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Bitcoin and Economic Incentives for Renewable Energy

Bitcoin just might be the greatest financial development of the current century. Within the past year alone, Bitcoin has achieved several significant milestones: its value surpassed $100,000 for a single Bitcoin (Wiles), it became part of the world's largest asset manager BlackRock's portfolio through the iShares Bitcoin Trust (IBIT) ETF[1] ("iShares Bitcoin Trust ETF | IBIT"), and it was designated as a U.S. government strategic reserve asset (The White House). From this, it's clear that large governments and corporations are taking a serious interest in Bitcoin; however, the true significance of these events is that of a stepping stone to a much greater stage. This argument will be highlighted in much greater detail in the following sections about Bitcoin economics. Whether the world likes it or not, Bitcoin is now perceived as a key asset powerful players have their eyes on rather than some internet novelty or a PayPal for drugs and dirty deeds. As such, it also becomes even more paramount to discuss the impact on the environment that Bitcoin has as global demand for Bitcoin rises. There are two camps on the issue of Bitcoin and climate change. Popular opinion is that Bitcoin, more specifically Bitcoin mining, is a complete waste of power so as a result, greenhouse emissions become needlessly higher. However my opinion is that rather than "...a program to wipe out the gains of several long, hard

[1] Exchange Traded Fund. Usually used to "own" multiple stocks while buying one. Think S&P 500 (SPY)

generations of green energy innovation," (Wells 34), Bitcoin might be one of the key incentives for pursuing carbon neutrality.

This paper will largely focus on Bitcoin but not other entities within the CryptoSphere[2]. To be more specific about this point, there will be no mention of Non-fungible Tokens (NFTS) or other cryptocurrencies, especially those that fall under the alt-coin[3] category with the exception of Ethereum which as a cryptocurrency occupies the most comparable niche. Many of these are understood as being no better than scams, even by those in the crypto community. The reason for not including these in the discussion of Bitcoin mining and the environment is that they are completely unrelated to the issue. Bitcoin, while having similar origins, has evolved into something that competes with gold rather than other crypto currencies and as such, has different pressures. It is now fundamentally different from these other Web3[4] technologies. Nevertheless, that is not to say other Web3 technologies have no merit such as stablecoins and other decentralized finance (DeFi). More specific discussions about this issue will be outlined in the following section about the economics of Bitcoin.

1. Why Bitcoin is important

To understand why Bitcoin is important, it is necessary to understand why gold has its value. My main argument which I will be elaborating is that Bitcoin functions as digital Gold. It takes what makes gold so great, does it better as well as does more. Gold's use case is that it is a store of value. Notice here that I did not mention anything about the "tangibility", the fact that gold is a real thing here. In further writing, we'll see why physicality is not a strict condition and

[2] Broad category: cryptocurrencies, blockchain technology as well as supporting infrastructure such as wallets and exchanges
[3] Also called "*meme-coins*"; coins used with the sole purpose of making money with no utility
[4] Internet that is based on decentralized protocols as opposed to Web2 which is based on centralized processes

that it is holding us back. To reiterate, a store of value is an asset which does not decrease in value over time. Gold, for most of history since at least the ancient Egyptians, was humanity's foremost way of displaying and preserving wealth across generations (Provident Metals). A natural question to ask is what makes gold a good store of value? What were other alternatives? The book, Layered Money by Nik Bhatia details the history of financial systems. Bhatia outlines that before people needed to store money, people needed to barter. Instead of directly exchanging goods and services, it was much easier to trade using a common good called a “unit of account”. The price of a good would be measured in that unit of account. This is how we measure prices today: using dollars. It ultimately allowed for a more robust network of trade. In the bartering system, a trader would need to wait for someone who needed their goods and had the exact goods they needed. Units of account solve this problem as goods could be sold and exchanged for this unit of account.

This “unit of account” needed to be scarce universally to have world wide demand – to give it some kind of “intrinsic” value. For example people far from the coast used sea shells as they were rare but could not be used near the coast as it wouldn’t be as rare. Gold is equally scarce everywhere. Secondly it needed to be easily portable and standardized. Gold, silver and iron were easily smelted and minted into coins at the time. Coins were not only portable but secure and standardized due to the minting process and governmental regulation of the purity of the coin. People could trust the value these coins contained (Bhatia). However, looking at this from a modern perspective, we don’t really see iron as valuable. No one today is going crazy over hoarding iron bars. This is explained with the final criteria that uniquely distinguishes goods from being “units of account” from being stores of value: durability. Other metals such as iron, copper and to some extent silver rust and tarnish. Gold stays gold. It’s something that can either

be spent right away or hoarded in a vault for hundreds of years to be used at some later time for similar or even greater value. Though this may not seem important to an average Joe, this is vital for powerful families and governments – institutions who shape the world. Consequently, it becomes an important topic to understand. In summary, a good store of value is precious, scarce and durable. Gold fulfilled these requirements the best.

