Cryptocurrency Mining Primer

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DPO Cryptocurrency Mining Primer

Overview:

- Bitcoin is "mined" by computers performing a series of calculations to unlock a portion (or block) of the underlying blockchain.
- Every 10-minutes, a pre-defined amount of Bitcoin is distributed by the Bitcoin software as a reward for those computers which are actively "mining" during that 10-minute period.
- Not all computers receive the reward, only one does, so there is a good chance that a miner could receive nothing for days or weeks on end if that miner is using a single computer unit vs the tens of thousands in existence.
    - Miners get around this dynamic by joining "pools" which are large collections of miners operating in concert to share computing power and split rewards. The vast majority of major cryptocurrency miners operate in such pools. Rewards given to any miner in the pool are shared by all participants pro-rata with their computing power contribution.
        - Through this mechanism, miners can circumvent the unpredictability of receiving rewards and have essentially created a more stable and regular revenue stream. Generally, pooling costs a small portion of the sale proceeds from a miner's bitcoin rewards, typically 1-1.5%.
- When Bitcoin was first introduced in 2009, the reward given every 10-minute period was 50 Bitcoin. The rewards have been programed to fall by 50% at regular predefined increments…every 210,000 blocks of the blockchain unlocked, or roughly every four years.
    - The initial halving occurred in November 2012, with the 10-minute block rewards halved from 50 to 25.
    - The second halving occurred in July 2016, with the 10-minute block rewards halved from 25 to 12.5.
    - The third halving occurred in May 2020, with the 10-minute block rewards halved from 12.5 to the current rate of 6.25.
        - This will occur repeatedly until the last Bitcoin is mined, which is expected to occur around the year 2140.
- The rate at which new "blocks" are created is adjusted every 2,016 blocks (or approximating a two-week adjustment period). This adjustment means that, over time, the "difficulty" of mining a new block will increase as more computers begin mining (i.e. more computers are competing over the same 10-minute rewards), and will decrease as fewer computers mine, most of which is driven by the relative cost of power and the relative price of Bitcoin.
    - **This is the magic of the Bitcoin programming which makes the DPO thesis so compelling…by partnering with the lowest cost energy, we virtually guarantee that we will be among the most economically competitive miners and will thus be able to operate profitability even when many others cannot.**

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Overview (cont.):

- For simplicity, think of the amount of block rewards distributed to miners as roughly pro-rata with that miner's processing power.
- If the price of Bitcoin rises, the profit margin of miners will increase. This will lead to more miners entering the business, which will in turn reduce the amount of Bitcoin each is awarded. Thus, a rise in price results in a rise in margin, which increases competition, resulting in a new natural equilibrium.
- If the price of Bitcoin falls, the profit margin of miners will decrease. This will lead to fewer miners mining, which will in turn increase the amount of Bitcoin each is awarded. Thus, a fall in price results in a fall in margin, which decreases the number of competitors, resulting in a new natural equilibrium.
- One might think that the price of Bitcoin declining would be bad for miners given the margin compression they experience.
    - However, one must consider the supply and demand dynamics noted above. If there are fewer miners mining because some were pushed out due to compressing margins, those remaining capture more of the 10-minute block rewards.
        - **It is possible, therefore, that a fall in the price of Bitcoin could actually lead to surviving miners capturing such a large portion of the block rewards, that their revenue and margin stay flat, or even increase.**
        - **WE SHOULD NOT ASSUME THAT A DECREASE IN BITCOIN PRICE WILL RESULT IN LOWER PROFITABILITY AND A DEGRADED BUSINESS.**
- Similarly, one might think that the price of Bitcoin increasing would be good for miners given the margin expansion they experience.
    - However, one must consider the supply and demand dynamics noted above. If there are now more miners mining because of the increased margin (and higher return on capex investment), the block rewards will now be shared by more parties, meaning each now captures less value.
        - **It is possible, therefore, that an increase in the price of Bitcoin could actually lead to miners capturing significantly smaller portions of the block rewards, such that their revenue and margin stays flat, or even decreases.**
        - **WE SHOULD NOT ASSUME THAT AN INCREASE IN BITCOIN PRICE WILL RESULT IN HIGHER PROFITABILITY AND A STRONGER BUSINESS.**

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Overview (cont.):

- As with the previous page, we can also infer some outcomes relating to the halving of block rewards:

