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Bitcoin and Economic Incentives for Renewable Energy

1. Recap and Introduction

As discussed in much greater detail in the CP, Bitcoin's recent growth—especially with respect to the institutional market—is not one of the most elaborate Ponzi schemes in financial history, but rather a symptom of the broken financial system¹ which results in the global need for a superior store of value. Bitcoin has achieved a level of adoption such that it can now fulfill many of its long-standing promises without the looming uncertainty that its value could collapse to nothing. The fruits of many a Hodler's² labor may now be realized: an apolitical decentralized financial system; uncompromising security, trust and persistence in the face of global crises; Digital Gold, a “Shining city in Cyberspace” so to speak. Be that as it may, the approach of hyperbitcoinization³ makes it all the more urgent that we address the prevailing climate framework, for if our legislative and mental framework fail to transform, renewable energy itself may be in danger—let alone a surge in emissions due to irresponsible mining. America and The World need to stop fighting against an inevitable change, but instead harness it to build a better future.

¹ For further reading, I would highly recommend Layered Money by Nik Bhatia

² HODL (Hold On For Dear Life). Moniker for people who hold Bitcoin and never sell.

³ The point where Bitcoin becomes the default system of valuation like how assets are “worth their weight in gold”. Buildings, cars etc. will be measured in how much Bitcoin they are worth.

Specifically in relation to the contents of this paper, the solution I will be discussing in greater detail and am personally a proponent of is the possibility of using Bitcoin mining to subsidize renewable energy. This initiative could potentially expand current renewable energy projects and give a more effective economic incentive than constant tax breaks and subsidies that the U.S Government has been giving for the past X years. There will be discussion on the current regulatory framework that could facilitate or hamper these changes; however, there will be less discussion and speculation about what new laws or actions need to be instituted. I intend for this paper to be a more broad view of the solution space while advocating for the integration of Bitcoin mining and renewable energy. A detailed plan to achieve this integration, albeit being an interesting academic endeavor, is not the paper I intend to write. I will also not be talking about the possibility of renewable energy companies using Bitcoin as capital, ie. the company owning and using Bitcoin as their primary asset. Alternative solutions such as transitioning Bitcoin to Proof of Stake (PoS) or implementing taxes based on energy use will also be discussed. Each section will detail what they propose with an emphasis on their practical impossibility and limitations.

2. General Obstacles Towards Success

2a. Public Opinion

The largest obstacle towards achieving anything productive in the Bitcoin space, let alone any product or company related to cryptocurrency as a whole, is public perception and sentiment. According to a Pew research study conducted in 2024, “Roughly six-in-ten Americans (63%) say they have little to no confidence that current ways to invest in, trade or use cryptocurrencies are

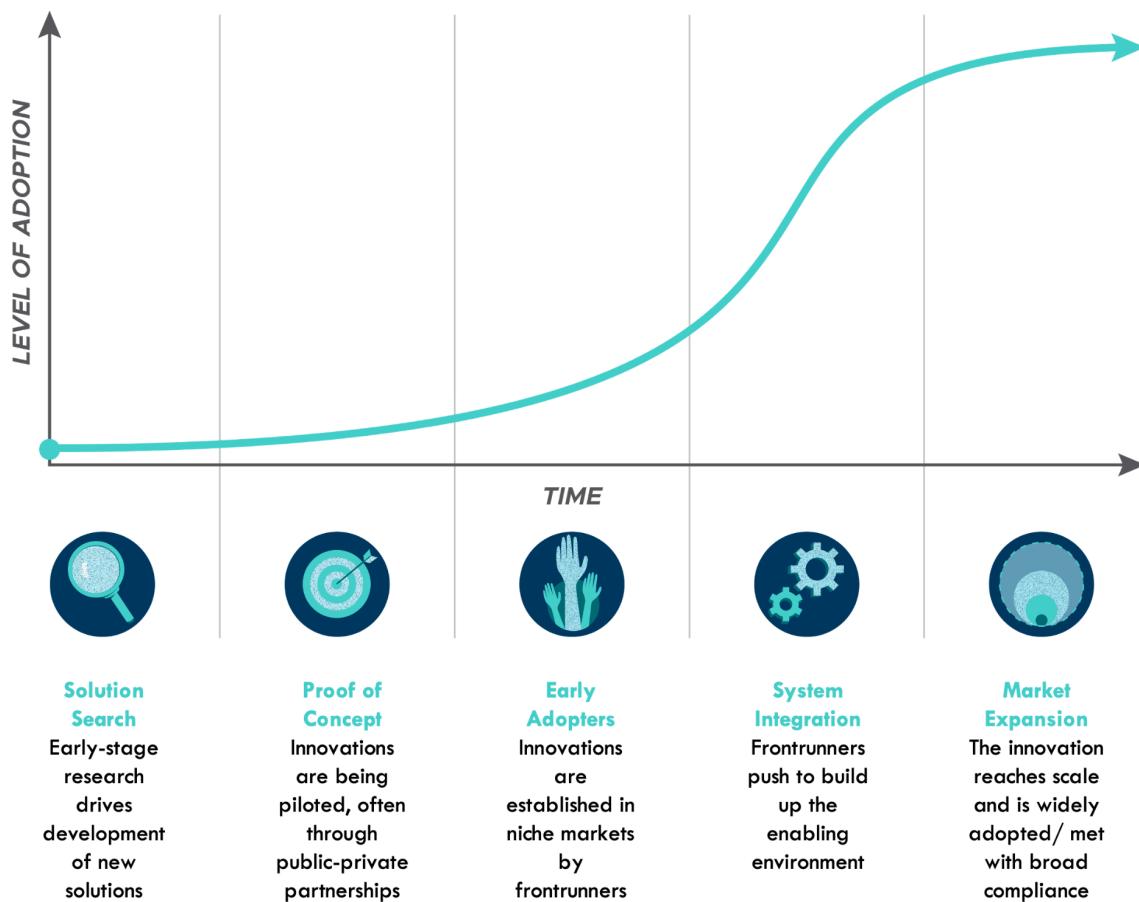
reliable and safe,” (Faverio et al.). The overall trends found in the study are also consistent with the results from the three previous years’ study. This is especially true after the collapse of FTX, one of the most prominent and infamous crypto scandals in recent history. As a result, 40% of Americans associated crypto with fraud, (CoinCover). Though the scandals of FTX and other crypto brokerages such as Celsius and the rise and dramatic fall of NFTs have little or nothing to do with the principles of Bitcoin, Bitcoin still takes the fall as it is the de facto representative of all crypto currencies.

