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Cryptocurrency Mining and Energy Consumption

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ABSTRACT: In recent years, the process of mining cryptocurrencies has come under increased scrutiny due to claims regarding its energy consumption and fears about its impact on the environment. To determine how much electricity mining cryptocoins uses, we update the analysis in Koomey's law correlating computational power and energy usage with data on the most popular digital currency (Bitcoin) and the second-most popular currency (Ethereum). We explain why previous estimates are likely incorrect or imprecise. Then we discuss methods for making reliable time series predictions of Bitcoin mining power consumption. Our new time series model can give us new insights into what future Bitcoin energy consumption will be if it follows historical trends, and based on this estimate discuss potential implications.

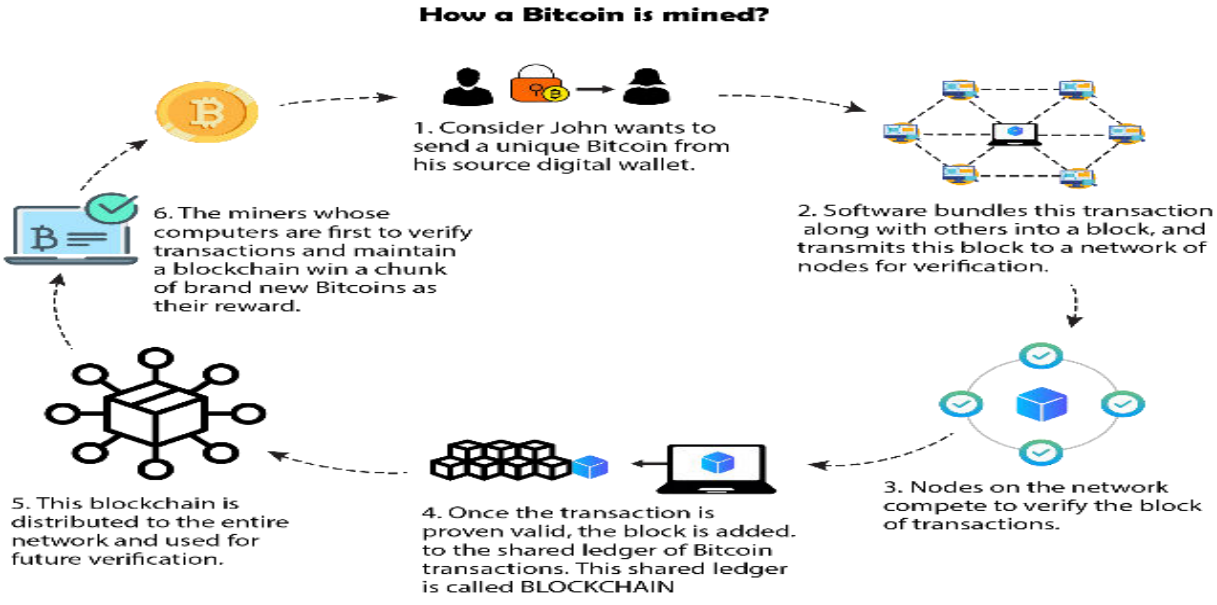
We also consider possible ways for mitigating the negative effects of cryptocurrency mining on the environment, such as transitioning to consensus processes that require less energy or utilize renewable energy sources. In order to foster sustainability in the cryptocurrency sphere, policy-makers and other stakeholders may be informed to make educated decisions, armed with knowledge of electricity consumption trends in mining.

KEYWORDS: Cryptocurrency mining, energy usage, sustainability, effect on the environment, mining hardware, network complexity, renewable energy, and consensus processes.

I. INTRODUCTION

Cryptocurrency mining is imperative in a digital economy as it is the process by which transactions are validated and added to the blockchain which enables the functioning of decentralised blockchain networks. Also, with Bitcoin"'s launch in 2009, mining transitions from conducting a specialist hobby done by early adopters on their laptops to an industrial activity utilising vast processing power and substantial energy. The exponential boom in cryptocurrency prices has ramped up concerns about its environmental impact.

The most famous of the cryptocurrencies, Bitcoin, operates on a proof-of-work (PoW) basis. This involves miners solving complex mathematical problems in order to process transactions and use considerable electricity in doing so. Energy usage has increased commensurate with the rising price of Bitcoin and other cryptocurrencies and the processing power required to mine them [1]. Recent work shows that the energy consumption of the Bitcoin network alone is similar to that of certain small countries [3], leading to questions about their longer-term sustainability.