- As the block rewards are halved on a pre-defined schedule, assuming all else is equal, EVERY BITCOIN MINER ON EARTH WILL HAVE ITS REVENUE CUT IN HALF.
  - E.g. if 1,000 miners are splitting 6.25 Bitcoins every 10 minutes, those same 1,000 miners will be splitting 3.125 Bitcoin every 10 minutes after May 2024.
  - Because those miners have the same energy costs, the same employee costs, and the same capex requirements regardless of how many Bitcoin they receive in each 10-minute window, many will not be able to cope with the fall in revenue and would shut down.
    - As discussed on the previous page, **if miners fall out of operation, those surviving capture a now-outsized portion of the now-reduced block rewards.**

- Instead of "all else being equal," **what has typically happened around block rewards halving is a dramatic run-up in Bitcoin price**.
  - **In the twelve months following the 2012 halving, the price of Bitcoin increased from $12.22 to $1,031, an 84-fold increase. In the following twelve months after that (24 months after halving), the price had retreated to $376, still a 31x increase over the price at the halving.**
  - **In the twelve months following the 2016 halving, the price of Bitcoin increased from $657 to $2,257, a value 3.4x the starting price. In the following twelve months after that (24 months after halving), the price had continued to move higher, and had reached $6,378, or 9x the initial the price at the 2016 halving.**
  - This makes sense because, if the miners are now receiving half as many rewards, the value of those rewards would need to increase to hold the mining industry more or less constant.
    - During the few brief periods (early 2019) where the price of Bitcoin had fallen below the all-in cost of production, instead of instantly liquidating the mined coins, miners held them, applying a popular industry acronym to their strategy: "HODL" (Hold On for Dear Life). In other words, the miners refuse to sell, thus denying the market a fresh supply of new coins, thereby driving the spot price back to the point where mining was again profitable.
  - **Since the May 2020 halving, Bitcoin price is up 567% from $8,698 on May 11 to ~$58,000 today.**

- **The highest margins and the safest operating position will be held by those miners with the lowest cost of energy as they can outlast competitors and capture an outsized share of the rewards.**

IT IS DPO'S CONTENTION THAT THE INVESTMENT RISK ASSOCIATED WITH PRICE MOVEMENTS AND BLOCK REWARD CHANGES IS DRAMATICALLY MISUNDERSTOOD BY THE MARKET AND SUCH DYNAMICS SHOULD HAVE VERY LITTLE IMPACT TO OUR BUSINESS MODEL IN THE LONG RUN, AS LONG AS WE PARTNER WITH OUR OWN SOURCES OF EXCEEDINGLY CHEAP ENERGY.

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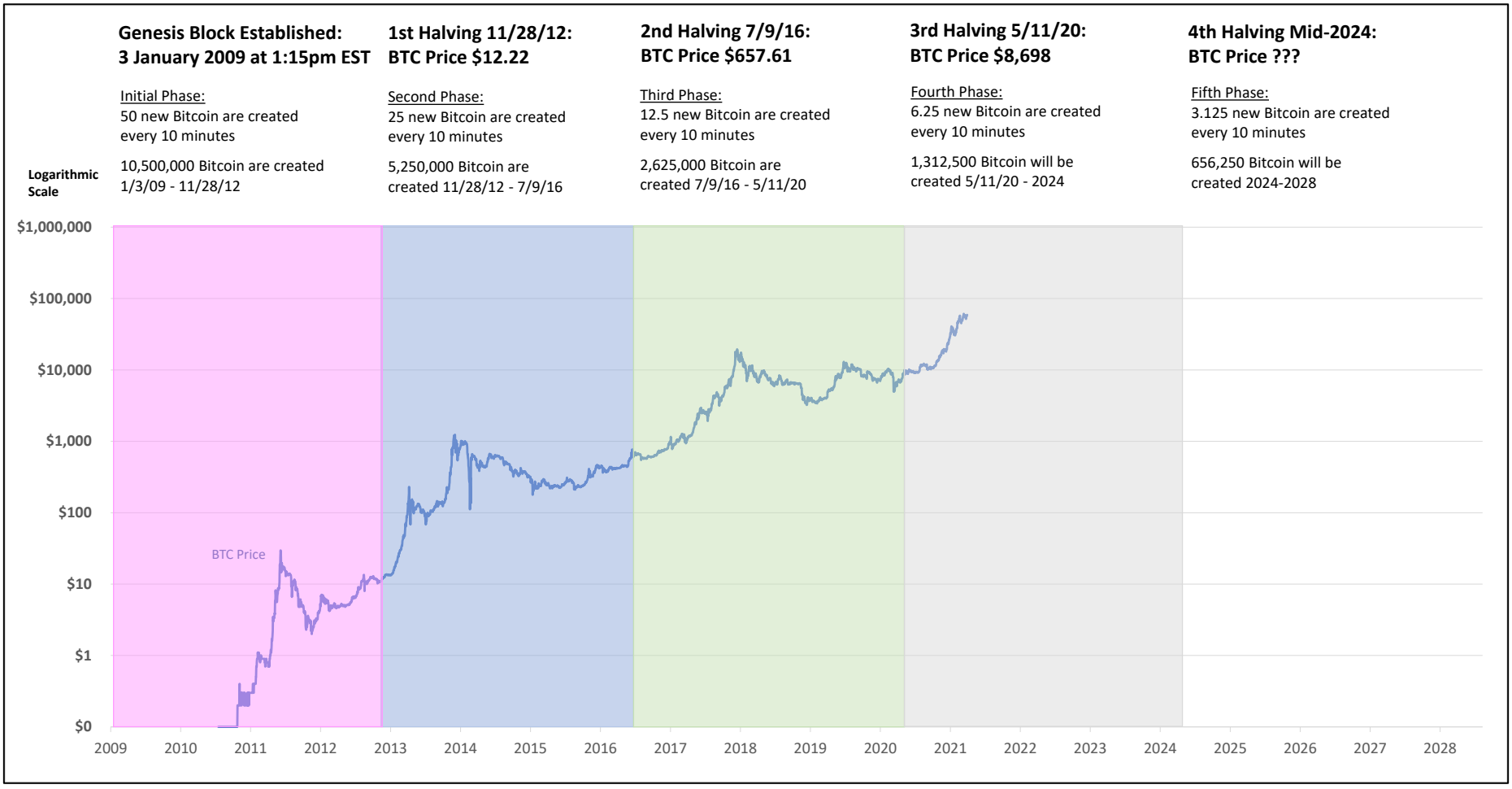
This chart shows the separate phases of Bitcoin block rewards and the associated halving dynamics. Each colored zone is a different "era" with a distinct amount of block rewards (50, 25, 12.5, or 6.25) per each 10-minute block.



