

Are NFTs Here To Stay?

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Abstract: *Non-fungible tokens (NFTs) are a replacement sort of unique and indivisible blockchain-based tokens introduced in late 2017. While fungible tokens have enabled new use cases like Initial Coin Offerings, the potential of NFTs as a valuable component and their future remains unclear. Non-Fungible Tokens (NFTs) have garnered remarkable investor attention recently, with some NFTs securing selling prices which can have seemed unthinkable for a non-fungible virtual asset. This raises fascinating questions on “value”, “scarcity” and “energy consumption” with reference to blockchain technology, through a prism of non-fungibility of a digital asset, and this paper aims to draw attention to those questions insofar as they'll shape an alternate space of blockchain development and exchange going forward. We will look at the carbon footprint of NFTs and the respective blockchains. Have a look into alternative resources that can be used for these blockchain systems also the Carbon Offsets these assets contribute to. As Ethereum blockchain is secured using a proof-of-work system similar to bitcoin, which consumes energy on a large scale, we will look into the scope of converting this system to Proof-of-Stake blockchain systems that do not rely on massive computing power, and thus consume much less electricity. Is a trend of auctioning non-fungible tokens supported scientific data a desirable art fad, an environmental disaster or the longer term of monetized genomics?*

Keywords: NFTs, NFT energy consumption, crypto, cryptoArt

I. INTRODUCTION

A non-fungible token (NFT) is a unit of data stored on a digital ledger, called a blockchain, that certifies a digital asset to be unique and thus not interchangeable.[1] NFTs are often used to represent items like photos, videos, audio, and other kinds of digital files. Access to any copy of the primary file, however, isn't restricted to the customer of the NFT. While copies of these digital items are available for anyone to urge, NFTs are tracked on blockchains to provide the owner with a logo of ownership that's break away copyright.

NFTs are best understood as computer files combined with proof of ownership and authenticity, kind of a deed. Like cryptocurrencies like Bitcoin, they exist on a blockchain—a tamper-resistant digital public ledger. But like dollars, cryptocurrencies are “fungible,” meaning one bitcoin is typically well worth the same because the other bitcoin. against this, NFTs have unique valuations set by the absolute best bidder, a touch sort of a Rembrandt or a Picasso. Artists who want to sell their work as NFTs got to sign up with a marketplace, then “mint” digital tokens by uploading and validating their information on a blockchain (typically the Ethereum blockchain, a rival platform to Bitcoin).

The biggest use of NFTs today is within the digital content realm. That's because that industry today is broken. Content creators see their profits and earning potential swallowed by platforms. An artist publishing work on a social network makes money for the platform who sell ads to the artists followers. They get exposure reciprocally, but exposure doesn't pay the bills.

NFTs power a replacement creator economy where creators don't hand ownership of their content over to the platforms, they use to publicise it. Ownership is baked into the content itself. When they sell their content, funds continue to them. If the new owner, then sells the NFT, the primary creator can even automatically receive royalties. this is often guaranteed whenever it's sold because the creator's address may be a component of the token's metadata – metadata which can't be modified.

NFTs have seen plenty of interest from game developers. NFTs can provide records of ownership for in-game items, fuel in-game economies, and convey variety of benefits to the players.

In a lot of normal games, you'll buy items for you to use in your game. But if that item was an NFT you'll recoup your money by selling it on when you're through with the game. you would possibly even make a profit if that item becomes more desirable.

For game developers – as issuers of the NFT – they could earn a royalty whenever an item is re-sold within the open marketplace. This creates a more mutually-beneficial business model where both players and developers earn from the secondary NFT market.

NFTs are often bought and sold, very almost like other assets on the exchanges, but they have no tangible kind of their own. There are two parties involved: the creator of digital content and thus the customer on the exchange. Now, these NFTs are kind of a physical collector's items, but in digital form. So, instead of purchasing an actual painting that you simply can hang on the wall reception, the customer gets a digital enter a token form which is saved within the buyer's wallet linked with the NFT exchange.

The buyer has ownership rights, which could be for a limited period or a lifetime as per the contract. At any particular point in time, an NFT can have only one owner. Each digital asset in NFT is distinguished by a singular code that's recorded on the blockchain. It's kind of a ledger with details of the creator and buyers. This code helps in tracing back the creator (owner) of the NFT. NFTs listed on exchanges have contracts and provides the creator (artist), a royalty for a lifetime or limited period as per terms of any future sale of the token.