Though these conditions described above may seem to all be equally related, I see these as being in two distinct categories: intrinsic and extrinsic. The intrinsic properties are scarcity and durability. These are physical properties that gold has: the fact that it is rare and the fact that it does not spoil. The more interesting property is preciousness. Preciousness is an abstract, subjective thing. A probable reason people started to use gold as value was jewelry as it was alluring. (Bhatia). Then eventually as many civilizations (Provident Metals) used gold for thousands of years, suddenly people covet gold simply because it can be exchanged for actual goods and others value it. Coming back to bartering, you couldn't really use gold for anything besides showing off, especially back in the ancient times. Even now, the total amount of gold for industrial use is around 8% ("Gold Market Structure and Flows") which makes up an even smaller fraction of the total market cap of gold. Here we see some departure from a "physical" aspect to a figurative one. Gold's intrinsic properties, which are given by its unique physical properties, help support a figurative notion of value and preciousness.

To show why gold being physical is not truly the reason why it's valuable, consider platinum. Platinum is even more rare than gold and shares the same physical properties that makes gold a store of value; however today there is no market around platinum besides for industrial use. This is because platinum is not considered as "precious" as you couldn't use it for anything, not even exchange it for goods and services as you could with a gold coin. In other

words, the preciousness of gold comes not from its physical properties such as rarity and durability as platinum has those but rather from human beliefs and financial systems. Put bluntly, there is no network for platinum so it has no value; there is an immense network for gold so it is valuable.

To elaborate on this point gold belongs to the one of the world's foremost trusted, traded and mature financial networks. The financial network is made up of, in a somewhat relative order, central banks, ETFs, over-the-counter[5] (OTC) markets, futures exchanges and mining companies. This network is what sustains and – more importantly – multiplies gold's "intrinsic value". The value of the network itself is much greater than that of "physical gold". One of the quantitative metrics that can be used to demonstrate this is to compare the daily transaction volume of physical gold to that of its financial derivatives. Physical gold, through ETFs, has a trading volume of $2.92 billion per day whereas gold OTC derivatives have a trading volume of $127.69 billion daily ("Gold Trading Volume | Gold Daily Volume"). In relative terms, derivatives are almost "worth" more than 44 times that of actual gold. When people refer to the "value of gold", what they really are referencing is the value of the network in which gold belongs. This is what makes gold "precious".

A perfect store of value must not only be precious, scarce and durable but must also be apolitical and secure. Gold largely accomplished apolitical as it is relatively rare throughout the world and countries who mine it have little incentive to hoard it. This is because demand for gold would drop causing other alternatives to take its market share such as silver, other rare metals and Bitcoin. A store of value must also be secure which gold can accomplish to some extent but fails in key aspects such as risk and cost of transportation due to robbery and forgery. Gold bars

[5]Deals that are between two parties, not using a centralized exchange (NASDAQ, NYSE etc)

mixed with tungsten are hard to test for non destructively and easily drive up the cost of security. This is just a simple limitation of the physical medium which gave gold its staying power.

Bitcoin not only has the properties gold has but also does what gold cannot, only needing that “preciousness”, the network effect that gold has. Bitcoin was designed to be scarce as there can only be 21 million ever. Bitcoin is durable as it is kept alive by many users from around the world. It never degrades or gets deleted even when power goes out as it is decentralized. It is apolitical as, at least in the early days, everyone could use a computer to mine Bitcoin. Now however, it faces similar if not greater pressure that gold has of people moving on to other stores of value so it needs to be sold somewhat to retain its value instead of just hoarded. Bitcoin is also extremely secure, with its transaction network not able to be controlled by one agency due to proof of work (PoW). PoW uses computational power to verify transactions. If a majority of random “validators” agree that a transaction is legitimate, it passes, otherwise it is rejected. Whereas gold is extremely hard to verify, Bitcoin verification is near foolproof. Bitcoin also happens to solve transportation issues as well. Gold bars and coins were frequently stolen so to combat this issue, world governments store their gold reserves in Fort Knox. Transactions using gold involve just switching the gold purely within the safe to a different country’s shelf. Maintaining that level of security costs much more than a simple Bitcoin transaction. Storing Bitcoin is cheap. It costs nothing for a user to keep around as it is being done by miners and maintainers whereas gold needs to either be kept by someone else, introducing fees and counterparty risk or self custody which introduces even greater risk. Bitcoin is also divisible, more so than gold. Gold in reserves cannot have any portion cut off to transact in. Bitcoin in reserves does not have this problem. Any useful amount of Bitcoin can be taken off the account and used for transactions elsewhere. Bitcoin does everything gold does and more.