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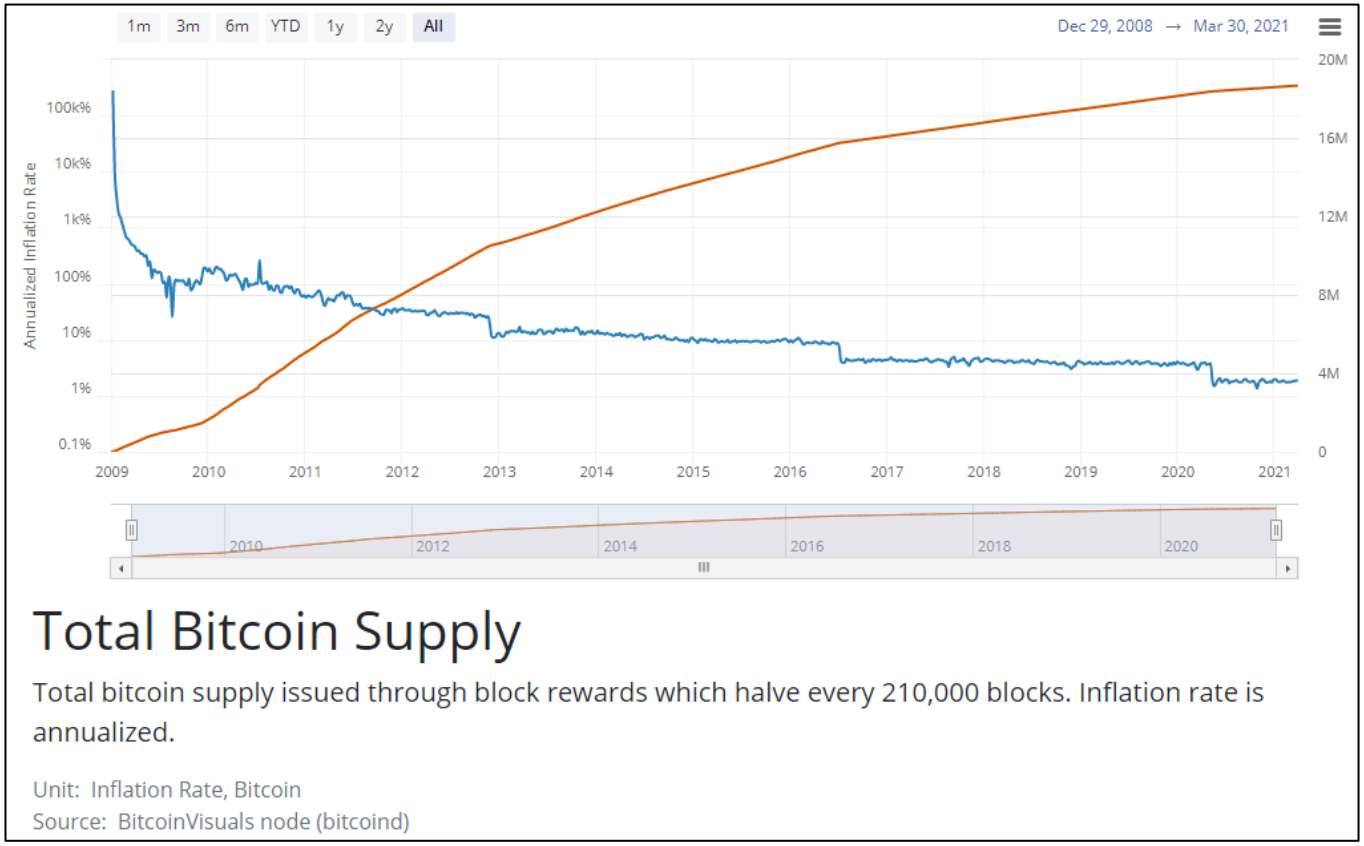
Despite only 12 years of history and mining operations, a significant majority of all potential Bitcoin have been mined…approximately 18.7mm of the 21mm maximum. We are now entering the steady-state and low-inflation (in units) stage of Bitcoin's life and expect the limited new supply of coins to put upward pressure on the price as cryptocurrencies gain broader acceptance and wider adoption.

