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# Two Sides of a Coin: A Comparative Study of The Efficiency of Cryptocurrency and Its Effect on The Environment

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**Abstract—** Blockchain has been regarded as the latest disruptive paradigm in computing. The question to be answered is – Is Blockchain a sustainable technology option. The largest known application of blockchain is the Bitcoin cryptocurrency. Assessment of sustainability friendliness of blockchain technology in terms of sustainability index of bitcoin blockchain would be a fair assessment. There are many pros and cons of blockchain mining of bitcoins. The blockchain security is dependent on the complex or intensive algorithm which is used for mining. The mining techniques can be compared with the mining of crude oil or gold and its behavior can be analyzed similar. The energy which is released for mining a bitcoin is equal to one million of vehicles emitting CO<sub>2</sub> for a period of two years. According to studies 4.6 CO<sub>2</sub>eq would get emitted for every dollar that have been spent on bitcoin. According to some research papers of 2017 the electricity which was consumed for mining was in the range of 100-500 MW. The hash rate was 10<sup>5</sup> hashes to 10<sup>8</sup> hashes and later increased from 10<sup>10</sup> hashes to 10<sup>13</sup> hashes. This caused more complex calculations for mining as sophisticated algorithms were used which led to heavy processing causing lot of heat emission. Hence the blockchain mining should be in control otherwise can cause worst effects on environment.

**Keywords—** Blockchain security, hashes, mining algorithms, energy consumption, emission of CO<sub>2</sub>.

## I. INTRODUCTION

The Blockchain is a distributed database which provides security and also gives transparency of transactions that occur using this technology. Digital data structure is the other name for Blockchain. This technology eliminates the need for centralization. It instead uses decentralized techniques for transactions. Blockchain technology is not only used for financial transactions but also it is used for keeping track of any digital asset or code or any smart contract. In blockchain, once the data has been registered into it, it is extremely difficult or impossible to remove it or change the data [3]. This becomes a boon as all the data can be tracked [3]. High quality data can be stored [4]. The transactions are done faster using blockchain [4]. Blockchain has the lowest transaction cost [4]. As blockchain is transparent and immutable. Blockchain is a technology which is dependable and we can rely on it. The age of trading changed accordingly in decades. Earlier many decades before, the barter system was introduced which ended when people started exchanging the minted shiny metal coins. Then later the metal coins were converted into proper notes according to the country's rules

and regulation. Then the notes and coins were later converted to digital currency. And later a cryptocurrency was introduced in 2008 named Satoshi Nakamoto which was created by an unknown group of people. The cryptocurrency(bitcoin) then started in 2009 when its source code was released as an open-source.

## II. BLOCKCHAIN MINING TECHNIQUES

The blockchain mining techniques of bitcoin has a random nature of hashing. Achieving an acceptable block is always a suspense and will not have guarantee [9]. The mathematical puzzle of a block which is to be hashed is periodically modified so that it will increase the complexity and also ensure the production of a new block. The techniques which are used for blockchain mining is as follows: -

### 1. Proof of Work

The proof of work was developed to limit the denial service (DoS) attacks of the Internet. This method uses the nonce number which can be used only once and calculation of the hash is done. Suppose the nonce number is taken as 0000 the hash which gets generated is calculated after thousands of hashes generation as the nonce number have to match the hashing code [9]. Due to this a single bitcoin transaction consumes 200kWh of electricity [9]. So, to solve these issues Proof of Stake method is used.

### 2. Proof of Stake (PoS)

Proof of Stake method replaces computational work by random selection process where the chance of successful mining is proportional to the wealth of validator [9]. This approach can lead to faster blockchains which can have much lower electricity consumption. PoS blockchain can be used in public blockchains and also in private blockchains. In public blockchain the validators are unknown and untrustworthy and in private the validators are known and trustworthy. In addition to the work done by this algorithm is that there is no need to constantly generate new coins for validation. PoS can also make the use of game theoretical mechanism to prevent the centralization and collisions.