That being said, overwhelmingly positive sentiment boarding on delusional fervor is also not the ideal scenario. This is especially true at the height of a bull market⁴ when crypto is being pushed as a “get rich quick scheme”. Everyone’s aunts, uncles, cousins and neighbor’s daughter’s brother-in-law suddenly want to get into this “crypto thing”. These unrealistic expectations set many unwitting and uninformed people into financial trouble. According to the previously mentioned Pew research study, 38% of people’s portfolios did worse than expected. The inherent volatility of even Bitcoin where drawdowns historically reached 70% and explosive growth just as or even higher is something that many who were taught to simply invest in a 60/40 portfolio⁵ or invest purely in the S&P 500 is simply a phenomenon which they were not taught to handle appropriately. Ironically, Bitcoin is considered stable and “slow” in the crypto community so it’s not a stretch to have people who would be happy with a 10% annual return be shocked when a coin goes up 200% in a single day then back down to 50% its original value the next. Overall, the system was a lottery—just choose any coin at the right time 10x your gains—but as the ecosystem becomes more mature and stable over time, the mindset of chasing gains will not be beneficial for the general public as well as the crypto space.

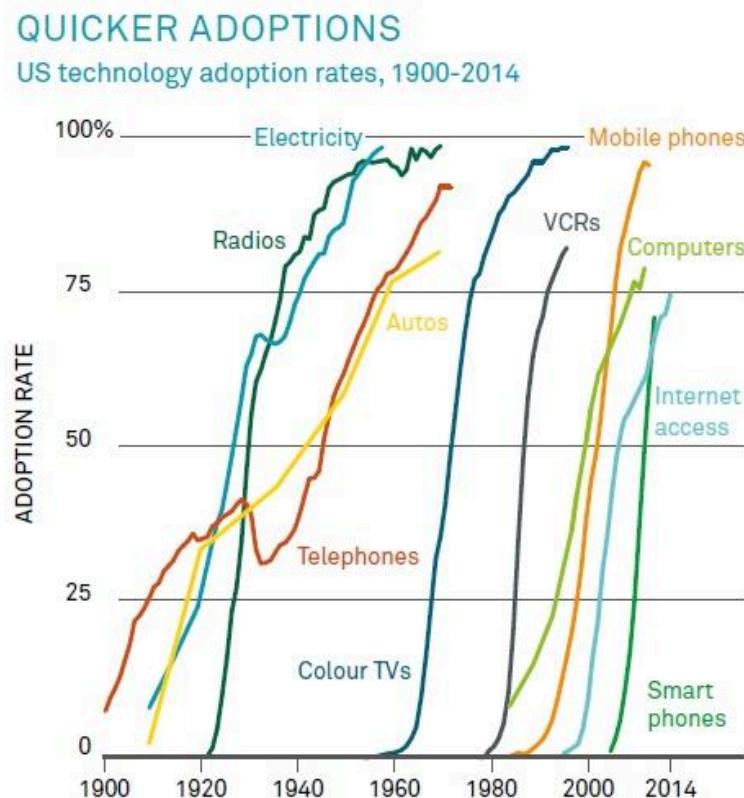
⁴ Market characterized by rising prices. Opposite is a “bear market”, characterized by lowering prices

⁵ Traditional portfolio where 60% are in stocks and 40% are in bonds.