Globally, there are more than 21 million millionaires in US$ terms (about 35-40mm, in fact). Since there are only ever going to be 21 million Bitcoin, if every millionaire on Earth tries to acquire just one each, there will not be enough to satisfy the demand. There are simply not enough coins to go around.



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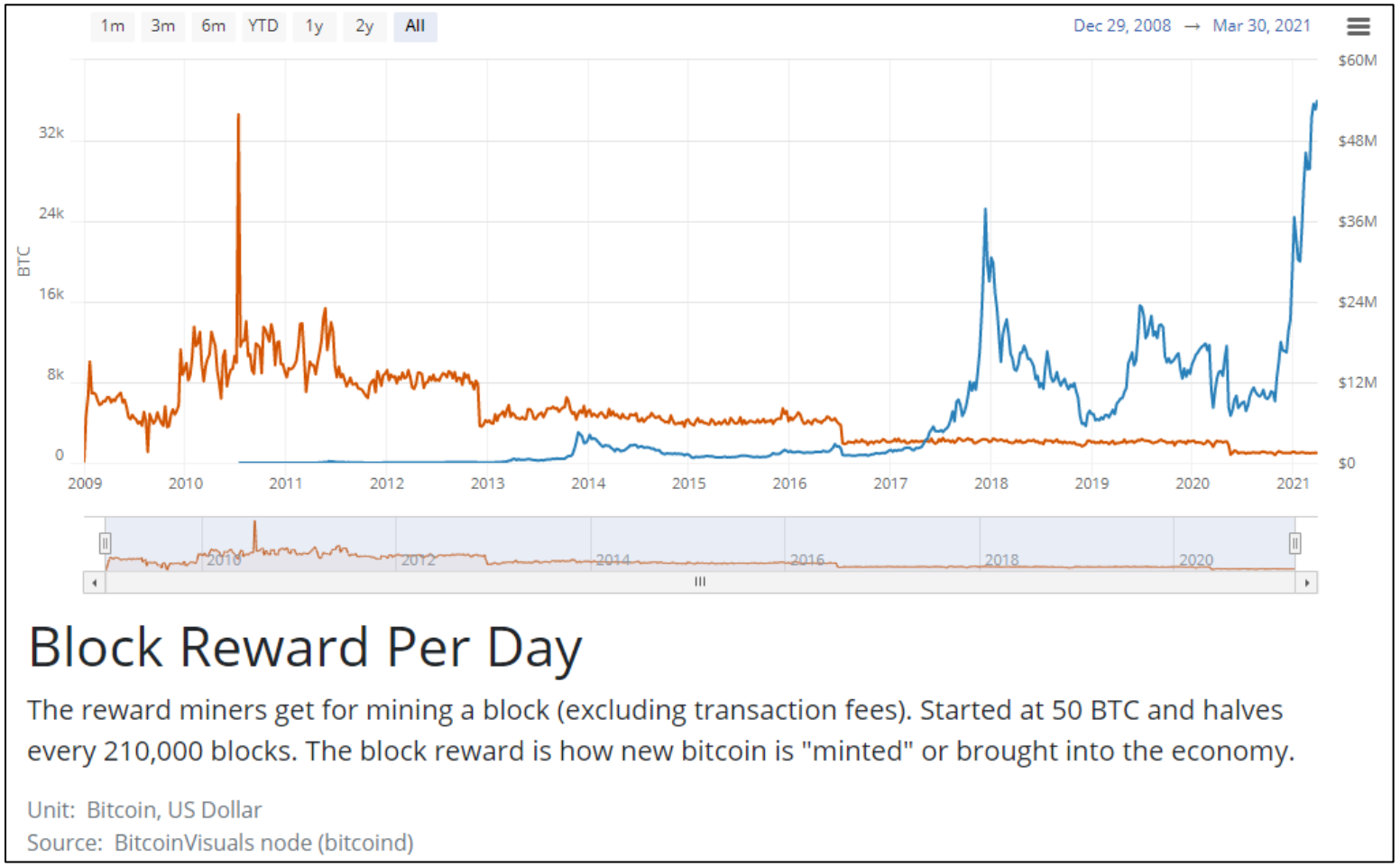
The orange line below shows the number of Bitcoin awarded per day as block rewards to miners. The blue line shows the US$ value of those rewards at the time they were given…essentially Bitcoin's spot price. Today, there are ~900 Bitcoin being mined per day, worth around $52.2mm assuming today's $58,000 spot price, or **approximately $19.1bn per year in total**.



