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In recent years, concerns over the effect of blockchain on the environment have become a massive topic of discussion and possibly a hurdle for adopting these technologies. In my paper, I will discuss if these concerns are valid and if the short-term losses taken on the technology can result in a much better future for the economics and finance of the world. I will also be discussing a very controversial topic which is NFTs. I will be talking about how NFTs help revolutionize the Proof of Ownership and the creative economy.

On January 27, 2009, Hal Finney, the first developer of Bitcoin after, of course, Satoshi Nakamoto, tweeted that he was thinking about ways to reduce CO2 emissions from a widespread Bitcoin implementation (Finney). The talk about the effect of mining blocks on the environment has been around for more than a decade and started soon after the Bitcoin Whitepaper (Technical Paper of Bitcoin) was launched. Although there have been a few upgrades to the Bitcoin Network over the years, most of it has stayed the same. For the last dozen years, the same methods have been used to process the blocks and the transactions.

Fig 1

This is not the case for every project in the crypto space. Projects like Cardano and Solana have achieved a fully-functional blockchain with smart contracts by using a tiny amount of energy compared to giants like Bitcoin or Ethereum. Ethereum, however, has plans to go from proof-of-work to proof-of-stake method of processing transactions. This will reduce the energy consumption of the Ethereum blockchain by more than 90% and make the transactions faster and cheaper (Digiconomist).

Basics of Cryptocurrencies

In every financial model, there is something fundamental called a ledger. It keeps track of all the transactions and the account balances of everyone. Every bank operates millions of separate ledgers and some central ledgers to keep track of their clients' money and to track all the assets available to the bank at any given time. Even governments have ledgers that keep track of how much foreign reserves they have and how much they owe to banks and people.

In every one of these situations, there is always a third party involved that keeps trust in the system and prevents double spending of the funds. For example, If person A sends a wire transfer to person B, the bank is a middle man who makes sure the money is credited from person A's account and debited into person B's. When we zoom out a little, we see the central government authorities acting as a middle man to maintain the ledgers in between the big banks (Nakamoto 1).

The term Cryptocurrency was officially established in 1998 by Wei Dai in his paper on B-money. B-money was a project that was developed almost ten years before Bitcoin, and a lot of the concepts developed for B-money were used in the development of Bitcoin (Reiff). One of the main aims for cryptocurrencies has always been to remove the middleman and reach a consensus between people without relying on one trusted third party. The consensus here means trust. Cryptocurrencies try to implement a system that all the users can trust without having a third party check the ledgers. From 1995 to 2008, we saw a lot of different projects like David Chaum's DigiCash, Adam Back's HashCash, and Nick Szabo's Bit Gold. Although none of these projects got mainstream attention, the concepts and technologies developed by these projects will be essential for Satoshi to create Bitcoin (Reiff).

Bitcoin in a nutshell

The Bitcoin whitepaper came out in late 2008, after the world's financial system was on its knees, primarily because of the actions of the big banks. This made people think about how much they can trust the banks with their money and assets. Mr. Nakamoto saw this as the perfect opportunity to unveil his revolutionary paper on Bitcoin. Bitcoin has many things that make it so popular and accepted, but most of all, Satoshi found a great way to solve the complicated problem of double-spending. Almost all cryptocurrency projects before Bitcoin suffered from this issue. Bitcoin uses the SHA-256 hashing algorithm, which in simple terms requires physical work done in terms of computing power to process blocks (collection of transactions). Miners compete to produce the correct hash for the current block or solve the puzzle for that block in layman's terms. The Bitcoin protocol rewards the person who can solve the puzzle the fastest (Nakamoto 3). The protocol also adjusts the puzzle's difficulty according to how many people try to mine a specific block. Bitcoin protocol always believes that the blockchain with the most amount of work done is the legit/truthful chain. If someone wants to go back to a block in the past and change values, they will have to redo all the work done on the blocks generated after that block (Nakamoto 4). This is what makes Bitcoin so revolutionary. Any way of changing the data in the previous blocks to double-spend is infeasible. This way of reaching distributed consensus between people is called Proof-of-Work.

Proof-of-Work vs. Proof-of-Stake

PoW and PoS are the two most popular ways to reach consensus in a Blockchain. I mentioned in the introduction that a lot of the newer blockchains like Cardano and Solana are successfully using PoS. PoS, in theory, uses a fraction of the energy PoW does and is supposed to be faster too. Although nothing is perfect and PoS is far from perfect.