Cryptocurrency, especially given the myriad types and potential use cases, is fundamentally harder to communicate the importance of in a realistic sense to a lay person than a technology like ChatGPT and others. Where once ChatGPT was a novelty that one can simply “try out” in isolation, cryptocurrencies as a whole are highly dependent on the network of people that use it. In other words, if a cryptocurrency is used by little to no people despite being a good idea in theory, it is much more difficult to convince others of its value. As a result, adoption follows an “S-curve” (see figure below) which starts off slow, quickening in the middle then leveling off in the end.



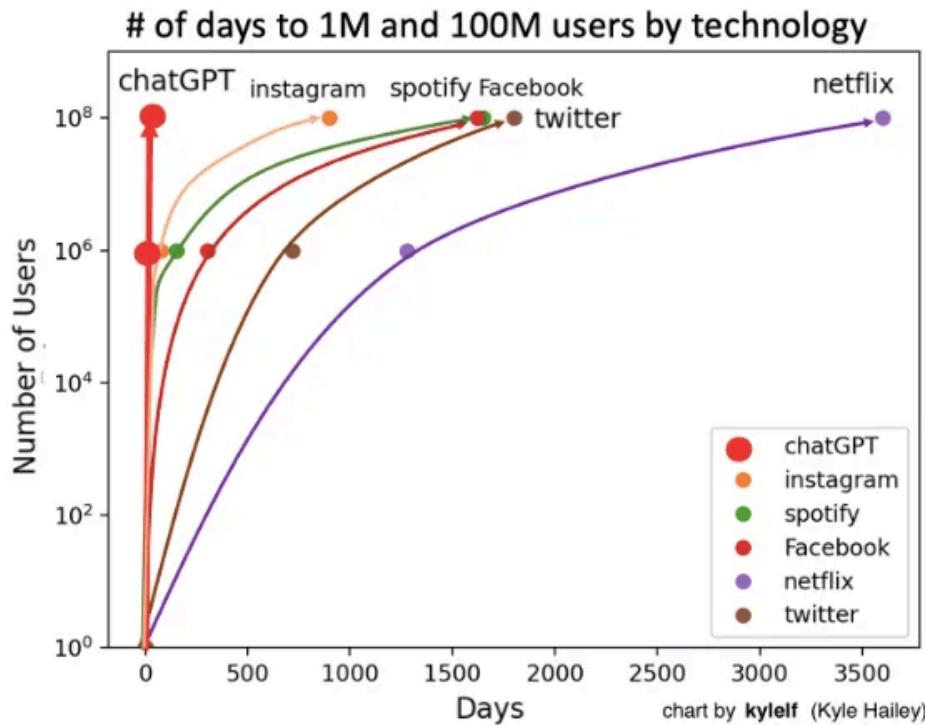
For those who need some mathematical/statistical justification, this curve is another way of framing a “normal distribution”. The specifics, however, are far beyond the course of this discussion as are the use of other models such as a Gompertz curve. Though the exact mechanisms and way of modeling is a topic for another debate, the empirical effects these models seek to describe are real.



Sources: BlackRock Investment Institute, Federal Communications Commission, US Census Bureau, World Bank and Statista, July 2014.
Note: adoption rates are based on household ownership except for cell phone and smart phones, which are based on ownership per capita.

From the chart above, we can see that different revolutionary technologies have their adoption rate start out slow. Suddenly there is a tipping point where the vast majority of the population start using the technology. Another major thing to note is that new technologies in general have “steeper” tipping points than those of older technologies. That is to say, the effects of new

technologies on society will be so sudden that reactionary moves will be impossible for corporations. An anecdotal example of this would be the rise of ChatGPT and other generative AI tools like it. The chart below largely speaks for itself. Change will happen instantly.



In summary, the issue of public opinion is extremely important. Currently, it may be difficult to garner public support for any initiative involving cryptocurrency; nevertheless, we must be properly prepared for the moment when it spontaneously becomes ubiquitous in society. We simply cannot afford to mishandle this opportunity for growth. In doing so, it can leave lasting consequences on not only the environment by irresponsible Bitcoin mining using fossil fuels but for the stature of American dominance. We must get the ball rolling in the correct direction before it's too late.