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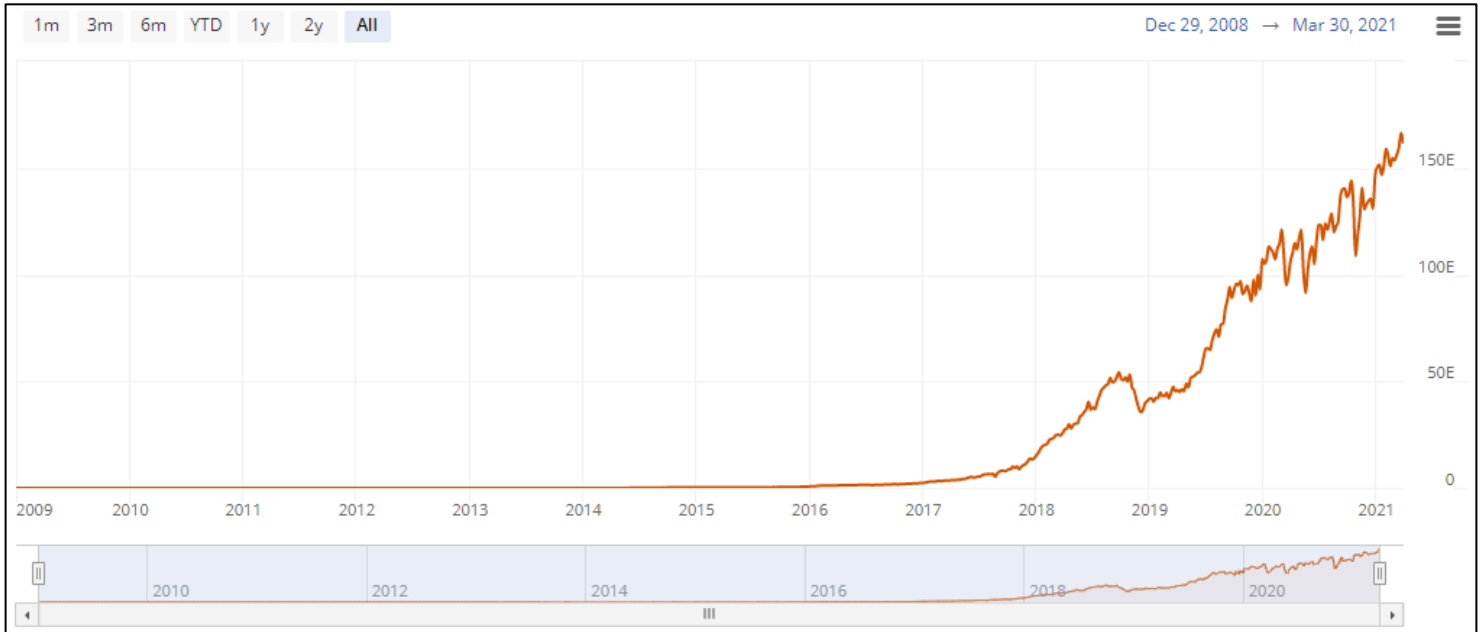

Mining Hash Rate

This chart shows an estimate of how many hashes per second bitcoin miners are performing on the network. Estimate = difficulty * 2^{32} / time. The bitcoin network has a global block difficulty that adjusts every 2016 blocks (~2 weeks) based on a target time of 10 minutes per block. As difficulty increases, more hashpower must be added to have the same statistical chance of finding a block. The time between bitcoin blocks can vary dramatically if there is a large increase or decrease in hashpower within this 2 week period.