The only thing missing is that system built around it. Corporations and governments are taking advantage of this hold in the market which explains the recent events detailed in the introduction. This is the main reason why I think that a Bitcoin revolution is inevitable as the main market makers of the world are starting to take seriously Bitcoin's potential to rival or even surpass gold as the chief store of value. That is why I think that is paramount to adapt to this rapidly developing paradigm shift with respect to the climate.

2. Current environmental impacts

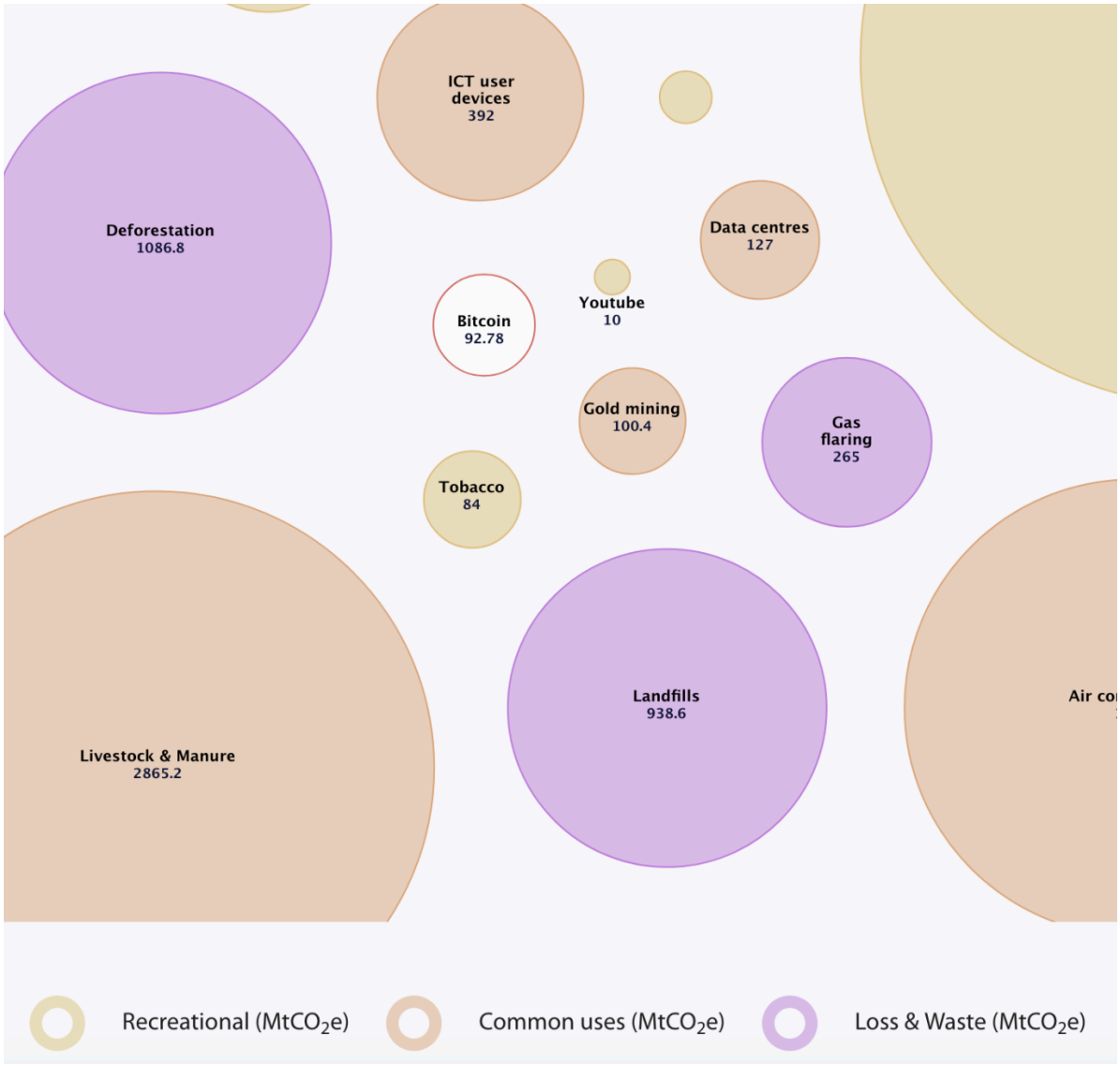

Figure 1: Shows sized representations of the carbon emissions caused by various industries

