Analyzing Cryptocurrencies: A Comparative Study of Bitcoin, Ethereum, and Tether

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***Abstract*—The rise of cryptocurrencies has revolutionized the way people view money and financial systems. Bitcoin, Ethereum, and Tether are among the most popular cryptocurrencies, each with its unique features, use cases, and potential benefits. This paper aims to compare and contrast Bitcoin, Ethereum, and Tether in terms of their history, technology, adoption, security, and limitations. The findings indicate that while Bitcoin remains the most widely adopted cryptocurrency, Ethereum has a more robust and versatile blockchain technology, while Tether provides a stable alternative to traditional cryptocurrencies. The paper concludes by highlighting the significance of the comparative study and outlining the future trends and challenges facing the cryptocurrency industry.**

***Index Terms*—Blockchain, Bitcoin, Ethereum, Tether, Cryptocurrency**

I. Introduction

A cryptocurrency is a digital currency, which is an alternative form of payment created using encryption algorithms. The use of encryption technologies means that cryptocurrencies function both as a currency and as a virtual accounting system. To use cryptocurrencies, you need a cryptocurrency wallet. These wallets can be software that is a cloud-based service or is stored on your computer or on your mobile device. The wallets are the tool through which you store your encryption keys that confirm your identity and link to your cryptocurrency.

Cryptocurrencies have gained massive popularity in recent years, with the likes of Bitcoin, Ethereum, and Tether dominating the market. Bitcoin, the first decentralized digital currency, was created in 2009 by an anonymous developer known as Satoshi Nakamoto. Ethereum, on the other hand, was launched in 2015 by Vitalik Buterin and has since become a popular platform for building decentralized applications (DApps). Ether is the native cryptocurrency of the platform. Among cryptocurrencies, Ether is second only to Bitcoin in market capitalization. Tether, a stablecoin pegged to the US dollar, was introduced in 2014 as a stable alternative to volatile cryptocurrencies. Crypto traders use stablecoins like Tether to make transfers between different cryptocurrencies or to move their investments into or out of fiat currencies. The value of USDT is pegged to the U.S. dollar. This paper aims to conduct a comparative study between Bitcoin, Ethereum, and Tether, examining their history, technology, adoption, security, and limitations.

II. Background

Since the creation of Bitcoin in 2009, the cryptocurrency market has grown rapidly, with new digital currencies emerging to offer unique features and use cases. Among the most popular cryptocurrencies are Bitcoin, Ethereum, and Tether. Bitcoin was created as a decentralized digital currency that could be used for peer-to-peer transactions without the need for intermediaries like banks. Ethereum, on the other hand, was designed as a platform for decentralized applications and smart contracts, allowing developers to build and deploy their own decentralized applications on the blockchain. Tether, a stablecoin, was designed to maintain a 1:1 peg with the US dollar, making it less volatile than other cryptocurrencies.

As the cryptocurrency market has evolved, there has been increasing interest in comparing the features, strengths, and weaknesses of these three cryptocurrencies. Understanding the similarities and differences between Bitcoin, Ethereum, and Tether is important for investors, traders, and developers who seek to make informed decisions about how to allocate their resources in this rapidly evolving market.

III. Literature review

This section deals with a brief description of the technology behind the cryptocurrencies under examination. Furthermore, a rundown of the consensus mechanisms is also described.

A. Blockchain

Blockchain is a digital ledger technology that allows data to be stored in a secure, transparent, and decentralized manner.

It consists of a chain of blocks that contains verified and encrypted data, which cannot be modified or deleted once it has been added to the chain. Each block in the chain contains a unique digital signature and timestamp, which ensures that the data is secure, tamper-proof, and easily auditable.

In the case of cryptocurrencies, the blockchain technology is used to create a decentralized, distributed ledger of all transactions on the network. Each transaction is verified and added to the network by a network of users (nodes), and once added to the blockchain, the transaction cannot be modified or deleted. Figure 1 demonstrates the working of a blockchain.