2b. Crypto Legislature

Crypto as of now is akin to the wild west of yore. There were little to no laws; those that did exist were not enforced or properly interpreted. Instead the prevailing law was that of the land: only the smartest or the strongest shall survive. If you get scammed it's your fault and yours alone. This picture is not attractive to the general public, especially to investors from traditional finance institutions, but it is possible to change this narrative. As there are no Billy the Kids prowling around Phoenix, Arizona; so too could there be no more explicit rug pullers given the correct intervention. Powerful outlaws become sanctioned linchpins in the system that holds the economy up today. Notwithstanding that there will be inevitable pushback from those who once enjoyed absolute freedom, it is a necessary step held by much of the community if crypto wishes to evolve into a true economic asset. That being said, laws and regulations must not only block rampant abuse but above all inspire and promote innovation. Increased protections for investors make it more attractive to invest into the space as well as less money leaving the space permanently, encouraging reinvestment. The current laws and regulations achieve the opposite of this ideal.



(Illustration by the author,
generated using DALL·E,
OpenAI)

The current laws which affect Bitcoin and cryptocurrencies are best described as patchwork. Currently, there are no agreed upon regulations with respect to cryptocurrency. In their place are state and federal agencies—each individual agency has a conflicting interpretation to how Bitcoin and cryptocurrency should be legally classified. The main players on the federal level are the Securities and Exchange Commission (SEC), Commodity Futures Trading Commission (CFTC) and the Internal Revenue Service (IRS). Other federal agencies to note are the U.S. Department of Justice (DOJ), Federal Deposit Insurance Company (FDIC) and the US Department of the Treasury’s Financial Crimes Enforcement Unit (FinCEN). In addition to these federal agencies, because of the lack of comprehensive regulation, most of every state must apply its own laws in addition to any state specific financial laws (Sneha Solanki). From this expansive list of agencies, it is clear even without direct examples that the regulatory landscape is a mess and will likely continue to be one as cryptocurrency is a complex and novel concept. Striking the balance between a comprehensive regulatory framework while simultaneously not harming markets and consumers will most definitely be the hallmark challenge. For this overview, I will largely be focusing on the key existing federal legislation enforced by the SEC and CFTC with some mention of other agencies as they relate to the overall topic. I will also be focusing on legislation proposed that is anti/pro crypto. This will most definitely not be a comprehensive list on all there is about legislation as it is far beyond the scope of the AP. What I do intend to accomplish is to give a brief insight into the complicated landscape—which I do not fully understand nor do I believe anyone truly does—that is ailing cryptocurrency.

One of the key pieces of legislation that hampers cryptocurrency development in the United States is the Securities Act of 1933 and the accompanying Howey Test which determines whether an asset is a security. “All four conditions of the Howey test must be met for an asset to

be a security: (1) an investment of money; (2) in a common enterprise; (3) with a reasonable expectation of profit; and (4) through the entrepreneurial or managerial efforts of others," (Birry et al.). Many crypto proponents disagree with how this is applied broadly to many currencies. Purely decentralized currencies such as Bitcoin do not fit requirement 2, that is being in a "common enterprise" ie. one company and recently Ethereum was also lifted from this restriction. However the vast majority of cryptocurrencies are considered securities by the SEC (Gratton). There are many reasons why this should not be the case for some coins. Bitcoin is purely decentralized meaning there is no common enterprise. Some coins are not fully decentralized; however, they should be exempt because they are considered "utility" coins. A utility coin is a token whose main purpose is to facilitate a task such as securing a transaction. There is ongoing debate in legal systems regarding which coins are securities such as Ripple's lawsuit against the SEC ending in Ripple's favor that their token, XRP, is not a security. "This decision was part of a broader challenge to the long-standing "Chevron deference," which typically grants federal agencies significant leeway in their interpretations..." (Gratton).

In addition the SEC under Gary Gensler has been particularly anti crypto by implementing "regulation by enforcement". The SEC does not push for new legislation that clarifies what can and cannot be done with cryptocurrencies given its unique capabilities: it would rather pursue litigation for an interpretation of the hazy laws which is noncompliant with its agenda. Hester Peirce commissioner of the SEC comments on this: "The decision by the previous Commission to shift this function to the Division of Enforcement by engaging in a large-scale regulation-by-enforcement initiative harmed the American public, adversely affected the industry, and impeded the ability of the Commission's skilled and dedicated professional staff to use their expertise as it was intended to be used," (SEC).

Though Bitcoin is considered by the SEC as a commodity, not a security, it being a cryptocurrency makes it dependent on the current regulatory landscape though not directly affected by it. In addition SEC rulings on Bitcoin being a commodity only apply to the Bitcoin currency itself and not its derivatives associated with it. An unfavorable SEC administration could stop Bitcoin progress in the United States causing all new innovations to move overseas and mining along with it to countries with less regulation overall, including those that are climate related.