There is no denying the fact that Bitcoin uses an extreme amount of energy. In fact, this is largely by design. However, there is a clarification point to be made. Bitcoin itself doesn't produce greenhouse emissions. It instead uses electricity. Greenhouse emissions associated with Bitcoin are only due to the power generation associated with Bitcoin. Therefore it is an

oversimplification to say that Bitcoin produces greenhouse emissions only if the energy used is non-renewable (MicroStrategy et al. 1). According to the CCAF, as of the most recent data, bitcoin mining is attributed to 91.98 Megatons of CO2 equivalent (MTCO2e). There are many comparisons which compare this to a “small country” however it's not exactly fair to compare this figure to a country. A country’s carbon footprint is simply dependent on different pressures than Bitcoin. The most apt comparison would be the carbon footprint of gold mining as Bitcoin is a competitor to gold.

Again from the CCAF, Gold mining actually produces 100.4 MTCO2e which is greater than that of Bitcoin. What’s even worse is that waste such as gas flares, gas emissions from landfills and deforestation produce 265.0 MTCO2e, 938.6 MTCO2e and 1086.8 MTCO2e respectively. These problems are not even theoretically trivial. As mentioned earlier, Bitcoin emissions are only contingent on the source of energy so in theory, there is an easy solution to the emissions caused by Bitcoin in stark contrast to the theoretical nightmare deforestation and landfills have when solving their problems. That’s not to say that practically switching Bitcoin to 100% renewable energy will be easy, but what it does say is that there is a model path we can follow to achieve a goal that will work.

There are also many misconceptions about what mining is. Mining is not like actual gold mining. It is just an analogy to gold. “Miners” are really transaction validators who, in exchange for the power used to validate a transaction, get a reward in Bitcoin where the reward is halved every period in an event called the halving to increase scarcity. Eventually when all Bitcoins are mined, it is thought that miners will subsist off of transaction fees though this event is predicted to happen around 2140. There is valid concern about miner e waste since miners are incentivized to compete by solving problems quicker however there is little concern for this. Academic papers

such as those by De Vries and Stoll "...is a chimera derived from an idle academic fantasy which failed to incorporate any relevant industry data." (MicroStrategy et al.). The main argument for this point was that the study assumed that all miners junk old models as soon as new ones come out, rendering them worthless. In reality, these older computational tools still have retail value even though they cannot do anything other than mine Bitcoin.

