Environmental Impact of NFTs

Introduction

NFTs are blockchain-based records signifying the ownership of digital assets. Blockchain is a technology originally developed for Bitcoin and later adapted for use across industries (and other cryptocurrencies), which creates an immutable record of transactions by adding a new line of information each time the asset is transferred.

Recent NFT News:

- Beeple sold an NFT for $69 million at a first-of-its-kind Christies auction. For that price, the buyer got a digital file of a collage of 5,000 images and a complex legacy of greenhouse gas emissions. But another crypto project attracted attention when it bought an original Banksy artwork for $95,000. The group literally burnt the artwork and sold its NFT on the OpenSea platform for $400,000 to make a significant point.
- Two Coinbase employees get married on the blockchain by exchanging NFT rings with their wedding vows.
- Jack Dorsey's sells his first ever tweet as an NFT for $2.9 million.
- The Weeknd's recent NFT drop sells for more than $2 million but is estimated to have emitted 86,000 kgs of CO2.
- A recent blog post by Memo Akten triggers a series of discussions and debates on the ecological impact of NFTs.

Problem

A majority of NFTs marketplaces currently run on Ethereum blockchain which uses Proof of Work. Proof of work acts as a sort of security system for cryptocurrencies like Ethereum and bitcoin since there's no third party, like a bank, that oversees transactions. To keep financial records secure, the system forces people to solve complex puzzles using energy-guzzling machines. Solving the puzzles lets users, or "miners," add a new "block" of verified transactions to a decentralised ledger called the blockchain. The miner then gets new tokens or transaction fees as a reward. This is process design makes it incredibly inefficient and resource intensive. More NFT transactions on Ethereum using Proof of Work would push up the value of Ethereum which miners might try to cash in by increasing how many machines they use. This would in turn have a drastic ecological impact in the long run.

The problem gets compounded as 1 NFT transaction on the Ethereum blockchain can potentially consist of multiple ETH transactions relating to GAS costs which further compounds the ecological impact of an NFT transaction on the environment. Multiply this with the growing popularity of NFTs especially in a post-pandemic world where everyone is moving towards the digital world and the growing number of artists who wish to strike gold by creating multiple artworks as NFTs, and the resultant impact is quite drastic.

An alternative like private blockchains do exist, and some, like Flow, are completely devoted to NFT transactions, allowing them to sidestep some of the issues with cryptocurrencies like Ethereum. But those kinds of blockchains move away from what cryptocurrencies were supposed to do in the first place, which is create a decentralised network where anyone can make transactions without the oversight of a single institution.

Impact Analysis:

A transaction on NFT is equivalent to 4.5 ETH transactions with each ETH transaction causing 82 kWh or 48 KgCO2 emission. This results in an NFT transaction have a total of around 215 KgCO2 emmission. [Memo's Analaysis]. Although this figure was later debated to be a bit on the higher side, Carbon.fyi provides a way to calculate the impact of transactions on an Ethereum wallet or a wallet connected via Metamask. An ETH transaction can have an impact as high as 50 Kg CO2 and an NFT transaction can have an impact of more than 80 - 100 Kg CO2 if the gas costs are high. This also translates to the impact that the average footprint of the work of a single cryptoartist is about six tonnes of CO2 - which in developed countries will pretty much **double** that person's annual carbon footprint.

These details have been put in perspective by using the below table I collated which consists of CO2 footprint of a wide varied of examples:

Examples	CO2 Emmissions	Data Source
Producing 10 Kgs of Coffee	0.17 Kg	Our World In Data
London to Rome flight	0.23 Kg	Guardian
Producing 10 Kgs of Meat	0.60 Kg	Our World In Data
London to New York flight	1 Kg	Guardian
A Tesla K80 AI Hardware running for 100 hours in GC	10 KG	Machine Learning CO2 Impact
Global per person emissions (2017)	5 Tonnes	Our World In Data
Raising a child in a developed Country	59 Tonnes	Science Magazine
Clothes bought every 10 minutes in the UK	500 Tonnes	Oxfam
1 Barrel of oil burnt	430 Tonnes	EPA
Energy use of 100 US homes	862 Tonnes	EPA

Another table collated below represents just how much energy it takes to power popular Ethereum-backed CryptoArt platforms, and what emissions are associated with this energy use as of April 29, 2021. This was derived as part of Kylie's effort to calculate energy consumption of Ethereum-Backed CryptoArt platforms:

Platform Name	GAS	Transactions	kgCO2
Async	1638562820	16335	464189
Foundation	20489990935	122582	10195179
Known Origin	5129939934	21156	1696116
Makersplace	24799705248	78510	7768245
Nifty Gateway	49791570029	202966	22253639
OpenSea	217410494380	1016553	82838112
Rarible	38112831226	293205	15496197
SuperRare	18267224757	195806	6197049
Zora	2317359284	9111	1091823

Solutions:

1. Offsetting your Carbon:

Creating offsets doesn't actually solve the current ecological impact by NFTs and blockchain in general, but aids in recovery of the environment. This is one of the ways one can give back to the environment for being carbon positive in this world. Many big market places like the Winklevoss twins' owned Nifty Gateway also plans to go Carbon neutral as immediate step amid criticism, by purchasing more Carbon offsets.