In addition to current regulatory laws, passing laws that more accurately clarify crypto in the legislature has been an ongoing challenge with opposition largely from the Democratic party. An example of this would be the Financial Innovation and Technology for the 21st Century Act (FIT21) which is the beginnings for an outline for a possible method to determine which agencies a given cryptocurrency falls under. The current proposition is shared jurisdiction under the SEC and CFTC if the token is “centralized” enough and only under the CFTC is the token sufficiently decentralized. Though not without its weaknesses, it provides the groundwork for a more accurate regulatory framework for cryptocurrencies by directly addressing the key aspect of decentralization. Instead of making progress with further deliberation and amendments, the bill has stalled in the Senate after being passed in the House of Representatives since May 2024, (Kielar and Guha). More groundwork needs to be done to better codify the ins and outs of crypto into law. There is some progress however with the admission of the GENIUS act to the Senate floor (United States) which seeks to define and regulate stablecoins—coins that represent 1 unit of a physical currency.

There are also anti-crypto regulations that have been proposed in the past which would make it harder to achieve any objectives in space. The most relevant to this discussion is the

Digital Asset Anti-Money Laundering Act of 2022. The long and short of it is that the law would make non direct participants of the blockchain network—wallet providers, validators and most importantly miners—subject under regulations which require them to collect data on customers without their knowledge and consent. Not only is this a breach of privacy but also unfeasible given a misunderstanding of what blockchain technology does and what data a miner has access to, (L0La L33Tz). This could increase the compliance costs that miners and other essential bodies have to face, causing them to move away from the U.S to unregulated countries where action is simply not possible.

Again to reiterate, if miners move away to less regulated places, they will go to places that predominantly use fossil fuels, (Drage). It's a correlation not causation. It is not out of malice they use fossil fuels but out of necessity to be profitable with tight margins given the current volatility of Bitcoin as an asset, (Solimano).

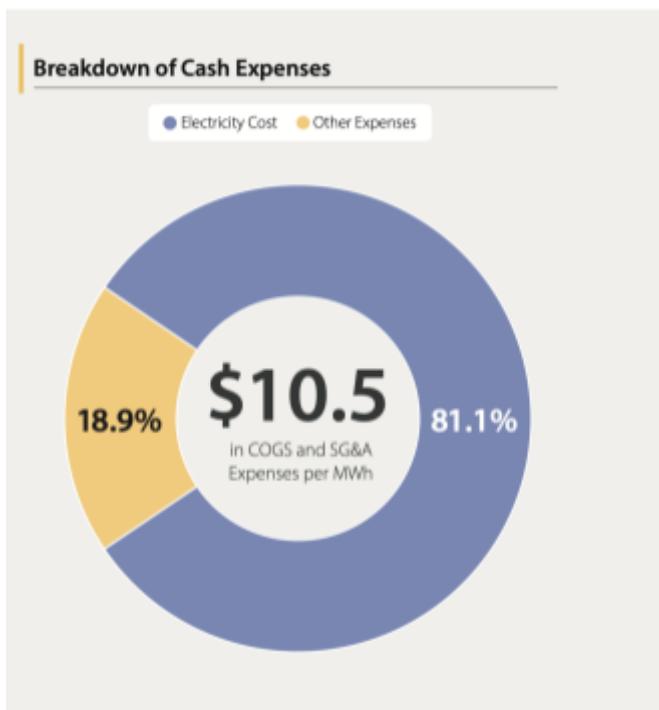


Figure from the Cambridge Mining Study.
Shows the proportion of costs directly traced back to electricity.

3. Flawed Bitcoin Emission Reductions

3a. Energy Tax

Taxing the energy usage of Bitcoin miners has been the goto for governments around the world to curtail Bitcoin mining. Sweden in 2023 raised taxes on energy usage by crypto miners by 6000% (Gkritsi); Kazakhstan implemented harsher regulations on irresponsible mining following the mass exodus from China following 2021 (Lillis); and the U.S proposing a Digital Asset Mining Energy (DAME) tax of 30% on electricity costs used by mining firms (Ward). In general, this sentiment is held by world leaders as a U.N climate conference proposed a global tax on crypto currency mining, (Leahy). “Harry Sudock, Chief Strategy Officer at GRIID, points out that the bill could potentially deter efficient energy consumption and investment in new power generation. Sudock notes, “This one-size-fits-all approach could discourage rational energy consumption and investment in new power generation.”

These mining taxes see little effect on reducing emissions and pushing miners towards green energy directly. Typically when miners face these regulations, the margins are too low to stay in that area. Consequently, they leave often going to areas that have cheaper energy dependent on fossil fuels. An example of this is when China banned Bitcoin mining in 2021 citing “environmental concerns” though in reality it was more likely to be a way to control wealth leaving in and out of the country, (Volpicelli). This as a result moved Bitcoin miners away from surplus hydroelectric power in Sichuan, China to coal and natural gas power found in Kazakhstan and Texas, (Tabuchi). This is called “carbon leakage”: where carbon emissions are simply shifted to another place rather than being reduced overall.