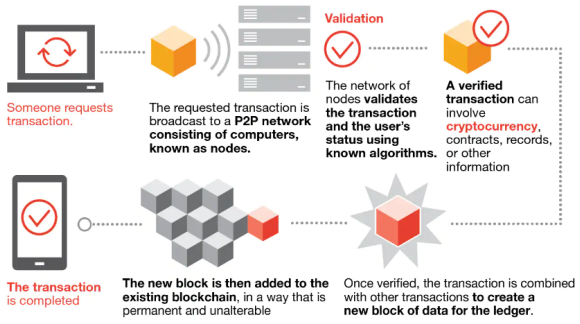

Fig. 1. Working of blockchain

This provides a secure, transparent, and efficient means of transacting online, as it eliminates the need for intermediaries like banks and payment processors, and provides users with greater control over their funds.

However, blockchain technology has several applications beyond cryptocurrencies. For example, it can be used to create decentralized marketplaces, digital identities, supply chain management systems, and voting systems.

B. Consensus mechanisms

Consensus mechanisms are the algorithms used by blockchain networks to validate transactions and ensure that the ledger remains secure and accurate. In other words, they are the means by which the network reaches agreement on the state of the ledger. There are several consensus mechanisms used in blockchain technology, each with its own advantages and limitations. Here are a few of the most common:

1) *Proof of Work (PoW)*: This is the original consensus mechanism used by Bitcoin and several other cryptocurrencies. It involves miners using computational power to solve complex mathematical puzzles, with the first miner to solve the puzzle being rewarded with newly created coins. While PoW is secure and proven, it is also energy-intensive and slow.
2) *Proof of Stake (PoS)*: This consensus mechanism involves validators (sometimes called ”forgers” or ”minters”) staking their own coins as collateral to confirm transactions and create new blocks. Validators are chosen based on the amount of coins they have staked, with higher stakes giving them a greater chance of being chosen. PoS is more energy-efficient than PoW, but can be vulnerable to centralization.
3) *Delegated Proof of Stake (DPoS)*: This is a variant of PoS that involves stakeholders electing a smaller group of validators to confirm transactions and create new blocks. This system is faster and more efficient than PoW and PoS, but can be susceptible to collusion and centralization.
4) *Proof of Authority (PoA)*: This consensus mechanism involves a small group of known validators who are trusted to confirm transactions and create new blocks. PoA is fast and efficient, but can be vulnerable to centralization and censorship.
5) *Proof of History (PoH):* It is a relatively new consensus mechanism where Proof of Work (PoW) and Proof of Stake (PoS) are combined. PoH uses a verified random function (VRF) to create unique, sequential values for blockchain block timestamps. These timestamps are based on a secure clock maintained by a network of independent validators. Like PoS, validators are chosen by stake in the network. In PoH, validators don't create new blocks or process transactions. Instead, they verify and transmit VRF timestamps to the network. A timestamp can prove transaction order if enough validators have validated it. PoH has high throughput and low latency since transactions can be processed and confirmed quickly.

There are several other consensus mechanisms used in blockchain technology, including Proof of Elapsed Time (PoET), Practical Byzantine Fault Tolerance (PBFT), and Federated Byzantine Agreement (FBA). Overall, the choice of consensus mechanism depends on the specific needs and goals of the blockchain network, with different mechanisms offering different trade-offs between security, efficiency, and decentralization.