NFTs are usually minted on the cryptocurrency Ether. This blockchain entry is exclusive to the piece of labor minted, so when it's purchased from the artist, it acts as a symbol of your ownership. the particular digital art can still be copied in its usual file types (e.g. .jpeg or .png), but not the associated NFT. It also enables the artist to urge a percentage of the profit whenever it's bought or sold. With every transaction, a record is added to the blockchain. once you sell an NFT, you're paid in Ethereum cryptocurrency, which can be cashed out supported the fluctuating rate of exchange, like converting between country currencies.

II. LITERATURE REVIEW

The global development of cryptocurrencies generated a lot of debates and interests from scholars (Alvarez-Ramirez et al., 2018; Balcilar et al., 2017; Brandvold et al., 2015; Brauneis and Mestel, 2018; Jiang et al., 2018; Koutmos, 2018; Takaishi, 2018; Van Vliet, 2018). In this article, we mainly focus on the underlying technology used in the trading of cryptocurrencies and NFTs and their energy consumption: the blockchain technology whose Bitcoin and Ethereum are well-known to be the first application.[9]

NFTs were first introduced in 2017 on the Ethereum blockchain. Since then, the use of NFTs has surged with the increasing popularity of cryptos and their security. Although a number of cryptocurrencies offer support for NFTs, a majority of NFTs available today are on the Ethereum Blockchain. This Ethereum Blockchain uses the Proof-of-work system to maintain the records on the block chain.

Although the idea existed before, Satoshi Nakamoto popularized the PoW consensus. The Bitcoin blockchain was the first major implementation of the PoW consensus protocol. So, PoW is often referred to as blockchain's 'original' consensus mechanism. Initially, at least, PoW was hailed as the most reliable method for blockchain consensus. It enabled the realization of the decentralized dream and ruled out intermediaries at the same time, ensuring valid transactions. However, as the size of the blockchain networks grows, the problems of this mechanism become increasingly apparent. And, at times, it is impossible to tackle them.

In PoW, miners have to solve a cryptographic puzzle to validate a transaction. One might visualize it as a race, where the miners are competing to be the first one to solve the puzzle. The answer to this puzzle is known as a hash. So, what's in it for the miners? For every transaction they validate, miners are rewarded with the blockchain's native cryptocurrency, plus, a transaction fee.

The puzzles are immensely complex, and it requires massive computational power to solve them. The implementation of the PoW consensus protocol can be summarized as follows,

- A new transaction is broadcast to the network.
- Miners rush to compute a hash value that matches with that of the transaction.

- The first one to solve the hash receives the reward.
- A new “block” is created, which includes the recently concluded transaction.

The complexity of a PoW puzzle depends upon the number of nodes in that network. Alongside, a puzzle’s complexity is directly proportional to the computational power required to solve it.

The biggest problem with PoW is that it requires insurmountable amounts of computational power. By extension, it entails a mammoth electricity consumption. According to a report published in The Economist in 2018, Ethereum uses about 33 terawatt-hours (TWh) of electricity a year, about as much as the whole of Nigeria.

Annually, Ethereum is currently estimated to consume roughly 55.28 terawatt-hours of electrical energy, which is Comparable to the power consumption of Romania.. It is responsible for about 26.26 metric tons of carbon dioxide released each year, comparable to the carbon footprint of Mongolia. [4]

Mora et al.(2018) or Morris (2018) warned about the negative externalities generated by the use of cryptocurrencies by explaining that the global temperature could increase of 2°C by 2034. Although they do not provide so apocalyptic numbers², several empirical studies suggest the same increasing trend in the Ethereum blockchain with its increasing popularity for NFTs support.[9]

So, what’s the problem here? Most of this computational power is wasted as only one miner is rewarded for each block while thousands compete for it. Moreover, such magnitudes of energy consumption are a serious threat to the environment. Added to that, is the huge cost of the hardware required for mining under the PoW protocol.

Although not all of this energy consumed is in regards to NFTs, the cost to maintain a single NFT is still significantly higher. And as NFTs are a substantial part of the Ethereum blockchain they have a noticeable carbon footprint. French artist Joanie Lemercier recently sold a set of six NFTs on Nifty Gateway for several thousand dollars in a matter of seconds. The energy required to complete the sale was a massive 8.7 megawatt-hours. The average U.S. home consumes 10.7 MWh per year, for comparison, meaning that single sale ate almost a year's worth of electricity for the average home. The art was later resold, requiring a similar amount of energy.

After going through the details of his transactions with Offsetra, a carbon offset company, Lemercier determined that his first NftGateway drop “consumed in 10 seconds more electricity than [his] entire studio over the past 2 years.”