Proof-of-Stake uses validators instead of miners to verify blocks. Validators on a blockchain are nodes that hold a significant amount of the currency as locked collateral. Validator nodes are rewarded for their service for validating the honest blocks and rejecting any malicious ones. If they validate a vicious block, they are fined by locking a percentage of their collateral.

There are several drawbacks of using PoS as the consensus mechanism. The biggest one is that it compromises the Decentralization of a currency, which is the whole point of using cryptocurrencies. New currency in PoS can only be minted by the people who have the currency already, which is very similar to Fiat Currencies (USD, GBP, etc.). Other drawbacks include compromised security of the network, unfair minting advantage to top holders, and less lucrative rewards (Bonheur).
Although many newer cryptocurrencies like Ethereum and Cardano are switching to a Proof-of-Stake model due to its vulnerabilities and security problems, something like Bitcoin can never switch to PoS.

Ethereum & Smart Contracts

Now that we have a better understanding of the differences between PoW and PoS protocol let's take a brief look at Ethereum and its different features, like Smart Contracts and NFTs.

If Bitcoin is trying to replace Gold, Ethereum is trying its best to become the medium in which people do everyday transactions, i.e., Cash. Ethereum is much more scalable and faster while still maintaining most of the decentralized qualities desired in a cryptocurrency. Ethereum also uses the PoW model for the verification of its transactions. Although with Ethereum 2.0 it will be switching to the much more energy-efficient PoS model (ethereum.org).

Another big reason for using Blockchains is the existence of Smart Contracts. Smart Contracts are a set of instructions given to a computer by code to settle a transaction between two parties without relying on a trusted third party. Essentially it provides people a way to give customized instructions to a blockchain. If a smart contract is activated, it can not be changed or stopped. It will execute the transactions when it gets the required input (Frankenfield). Nick Szabo pioneered smart Contracts in 1998 with his project called Bit-Gold (Reiff). Most of the modern smart contracts run on the Ethereum blockchain.

NFTs as a proof of ownership

NFTs or Non-Fungible Tokens are special tokens that represent ownership of unique items. "They let us tokenize things like art, collectibles, even real estate. They can only

have one official owner at a time, and the Ethereum blockchain secures them – no one can modify the record of ownership or copy/paste a new NFT into existence" (ethereum.org).

To understand what Non-Fungible means, we first have to understand what Fungibility is. The best example of something being fungible are currency bills. A $10 bill will always be worth $10. It doesn't matter what serial number it has, what year it was made in, or what state you are using it in. Two people can exchange their $10 bills and still maintain the same value they started with. Now imagine two people exchanging art they made. It is very unlikely that both of those pieces will be of the same value, so in that case, we can say that those things are Non-Fungible. The term Non-Fungible is a term from Economics that you could use to describe things like your furniture, a song, etc.
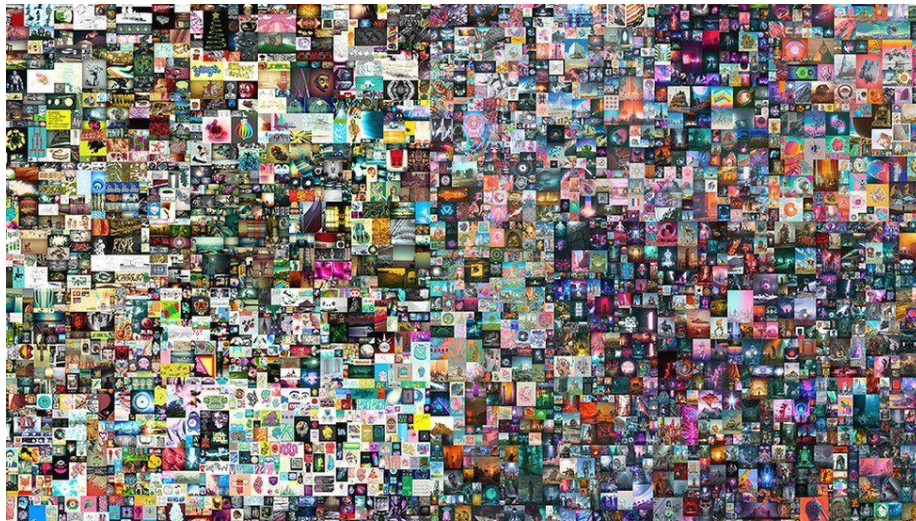
Fig 2

NFTs have been the most popular things in crypto this year, taking the world by storm soon after the famous piece from Beeple sold for $69 Million. Their popularity isn't

without reason, though; they solve a massive problem of proving ownership of something. Earlier this year, a house in Kyiv, Ukraine, was sold through NFTs. That was the first publicly known NFT real estate sale. Traditionally when you would buy a home, it would have a whole file of paper, which needs to be signed by several people before a real estate sale can take place. Not to mention all the energy that is spent in preserving these records, and if we lose them, it is a really long process to prove your identity and your ownership to get the papers back. This is the problem NFTs are trying to solve. They are a revolutionary new way of owning anything like Art, Real Estate, Music, etc. Their popularity in the Digital Art industry has skyrocketed because, for the first time, there is a legitimate way of owning your favorite artist's work. It is also beneficial for the artist as it helps them protect their ideas and concepts from being stolen and helps them get an even bigger audience.