C. Related work

Several research papers have discussed the differences and similarities between Ethereum and Bitcoin, two of the most well-known blockchain technologies. One such paper is ”An Overview of Ethereum & Its Comparison with Bitcoin” [09] by Shailak Jani (2018). It provides an introduction to Ethereum and its key features, as well as a comparison to Bitcoin. The author explains that Ethereum is a decentralized blockchain platform that allows developers to build decentralized applications and execute smart contracts. Unlike Bitcoin, which focuses on facilitating peer-to-peer transactions, Ethereum aims to create a decentralized platform for various use cases beyond just cryptocurrency transactions. The paper also discusses Ethereum's key features, including the Ethereum Virtual Machine (EVM) and Ether (ETH) cryptocurrency. The EVM is a Turing-complete virtual machine that allows developers to write smart contracts and execute them on the Ethereum blockchain. ETH is the cryptocurrency used to pay for transaction fees and incentivize network participants. The author then compares Ethereum to Bitcoin in terms of their

architecture, use cases, and market capitalization. While both are decentralized blockchain platforms, Ethereum has a more diverse set of use cases and a larger market capitalization than Bitcoin. Overall, the article provides a high-level overview of Ethereum and its comparison to Bitcoin, highlighting Ethereum's potential to disrupt various industries through its decentralized platform and smart contract capabilities.

The paper "Comparative Study on the Environmental, Political, Social Effects And Long-Term Sustainability Of Bitcoin, Ethereum, Tether and Cardano Cryptocurrencies" [10] presents a comparative study on the environmental, political, social effects, and long-term sustainability of four major cryptocurrencies: Bitcoin, Ethereum, Tether, and Cardano. The study analyzes the carbon footprint and energy consumption of these cryptocurrencies, their impact on political and social stability, and their potential for long-term sustainability. The author concludes that while Bitcoin and Ethereum have significant environmental impacts and potential social and political risks, Tether and Cardano are more sustainable and have lower environmental and social risks. The study emphasizes the need for the development of sustainable and socially responsible cryptocurrencies and calls for further research in this area.

The study "Crypto-Currencies - A Comparative Study on Volatility of Top 5 Crypto-Currencies" [32] conducted by D. Rajagopal, an Assistant Professor, compares the volatility of the top 5 cryptocurrencies. Cryptocurrencies are digital or virtual tokens that use cryptography to secure their transactions and to control the creation of new units. The top 5 cryptocurrencies, in terms of market capitalization, are Bitcoin, Ethereum, Binance Coin, USD Coin, and Tether. The data was collected from the secondary sources including newspapers, journals, publications and websites. The author concludes that Bitcoin can exploit its current user base and demonstrated use case, and that it will probably grow more over the next five years. The price of the top 5 cryptocurrencies leads with Bitcoin, followed by Ethereum, then Tether, followed by USD Coin and Binance (BNB). Overall, the study highlights the need for investors to be aware of the risks associated with investing in cryptocurrencies, particularly their high volatility. It also suggests that investors should diversify their portfolio to mitigate the risks of investing in cryptocurrencies.

"The Impact of Tether Grants on Bitcoin"[29] examines how Tether grants affect Bitcoin. Tether is a stablecoin that is supposed to be backed by US dollars in a 1:1 ratio. The author looks at the period from March 2017 to March 2018 and finds that Tether grants are positively correlated with Bitcoin returns. In other words, when Tether grants were issued, Bitcoin prices tended to rise. The author suggests that this correlation may be due to Tether grants being used to manipulate the Bitcoin market. The article highlights the need for further research on the impact of stablecoins on cryptocurrency markets.

In the sections that follow, a detailed comparison of these three cryptocurrencies: Bitcoin, Ethereum, and Tether, will be presented.

IV. History

A. Bitcoin

Bitcoin's creation in 2009 marked the birth of the first decentralized digital currency, which aimed to provide an alternative to traditional fiat currency. The currency's popularity grew steadily, and by 2017, Bitcoin's value had skyrocketed to over $19,000, attracting both investors and speculators.

B. Ethereum

Ethereum's creation in 2015 marked a significant milestone in the development of blockchain technology. Ethereum's blockchain introduced smart contracts, enabling developers to build decentralized applications and execute transactions without the need for intermediaries.

C. Tether

Tether was introduced in 2014 by a group of individuals led by Brock Pierce, Reeve Collins, and Craig Sellars, as a stablecoin pegged to the US dollar. Tether aimed to provide a stable alternative to volatile cryptocurrencies and enable users to trade cryptocurrencies without having to convert them to fiat currency.

