

Environmental Impact of Crypto-Assets

John Preuß Mattsson, Ericsson Research

Abstract: The electricity consumption of crypto-assets exceeds that of many relatively large countries and results in significant air pollution and emission of greenhouse gases. A huge energy consumption could be excused if crypto-assets strongly contributed to the benefit of humanity, but according to many recent reports the impacts of crypto-assets are strongly negative. We propose that the Internet community should follow the Wikimedia Foundation in making sure to not legitimize or implicitly promote proof of work mechanisms.

1. Introduction

A blockchain is a chain of records (blocks) that are linked together using cryptography. Blockchains provide a mechanism through which mutually distrustful remote parties can reach consensus on the state of a ledger of information [1]. Most of the fundamental ideas behind cryptographically secured chains of records and proof of work were invented in the 1970s by Merkle [2][3] and Chaum [4]. The term blockchain was coined (no pun intended) in the paper on Bitcoin published by the pseudonym Satoshi Nakamoto [5] and the hype has been growing ever since. In addition to cryptocurrencies, blockchains are also used in Non-Fungible Tokens (NFTs) where the record is associated with a digital asset such as an image. Cryptocurrencies and NFTs are commonly referred to as crypto-assets. Blockchain technologies and crypto-assets are also part of Web3 which by some is viewed as a way to decentralize and democratize the Web [6] while other describe it as a marketing buzzword intended to sell more crypto-assets [7].

“The concept of Web3 conjures images of open, decentralized, and democratized systems of greater utility”

“web3 is a marketing buzzword with no technical meaning. It's a melange of cryptocurrencies, smart contracts with nigh-magical abilities, and NFTs just because they think they can sell some monkeys to morons.”

2. Environmental Impact of Crypto-Assets

One aspect of many blockchains and crypto-assets are their humongous energy consumption. The White House has published a report [8] describing the effects crypto-assets have on climate change. The electricity usage exceeds that of many relatively large countries and is comparable to the electricity usage of all other data centers in the world.

“As of August 2022, published estimates of the total global electricity usage for crypto-assets are between 120 and 240 billion kilowatt-hours per year, a range that exceeds the total annual electricity usage of many individual countries, such as Argentina or Australia. This is equivalent to 0.4% to

0.9% of annual global electricity usage and is comparable to the annual electricity usage of all conventional (i.e., non-crypto-asset) data centers in the world.”

The numbers in the White house report are one of the highest published estimates on crypto-asset electricity usage. The International Energy Agency (IEA) [9] estimates that crypto mining uses 100-140 TWh and many other estimates [10][11] are lower than the IEA estimate. But even if the actual electricity usage is lower than the numbers in the White House report, the overall conclusions remain true.

The reason for the enormous energy consumption is the consensus mechanism proof of work used by Bitcoin and many other blockchains where provers/miners compete to solve complex cryptographic problems such as finding hash digests beginning with a certain number of zeros. Other consensus mechanisms such as proof of stake where provers offer crypto-assets as a stake use much less energy. In September 2022, the Ethereum blockchain transitioned from proof of work to proof of stake which according to Ethereum [12] reduced energy consumption by 99.95%. It is unclear how the energy consumption of proof of stake systems compare to systems not using blockchains.

So why is a huge electricity consumption a bad thing? This boils down to two things; current electricity production causes significant air pollution and significantly contributes to climate change. An overview of estimated death rates per energy production from various electricity supply technologies is given by [13] which summarizes estimates from academic papers and the United Nations (UN). Life-cycle greenhouse gas emissions of electricity supply technologies for various electricity supply technologies has been calculated by the Intergovernmental Panel on Climate Change (IPCC) [14] and the United Nations (UN) [15]. Note that air pollution and greenhouse gas emissions vary greatly with electricity supply technology and that future energy production might therefore cause far less pollution and greenhouse gas emissions.