I also personally believe that using taxes to push miners towards green energy will not work as cigarette taxes push lower consumption. They face different pressures. Cigarettes are localized—consumers will likely not move to where a cigarette tax is not in effect to buy cigarettes. Bitcoin mining is mobile—miners need to move to another location to stay profitable and the cost for doing so is much less than not. Cigarettes have little functional use besides an addiction—a tax on cigarettes curbs the main symptom of use. Bitcoin, as explained heavily in the CP, will always be in demand as a store of value fit for the digital age. As a result, miners will always be needed. This creates a stronger incentive than the disincentive created by taxes.

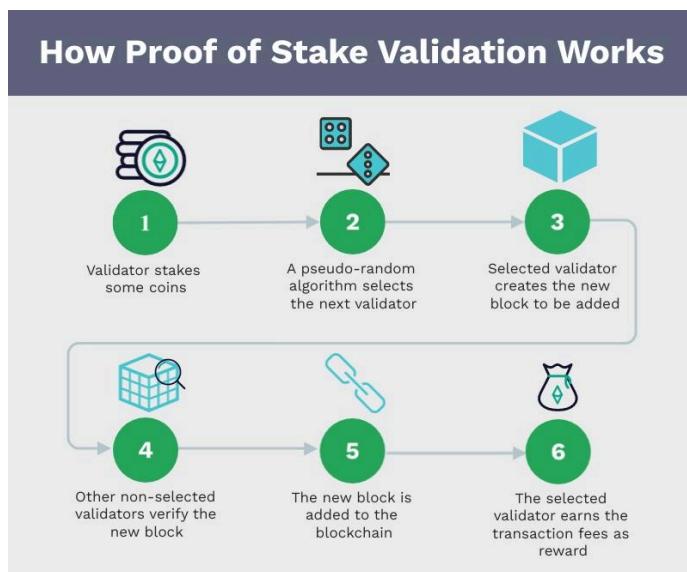
3b. Proof of Work (PoW) vs PoS (Proof of Stake)

Proof of Stake (PoS) and Proof of Work (PoW) are both ways to secure the blockchain, that is the ledger of transactions which cannot be reversed. These are also the ways that produce new tokens of the cryptocurrency as a reward for validating the transaction. For term clarification, a “miner” is the same as a “validator” just in different contexts. Typically a miner is used when referring to a PoW based system where a “validator” is referring to a PoS based system. They both attempt to achieve common objectives such as securing and verifying transactions fairly without a single entity controlling passes and vetoes.

To become a validator in a PoS system you need to “stake” your currency. Staking cryptocurrency is like putting money in a bank savings account. You “deposit” funds into the blockchain to help secure it. In return, you earn rewards, like interest, from transaction fees and new coins. You can withdraw your funds, but you’ll stop earning rewards and there may be a short wait. For security, just like a bank can freeze your account for fraud, staked funds can be “slashed” (partly or fully lost) if you act dishonestly, like proposing fake transactions. The

process for how a block—a group of transactions—is verified is as follows: A randomly chosen validator proposes a block after checking them. Other validators vote to confirm the block is valid. If most agree, the block is added to the blockchain, and the proposer gets a reward. Dishonest validators who try to cheat are punished by slashing their staked funds. A key insight here is that since validators who vote are chosen randomly, the more validators that belong to a single entity, the more sway they have on validating transactions. As stated previously, validators can be purchased with funds. The consequences of this will be discussed in further detail.

Figure shows infographic detailing PoS (Escobedo)



Bitcoin's transaction process is like a global lottery where miners compete to win prizes. Instead of depositing money like a bank savings account, miners buy "lottery tickets" by spending on powerful computers and electricity. The winner adds a batch of transactions (a block) to the blockchain and earns rewards (new Bitcoin and fees). Unlike a bank account, miners must keep spending to stay in the game, with no withdrawals. For security, cheating

miners who add fake transactions lose their investment, as the network rejects their blocks.

Given the above, how a block is transacted is as follows: Miners collect and verify transactions from a pool, bundle them into a block, and race to solve a puzzle. The winner's block is checked by the network. If valid, it's added to the blockchain, and the miner gets a reward. Cheating wastes their resources, as invalid blocks are ignored. Other explanations online may use the term, "solving math puzzles" or something of the like. My opinion is that the "solving of puzzles" detracts from the real purpose of a PoW system, that is the equity and distribution of computing power. The "puzzles" are just a means to use electricity in a way that heightens the cost to perform an attack on the Bitcoin network and to incentivize honesty. Having Bitcoin cost money to create causes miners to want Bitcoin to have value. As a result if miners cause trust to waver in the Bitcoin network, Bitcoin's value will crash substantially. As described in the CP, Bitcoin's selling point is that of a trustless store of value. If any of these conditions are not met, Bitcoin has no use: no value.



As stated previously, both of these methods have similar end goals, that is to allow for a way to verify transactions without a single entity being able to approve or deny them. Although this is true, there is nuance to be had with respect to both of these systems as there are more factors at play than simply “decentralizing”. Bitcoin and the most famous PoS system, Ethereum have different pressures that cause each system to have a different optimal way for validating transactions. Ethereum is a token used for developing smart contracts and securing transactions whereas Bitcoin's primary focus is a store of value with the ability to transact securely. Bitcoin emphasizes security above all else whereas Ethereum emphasizes scalability along with security. To improve one is to decrease the other.