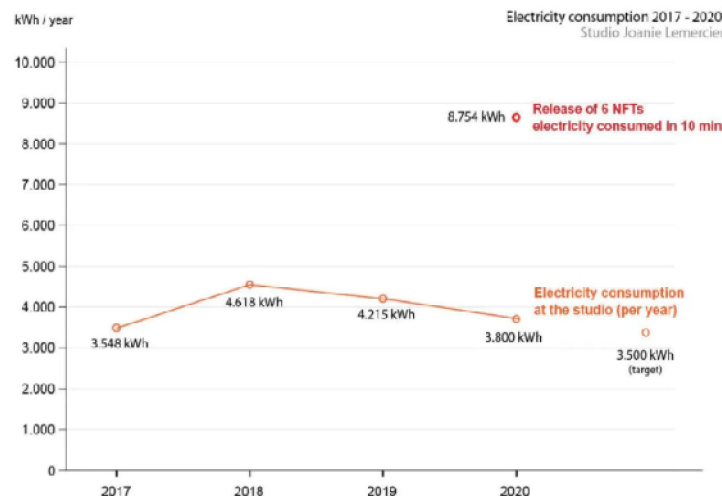


Figure 1: Energy consumption of Lemercier’s studio [7]

Ethereum alone is responsible for 96,200,000 tons of CO₂ since its inception; this is equivalent to the combined annual carbon emissions of the 84 least carbon intensive countries around the globe. But how much of that can NFTs be blamed for?

NFTs have exploded in popularity recently, with sales increasing by 1700% between December 2020 and February 2021. A specialist at Nifty Gateway told ARTnews that NFTs make up about 1-2 percent of the Ethereum network.

III. METHODOLOGY AND DATA

To research whether NFTs are going to just be a fad and die down or are going to be a staple part of technology in the future we started by going through a lot of secondary data available to use about NFTs and its trends. We found out a major chunk of people do not want to accept the NFT system because of ethical reasons and not monetary value. That's why using qualitative research method along with quantitative methods to analyse secondary market data. Content analyses were done of many scholarly articles and journals to understand multiple concepts and to also understand the intentions of an individual, group and identify biases in opinions.

With the aim at examining the effect of NFT creation and trading on the energy consumption. The data gathered for this study comes from the website "CryptoArt.wtf". In December 2020, computational artist and engineer Memo Akten launched a website called "CryptoArt.wtf" that calculates the energy usage and CO₂ emissions of any NFT on SuperRare, Nifty Gateway, or any given URL with an ETH address. The site then compares the energy consumption of that NFT to a number of comparative metrics applicable to average people's energy consumption in daily life. So, according to metrics on CryptoArt.wtf, the skull NFT below has consumed the same amount of energy as an EU resident's electricity consumption for 3 weeks or a laptop's energy consumption over the course of 1.5 years.