**Concerns and Myths around Blockchain**

- Energy Consumption per transaction is too high.

We often see this metric in the mainstream media and on the internet. People compare the energy consumption per transaction of Bitcoin to something like Visa. There is no doubt that Bitcoin uses much more energy when compared to systems like Visa or Mastercard. "Digiconomist reports that Bitcoin uses 550,000 times as much electricity per transaction as Visa." (Zuluaga)

No one seems to mention that the average transaction amount is also much larger on Bitcoin than something Mastercard. The average transaction on the Bitcoin network is

more than $16000, while it is only $75 on Mastercard (Zuluaga; statista.com). Even though it is not as inefficient as people make it to be, I still believe that it is inefficient and not a very good medium for everyday transactions. It has a lot of scalability issues, which is one reason why people call it "Digital Gold." In recent years people have started to look at Bitcoin as a store of value rather than a transaction medium. Later in this paper, we look at how much more efficient it is as a store of value.
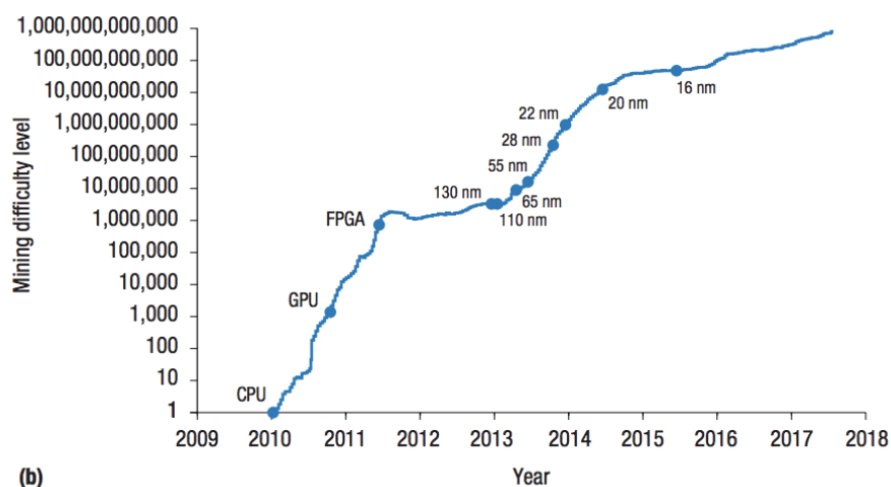
Fig 3

This is a chart of the difficulty of mining 1 Bitcoin compared to the average transistor size in the processors. This chart is only up to 2018, now we are down to 5nm, and it will be unfair not to credit crypto mining for this incredible technological feat. The incentive provided by mining has pushed us to the limits of how small transistors can get. We are almost at the limits set by Moore's Law (Gianfagna). A smaller transistor size results in a more powerful and efficient processor.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hash Rate (Gh/s)	0.003	0.575	0.550	0.650	63	878	4,255	9,750	11,500	22,550
Watts	55	241	271	250	445	509	1,145	1,200	1,450	1,786
Price (Release)	104	540	369	550	1,299	460	1,553	1,494	1,100	1,709
Efficiency (Gh/W)	0.00005	0.002	0.002	0.003	0.16	1.7	3.7	7.9	7.9	12.4
y/y		4749%	-14%	27%	6190%	923%	121%	112%	1%	56%
Hash Rate Cost ($/Gh)	$39,808	$938	$671	$846	$21	$0.5	$0.4	$0.2	$0.1	$0.1
y/y		-98%	-28%	26%	-98%	-97%	-30%	-58%	-38%	-21%

Fig 4

This chart shows how mining has become more efficient throughout the last several years.

The crypto industry undoubtedly has some of the most talented people in the world working on improving these technologies every day. So, my bullishness on this technology is not without reason. These intelligent solutions will be what the future finance industry will be based upon. We are still in the early stages of the crypto revolution. I will mention some of the innovations happening right now, which are typically not covered by the media as it isn't as good of a clickbait as "Bitcoin is destroying the environment."