Most literature involving PoS vs PoW involves citing security concerns and while that is an important topic of debate, it is not something that I have the capacity to answer even if given an entire paper dedicated to this topic. Instead I will give a practical argument to why a PoS switch to Bitcoin is simply unfeasible. Bitcoin's development is run by a highly selective and above all conservative council. A large change in how the Bitcoin model works would require what is called a “hard fork” meaning that the new Bitcoin network that uses PoS will exist as a separate entity from the Bitcoin network with PoW. In general, the change would be too large for the possible benefits of a direct “emission” reduction due to the low usage of computation power in a PoS system, (Crypto with Lorenzo). As will be discussed in future sections, the demand for electricity consumption that is associated with a PoW system could be the driving force behind a green revolution. Moving to a PoS would completely remove this possibility.

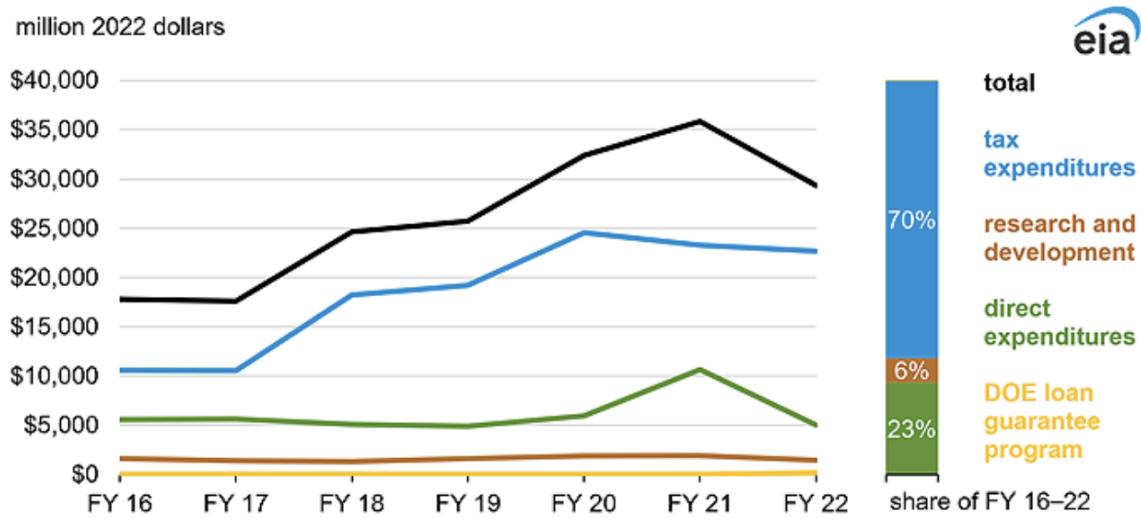
For those more interested in a decentralization argument, a brilliant argument is made by Tory Cross that ties into how Bitcoin can be used for renewable energy. The short version of his argument is that while currently mining is centralized, the competition from other industries that

need large amounts of cheap power and are able and willing to pay a higher price—such as AI—limit the growth of centralized Bitcoin miners. What will be available to Bitcoin miners is the scattered renewable energy sources that need any type of funding, not only increasing decentralization but increasing renewable energy usage not only for the Bitcoin network but for people world wide, (Cross).

4. State of Renewable Energy

Renewable energy as it is broken. As seen on the figure below, subsidies have almost doubled from 2016 to 2022 from \$20 billion to \$40 billion. The share of energy produced in the

Figure 1. Energy-specific subsidies and support, FY 2016–22



Data source: U.S. Energy Information Administration, *Federal Financial Interventions and Subsidies in Energy in Fiscal Years 2016–2022*, Table 1 and Table A3

Note: DOE=U.S. Department of Energy.

U.S being renewable has grown from 15 to 24 percent from 2016 to 2024. At first it seems like this is a problem that goes away the more money that is thrown at it. While this may be true to some extent, one must wonder where does the money come from? Renewable energies are fighting an uphill battle. Not only do they need to contend with fossil fuel incumbent but also