V. Purpose

A. Bitcoin

Bitcoin was designed as a decentralized digital currency, aiming to provide a peer-to-peer payment system without the need for intermediaries like banks.

B. Ethereum

Ethereum, on the other hand, was designed as a platform for decentralized applications and smart contracts, allowing developers to build and deploy their own decentralized applications on the blockchain.

C. Tether

Tether is a stablecoin designed to maintain a 1:1 peg with the US dollar, making it less volatile than other cryptocurrencies.

VI. Working

A. Bitcoin

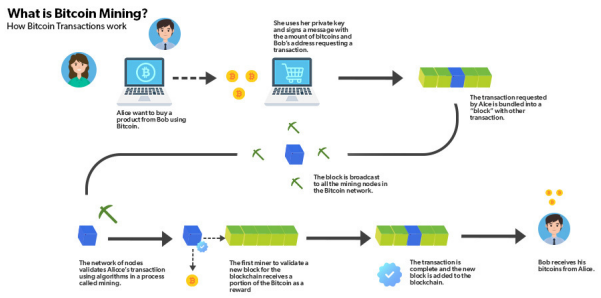

Fig. 2. Working of Bitcoin tractions

Let us understand with an example as shown in figure 2. If Alice has to send 10 BTC to Bob, A's transaction data is shared with the miners from the memory pool (where the unverified transaction waits for its confirmation). Miners start competing to solve the mathematical riddle. They validate and verify the transaction using proof of work. The one who solves the riddle first shares his findings with other nodes. The miner who came up with the solution first gets a reward of 6.25 bitcoins. The 10 BTC related to the transaction data is transferred to Bob from Alice after the addition of the transaction block.

B. Ethereum

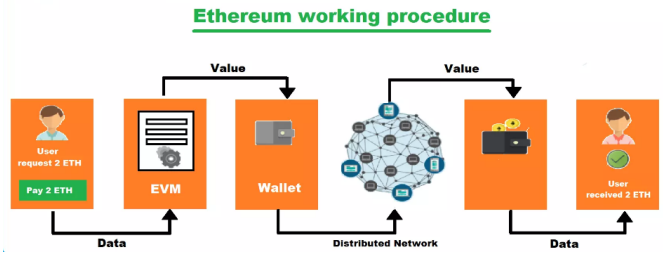

Fig. 3. Working of Ethereum

The memory in Ethereum stores data and code. The Ethereum blockchain tracks the changes in data and thus it tracks the changes in its memory. Ethereum first loads the program, executes it and finally stores the results in its blockchain as dipcted in figure 3. This procedure is the same as in the computers that we use in our daily life. The difference is that the data in our computer is stored locally while in Ethereum blockchain, the changes in state are distributed and each node has data stored in it. Also, the changes in data are according to the consensus rules.

C. Tether

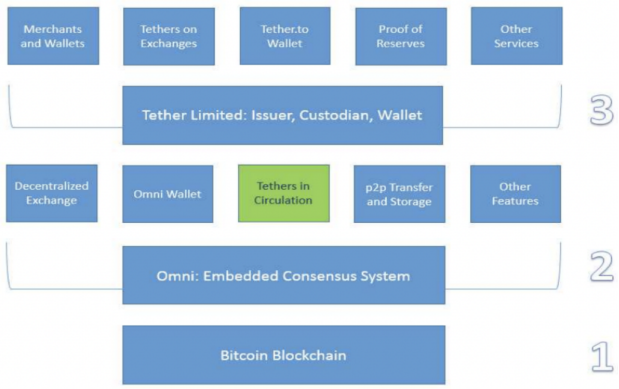

Fig. 4. Working of Tether

The Bitcoin blockchain is the first layer. The Tether transactional ledger is embedded as metadata in the Bitcoin blockchain via the Omni embedded consensus system. This can be seen in the figure 4.