- Ethereum 2.0

We have previously touched on this in the PoW vs. PoS section. Although I will go into a little more detail about what it is all about. As I mentioned before, Ethereum is in the process of switching from Proof-of-Work to Proof-of-Stake. This will make the blockchain magnitudes more efficient and fast. "This will remove computing power as a security mechanism, and reduce Ethereum's carbon footprint by ~99.95%" (ethereum.org). As people in the media like to use the energy used per transaction metric, let's compare the energy use per transaction of Ethereum 2.0 vs. Visa. 100,000

Visa Transactions use on average 149kWh of energy. On the other hand, ETH 2.0 will do the same amount of transactions in just ~11% of the energy at 17.4kWh. In theory, at the maximum efficiency of ETH 2.0, it will be able to do the same amount of transactions in 0.166kWh which is ~0.1% of the energy used by Visa (Digiconomist).

Ethereum 2.0 is being implemented as we speak. In December 2020, the Beacon Chain was launched. That chain is the first step in the PoS upgrade of the network. It is coming very soon.

- Lightning Network

Lightning Network is a technology being developed for Bitcoin by Blockstream. It allows small frequent transactions to happen off-chain. For example, if a person buys coffee at a local coffee shop every day, they can open a payment gateway and transact through Bitcoin without the latency or the transaction fees. If the owner of the coffee shop wants, he can later settle the transaction on the main blockchain (Frankenfield). It sounds a little complicated while explaining, but when implemented, this technology will be seamless to the users providing them with fast and cheap transactions. It will be like Venmo but for the blockchain.

These technologies are right around the corner, and they are developed by keeping Decentralization in mind, one of the main features of cryptocurrencies. Crypto will become much more efficient in the next 2-3 years.

- NFTs lead to high carbon emissions.

Most of the NFT projects and Smart contracts work on the Ethereum blockchain. Similar to Bitcoin, Ethereum also uses Proof-of-Work to verify transactions. So the environmental impact from it is also very similar to Bitcoin. As we discussed before, NFTs got popular earlier this year, and because NFTs use a bunch of different transactions at a time to process, this is what makes people think that NFTs are what is responsible for the high carbon emissions.

"An NFT sale can result in the consumption of more than twice what an average British household consumes in one year" (Barber). This is a headline from an article written by Wired Magazine. "The problem is right there in that passive text "can result" like who is actually doing it" (Abram). That article by Wired is filled with inaccurate and hypothetical numbers like this one.

While this is somewhat true because the extra transactions added to the blockchain by NFTs do result in a slightly higher difficulty of mining blocks. Although it is very minimal, an argument can be made that people will mine the blocks anyway for their financial interests until there is a running blockchain. "This analogy can be compared to buying a plane ticket, are you buying a ticket on a plane which is going to go anyway, or are you causing the plane to go? And the truth is somewhere in between" (Abram). NFTs will automatically become more efficient when the platform they are based on, i.e., Ethereum, becomes more efficient with the PoS upgrade.

I recommend watching [this](#) 1-minute video for a more detailed explanation.

"...yes, there is a carbon footprint associated with creating blocks by mining – and this is a problem for chains like Bitcoin too – but it's not directly the fault of NFTs" (ethereum.org).
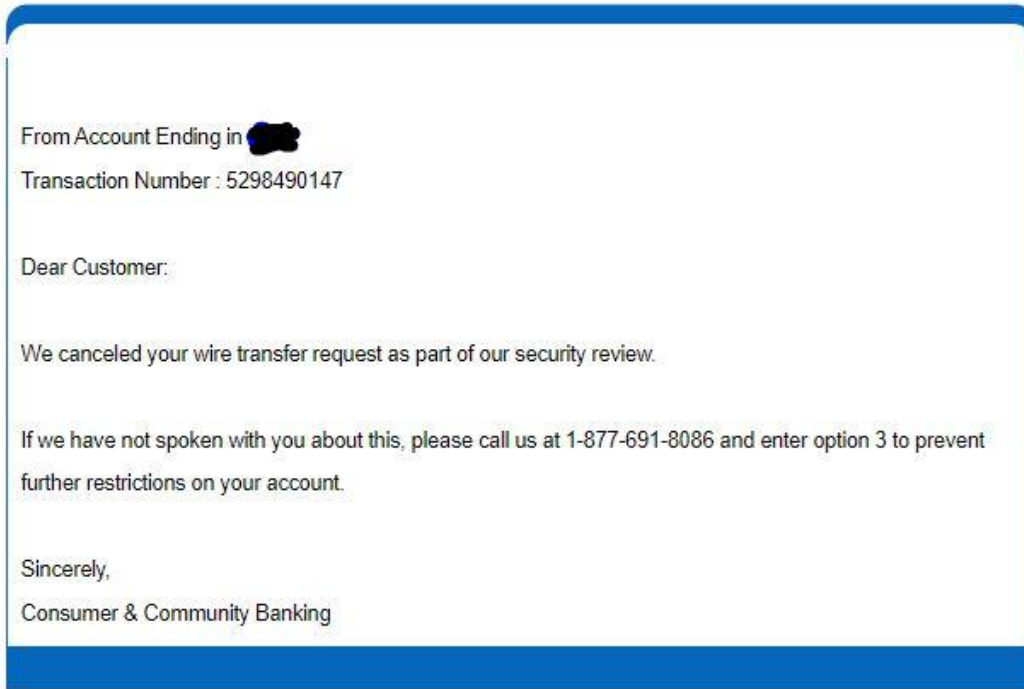
- Cryptocurrencies are a bad store of value as nothing is tangible to back them.