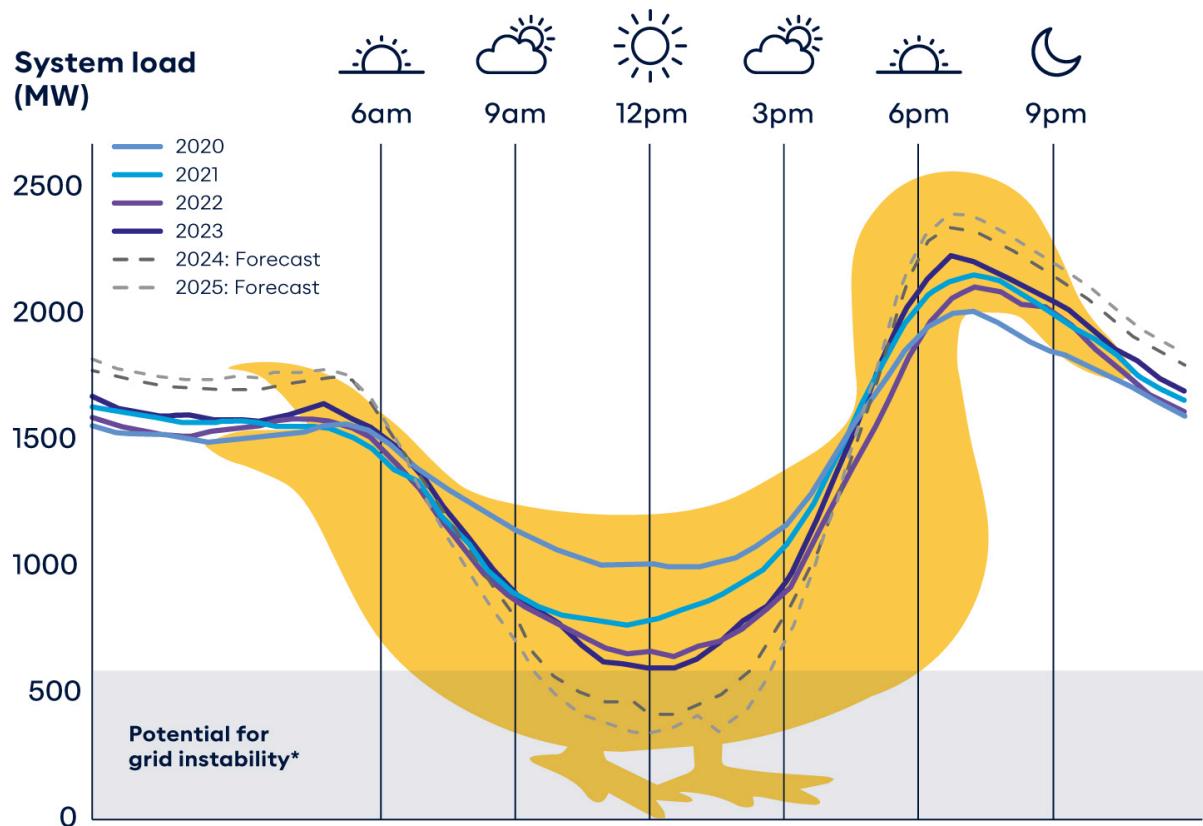
they are subject to a higher upfront cost and maintenance than traditional power generation facilities like coal and natural gas (Regen Power) making it unattractive to investors. In short, renewable energy needs a way to support themselves, to be self-sustaining and practical. Though the climate is important, there are other matters of concern, all of which need money. To achieve any modicum of success, climate activists need to be pragmatic and think of more efficient solutions than giving more money and hoping.

5. Energy Subsidies Using Mining

In Saul Griffith's book, "Electrify", Griffith makes the case for pursuing renewable energy by "electrifying" everything. That is to make as many of the technologies that rely on purely fossil fuels for power such as cars and heaters to be based purely on electricity. This electricity can then be made using purely renewable sources. For this plan to be successful, there must be a significant overhaul in our infrastructure to accommodate renewable energy's intermittencies. Therefore, following the basic laws of supply and demand, there must be a demand for non-constant and unpredictable energy, (Battes). If the demand is not met, this endeavor is simply unsustainable as subsidies must come from somewhere, already adding strain to the "grid of financial systems".

Data Centers, especially given the rise of AI, will be a key consumer of electricity in the coming future (Skidmore); however, data centers typically need a constant uninterrupted supply of power. This power is called "dispatchable" meaning that it is readily available to meet demand. Only coal, natural gas and nuclear power allow for an on demand tap. To do this with wind or solar power, storage systems are needed that can supply a steady stream of energy to a

datacenter. “In 2025, 37% of respondents expect their UPS⁶ battery backup run times to decrease in the future, a notable rise from 26% in 2024. Meanwhile, 31% anticipate no change, down from 38% last year”, (“2025 Data Center Energy Storage Industry Insights Report”). From this, we can see that data centers are not a good product market fit for solar and wind energy. Without an organic demand for these sources of renewable energy, solar and wind will either fall behind in usage or be heavily subsidized. There needs to be a buyer of energy that can be flexible according to a “duck curve” and other unexpected power needs. Below a duck curve illustrates how electricity is used throughout the day. Higher loads that can cause grid instability are towards the bottom whereas lighter loads are on the top.



⁶ Uninterruptible Power Systems

5a. Bitcoin Mining

TBD this

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