The Omni Layer protocol is the second layer. Omni is a basic technology capable of:

1) Granting (creating) and revoking (destroying) digital tokens represented as metadata included in the Bitcoin blockchain. In this instance, fiat pegged digital tokens, tethers.
2) Monitoring and reporting on tether circulation using Omnichest.info (for example TetherUSD is represented by Omni asset ID 31) and the Omnicore API.
3) Allowing users to buy, sell, and store tethers and other assets/tokens in the following manner: a peer-to-peer, pseudo-anonymous, cryptographically secure environment or in Omni Wallet which is an open source, browser based, encrypted web wallet.

Tether Limited is the third layer and responsible for:

1) Accepting deposits in fiat currency and releasing the matching tethers.
2) Making withdrawals in fiat and canceling the relevant tethers.
3) Ownership of the fiat reserves that support all active tethers.
4) Making audit findings Proof of Reserves results public.
5) Starting and maintaining connections with already-existing wallets, exchanges, and businesses that accept Bitcoin and blockchain.
6) Using Tether.to, is an online wallet that enables users to effortlessly transfer, receive, store, and convert tethers.

VII. Consensus Mechanism

A. Bitcoin

Bitcoin uses the Proof of Work (PoW) consensus mechanism, which involves miners using computational power to solve complex mathematical puzzles in order to validate transactions and create new blocks. Miners compete against each other to be the first to solve the puzzle and add the new block to the blockchain. This process is energy-intensive and can be slow, but is widely regarded as one of the most secure consensus mechanisms available.

B. Ethereum

Ethereum, uptill 2021, used the Proof of Work (PoW) consensus mechanism, similar to Bitcoin. However, in the year 2022, the Ethereum community transitioned to Proof of Stake (PoS) through the development of Ethereum 2.0[21]. This transition aimed at improving the energy efficiency of the network and make it more scalable while still maintaining a high level of security.

C. Tether

Tether (USDT) is a stablecoin that is pegged to the US dollar, meaning that its value is always equal to one US dollar. It currently uses several blockchain platforms to issue and transfer its stablecoin tokens, that means tether uses the consensus mechanism of the underlying blockchain that it is built on. Table I shows the blockchain platforms (and their

respective consensus mechanisms), on which USDT tokens are currently hosted on[04].

TABLE I
BLOCKCHAIN PLATFORMS FOR USDT

Blockchain platform	Consensus mechanism
Ethereum	Proof of Stake (PoS)
Tron	Delegated Proof of Stake (DPoS)
Algorand	Pure Proof of Stake (PPoS)
Solana	Proof of History (PoH)
Avalanche	Proof of Stake (PoS)
Polygon	Proof of Stake (PoS)

VIII. ADOPTION

A. Bitcoin

Bitcoin remains the most widely adopted cryptocurrency, with a market capitalization of over $390 billion[2] as of March 2023. It has the highest adoption rate among the three cryptocurrencies, with a large and growing number of merchants accepting Bitcoin as a form of payment.

Figure 5 displays these three cryptoassets as a share of the total market capitalization, demonstrating Bitcoin's market dominance.

B. Ethereum

Ethereum has also gained significant adoption, with a market capitalization of over $180 billion[2] in March 2023 and a growing ecosystem of decentralized applications built on its blockchain.

C. Tether

Tether has gained significant adoption among traders and investors who use it as a stablecoin to trade cryptocurrencies without having to convert them to fiat currency. The current market capitalization is around $81.5 billion[3].

IX. PRICE VOLATILITY

Bitcoin is known for its high price volatility, with its value fluctuating greatly over short periods of time. Ethereum is also relatively volatile, but less so than Bitcoin. Tether, on the other hand, is designed to be a stablecoin with a peg to the US dollar, making it less volatile than other cryptocurrencies.

The prices of these three cryptocurrencies relative to the US dollar are displayed in Figure 6 for the years 2019 through 2023.