According to the United Nations (UN) [16], the effects of climate change are frequent and destructive wildfires, storms, and drought causing deaths and huge economic losses. Global warming causes the oceans to rise threatening coastal and island communities and poses risks of extinction of many species. Climate change is behind a global rise in hunger, poor nutrition, and poverty. UN estimates that climate change takes the lives of around 13 million people every year. The economic consequences are also disastrous, as stated in [17]:

“The effects of climate change can be expected to shave 11 percent to 14 percent off global economic output by 2050 compared with growth levels without climate change, according to a report from Swiss Re, one of the world’s largest providers of insurance to other insurance companies. That amounts to as much as \$23 trillion in reduced annual global economic output worldwide as a result of climate change. Some Asian nations could have one-third less wealth than would otherwise be the case”

A huge energy consumption could be excused if crypto-assets strongly contributed to the benefit of humanity, but according to many recent reports the impacts of crypto-assets are strongly negative. Many central banks [18][19] are openly describing crypto-assets as a bubble, comparing them to the tulip mania in the Dutch Republic during the 17th century, and expressing worry what will happen to broader financial markets when the bubble bursts. Central Bank Digital Currencies (CBDCs) which many central banks are currently investigating do not need any sort of distributed ledger such as a blockchain [20]. Nobel Prize-winning economist Paul Krugman explains in a New York Times article [21] that cryptocurrencies are in large part

Ponzi schemes built on nothing at all and sold with technobabble. In a letter to the US congress [22], 1500 prominent technology experts summarize that blockchain technology is poorly suited for everything, and that crypto-assets are mainly used for large scale scams and other criminal financial activity. The internationally renowned expert in computer security Bruce Schneier is even more straightforward, describing all blockchain systems as useless and awful [23]. Matthew Green wrote a response [24]. A report from Chainalysis illustrate how terrorist organizations like Al-Qaeda and ISIS are using cryptocurrencies for funding [25]. Lyn Alden has convincing arguments about how bitcoin can be used to finance human rights organizations in authoritarian regimes, but less convincing arguments about energy, where she states that bitcoin uses energy that would otherwise be wasted [26].

3. Conclusion

The non-profit Wikimedia Foundation, which owns and operates Wikipedia, has decided to stop accepting cryptocurrency donations, not only from proof of work systems, but from all cryptocurrencies [27]. The decision was taken due to environmental concerns and because by accepting cryptocurrencies Wikimedia was legitimizing and implicitly promoting a predatory system.

For the same reasons we think the broader Internet community including IAB, IETF, IRTF, and ISOC should have a discussion and decide on a stance on crypto-assets. At a minimum the Internet community should make sure to not be associated with, legitimize, or implicitly promote proof of work mechanisms. Unfortunately, the IRTF Decentralized Internet Infrastructure Research Group [28] and the IETF Secure Asset Transfer Protocol (SATP) BoF [29] might have done just that. While proof of stake is much more energy efficient than proof of work, many such systems are mainly used for predatory crypto-assets.

References

- [1] Sherman, Javani, Zhang, Golaszewski, “On the Origins and Variations of Blockchain Technologies”
<https://arxiv.org/abs/1810.06130>
- [2] Merkle, “Secure communications over insecure channels”
<http://www.ralphmerkle.com/1974/PuzzlesAsPublished.pdf>
- [3] Merkle, “Secrecy, authentication, and public-key systems”
<http://www.ralphmerkle.com/papers/Thesis1979.pdf>
- [4] Chaum, “Computer systems established, maintained, and trusted by mutually suspicious groups”
https://chaum.com/wp-content/uploads/2022/02/chaum_dissertation.pdf
- [5] Nakamoto, “Bitcoin: A peer-to-peer electronic cash system”
<https://bitcoin.org/bitcoin.pdf>
- [6] WARC, “How Web3’s expectation of decentralized and democratized trust will further disrupt the marketing industry”
https://www.theregister.com/2021/12/15/web3_apparently_the_next_generation/
- [7] The Register, “Web3: The next generation of the web is here... apparently”
https://www.theregister.com/2021/12/15/web3_apparently_the_next_generation/

