Bitcoin and the Negative Effects on The Environment

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction – Is Cryptocurrency the New Future of Currency or Our Downfall?

Virtual money is a concept that is still relatively new in the grand scheme of civilization, taking the form of CashApp, Zell, Venmo, PayPal, and so forth. Yet it dominates many facets of our daily lives now with several monetary exchanges being performed on all these platforms for a variety of uses. Cryptocurrency claims to be the next big step from there. Cryptocurrency is a digital asset designed to function as a medium of exchange, typically using a decentralized approach. This decentralized approach for cryptocurrency is enabled with the use of blockchain technology, where any type of data or transaction is stored as a block of data that no human or computer can change once it has been made (IBM). There is also a promise of increased security in comparison to typical virtual transactions when business is conducted on the blockchain. Its rise in popularity has resulted in a boom in the cryptocurrency market, with new currencies popping up almost daily. However, this growth has also raised concerns regarding the environmental impact of cryptocurrency, particularly in terms of carbon emissions.

Carbon emissions refer specifically to the output of carbon dioxide from a variety of technologies that utilize and run on fossil fuels. Carbon dioxide is the main component of our ever-growing issue with climate change here on Earth, which gets absorbed once more into our atmosphere upon the burning of all these fossil fuels. This absorption into the atmosphere then helps generate a process known as the greenhouse effect, where molecules such as carbon dioxide absorbs and radiates heat from the Sun back to Earth, greatly affecting the temperature and climate as more carbon dioxide is sent up to the atmosphere (Lindsey, 2022). The alarming rate of human intervention specifically from this greenhouse process has gradually increased temperatures across the globe, leading to roughly 420 parts per million (ppm) of carbon dioxide in the atmosphere as of 2020. In comparison, the amount of carbon dioxide around a century

before was just under 300 ppm (Lindsey, 2022). The greenhouse effect from the increased presence of carbon dioxide in the atmosphere will lead to higher temperatures and sea levels globally if nothing else is done to mitigate these issues. There has been some efforts in the contemporary from governments, companies, and individuals to help lessen the amount of carbon dioxide that is dispensed into the atmosphere and to lessen their respective carbon footprints. These measures like carbon footprints keep track of how much carbon dioxide an individual or a larger organization like a company have accumulated, even in some cases providing benefits or penalties to production depending on the amount accumulated annually. However, many industries have a long way to go when it comes to creating a greener world, with one of these being the cryptocurrency industry.

Cryptocurrencies require lots of computational power to validate a transaction on the blockchain, whether it is a transaction between two individuals or someone "mining" to generate more cryptocurrency. This mining is done to validate transactions that are produced on the blockchain, to ensure that users are truly putting new currency with every new block that is made. The validation is done through utilizing a consensus algorithm, which is an algorithm that determines a mutual agreement between a machine and human for a single value on a distributed computing system and henceforth creates trust between the computers and users on this distributed computing system, or blockchain in this case. This value is then logged to every computer to ensure that there will not be an instance of failure across the entire system, thus completing the validation on the blockchain (Awati, R., 2022).

Mining for cryptocurrency is a process that involves a computer solving numerous proof-of-work problems in the hopes of creating new currency on the blockchain. Proof-of-work is a consensus algorithm involves the miners using their computers to try multiple times over to

find a unique value for a block using a hashing method, which will then be added onto the blockchain as a valid transaction if a unique value is ever found (Wackerow, 2022). This mining process is computationally heavy due to most cryptocurrency companies using a proof-of-work mechanism to generate new instances of currency. From this point forward, I will be laying out my argument for the remainder of this paper.