X. SECURITY

A. Bitcoin

There have been several attacks attempted on Bitcoin over the years. One such attach was the 51% attack. In this attack, a malicious actor gains control of 51% or more of the computing power (hash rate) of the Bitcoin network, allowing them to manipulate the blockchain and potentially double-spend coins. While 51% attacks are difficult to execute, there have been some attempts in the past. For example, in 2014, a mining pool called Ghash.io briefly gained control of over 51% of the network's hash rate, causing concern in the Bitcoin community. A similar attack happended on a bitcoin fork, Bitcoin SV in 2017 in an attempt to destroy the cryptocurrency[6]. Bitcoin has also suffered through transaction malleability attacks. In this, a malicious actor can modify the ID of a transaction in the blockchain to make it appear as if a transaction never occurred. This can lead to confusion and potential loss of funds. In 2014, the Mt. Gox exchange was targeted by a transaction malleability attack, leading to the loss of 850,000 Bitcoins[7]. Recently in 2021, a hacker stole $600m in cryptocash from blockchain company Poly Networks[8]. DDoS attacks have also been attempted where Bitcoin nodes and mining pools have been targeted aiming to overwhelm the network with traffic and bring it down[12]. It's important to note that while attacks have occurred, the underlying blockchain technology of Bitcoin has proven to be resilient and has withstood these attacks. Additionally, improvements in security measures and the decentralization of the network have helped to mitigate the impact of attacks.

B. Ethereum

Ethereum has also been targeted by several attacks over the years. The DAO was a decentralized autonomous organization built on top of the Ethereum blockchain. In 2016, a hacker exploited a vulnerability in the DAO's code and stole 3.6 million Ether, worth around $50 million at the time[14]. This incident led to a hard fork of the Ethereum blockchain, which resulted in the creation of two separate blockchains - Ethereum and Ethereum Classic. In October 2022, a hacker stole $300K from Olympus DAO, but returned it on the same day[13]. Ethereum has also also suffered the 51% attack. In January 2019, a hacker gained control of over 51% of the Ethereum Classic network's hash rate, allowing them to manipulate the blockchain and potentially double-spend coins[15]. Hackers can also exploit smart contracts vulnerabilities on the Ethereum blockchain. A smart contract is a self-executing contract with the terms of the agreement between buyer and seller being directly written into lines of code on the blockchain. In 2017, a bug in the Parity multisig wallet contract led to the loss of around $30 million worth of Ether[16]. Like Bitcoin, Ethereum has also been able to withstand and recover from these attacks due to the underlying blockchain technology and improvements in security measures.

C. Tether

There have been a few security incidents and concerns related to Tether (USDT) over the years, but no successful attacks on the underlying blockchain have been reported to date. In November 2017, Tether reported that around $31 million worth of USDT had been stolen from its treasury wallet due to a hack[17], leading to a temporary suspension of trading. However, Tether was able to recover the stolen funds and issued a new version of the USDT token to prevent