- [8] The White House, “Climate and Energy Implications of Crypto-Assets in the United States”
<https://www.whitehouse.gov/wp-content/uploads/2022/09/09-2022-Crypto-Assets-and-Climate-Report.pdf>
- [9] International Energy Agency, “Data Centres and Data Transmission Networks”
<https://www.iea.org/reports/data-centres-and-data-transmission-networks>
- [10] Gellersdörfer, Klaaßen, Stoll, “Energy Consumption of Cryptocurrencies Beyond Bitcoin”
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7402366/>
- [11] Jones, Goodkind, Berrens, “Economic estimation of Bitcoin mining’s climate damages demonstrates closer resemblance to digital crude than digital gold”
<https://www.nature.com/articles/s41598-022-18686-8>
- [12] Ethereum, “The Merge”
<https://ethereum.org/en/upgrades/merge/>
- [13] Our World in Data, “Death rates per unit of electricity production”
<https://ourworldindata.org/grapher/death-rates-from-energy-production-per-twh>
- [14] IPCC, “Mitigation of Climate Change, Annex III: Technology - specific cost and performance parameters”
https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-iii.pdf#page=7
- [15] UNECE, “Life Cycle Assessment of Electricity Generation Options”
<https://unece.org/sed/documents/2021/10/reports/life-cycle-assessment-electricity-generation-options>
- [16] United Nations, “Effects of Climate Change”
<https://www.un.org/en/climatechange/science/causes-effects-climate-change>
- [17] The New York Times, “Climate Change Could Cut World Economy by \$23 Trillion in 2050, Insurance Giant Warns”
<https://www.nytimes.com/2021/04/22/climate/climate-change-economy.html>
- [18] ECB, “For a few cryptos more: the Wild West of crypto finance”
<https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220425~6436006db0.en.html>
- [19] The Economic Times, “Warning Indians against cryptocurrencies, RBI chief says tulips have more value”
<https://economictimes.indiatimes.com/news/economy/policy/cryptos-a-threat-to-financial-stability-value-not-even-a-tulip-shaktikanta-das/articleshow/89474805.cms>
- [20] Forbes, “When The CBDC Revolution Comes, It Won’t Be On The Blockchain”
<https://www.forbes.com/sites/davidbirch/2022/08/03/when-the-cbdc-revolution-comes-it-wont-be-on-the-blockchain/>
- [21] Krugman, “From the Big Short to the Big Scam”
<https://www.nytimes.com/2022/06/06/opinion/cryptocurrency-bubble-fraud.html>
- [22] “Letter in Support of Responsible Fintech Policy”
<https://concerned.tech/>

[23] Schneier, “On the Dangers of Cryptocurrencies and the Uselessness of Blockchain”
<https://www.schneier.com/blog/archives/2022/06/on-the-dangers-of-cryptocurrencies-and-the-uselessness-of-blockchain.html>

[24] Green, “In defense of crypto(currency)”
<https://blog.cryptographyengineering.com/2022/06/09/in-defense-of-cryptocurrency/>

[25] Outlook, “Al-Qaeda, ISIS, Hamas Using Cryptos For Terror Activities, Says Chainalysis Report”
<https://www.outlookindia.com/business/al-qaeda-isis-hamas-using-cryptos-for-terror-activities-says-chainalysis-report-news-182792>

[26] Alden, “Bitcoin’s Energy Usage Isn’t a Problem. Here’s Why”
<https://www.lynalden.com/bitcoin-energy/>

[27] Wikimedia, “Stop accepting cryptocurrency donations”
https://meta.wikimedia.org/w/index.php?title=Talk:Requests_for_comment/Stop_accepting_cryptocurrency_donations

[28] IRTF, “Decentralized Internet Infrastructure Research Group (DINRG)”
<https://datatracker.ietf.org/rg/dinrg/about/>

[29] IETF, “Secure Asset Transfer Protocol (SATP)”
<https://datatracker.ietf.org/wg/satp/about/>

John Preuß Mattsson is Expert in Cryptographic Algorithms and Security Protocols at Ericsson. He has a Master of Business Administration with a focus on finance.