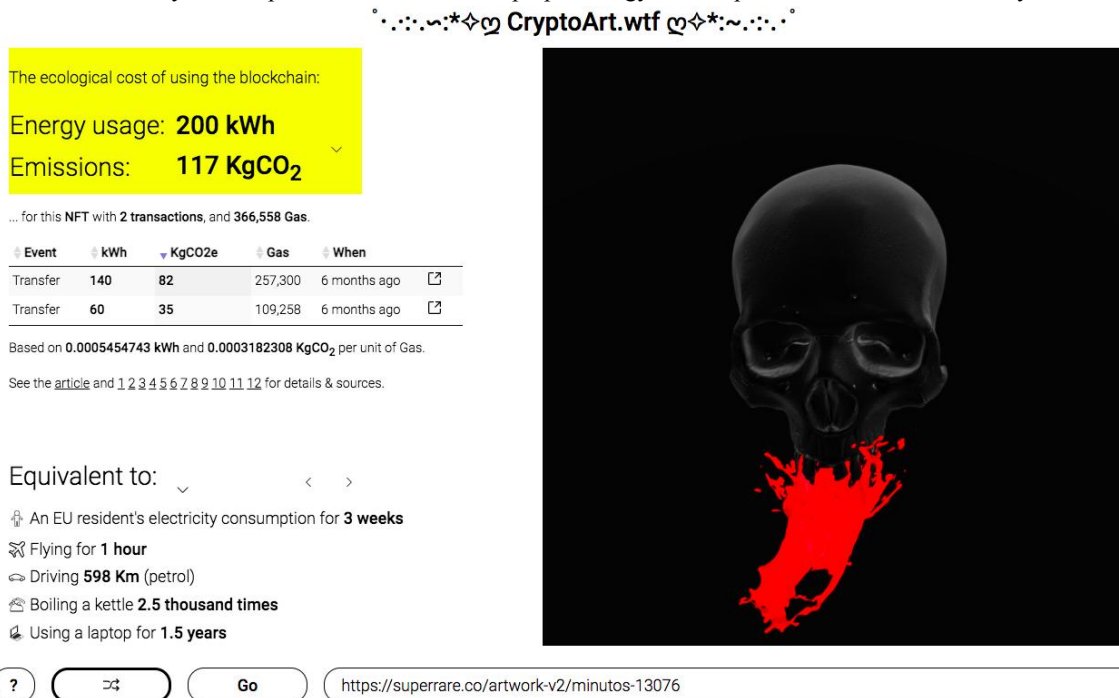


Figure 2: UI of CryptoArt.Wtf [7]

IV. FINDINGS AND DISCUSSION

Our study collected the data of primary energy consumption from ~80000 transactions relating to ~18000 NFTs on the CryptoArt NFT market site SuperRare (which is just one of many CryptoArt NFT platforms) using the site "CryptoArt.wtf" that calculates the energy usage and CO₂ emissions of any NFT on SuperRare, NiftyGateway, or any given URL with an ETH address.

The footprint of a single transaction relating to a NFT on SuperRare averaged across all 80000 transactions (including minting, bidding, sales, transfers etc) is 82 kWh, with emissions of 48 KgCO₂. Which is more than double that of an average ETH transaction.

1 single-edition NFT

The ecological cost of tracking sales & bids on the blockchain:

Energy usage: **340 kWh** ⓘ
Emissions: **211 KgCO₂**

Equivalent to: ⌵ ⌴ ⌶

- ✈ An EU resident's electricity consumption for **1 month**
- ✈ Flying for **2 hours**
- 🚗 Driving **1 thousand Km** (petrol)
- 🍲 Boiling a kettle **4.5 thousand times**
- 💻 Using a laptop for **3 years**
- 🖨 Using a computer for **10 months**

Figure 3: Energy Consumption for Maintaining a Single NFT [1]

The table below shows statistics on all NFTs that were traded on the SuperRare platform. Also, the data displayed below is related to the single edition NFTs on the SuperRare marketplace. The data for multiple edition NFTs is not included.

Note that this data is only related to maintaining the NFT details on the blockchain ledger. It excludes the energy consumption of the actual production of the work. It excludes the energy consumption related to storing the work online. It excludes the energy consumption of the website itself, or the computers of those involved in minting, bidding or selling.

Statistics on 17812 NFTs				
Click a link in the first column (Statistic) to see corresponding eco-cost comparisons.				
Click a link under the other columns (KgCO ₂ etc.) to retrieve the NFT corresponding to that statistic.				
nfts	kWh	KgCO ₂ e	Transactions	Gas
#minimum	44	27	1	87,214
#maximum	8,334	5,170	51	16,584,453
#median	250	155	4	497,157
#average	340	211	4.5	675,967
#stddev	436	271	3.3	868,049
#total	6,050,560	3,753,475	79,977	12,040,321,070

Figure 4: Statistics on all NFTs present on the SuperRare marketplace [1]

The above-mentioned data states the energy consumption of a single NFT marketplace. Like this there are multiple market places that sell NFTs over the Crypto Blockchain. We have to note that these costs are entirely reflective of the energy consumption for using a Proof-of-Work (PoW) blockchain, without taking the energy cost of creating any of the original artwork into account. If these CryptoArt. Wtf metrics are accurate, the sheer energy cost of NFTs are unsustainable for the environment if they were to rise in popularity and use.

The heavy energy consumption isn't the only factor that can stop NFTs from taking off in the future. There are several other issues related to NFTs and its Markets. There has been a significant fall in the NFT market trade volume since February of 2021. Weekly trade volume of NFTs peaked at nearly \$200 million in the last week of February, fuelled by \$125 million worth of activity on NBA Top Shot, the Dapper Labs-owned platform for buying and selling basketball highlight clips minted on a blockchain.