Traditionally Gold has been the best store of value over time. Through the Famines, Wars, and Political Unrests, Gold has always gone up in value in the long term, making it the "Gold" standard for preserving wealth or store of value. For centuries, nothing has challenged Gold as the wealth preservation asset until Bitcoin. I would argue that Bitcoin is a better store of value than Gold. Bitcoin has a hard cap on the number of coins that the protocol can mint. That limit is set at 21 Million coins. Meaning that no more than 21 Million coins can ever be minted, making Bitcoin a very scarce asset, much more scarce than Gold as almost 19 out of those 21 Million have already been minted (Nakamoto). We don't have to worry about protecting it, maintaining it or about its liquidity. Of course till the time we have secured our blockchain wallets.

What gives value to Gold is just the demand, at the end of the day, it is still just a shiny rock. Although, as it's possession is desired by humans, that gives Gold its value. It is very similar in the case of Bitcoin, because the supply is hard-capped and the demand has been increasing, resulting in rise of asset prices. I don't see the demand going down anytime soon for crypto assets.

- Transaction Fees are too high for a medium of exchange.

Recently I was in my home country, India. I needed to urgently transfer some funds to one of my contacts in the US. As per the forex law in India, an individual is not allowed to transfer funds internationally to a third party. So I had to transfer it to my account in the US and I thought I would wire it from my US account after receiving the funds. So the transfer took a couple of days but it went through. I could now see my funds in my Chase College account. When I tried to transfer it to my friend through a wire, it restricted me from doing so. I contacted support multiple times to verify my identity. They would tell me it would work this time but it never did. After a couple of days, I was connected to someone more knowledgeable on the topic. They told me that because I was trying to initiate a transaction from a "high risk" country, their automatic system kept on blocking me. They told me there was no way around it.

CHASE

From Account Ending in █████
Transaction Number : 5298490147

Dear Customer:

We canceled your wire transfer request as part of our security review.

If we have not spoken with you about this, please call us at 1-877-691-8086 and enter option 3 to prevent further restrictions on your account.

Sincerely,

Consumer & Community Banking

Fig 5

Then I tried to do the same thing through Bitcoin. It took me 10 minutes to buy the coins and transfer them to my friend's address. I was charged around $10 for the transaction fee. It is just incomparable in terms of ease of use. The process with chase took me a week to figure out and still failed, while Bitcoin only took 10 minutes. Chase charged me $35 as "International Wire Settlement fees," and my bank in India charged me "Swift Fees," which were around $40. While it took two days to settle an International Wire transfer, it was done in 10 minutes with Bitcoin.

This was just a small example. A lot of people don't understand that the benefits scale exponentially. As we discussed previously, Bitcoin is an excellent store of value.

Imagine the cost of maintaining and moving gold. I couldn't find the exact amount that the federal government of the US spends on maintenance, security, and transportation of their gold reserves, but my educated guess would be in Billions every year. With Bitcoin as a store of value, there is no need for maintenance as a digital asset can't be damaged. Very little security is needed as it is infeasible to guess a private key for a wallet, and transferring Bitcoins costs around $10, no matter how big the transaction is.

