JOULES) REQUIRED TO GENERATED ONE TRILLION (TERA OR 10^12) HASHES OF THE SHA-256 CRYPTOGRAPHIC HASH FUNCTION

• NETWORK BLOCK REWARD IS RELATED TO HASHES BY: THE **NUMBER OF HASHES PER BLOCK = DIFFICULTY X 2^32**

• THE MORE HASHES A MINER CONTRIBUTES, THE LARGER PORTION OF THE BLOCK REWARD THEY RECEIVE

• AS DIFFICULTY INCREASES, MORE HASHES PER BLOCK ARE REQUIRED TO SOLVE A BLOCK
  • IF DIFFICULTY DECREASES, LESS HASHES PER BLOCK ARE REQUIRED TO SOLVE A BLOCK

• AS MORE MINERS ENTER THE ECOSYSTEM, THE TOTAL NUMBER OF HASHES ON THE NETWORK WILL INCREASE, THIS MEANS BLOCKS WILL GET SOLVED FASTER
• DUE TO THE SELF-HEALING NATURE OF THE BITCOIN MINING NETWORK, THE TIME TO SOLVE A BLOCK IS KEPT CONSTANT AT 10 MINUTES. THIS IS DONE BY INCREASING/DECREASING THE NETWORK DIFFICULTY

• THIS IN TURNS DIRECTLY IMPACTS BITCOIN MINING ECONOMICS; THE \textit{BITCOIN MINER REVENUE DECREASES}, AS A FUNCTION OF THE ENERGY THEY CONSUME, \textit{AS DIFFICULTY INCREASES}

• SIMILARLY, AS BITCOIN MINING IS A TECHNOLOGY DRIVEN INDUSTRY, AS NEWER BETTER ASIC MINERS COME OUT, LESS JOULES ARE REQUIRED PER TERAHASH; THE \textit{BITCOIN MINER REVENUE INCREASES}, AS A FUNCTION OF THE ENERGY THEY CONSUME, \textit{WITH MORE EFFICIENT ASIC HARDWARE}

• THE BEAUTY OF BITCOIN MINING IS IT PURE PURELY QUANTITATIVE AND WE CAN MATHEMATICALLY MAP OUT THESE HORIZONS
<table>
<thead>
<tr>
<th>DAILY PROFIT $/KWHR</th>
<th>Variance of Difficulty</th>
<th>Variance of Efficiency [W per TH]</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTC ($)</td>
<td>Operating Cost</td>
<td>2.20E+13</td>
</tr>
<tr>
<td>$</td>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>20</td>
<td>$0.238</td>
<td>$0.228</td>
</tr>
<tr>
<td>25</td>
<td>$0.190</td>
<td>$0.182</td>
</tr>
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<td>30</td>
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<tr>
<td>50</td>
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<tr>
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<tr>
<td>85</td>
<td>$0.056</td>
<td>$0.054</td>
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<tr>
<td>90</td>
<td>$0.053</td>
<td>$0.051</td>
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<tr>
<td>95</td>
<td>$0.050</td>
<td>$0.048</td>
</tr>
<tr>
<td>100</td>
<td>$0.048</td>
<td>$0.046</td>
</tr>
</tbody>
</table>
CURRENT LANDSCAPE OF BITCOIN MINING

- WITH BITCOIN AT $20,000 USD, and DIFFICULTY AT 29.1 TRILLION, THE BITCOIN MINING REVENUES ARE
  - APPROXIMATELY 12 CENTS PER KWHR FOR NEWEST GENERATION HARDWARE 30 J/TH BITMAIN S19 PRO
  - APPROXIMATELY 9 CENTS PER KWHR FOR NEWER GENERATION HARDWARE 40 J/TH MICROBT M30S
  - APPROXIMATELY 7 CENTS PER KWHR FOR OLDER GENERATION HARDWARE 50 J/TH CANAAN
  - APPROXIMATELY 4 CENTS PER KWHR FOR OLD GENERATION HARDWARE 90 J/TH BITMAIN S9
- THE MINING NETWORK HAS MATHEMATICALLY DEFINED LIMITS OF REVENUE, WHICH WILL CAUSE OPERATORS USING LESS EFFICIENT ASICS TO WIND DOWN THEIR MACHINES (THUS NOT CONSUME ENERGY)
- THIS DRIVES INNOVATION SO MORE ENERGY EFFICIENT MACHINES ARE DEVELOPED AND OPERATED
- AS DIFFICULTY INCREASES, REVENUE PER KWHR WILL DECREASE, THUS THE BITCOIN MINING NETWORK WILL TREND TOWARDS CONSUMING LESS ENERGY, AS OPERATORS WILL HIGH POWER COSTS WILL WIND DOWN
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Recent Headlines

Electricity used to mine bitcoin plummets as crypto crisis widens
Consumption down by third since 11 June, with even sharper falls among other cryptocurrency networks

The Guardian

Bitcoin’s energy use drops following price plunge
It’s taken a prolonged price plummet to get to this point

The Verge

Crypto bear market has brought Bitcoin’s energy consumption to a one-year low

Business Insider

Bitcoin energy use suddenly drops after price collapse
Figures suggest cryptocurrency’s electricity demands dropped by a third in the space of a week in June

Independent
1. Miners Revenue = blocks rewards + transaction fees * Bitcoin price
2. Total Electricity Cost = Miners Revenue * 60%
3. Total kwh = Total electricity cost / 5c per kwh
4. Total kw = Total kwh / hours
DEBUNKED 4 WAYS

1. Model doesn’t change with respect to network hashrate

2. Combining power estimates and network hashrate gets network efficiency, w/TH
   At peak showed an average efficiency 5.5x less efficient than the majority of miners being produced since May 2020, Bitmain S19s

3. Rebuilding the original model shows the stated methodology is not followed

4. Model doesn’t change with respect to miners revenue (the stated methodology)