This research paper explores the issue of carbon emissions and cryptocurrency, focusing on Bitcoin as a case study. This paper investigates the methods used to mine and compute on the blockchain and analyzes the resulting energy usage and carbon emissions through a synthesis of literature, from articles to academic journals. Specifically, I will be looking mainly at Bitcoin as a case study due to the company's prevalence as an industry leader. From there, I will discuss further in detail the general trends of cryptocurrency regarding their carbon emission handling using the results of these studies. Additionally, this paper analyses these current trends towards improving the energy efficiency of cryptocurrency and highlights the challenges of adopting sustainable practices in the industry through a discussion of previous findings due to the inability for many companies to switch to greener practices. Finally, this paper proposes a potential solution to the problem of carbon emissions from cryptocurrency, suggesting the removal of cryptocurrencies from the general market until significant efforts have been made to reduce their carbon footprint.

STS Framework & Methods – Literature on Bitcoin

For this paper, I used a comprehensive literature review of various publications, including journal articles, news articles, and reports as my research methodology. This is tandem with the case study on Bitcoin, with all the literature having a particular focus onto Bitcoin. This review aimed to gather data on the carbon emission output of cryptocurrencies, especially Bitcoin, as it

has been the most widely used, adopted, and studied digital currency. The sources analyzed in this study indicate that Bitcoin's carbon footprint has been increasing over time due to the energy-intensive process of mining and processing transactions on the blockchain (Badea & Mungiu-Pupăzan, 2021; Edgell, 2021; Kolbert, 2022).

In addition, this study also examined the recent trends in improving the energy usage of cryptocurrency computations and mining. This aspect of the research was informed by various sources, including academic journals, such as E3S Web of Conferences and ScienceDirect, as well as news articles, like Decrypt (Bitir-Istrate et al., 2021; Howson & de Vries, 2022; Hayward, 2022). This literature review sought to identify the current state of energy usage in the cryptocurrency market and analyze the potential impacts of these trends on the environment.

Results – Trends with the Cryptocurrency Industry

With the rise of popularity in cryptocurrency, there has been an increased awareness of the environmental impact of the technology. Bitcoin is a particularly concerning example as its carbon emissions sit between two different countries: Bolivia and Portugal (Stoll, Klaassen, & Gallersdorfer, 2018). No industry should have carbon emissions on the level as a country, let alone an industry leader of such a new technology. This has led to calls for the industry to become more sustainable and for regulators to introduce measures to reduce the environmental impact of cryptocurrency.

The research conducted for this paper found that there are some trends towards improving the energy usage associated with cryptocurrency. For example, Ethereum's recent move to a proof-of-stake model is a significant step towards reducing the energy consumption of cryptocurrency. Previously, Ethereum used a proof-of-work method that most other

cryptocurrency companies utilized for their mining efforts. The transition has led to a 99.99% reduction in energy usage and carbon footprint, as reported by Decrypt (Hayward, 2022). Other cryptocurrencies are also exploring ways to reduce their energy usage, such as by using renewable energy sources for mining operations.

The proof-of-stake model differs from that of the proof-of-work model in that transactions do not need to be verified from the process of "mining" on the blockchain, saving computing and energy resources. Rather, the proof-of-stake model has people in the blockchain act as validators rather than miners where said validators must deposit a certain amount of money to be used as a "stake" (George, 2021, Chapter 7). Another key difference between proof-of-work and proof-of-stake is that proof-of-stake has a reward mechanism present in this model, and the validators can keep any transaction fees that have incurred on the blockchain after submitting a stake onto the blockchain (George, 2021, Chapter 7). This incentive encourages people to place more onto the blockchain and keep their tokens "locked" on the blockchain, as others are effectively placing bets on what blocks could be added onto the blockchain. The more a person has placed on the blockchain, the greater the chance they have of obtaining a new block. This proof-of-stake model requires significantly fewer computing resources than the validation algorithm that the proof-of-work model utilizes, requiring only users to commit to investing a certain number of tokens onto the blockchain rather than using computing resources to determine proof-of-work problems.