- Offsetra helps in offsetting carbon by giving different options to offset carbon you would've used for your NFT and other crypto transactions. You can check out the different options they provide here. They have a section for flights where you can even offset the carbon generated for the last flight you took.
- They have now come up with Offsetra Grow subscription which is currently in Beta stage and offsets 2000 kgs of CO_2 every month for each subscription. They do that by funding a selection of high-impact, certified carbon reduction projects working in reforestation, conservation, and renewable energy installation. All subscribers receive a unique seed code and if they share that seed code to others then all of them will become your seedlings if they subscribe using your seed code. You can send your seed code to as many people as you want. This way you can create a forest of your seedlings, and their seedlings and so on. And each subscription contributing an offset of 2000 kgs Carbon every month, will make it a very green forest indeed.
- Offsetra are quite efficient and transparent with their spendings and they have mentioned in their transparency report for 2020 that they spent 84% of every money spent towards securing carbon offset credits on behalf of their customers.
- GoldStandard is another way to offset your carbon and become carbon neutral.
- Aerial also allows you to offset the huge carbon footprint created by blockchain technology and it is supported by some great artists. They have an iOS app as well. You can visit their NFT section here.

2. Gasless minting and Printable Series

Some marketplaces like Mintable offer Gasless minting and Printable series for NFTs. Gasless minting or delayed minting or lazy minting is when wallets look for NFTs by listening for a transfer event. Since there is no transaction on the blockchain, the transfer event only happens when someone buys it, or you transfer it to yourself or someone else. The item still exists, you can see it on Mintable and also on Etherscan. If you manually add it to your wallet, depending on the wallet, you should be able to see it. Since it is already minted, the buyer and seller have no extra costs.

- The collection manager of OpenSea also provides this option.
- If the cost of minting is too prohibitive, Mint Fund helps first-time crypto creators with covering the gas fee.
- There is also a concept of Sidechains where NFTs are mined on non-Ethereum Proof of Stake side chains, but can be moved to Ethereum later. If they're not moved they can be much more efficient.

A printable series is a way to create any amount of NFTs that are for sale, but are not minted until purchased. In other words, you can make a series of 500 NFTs and if only 2 are purchased, only 2 exist. One needs to submit 1 transaction to create a printable series, but they can do any amount of NFTs.

3. Layer 2 and Bridges

Immutable X alpha, launched on mainnet a month back, is created by Immutable, which is one of the first Layer 2 for NFTs on Ethereum and it is 100% carbon neutral. It has zero gas fees and is built for efficiency and scalability. Immutable X Mint is a secure way to create and distribute assets on a massive scale.

Some features include:

- Ability to create ERC-721 and ERC-20 tokens.
- Designed for single and bulk minting.
- Zero gas costs.
- Assets tradable instantly.
- Same security as mainnet Ethereum.

- Harmony allows single or in batch bridging of ERC721 (or NFTs) to Harmony to receive HRC721.

4. Carbon Removal Tokens

Nori's mission is to reverse climate change by building a dedicated carbon removal marketplace where users can purchase Nori Carbon Removal Tokens (NRT). NRTs are different from carbon offsets in a number of ways:

- The first NRTs will come from soil carbon removal in US croplands, an area which has not been successfully served by carbon markets to date.
- They have introduced carbon removal quantification methodologies that are open source. The Nori market is designed to account for uncertainties associated with even the best possible methods for estimating changes in CO2 concentration and terrestrial C stocks, and to reduce uncertainties as much as possible, over time, by incentivising better data collection and sharing techniques.
- Each NRT represents one metric tonne of NRT removed, and will always sell for one NORI token or a combination of cash and a token. CO2 removed from one part of the atmosphere by one process is the same as removing CO2 from a different location by a different process.
- NRTs represent one tonne of CO2 removed from the atmosphere, treating carbon removals as non-fungible with other carbon activities. Projects such as clean cook stoves, renewable energy, avoided deforestation, or avoided emissions will not be eligible for the Nori marketplace.
- The NORI token sets a universal price on taking carbon out of the atmosphere, and does not reward individual projects based on co-benefits.
- When carbon offsets sell more than once they lose their underlying value. NRTs are immediately retired when they are purchased for the first time by a buyer.