	Yearly Cost	Energy Used (GJ)
Gold Mining	$105B	475M
Gold Recycling	$40B	25M
Paper Currency and Minting	$28B	39M
Banking System	$1,870B	2,340M
Governments	$27,600B	5,861M
Bitcoin Mining	$4.5B	183M

Fig 6

Innovation and Efficiency over time
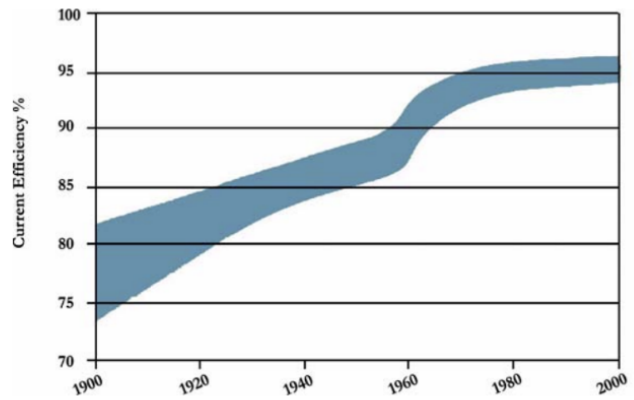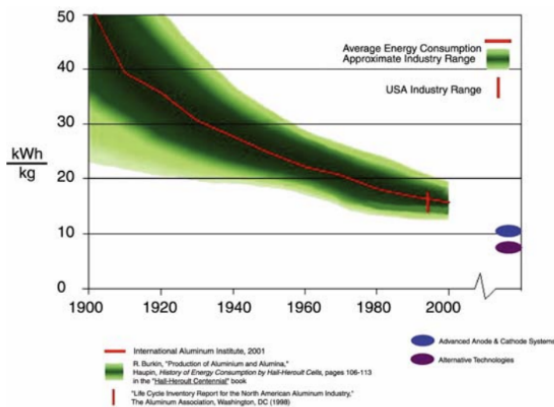
Fig 7

This chart shows the efficiency of producing Aluminium. Similar "unfair" energy consumption concerns existed for aluminum nearly 40 years ago. "Aluminum manufacturing has matured over the decades, the kWh per Kg of aluminum produced became more efficient" (Held). A similar pattern of efficiency through innovation can be seen in Trains.

Fig 8

First, we had steam engines responsible for so much pollution. Then we moved on to Diesel engines, which were still polluted but were much more efficient than a steam engine. Now we have fully electric trains and even Maglev, which are carbon neutral.

I am trying to make from these examples that these technologies have taken decades to become efficient. There were concerns about the emissions of these technologies back then, but because the Media wasn't as strong as nowadays, awareness around these topics was non-existent. Satoshi unveiled his paper in 2008, almost 13 years ago, but Bitcoin and other cryptocurrencies became mainstream in the 2017 pump. It was just considered funny internet money, which was used to buy drugs online before this. In the

last four years, there has been so much development in the crypto space that the market's overall market cap crossed $3 Trillion. We now have fully functional Decentralized Finance Protocols (Decentralized Banks) running on the blockchains. We have projects like Cardano and Solana, which use minimal energy to enable smart contracts. This is just the beginning of the revolution. I believe one day in the near future, crypto will be seen as a greener alternative to legacy financial services like Banks, Credit Cards, etc.

The Role of NFTs in Digital Art.

As we discussed, one of the most popular use cases of NFTs right now is Art. Digital Art, Generative Art, etc. It is without a doubt the hottest thing in Crypto Markets. The concept of people buying Art has been around for centuries, although for the most part, before NFTs, the market was controlled by a small group of very wealthy individuals. Companies like Sotheby's and Christie's handled almost all big art sales. Until someone had big contacts in these companies or had a big promoter backing them, it was tough for independent artists to showcase their work to be sold. Most of the time, people who buy art pieces in these auctions care a lot about the originality and if the piece will retain its value in the future. This was what was provided to the customers by the auction houses like Christie's, the trust that a piece is original and that it will be an asset that will go up in value over time. Everything changed for the creatives when NFTs came around. Now they can sell their work directly to the customers. People who buy expensive Art still care about originality, but with NFTs, it is promised by the Ethereum

Blockchain rather than an auction house. As for the price going up, now customers have so many more options than what auction houses provided to them previously, so they can choose whose pieces they think will go up in value over time.

NFTs have entirely changed the lives of Artists all around the world. I interviewed 2 artists recently, [Hillary Coe](#) (Director of Design at SpaceX) and [Sebastian Hoppe](#) (Design Lead at Apple). They both agreed that NFTs help removes the constraints/restrictions an artist would feel while working a 9-5 job. Now, if people like what the artist does, they can work from anywhere in the world and earn a living selling directly to the customers. I sometimes like to compare this to what OnlyFans did to the Sex Work industry. So many people on OnlyFans talk about how they were taken advantage of in the institutions they worked in before OnlyFans was a thing. Cutting out that middleman is the key.