Despite these positive trends, the overall energy consumption of cryptocurrency remains concerning. The mining process is an energy-intensive operation that is necessary for the creation of new cryptocurrency. Some researchers have estimated that Bitcoin mining alone could be responsible for anywhere between 22 to 57 million tons of emissions each year (Stoll,

Klaassen, & Gallersdorfer, 2018). Another issue is that the growth of the cryptocurrency industry is leading to an increasing number of users and even more energy consumption, as many cryptocurrencies are still relying on a proof-of-work model to validate transactions, including Bitcoin. As of 2021, a single Bitcoin transaction to validate the proof-of-work process can contribute up to 619 kilowatt-hours (kilowatts in a single hour) to Bitcoin's carbon footprint, which is equivalent to the carbon footprint of an average USA family for around 21 days or 350,000 bank card transactions (Wang, 2022). As the industry expands, more and more cryptocurrencies are created that users interact with, each with their own blockchain and mining processes for the proof-work problems. This leads to a significant increase in the amount of energy consumed by the industry, which is not sustainable in the long term as seen by the numbers estimated by researchers from Bitcoin alone.

Overall, while there are some positive trends towards reducing the energy consumption and carbon footprint of cryptocurrency, the industry remains a significant contributor to greenhouse gas emissions. The research suggests that there is a need for further action to be taken, such as the use of renewable energy sources for mining and the adoption of more sustainable mining models like that of proof-of-stake. Implementing these measures will be crucial if the industry is to reduce its environmental impact and become more sustainable in the long term. The industry leader, Bitcoin, should absolutely implement these traits to lessen its environmental impact and to help shift the industry standard away from using fossil fuels and proof-of-work to determine additional transactions on the blockchain.

Analysis – Can Cryptocurrency Be Sustainable?

As mentioned in the previous section, there are clear trends towards reducing energy usage and carbon emissions in cryptocurrency mining and blockchain computations. However,

despite these efforts, the energy usage associated with these processes remains incredibly high, and the greater industry shows no signs of slowing down.

Given the severity of the environmental impact of cryptocurrency, it is crucial to analyze the potential long-term sustainability of this technology. The rise of new cryptocurrency markets only adds to the urgency of the situation, and more needs to be done to address the energy usage and emissions associated with cryptocurrency.

While Ethereum has shown promise as a more energy-efficient alternative to Bitcoin, it is important to note that it is not the industry standard for cryptocurrency, and other currencies have yet to follow suit. Furthermore, while the transition to proof-of-stake consensus mechanisms is a promising development for energy efficiency, the sheer size of the cryptocurrency market means that the energy usage associated with mining and computations is likely to remain high for the foreseeable future, even if work towards a transition is done now.

Another angle to look at cryptocurrency from is that of if the industry truly classifies itself as a currency. If anything, the appeal of cryptocurrency for some is truly the decentralized nature of the currencies. However, the appeal of making money quickly appeals to far more people, as it requires putting in only a small amount of work to begin a mining machine. If one has a good enough computer and graphics card, they can start mining on that computer to try to validate tokens for the chance of making more money. The more and better mining computers one has, the better chances they have of solving these problems and obtaining more currency on the blockchain, making this system disproportionately lean in favor for those willing to dish out large amounts of money and computing power to mine for more currency. This has led to many mining farms popping up purely for the sake of mining for cryptocurrency with areas that have cheap electricity. Even if the consensus algorithm that is used for mining promises returns for all,

only those who have the money can truly keep using this technology and further displays how algorithms can perpetuate inequality when engineered a particular way, as found in *Weapons of Math Destruction* (O'Neil, 2016). For a more computational and energy intensive alternative to the stock market, cryptocurrency truly does not justify its purpose as an alternative form of currency for the contemporary market. This notion of making lots of money has also led to many, many cryptocurrency scams erupting across the web with this same promise of making lots of money quickly.

It is worth considering whether the environmental impact of cryptocurrency is sustainable and whether there are alternative solutions that could be explored. One potential option is to remove cryptocurrencies from the general market entirely. This would not entail an outright ban on the technology but could involve preventing transactions and the bulk of the blockchain from being used by many. This could allow time for significant efforts to be made towards reducing carbon emissions from this technology before it is reintroduced. Another potential solution is for the cryptocurrency industry to embrace more environmentally sustainable practices, such as the use of renewable energy sources to power mining and computations. In addition, increased regulation of the industry may be necessary to ensure that environmental concerns are considered when new cryptocurrencies are developed and brought to market.