Nori marketplace itself plans to be carbon neutral by buying offsets to cover the emissions generated by the marketplace for selling offsets. Their mission is to enable corporations and individuals to help restore atmospheric concentrations of heat-trapping gases back to 300 ppm. They also give a publicly visible digital Carbon Removal Certificate which displays the amount of NRTs bought. This works in the below 3 steps:

- By using sustainable farming practices, farmers remove carbon from the atmosphere and store it in their soil. (Carbon Removal)
- These carbon removals are then quantified and verified by an independent third party before being listed in the marketplace. (Verification)
- You pay the farmer for ownership of their carbon removals, and receive a certificate from Nori to prove it. (Carbon Removal Certificate)

5. Ethereum 2.0

NFTs and Ethereum use proof of work (PoW) to verify their transaction. In PoW, all participants race to cryptographically secure transactions and add them to the blockchain's globally distributed ledger. Ethereum 2.0 blockchain users will get rewards for helping run the network based on the amount of ETH they are willing to stake to it. This is known as Proof of Stake (PoS). This shift will lower the network's energy use allowing the Ethereum network to process more transactions per second and reduce fees. Moving Ethereum from using Proof of Work to Proof of Stake has a potential to reduce carbon impact by around 99%. These initiatives are part of Ethereum 2.0, an ongoing project that does not have a definitive completion date. However, Justin Drake, one of the researchers working on Ethereum 2.0, has said, "I am confident we can ship the merge in 2021." So the wait for Eth 2.0 continues…

7. Other CryptoArt NFT ecosystems

The NFT ecosystem is currently evolving at a fast pace which presents a good opportunity to steer the evolution towards a greener future. The need of the hour though, is for the evolving NFT ecosystems to be committed to the environment and transparent about the total carbon emissions associated with each sale.

- One ecosystem is Algorand which empowers developers to create NFTs as an Algorand Standard Assets (ASA) - a simple token creation framework that resides on Layer-1. Algorand is the first and currently the only distributed network that addresses the so-called Blockchain Trilemma (termed by Vitalik Buterin), as it achieves all three key elements of an ideal blockchain - scalability, security, and decentralisation - without compromising any of them. Algorand's Layer-1 functionalities enable users to create, launch and manage NFTs on the public network, which means that they're highly secure, unique, efficient, and user-friendly. ASAs are super fast and benefit from Algorand's security and they're low cost to mint, thanks to Alogrand's low fees.

- Burnt Finance reported that it has raised $3 million for a decentralised auction protocol built on the Solana blockchain. The project is being incubated by Injective Protocol (which recently raised $10 million from investors and Mark Cuban, as well as Multicoin, DeFiance, Alameda, Mechanism, Vessel Capital, Hashkey, Spartan, Do Kwon (CEO of Terra), Sandeep (COO of Polygon), and others. The reason why it's worth mentioning all this is that in trying to auction the painting, the Burnt Banksy group stumbled on an increasing problem in the world of NFTs: The rising congestion on the Ethereum network is leading to larger and larger gas fees. This is making both the creation and bidding on NFTs increasingly expensive, just from a baseline. As a result, the team decided to build the Burnt Finance NFT auction platform away from Ethereum and hit upon the Solana blockchain, which has comparatively good speed, performance and lower transaction costs. It will use "Solana Wormhole," which connects ETH and ERC20 tokens to SPL Tokens.

- The open-source Tezos network is a Proof of Stake blockchain that consumes over two million times less energy than Proof of Work networks like Bitcoin or Ethereum. It has a very low carbon footprint. The self-amending properties of Tezos allow the network to stay ahead of the constantly evolving trends in the blockchain ecosystem, such as gas optimisations and NFTs. The energy used annually by validators of the Tezos network (also known as "bakers" in the Tezos ecosystem) is in the range of 60MWh, a continuous draw of 7 kilowatts. Compared to Ethereum, these numbers differ by a factor of over two million, between six and seven orders of magnitude. Moreover, the low gas costs on Tezos provide for a seamless, congestion-free user experience that allows anyone to mint, host, and trade NFTs with minimal barriers to entry.

- OpenSea, a leading NFT marketplace, also recently announced that it will support Tezos NFTs on its platform.

- Below are some other eco-friendly NFT marketplaces [Source: Memo],

Name	Website	Blockchain used
Viv3	https://viv3.com/	Flow (by CruyptoKitties folks)
Kodadot	https://kodadot.xyz/	Kusama/Polkadot
Hic et nunc	https://www.hicetnunc.xyz/	Tezos
Kalamint	https://kalamint.io/	Tezos
SIGN Art	https://sign-art.app/	Waves Protocol
Atomic	https://wax.atomichub.io/	Wax
Pixeos	https://pixeos.io/	EOS
Paras	https://paras.id/	NEAR
NFTshowroom	https://nftshowroom.com/	HIVE
Exporio	https://epor.io/	xDai
Solible	https://solible.com	Solana
Lovada	https://twitter.com/lovadaart	Cardano
Stellar NFT	https://stellarnft.com/	Stellar

- There is also a developer community spread sheet on all the NFT platforms for both Proof of Work and Proof of Stake.

6. Increase awareness about ecological impact of NFTs

Increasing awareness amongst, artists, developers, platform creators and public in general would help steer NFT evolution towards a greener future in a big way. There's already an artist-led effort to raise money to reward people who can figure out new ways to make crypto art more sustainable. Anyone who wants to support those artists by buying their work can migrate along with them to less polluting platforms — or maybe just buy a physical copy of their work.

Extra Resources

- Complete NFT resource
- Kylie's work on calculating the energy required to power Ethereum-backed CryptoArt platforms
- Kylie's attempt to estimate the per-day energy consumption of Ethereum
- Memo Atken's research on ecological impact of NFTs