3. Problems in renewable energy

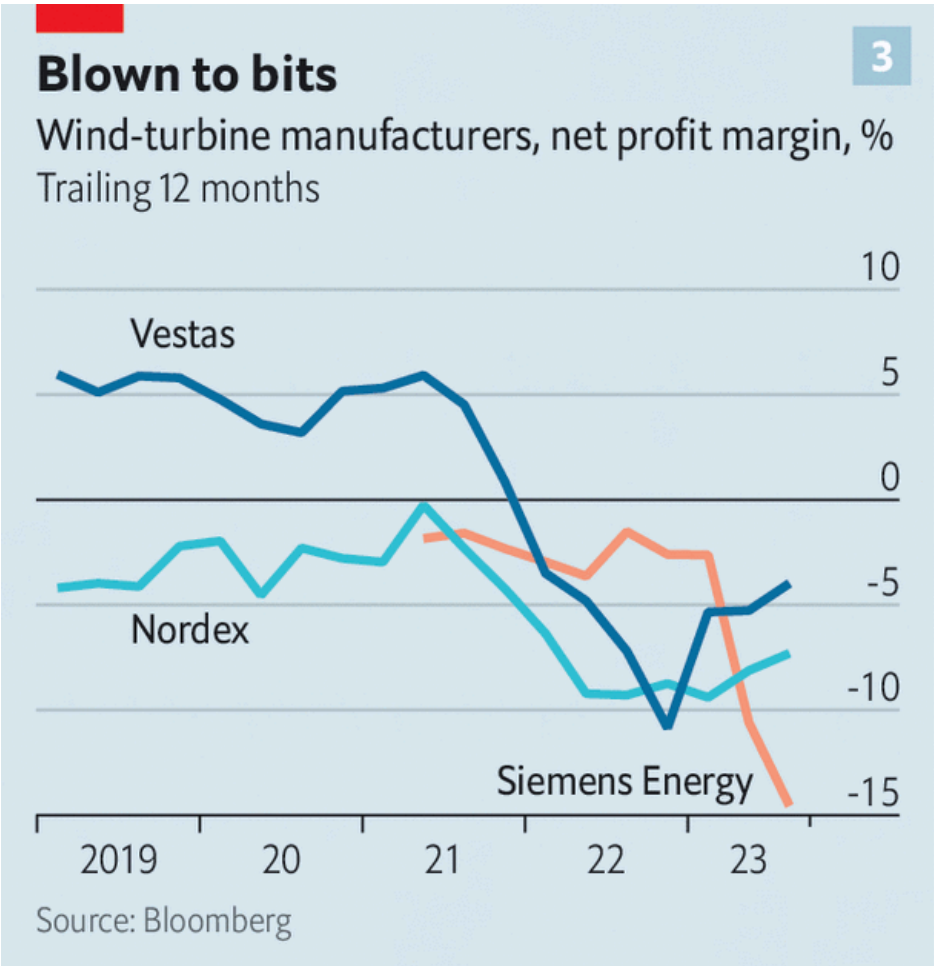

Figure 2: From the economist showing losses for renewable energy industry

It's no secret that the renewable energy industry is heavily dependent on subsidies from governments. An indirect way we can see this is from figure 2 which shows that all major manufacturers are having net losses year after year with the losses only increasing. More directly, between 2010 and 2023, U.S. federal subsidies for solar energy totaled $76 billion and for wind energy $65 billion, far outpacing the $33 billion for oil and gas and $20 billion for coal in the same period (Staff). Nearly half (46%) of all federal energy subsidies in the U.S. from 2016 to 2022 were allocated to renewable energy sources (EIA). These subsidies are the reason for the relatively rapid expansion of renewable energy despite not making but losing money in the process. Fossil fuels are simply more attractive to run in the long term because as soon as subsidy money dries up, there will be little incentive to make renewable energy due to the challenges renewable energy has involving supply chain issues, stranded energy and lack of existing infrastructure.

Supply chain issues are one of the largest challenges associated with clean energy as many of the technologies required for clean energy often use resources such as rare earth metals and lithium which are mined unsustainably in developing countries. Increased demand in these industries could cause more damage to the environment and human well being than the positive contribution clean energy has to the planet. As a result, if a company wants to have these ethically sourced, more money needs to be spent in spite of the declining negative profit margins. This is simply impossible without other forms of revenue generation besides selling power.

Stranded energy is energy generated from clean sources that is not used. Since there are no good energy storage facilities and mediums on the market this energy is wasted not doing anything productive such as earning revenue. In addition, renewable energy sources need to be overbuilt to accommodate for peak strain on the power grid during extreme weather conditions

or even just peak daily usage for appliances such as A/C. This overbuilding leads to even more upfront cost, maintenance costs and stranded power.

In conclusion, economics and renewable energy are deeply intertwined as seen in the previous paragraphs of renewable energy and profit margins. We've also seen that Bitcoin is an up and coming financial institution that relies heavily on energy and how it is produced. The more demand for Bitcoin there is, the higher demand for energy as a result. Therefore it is important to understand that Bitcoin will become integral to world finance and as a result, renewable energies need to be the predominant source of energy worldwide. Otherwise, there will be necessarily an negative impact as Bitcoin will use fossil fuels as its source of energy since Bitcoin will need to pull energy from somewhere regardless of whether it is clean or not.

Section 1: Economics of Bitcoin: Why Bitcoin is important.

The purpose of this section is to attempt to give a novice reader an understanding of why Bitcoin is important (digital capital, apolitical, secure, trusted, backed by energy) especially in a modern context's lens rather than a purely and largely dated "owning your own money" and "peer to peer transactional" lens.

Section 2: Current environmental impacts.

Paragraph 2: What are the emissions Bitcoin produces

This paragraph will quantify the emissions the bitcoin produces along with clearing any misconceptions with how bitcoin produces the emissions that it does produce. It will also show more applicable comparisons to its scale

Paragraph 3: Why Bitcoin produces the emissions it does.

This paragraph will be about the *what* of bitcoin mining. What is the process? Distinct from what is Bitcoin. Explains calculations, POW, ASIC's, energy sourcing and electricity price and mining. Debunks argument of lots of E-waste. More of the physical aspect as the theoretical "why is it important" is covered in section 1.

Section 3: Problems in Current Renewable energy

Talks about profitability, margins, stranded energy, energy storage, iceland aluminum energy storage

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