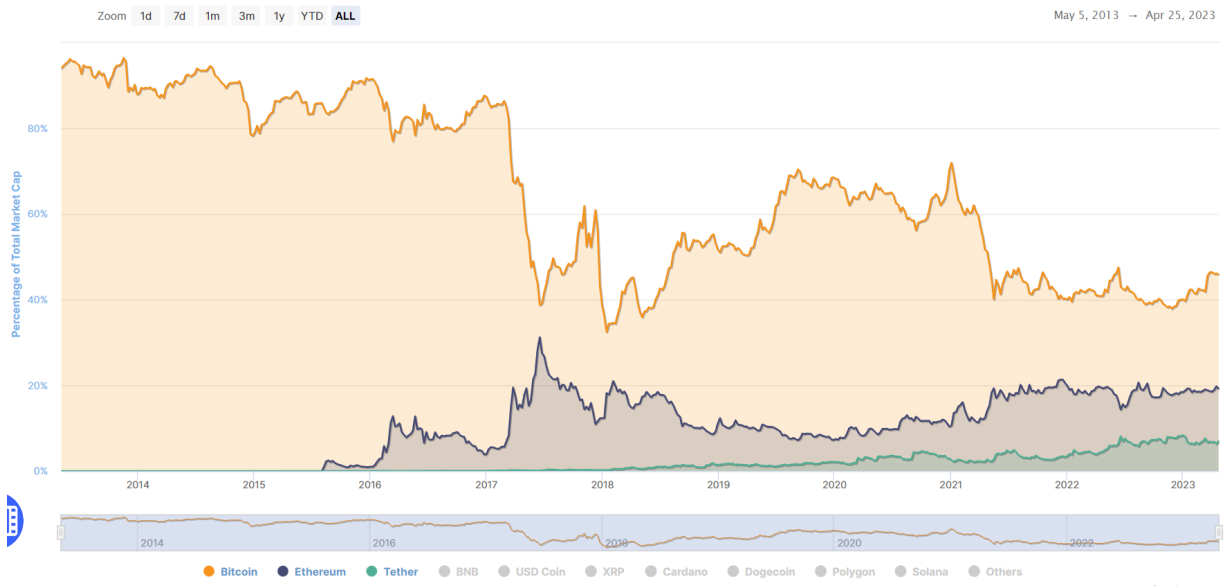

Fig. 5. Cryptoassets by percentage of Total Market Capitalization - source: CoinMarketCap[30]

Fig. 6. Prices against US dollar - source: Google Finance[31]

further exploitation of the stolen tokens. In June 2022, Tether confirmed DDOS attack on tether.io where the number of requests for the website increased from 2,000 to 8,000,000 every five minutes[18]. While Tether has not experienced any successful attacks on its blockchain, the cryptocurrency has faced criticism and controversy over its transparency and allegations of market manipulation[19].

XI. Environmental Impact

A. Bitcoin

Bitcoin mining and transaction verification require a significant amount of computational power, which results in high energy consumption and carbon emissions. According to the Cambridge Bitcoin Electricity Consumption Index, as on March 2023, the annual energy consumption of the Bitcoin network is estimated to be around 147.51TWh [25], which is comparable to the annual energy consumption of countries such as Ukraine, Malaysia or Poland. Bitcoin's power demand trend can be observed in Figure 7. The majority of Bitcoin mining is currently done using fossil fuels, such as coal, which increases the carbon footprint of the cryptocurrency[26]. However, it is important to note that the environmental impact of Bitcoin is not solely negative. Some argue that the high energy consumption incentivizes the development of renewable energy sources and energy-efficient technologies. Additionally, some Bitcoin mining facilities (like Alps Blockchain[24]) are powered by renewable energy sources, such as hydroelectricity.

B. Ethereum

Similar to Bitcoin, Ethereum mining and transaction verification also require significant computational power, which results in high energy consumption and carbon emissions. The Ethereum network used a proof-of-work consensus mechanism till 2021, which required a lot of energy to secure the network. According to the Ethereum Energy Consumption Index, the annual energy consumption of the Ethereum network was estimated to be around 78 TWh, which is almost half of the energy consumption of the Bitcoin network. However, Ethereum switched to a proof-of-stake consensus mechanism in 2022, which reduced the energy consumption of the network significantly and brought it down from 78 Twh to 0.0026 Twh[27]. The proof-of-stake mechanism requires validators to hold a certain amount of Ethereum as collateral and does not require energy-intensive mining. Ethereum's energy consumption[28] over the years can be observed in figure 8.