Unit: Hashes per second
Source: BitcoinVisuals node (bitcoind)

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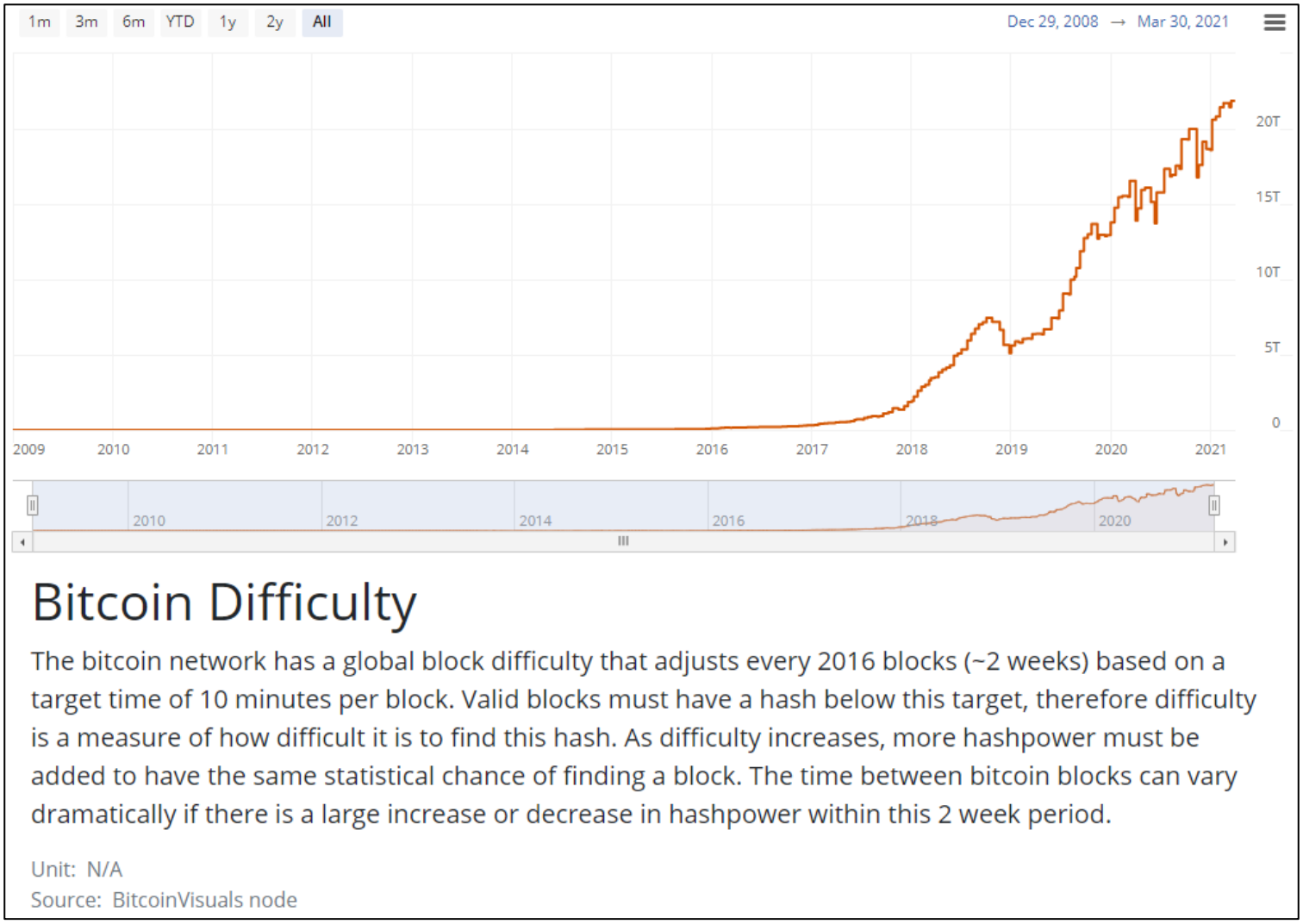

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This shows the efficiency of the Bitcoin algorithm in adjusting the difficulty of mining to match a target 10-minute interval for the block rewards. This stays 10 minutes no matter how much computing power is thrown at the blockchain and why the coins will be mined no slower and no faster than prescribed by the algorithm. This is what creates scarcity and prevents miners from flooding the market with new Bitcoin earlier than prescribed. Compare this to the charts on the previous two pages showing the dramatic increase in hash power coupled with the simultaneous rise in difficulty, resulting in a steady 10-minute interval despite the extreme increase in computing power.