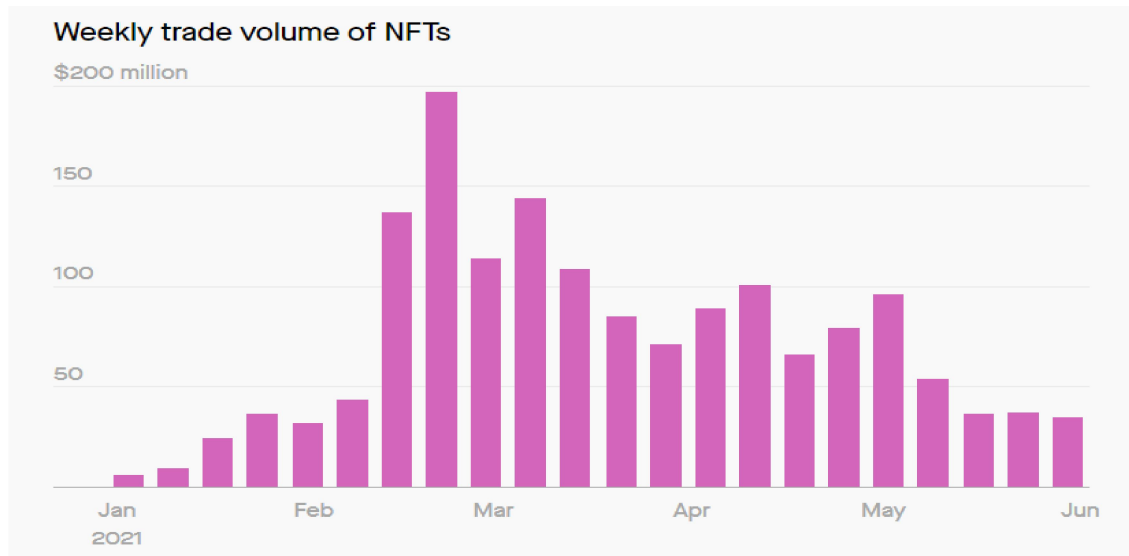


Figure 5: Trend in NFT trade volumes [11]

Now NFT activity is down across nearly every trackable metric. Last week, the NFT market saw about \$35 million in sales, according to the data tracking firm DappRadar, down significantly from its February peak. During the same period, the number of people using NFT marketplaces fell 80% from a peak of 650,000 people to a more modest 128,000.

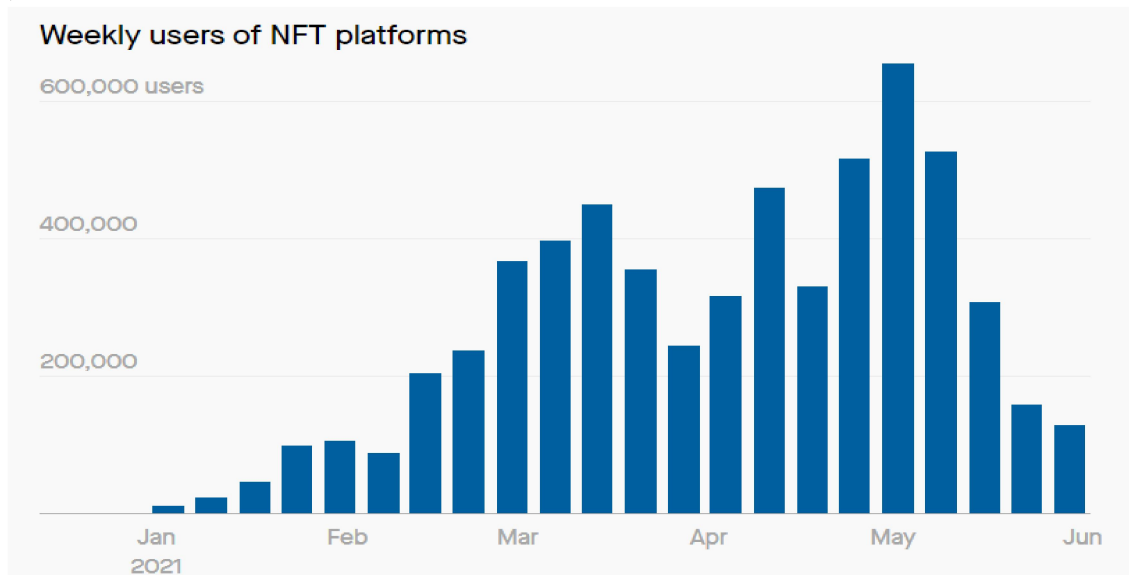


Figure 6: Trend in the user base of NFTs

Although we can say that the major reason for this fall can be the awareness about the energy consumption of NFTs after their increasing popularity, but there are several other reasons too that contribute to this fall in the trade volumes of NFTs. Some of these reasons are:

- There is no guarantee that an NFT market replaces something like the art fair. If anything, a robust NFT market bolsters the idea of the art fair or the blue-chip gallery, which have always been about investment, speculation, and resale- even when the work bought or sold is also talked about for its aesthetic, conceptual and emotional qualities. Some have said that the contemporary art market's sudden interest in NFTs is due in part to this year of quarantine,

where art markets are having to look at other models than the traditional wine-and-dine at Basel to attract buyers, but my bet is just that the art market is just remarkably good at smelling money.