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The carbon footprint of the electricity consumed, particularly in territories where coal or other (similar) fossil fuels constitute the source of power, further affects these environmental effects [4]. In an attempt to provide a better understanding on the energy utilization in cryptocurrency mining several critical factors such as most efficient mining facility, complexity of mining operation, and geographic distribution of mining farms are primarily highlighted. Possible ways to lower those environment impacts are also discussed in addition by incorporating renewable energy sources into their systems, changing to less energy requiring consensus protocols, and modifying the mining machine itself [5].

An appreciation for the complicated interplay of energy use in digital currency mining is fundamental for crafting regulations and policies which provide avenues for growth and innovation while ensuring ecological sustainability. In this paper we hope to contribute to this understanding by providing an overview of the most recent works and recommendations on future work.

II. LITERATURE SURVEY/ EXISTING SYSTEM

Cryptocurrencies are generated as a result of the creation of new cryptocurrency currencies, verifying transactions and appending them to the blockchain process called mining. Figuring out challenging computational riddles, a system called proof-of-work (PoW), is the most well-known method. Whichever miner is the first to solve your challenge gets awarded a fixed amount of cryptocurrency. These puzzles are competition among miners [8]

Hardware for Mining

Initially, CPUs were used for mining but as the workload grew; miners resorted to more powerful technology such as GPUs and ASICs. Especially when it comes to ASICs, since they are capable of delivering surprisingly high performances and doing so efficiently, they have become the new default within Bitcoin mining. ASICs getting more powerful, but efficiency gains result in bigger, more centralized mining power [9].

Energy Usage

The processing power required and shelf life of available mining hardware are what primarily influence cryptocurrency energy usage, other than those related to currency choice. The puzzles become harder to solve and require more energy as increased numbers of miners participate. Terawatt-hours (TWh) annual energy consumed by mining for comparison, the annual energy consumption of the Bitcoin network - approximately 100 TWh - is on par with that of a small country [10].

Factors Influencing Energy Consumption

Mining Hardware Effectiveness

The fundamental factors driving energy consumption of cryptocurrency mining processes are the power need by the processing and efficiency realized by mining hardware. The problems get harder, and they require more energy as more miners join the network It measures the energy consumed per year for mining, and these are actually known as terawatt-hours (TWh). E.g., the projected annual energy consumption of the Bitcoin network will amount to about 100 TWh a year - on par with whole nations [11].

Network Complicacy

How easy it is to find a new block on a network, relative to being as hard as possible. To ensure that a block is discovered ~ every 10 minutes, Bitcoin adjusts the difficulty roughly every two weeks. The more miners participate and contribute their processing power to the network, the harder it becomes - and while more calculations are needed to find a new block, that in turn means consuming more energy [7].

Areas of Distribution

Geographic distribution of mining operations affects the impact on the environment from energy consumption This has driven mining to move into regions which offer cheap electricity, such as China, Russia and the US. FooterElectric supply Full Brand ListManufacturer Type A smaller environmental impact is observed in mining activities driven by renewable energy sources such as the photovoltaic power plant, as opposed to those which are based on coal or other fossil fuels [12].

Effect on the Environment

Cryptocurrency mining is very harmful to the environment, among other things, due to its high energy consumption and thus carbon footprint of the used electricity. The carbon foot print changes for each state as the energy composition of

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states is different where mining take place. Example of this include higher carbon emissions from coal electricity production as opposed to ones from renewable energy forms (Sharp et al., 2019).

Emissions of Carbon

Mining contributes to a large portion of carbon emissions in regions with high fossil fuel dependency. For instance, much of the mining that occurs in Bitcoin, which has been heavily for of coal, was carried out in China traditionally. This has elicited concerns about the carbon footprint of Bitcoin and its implications on climate change [2].