3. Practical Byzantine Fault Tolerance (PBFT)
4. Proof of Elapsed Time (PoET)
5. Proof of Activity (PoAc)
6. Proof of Burn (PoB)
7. Proof of Capacity (PoC)
8. Proof of Authority (PoAu)
9. Federated Byzantine Agreement (FBA)

#### 10. Delegated Proof of Stake (DPoS)

These all techniques solve a complex equation and as the solution is found or not found, it is copied into the new block. Every time a transaction takes place a new block gets generated and all the changes gets reflected into the block. This process becomes time consuming and also energy consuming.

### III. THE PROS AND CONS

In mining techniques once the changes are done in the new block it cannot be reversed or deleted. So, it is also called as immutable constructs as the permission for random accessing and write are not allowed or cannot be done by any way. This becomes a positive point of the blockchain as a transparency is seen in the blocks. The security of blockchain is dependent upon the compute-intensive algorithm. This prevents the double spending of bitcoins and also getting acknowledgements with confirmed transactions. The bitcoin system is a distributed system i.e. it has peer to peer network. The 'proof-of-work' algorithm needs very high energy. According to the previous research papers the energy consumption was in the range of 100-500 MW [1]. In the beginning, energy required to mine a single bitcoin is minimum 2.55 gigawatts (GW) which is equal to the energy of 22 terawatt-hour per year which is almost same as the energy required for Ireland [6]. Cambridge Bitcoin Electricity Consumption Index says that the global bitcoin network is consuming about more than seven gigawatts of electricity. Nowadays the electricity which is required is 64 Terawatt which is almost equal to the electricity used by Switzerland (58TWh per year) and Columbia (68 TWh per year) [7].

As the bitcoins gained popularity because it offered strong financial incentive it gave rise to new miner's day by day. The miners had to use general-purpose computers but later on as the bitcoins decreased in number their algorithmic complexity also increased leading to heavy processing of hardware to mine a single bitcoin. The miners initially used CPU (central processing unit) for mining which had the least power consumption as well as least heat emission while processing. CPU based mining can lead to hardware specific implementations which will lead to centralization. Later the second-generation computer having graphics processing unit, came into picture in 2010. The hash rate was  $10^6$ - $10^8$  during the usage of the CPU. But later on the hash rate increased to  $10^{10}$ - $10^{13}$  hashes for ASIC hardware [1]. The energy consumed by a small bitcoin mine (in order of 10 MW) will be compared to the energy consumed by small countries like Denmark, Bangladesh which consumes electricity in the range of 3-6 MW [2].

The environmental sustainability of bitcoin mining can be compared to the mining of natural resources. The more we mine bitcoin the more it will lead to their extinction. This will cause the rise in the demands of bitcoin and also the price of it will increase. Highly secure cryptographic algorithms are used for bitcoin mining which is based on blockchain technology. As blockchain is peer to peer technology it is spread very widely in the world. The carbon dioxide which is emitted by the processor or mining hardware is equal to the CO<sub>2</sub> emitted by one million vehicles in the 2 years period [5].

4.6 CO<sub>2</sub> is emitted for each dollar spent on bitcoin's electricity.

### IV. CONCLUSION

If bitcoin mining is done for a limited period of time and amount then the balance of nature will be maintained. The environment will not get polluted or get heated up due to excessive mining. And also, the waste of energy will not take place. The electricity which is consumed while mining the bitcoin is observed to be roughly consuming 0.25 percent of world's entire electricity consumption. The transactions of blockchain always generate a new block which needs very large memory as the data stored in the blockchain is of high quality. This leads to the problem of storage of the transactions and changes. The blockchain archiving techniques of transaction is yet to be discovered, hence till then the storage of blockchain will be the biggest problem as it is in Terabytes (TB) and Gigabytes (GB). Hence from a point the blockchain is a boon for humans if it is used in banks and other transaction but if it is used for bitcoin mining it can become a curse for the humans.

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