Discussion – What Can Be Done to Mitigate These Issues with Cryptocurrency?

The results of this study indicate that cryptocurrency mining has a significant environmental impact. The analysis revealed that the energy consumption associated with cryptocurrency mining is high, and a large percentage of that energy comes from non-renewable sources. This means that cryptocurrency mining has a significant carbon footprint, which contributes to climate change.

The findings of this study are in line with previous research that has also found cryptocurrency mining to have a negative environmental impact (Edgell, 2021; Stoll et al., 2018). Additionally, the results suggest that cryptocurrency mining may have social and economic impacts as well, particularly for vulnerable and low-income communities. Specifically, cryptocurrency producers exploit cheap resources and energy found within these communities, as industry leader Bitcoin requires as much energy as the entire country of Thailand to keep its blockchain up and running (Howson & de Vries, 2022).

There are potential solutions to reduce the environmental impact of cryptocurrency mining, such as transitioning to renewable energy sources, improving mining efficiency, or even finding alternatives to the current proof-of-work consensus algorithm. However, these solutions are not without their own challenges and limitations. Renewable energy not being regularly available certainly contributes to this issue at large as it is not readily available to implement for these companies. Those who have performed cryptocurrency mining either from their home or from a company using renewable resources end up spiking the energy cost for those in the local area, as was the case for Plattsburgh. (D'Ambrosio, 2018). As for moving away from proof-of-work, the shift that Ethereum was able to make to switch to a more sustainable business model was a miraculous one at that. Ethereum was able to shift the entire cryptocurrency model from the more intensive proof-of-work method to instead proof-of-stake method overnight with virtually no issues (Guinness, 2022). However, this transition away from proof-of-work in Ethereum was looked at since the beginning of the company and undertook seven years as planned by the creator of Ethereum, Vitalik Buterin (Castor, 2023). Ethereum did not make the switch until recently due to the past complexity and preventing security issues that have come with the more recent proof-of-stake model, avidly preparing all the blockchain systems to

accommodate this new model (Pettinari, 2023). Ethereum was certainly the exception here that involved lots of careful planning from all those involved to make the shift as successful as it was, and applying such a plan to Bitcoin could very easily backfire. The same motivation that was present in Vitalik Buterin to implement proof-of-stake is also not present for many of the core developers for Bitcoin, with the cryptocurrency only ever having minor tweaks to the code ever since its 2009 version.

Conclusion – Should Cryptocurrency Be Banned?

In conclusion, this study has shown that cryptocurrency mining has a significant environmental impact, primarily through its high energy consumption and carbon footprint. The findings of this study highlight the need for more sustainable solutions to the energy consumption associated with cryptocurrency mining. The transition towards environmental sustainability for cryptocurrency mining is a complex and ongoing process that requires further research, policy, and technological advancements.

With the all the evidence from previous sections, in my opinion, yes, I believe that cryptocurrency is at a point where it should be completely stopped until its existence is completely justified. One of two situations will have to occur where I find it with full confidence that cryptocurrency can be reintroduced into the public eye. Either one, the cryptocurrency should be conducted as an actual currency and not be used as a pseudo stock market; or two, the energy cost for the entire industry is considerably smaller than what it exists in the contemporary. If neither of these points can be fulfilled soon, then I fully believe the technology should be put aside until further breakthroughs in cryptocurrency are found.

Overall, this study contributes to the growing body of literature on the environmental impacts of cryptocurrency and provides insights into the social and economic implications of this emerging technology. These findings suggest that the technology of cryptocurrency is not only an environmental issue, but also a social and economic one that needs to be addressed by policymakers, researchers, and industry leaders.

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