"More popular than ever, the blender.org website and several of its subdomains have received a combined 23M unique visitors. That is a 35% increase from last year, approaching 2M visitors per month" (Siddi). These are the statistics of Blender, an open-source, free 3D content creation software. In 2021 people expect a 100% increase in the number of unique software users. This proves my point of NFTs helping make Digital Art more popular and encouraging creativity.

Conclusion

I think the facts and the arguments I have presented in my paper make it clear that we should not judge the technology behind cryptocurrencies on their current efficiency. The long-term advantages exponentially outweigh the currency inefficiencies. I mentioned earlier that crypto markets recently achieved a total market capitalization of over $3 Trillion, which is not a number that is easily achievable, for comparison, the market cap of Gold is $11 Trillion. We recently experienced Facebook and Square changing their names to Meta and Block, respectively. They are two of the biggest companies in the US, and changing the name of a trillion-dollar company shows their bullishness towards the technology. NFTs have changed the whole creator economy, everyday we see new celebrities and creators joining the community. It has revolutionized the way artists work, and it is just the beginning. I think this revolution is as big as the internet, if not bigger.

Annotated bibliography

1) **Held, Dan**. "Proof of Work Is Efficient." *Dan Held*, Dan Held, 10 Apr. 2021, https://www.danheld.com/blog/2019/1/5/pow-is-efficent.

[Author Credentials] - Dan is currently Director of Growth Marketing at Kraken. His former company Interchange, a portfolio reconciliation tool for crypto institutional traders, was acquired by Kraken in 7/2019. Prior to that, he was at Uber on Rider Growth/Global Data. Before Uber, Dan built some of the most popular early crypto products including ChangeTip (acquired by AirBnB), and ZeroBlock (acquired by Blockchain.com in the second ever all Bitcoin acquisition). He was part of the original

2013 crypto meetup group in SF which was comprised with the founders of Kraken, Coinbase, Litecoin, and others.

[Audience / Type of Information] - Dan Held is one of the very respected people in the crypto community. His articles are normally very technical and go in the depths of cryptography and algorithms. The audience for his content are developers or the people who are really into the world of cryptography.

[Purpose / Bias / Point of View] - The purpose of this article is to spread awareness about the PoW consensus method. Dan presents very valid points about how PoW is efficient. This article also talks about how wrong information about PoW is spread through mainstream media, who aren't even knowledgeable about the topic.

[Currency of the Source] - The article was written in early 2021, that is when all the talk about Bitcoin being bad for the environment hoax spread. This is also the time when Bitcoin reached its all time high price of $64k, so everyone was talking about it. I would say the source is current.

[Relevance to Paper] - My argument is very close to what Dan is trying to say in his article. Although the article is mainly focused on Bitcoin and Proof of Work, it is still very relevant to a big part of my paper which talks about Bitcoin.

2) **Zuluaga, Diego**. "Why Bitcoin Is Not an Environmental Catastrophe." *Cato.org*, 4

   Sept. 2018,

   https://www.cato.org/blog/why-bitcoin-not-environmental-catastrophe.

[Author Credentials] - Diego Zuluaga was associate director of financial regulation

studies at the Cato Institute's Center for Monetary and Financial Alternatives. He is the

author of "Should Cryptocurrencies Be Regulated like Securities?" and "The Community

Reinvestment Act in the Age of Fintech and Bank Competition." Zuluaga holds a BA in

economics and history from McGill University, and an MSc in financial economics from

the University of Oxford.

[Audience / Type of Information] - Diego in his article is trying to explain the issue to

the normal people. His language in the paper is very easy to read and the whole content

is targeted for increasing awareness about blockchains in the groups of people who are

not familiar with the topic.

[Purpose / Bias / Point of View] - The article throws some light on the real metrics of

each transaction, and explains why Bitcoin is the way that it is. Diego agrees that

Bitcoin does have an impact on the environment but mentions that it is much better than

the image that is put out by people and the media.

[Currency of the Source] - The article was published in 2018, after the massive bull

run that got everyone interested in the technology behind it. I think the source and the

content is fairly current.

[Relevance to Paper] - The article gives me a lot of information about what a cryptocurrency/finance expert thinks about the buzzwords like "mining" or "energy use per transaction" which we see in the media all the time. People talking about them most of the time don't even understand the logic behind these technologies. So I think the information in the article is very important to my argument and my paper in general.

3) "Non-Fungible Tokens (NFT)." *Ethereum.org*, https://ethereum.org/en/nft/.