- CryptoArt offers no intellectual property protection and there is no regulatory structure in place to keep copyrighted materials from being minted into and sold as NFTs, with or without the consent of the creator or copyright holder. Once an NFT is minted, there is no way to remove it from the blockchain or secondary market.
- Most of the CryptoArt now a days is purchased in cryptocurrencies. So, we can say that the value of these NFTs depends on the value of these cryptocurrencies. I.e. if a NFT is sold for 20 ETH , the value of these 20ETH coins can go up or down depending on the market trends. Hence a regulatory method needs to be implemented to determine the value for these NFTs.

So, with all these issues, how will NFTs survive in the future. As the motive behind NFTs are for the better good of the digital artists, the underlying blockchain technology on which these NFTs reside on are a major concern.

So what are the alternatives available that can enable NFTs to thrive in the future?

The answer to this question lies in the use of Proof-Of-Stake (PoS) blockchain systems. The Proof of Stake (PoS) concept states that a person can mine or validate block transactions according to how many coins they hold. This means that the more coins owned by a miner, the more mining power they have.

The proof of stake was created as an alternative to the proof of work (PoW) concept, to tackle inherent issues in the latter. Currently, only alt coins use the proof of stake concept. The proof of stake (PoS) seeks to address the energy consumption issue of PoW by attributing mining power to the proportion of coins held by a miner. This way, instead of utilizing energy to answer PoW puzzles, a PoS miner is limited to mining a percentage of transactions that is reflective of their ownership stake. For instance, a miner who owns 3% of the coins available can theoretically mine only 3% of the blocks.

PoS also addresses the 51% attack issue of Pow efficiently. With a PoS, the attacker would need to obtain 51% of the cryptocurrency to carry out a 51% attack. The proof of stake avoids this ‘tragedy’ by making it disadvantageous for a miner with a 51% stake in a cryptocurrency to attack the network. Although it would be difficult and expensive to accumulate 51% of a reputable digital coin, a miner with a 51% stake in the coin would not have it in their best interest to attack a network that they hold a majority share. If the value of the cryptocurrency falls, this means that the value of their holdings would also fall, and so the majority stake owner would be more incentivized to maintain a secure network.

These PoS blockchains consume almost 98% less energy than the PoW systems, as here there is no competition for mining the block. Only the selected individuals who stake their coins can verify the block and thus earn the transaction fee incentive. This reduces the wasted energy consumption of other miners which happened in PoW system.

As such, Ethereum is currently in the midst of an infrastructure overhaul — a project widely referred to as Ethereum 2.0. Ethereum is undergoing development to update its underlying protocol to become a truly modern blockchain designed to accommodate all of the transaction volume required for the network to achieve its vision of becoming the distributed global supercomputer. The core of this update is the long-awaited transition from PoW to PoS — which is a drastically more scalable and resource-efficient blockchain consensus mechanism. Which in turn will also reduce the carbon footprint of NFTs.

In Ethereum 2.0, the PoS consensus mechanism will require validators to stake 32 ETH to run a validator node on the network. Each time a block is set to be proposed, at least 4 and up to 64 random committees of 128 validator nodes will be selected from the entire pool of validators to attest the block. (This is probably secure, and there is less than a 1 in a trillion chance that an attacker controlling 1/3 of the validators on the network would control $\frac{2}{3}$ of the validators in a committee to successfully execute an attack).

Also regarding the legal proprietary issues, it’s important that legal protections are added directly into the NFTs themselves, and that consumers have legal recourse if something goes wrong.

V. CONCLUSION

The opportunities that NFTs present for digital art, including solving the fundamental problems of scarcity and ownership of digital assets, are genuinely revolutionary. Greater adoption of stable Coins and of less energy-intensive consensus mechanisms may also help to solve some of NFTs' biggest drawbacks. So while making predictions in this area is notoriously unwise (hence no attempt here to predict whether recent prices will be maintained or whether that bubble may burst), it does seem likely that digital art NFTs are here to stay.

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