THIS is what turns Bitcoin mining into a race to the cheapest and most secure power, rather than simply a race to acquire more mining equipment.

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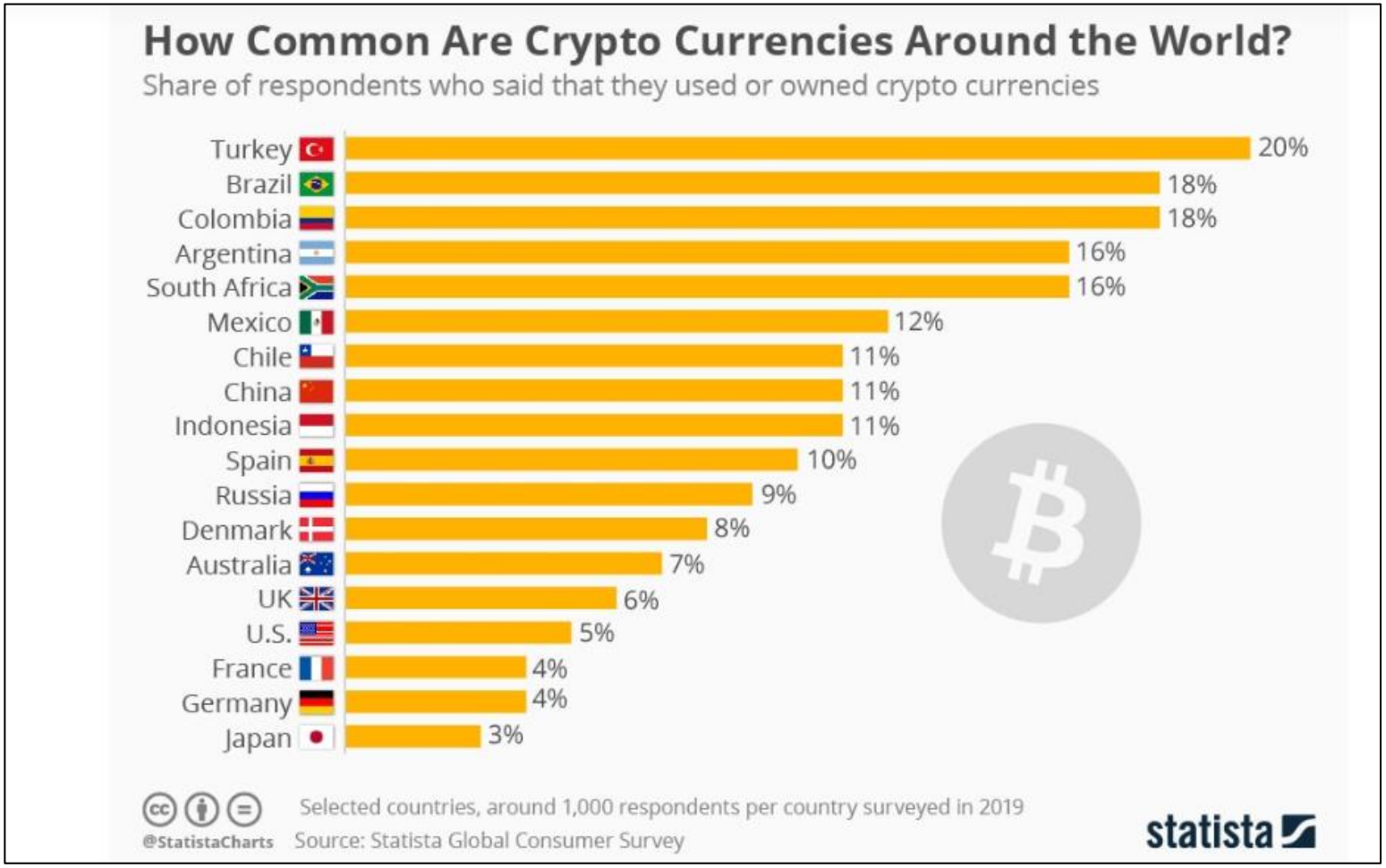
Cryptocurrencies are NOT primarily a U.S. phenomenon and there is tremendous room for growth in some of the world's wealthiest countries.