Telecommunication Waste

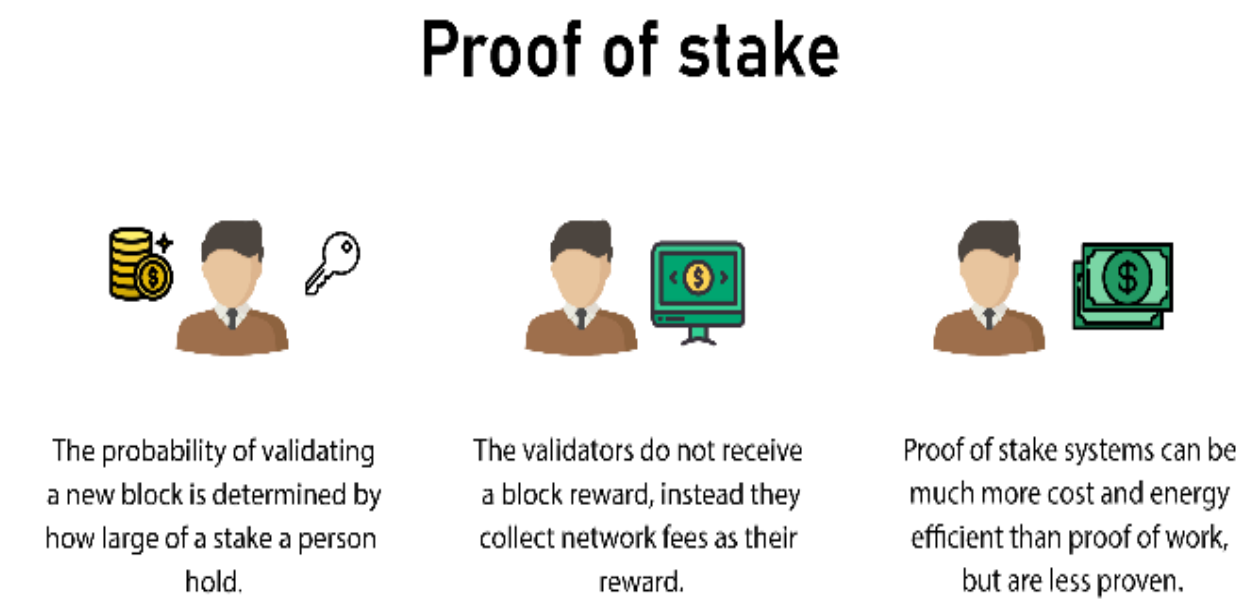
As well, because of how quickly mining hardware is rendered obsolete, electronic waste is a fact of the process. When a newer, better hardware is developed the previous equipment becomes obsolete and frequently this hardware end up being dumped. This leads to an increasingly serious electronic waste problem, the mismanagement of which can cause environmental and public health hazards [4].

III. PROPOSED METHODOLOGY AND DISCUSSION

Reducing the Effect on the Environment

Consensus Mechanisms That Use Less Energy

One proposed mitigation for the energy consumption is to start implementing more energy-efficient consensus mechanisms. One of those more computationally light weight approaches is that of PoS (proof-of-stake) [3].



Proof of Stake (PoS) has validators chosen proportional to the amount of coins that they are willing to stake as security. Ethereum, the second most valuable blockchain technology after Bitcoin famously worded its consensus mechanism from Proof of Work (PoW) to Proof of Stake (PoS), hoping to reduce it's environmental footprint.

Renewable Energy Source

Another way is to power mining operations from renewable energy sources. Several mining companies are already working to lower their carbon footprints by using renewable energy sources. Depending on the availability of water resources, sunlight or a sustainable energy source for mining operations may be solar electricity in sunny regions or hydropower [6].

IV. RESULTS

Improvements in mining hardware technology could also help reduce energy consumption. Reducing the energy consumption produced from mining operations as a whole can be answered by developing more efficient technology that is able to perform more calculations per unit of energy spent. Energy management and cooling solutions for mining

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farms can also be more innovative to increase efficiency [5]. These kinds of policies can help create restrictions from governments and regulatory agencies to ensure mining is done in a sustainable fashion. To be more specific; limits on e-waste disposal the minimum energy efficiency, and renewable energies implemented with a possible reward. This may help develop the cryptocurrency market and reduce the adverse environmental impact [7].

V. CONCLUSIONS

As you all know, mining of cryptocurrencies has developed into an enormous industry with significant technological and economic consequences. However, in terms of its high energy consumption and the negative impact on environment there are serious problems. With the light of these, stakeholders might help contribute to a greener future for locating more sustainable options in bitcoin mining. This includes moving to energy-efficient consensus, increasing renewable use, improving mining technology, and formalizing the industry through regulation. Solutions can be found that protect the environment, and at the same time allow for growth of the bitcoin market [1].

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