[Credentials] - Ethereum.org is the official webpage of the Ethereum Foundation. The Ethereum Foundation was created by the founders of Ethereum including **Vitalik Buterin**.

[Audience / Type of Information] - The page is almost a documentation for NFTs and its use cases. It is written for developers who are trying to get into the technology.

[Purpose / Bias / Point of View] - The source has no bias, it simply provides the information on the Ethereum Blockchain and NFTs.

[Currency of the Source] - The publishing date is not mentioned, as the web page gets updated regularly whenever there is an update to the network. So the information is up to date.

[Relevance to Paper] - The source provides vital information about NFTs and how they work. This information is essential to the second half of my paper as I go into details about NFTs and Smart Contracts on Ethereum.

Works Cited

Nakamoto, Satoshi. "Bitcoin: A Peer-to-Peer Electronic Cash System"

https://bitcoin.org/bitcoin.pdf.

Held, Dan. "PoW is Efficient", 14 Sept. 2018,

https://www.danheld.com/blog/2019/1/5/pow-is-efficent.

Zuluaga, Diego. "Why Bitcoin Is Not an Environmental Catastrophe" Cato.org, 4 Sept.

2018, www.cato.org/blog/why-bitcoin-not-environmental-catastrophe.

Bonheur, Kristoffer. "Pos: Advantages and Disadvantages of Proof-of-Stake." Profolus,

18 Sept. 2021,

https://www.profolus.com/topics/pos-advantages-and-disadvantages-of-proof-of-stake/.

Reiff, Nathan. "Were There Cryptocurrencies before Bitcoin?" Investopedia,

Investopedia, 20 Nov. 2021,

https://www.investopedia.com/tech/were-there-cryptocurrencies-bitcoin/.

Frankenfield, Jake. "Smart Contracts: What You Need to Know." Investopedia,

Investopedia, 20 Nov. 2021, https://www.investopedia.com/terms/s/smart-contracts.asp.

Gianfagna, Mike. "What Is Moore's Law?: Is Moore's Law Dead?" Synopsys, Synopsys,

30 June 2021, https://www.synopsys.com/glossary/what-is-moores-law.html.

Frankenfield, Jake. "Lightning Network." Investopedia, Investopedia, 1 June 2021,

https://www.investopedia.com/terms/l/lightning-network.asp.

Abram, Cleo. "NFTs and the Environment." TikTok,

https://www.tiktok.com/@cleoabram/video/7032314353097477381?lang=en&is_co

py_url=0&is_from_webapp=v1&sender_device=pc&sender_web_id=695

1838257685497345.

Barber, Gregory. "NFTs Are Hot. so Is Their Effect on the Earth's Climate." Wired,

Conde Nast, 6 Mar. 2021, https://www.wired.com/story/nfts-hot-effect-earth-climate/.

Siddi, Francesco. "Blender by the Numbers – 2020." Blender.org,

https://www.blender.org/news/blender-by-the-numbers-2020/.

Images Cited

Fig 1. Tweet by Hal Finney, Twitter, January 27, 2009. Web.

https://twitter.com/halfin/status/1153096538

Accessed December 2, 2021

Fig 2. Uploaded by BBC, BBCI. Web.

https://ichef.bbci.co.uk/news/976/cpsprodpb/144A2/production/_117560138_beeplecolla

ge64457741-5_976x549.jpg

Accessed December 2, 2021

Fig 3-4. Uploaded by Dan Held, Danheld.com, September 12, 2021. Web

https://www.danheld.com/blog/2019/1/5/pow-is-efficent

Accessed December 2, 2021

Fig 5. Email from JP Morgan Chase, Email.

Fig 6-7. Uploaded by Dan Held, Danheld.com, September 12, 2021. Web

https://www.danheld.com/blog/2019/1/5/pow-is-efficent

Accessed December 2, 2021

Fig 8. Uploaded by Nandakumar Narasimhan, kosmofoto.com, April 5, 2021. Web

https://kosmofoto.com/2021/04/capturing-a-disappearing-generation-of-indian-trains-on-film/

Accessed December 2, 2021

Referenced

https://digiconomist.net/bitcoin-energy-consumption

https://howmuch.net/articles/crypto-transaction-speeds-compared

https://www.statista.com/statistics/272983/market-share-of-art-auction-revenue-and-lots-sold-by-auction-house/

https://www.fiscal.treasury.gov/reports-statements/financial-report/government-financial-position-and-condition.html

https://www.statista.com/statistics/279249/purchase-transactions-on-general-purpose-cards-worldwide/