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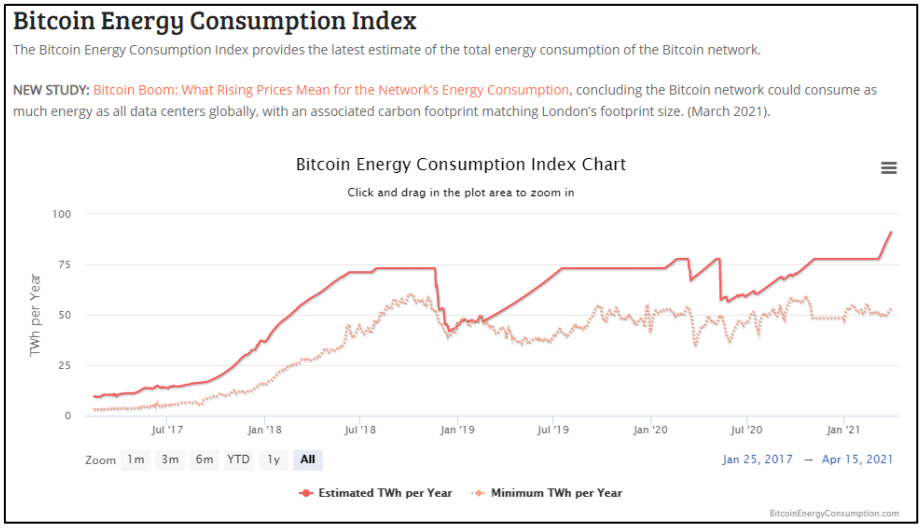
- ***How much energy is Bitcoin/blockchain/cryptocurrency technology using, how dirty is it, and how much does it cost?*** Those things can be estimated, but not calculated.
  - The "hash rate" is a known and transparent quantity, but we cannot accurately know how many mining computers were running to produce it, how clean or dirty the source of power, or how much that end-use electricity is actually costing the miner. Everything we see and read in the press on those topics, at least when taken in aggregate, are estimates. **Today, Bitcoin's total estimated energy usage is over 90 TWh per year; some estimates are as high as 130 TWh per year.**
- Digiconomist.net's Bitcoin Energy Consumption Index (chart below) is frequently cited in the press as a reliable estimate and takes into account various academic studies such as Hileman & Rauch's 2017 "Global Cryptocurrency Study" and the 2019 Cambridge Bitcoin Electricity Consumption Index (CBECI).
  - What seems clear from all research and observable inputs, is that the use of energy to mine bitcoin has skyrocketed with its price in 2017-2018 and again in 2019, which again makes sense as a wider margin will attract more and more capital and more and more computers to the industry, as further evidenced by the increasing hash rate.
  - **At higher Bitcoin prices, more energy will be used.** If the price of Bitcoin reaches some predictions of $100,000 or $500,000 or $1,000,000 per coin, the amount of energy required…**green energy by regulatory mandate**…will be immense.

"But mining bitcoins remains profitable, so the amount of hardware it uses and the quantity of electricity it inhales will continue to surge dramatically for years. Another price spike could push energy use even higher. "We fundamentally don't know how high the price of bitcoin will go," Bendiksen said. "If the bitcoin price goes up by 10x, you would expect the energy consumption of the network to also go up by 10x."

-- U. Ifran via Vox.com 6/18/19: "Bitcoin is an energy hog. Where is all that electricity coming from?"



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Parting thoughts on Bitcoin mining vs Traditional mining:

Imagine if all of the gold miners on Earth could only extract (and would always extract) a set amount of gold per day, regardless of how much (or how little) heavy equipment they used to extract it or how many mines they collectively operated.

Imagine if there were 10 gold miners on Earth and each extracts 1,000 oz of gold per year. Three go out of business due to mismanagement or perhaps political disruption in their country halts operations indefinitely, leaving seven. Those remaining seven, however, now receive the share of those shuttered gold miners as though they were still operating. Those 3,000 oz of gold per year are still being "extracted" and distributed to the remaining 7 miners, but those remaining miners don't have to operate additional machinery or change their operations in any way. So now each remaining miner is suddenly extracting 1,428 oz per year, but doing no additional work.

Imagine if gold miners knew exactly how much gold they would extract week-to-week and day-to-day with the certainty of a mathematical calculation and knew exactly when the world's supply would run out.

Imagine if gold miners didn't need to process or physically transport their product and could instead transmit it through the air at virtually the speed of light immediately upon extraction.

Imagine if the custody chain of the product being mined is 100% transparent to everyone with a computer from the moment it is extracted.

Imagine if cryptocurrency mining becomes (or perhaps already is) the global marginal buyer of energy, essentially transferring the economics of Bitcoin to the power and energy industry, thus driving an explosion of investment in search of cheap green energy which would otherwise not have occurred without this massive marginal buyer. In other words, imagine if crypto is the "Trojan Horse" that forces green energy upon the world at a rate far faster than would have otherwise been thought possible with traditional economic structures.