C. Tether

As Tether is not a blockchain network, it does not require mining or transaction verification that consumes significant

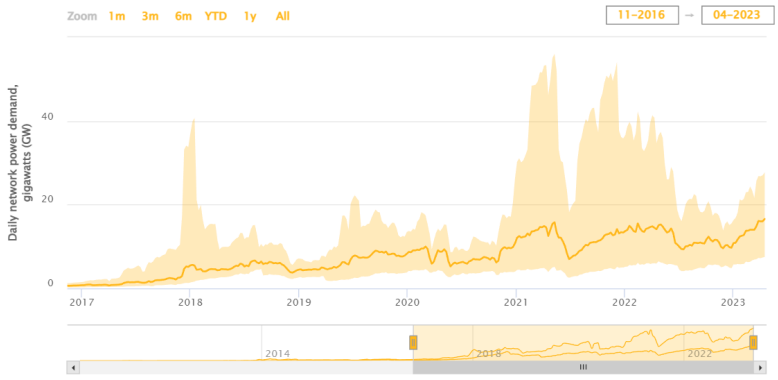

Fig. 7. Historical bitcoin network power demand - source: CBECI

Fig. 8. Ethereum Energy Consumption - source: Ethereum Energy Consumption Index

amounts of energy. Therefore, Tether's environmental impact is much lower than that of Bitcoin or Ethereum. However, Tether's environmental impact cannot be completely ignored, as it operates on various blockchain networks such as Bitcoin and Ethereum, which have high energy consumption. Additionally, Tether's use in transactions and trading may contribute to the overall energy consumption of the cryptocurrency market.

XII. Limitations

A. Bitcoin

Bitcoin's primary limitation is its scalability, with the network currently able to process only a limited number of transactions per second. This has led to high transaction fees and slow confirmation times during periods of high network activity. Slow transaction rates, expensive gas fees, expensive operational fees and eco-hazardous energy usage summarize the inefficiency associated with a proof-of-work system. Bitcoin's average block time (time taken to process a transaction) is 10 minutes, and the process requires a staggering amount of electricity[20].

B. Ethereum

Ethereum's blockchain has also faced scalability challenges, leading to congestion on the network during periods of high activity. Additionally, the complexity of Ethereum's smart contracts has led to security vulnerabilities, with several high-profile hacks and exploits in the past.

C. Tether

Tether's primary limitation is its reliance on the US dollar, which means that any instability or volatility in the US economy could affect the stability of Tether. A major concern is that Tether's reserves may not be fully backed by actual US dollars, as the company has faced accusations of not providing enough transparency into its reserves[22]. This lack of transparency can lead to questions about Tether's stability and value, and may erode trust in the coin. Another limitation is that Tether is not decentralized like other cryptocurrencies. Instead, it is issued and managed by a centralized company, which means that users must trust that company to properly manage the coin and its reserves. Finally, Tether's use as a stablecoin is limited to certain use cases[23], and it may not be suitable for more complex financial applications or decentralized finance (DeFi) platforms.

XIII. Results

Overall, while Bitcoin remains the dominant cryptocurrency in terms of market capitalization and trading volume, Ethereum and Tether offer unique features and use cases that make them attractive to different types of users. All the cryptocurrencies have security issues. However, it's important to remain vigilant and continue to improve security measures to prevent future attacks. As the cryptocurrency market continues to evolve, it is essential to understand the key

differences between these cryptocurrencies and their potential future prospects.

XIV. Conclusion

In conclusion, Bitcoin, Ethereum, and Tether represent three different types of cryptocurrencies with varying strengths and weaknesses. While Bitcoin remains the most widely adopted cryptocurrency, Ethereum's blockchain technology offers a more robust and versatile platform for building decentralized applications. Tether provides a stable alternative to volatile cryptocurrencies, enabling traders and investors to trade cryptocurrencies without having to convert them to fiat currency. The comparative study between Bitcoin, Ethereum, and Tether highlights the significance of understanding the different use cases, the underlying technologies, price and market capitalization, adoption rates and potential benefits of each cryptocurrency. However, the cryptocurrency industry faces several challenges, including regulatory uncertainty, scalability, and security issues. The environmental impacts of these cryptocurrencies also can't be ignored. As the cryptocurrency market continues to grow and develop, it is important to consider the environmental impact of all cryptocurrencies. The future trends and challenges facing the cryptocurrency industry will largely depend on the ability of developers and stakeholders to address these issues and build a more stable and sustainable ecosystem.

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