

# THE GREEN **BITCOIN** -

CO<sub>2</sub> offsetting the largest cryptocurrency in the world.

Article by Philipp Sandner and Constantin Lichti



Last month's guest article examined how new crypto players are using a Proof of Stake process as a lowenvironmental-impact alternative to bitcoin's energyhungry Proof of Work mining process.

In response, this month Prof. Dr. Philipp Sandner, Founder of the Frankfurt School Blockchain Center (FSBC), Constantin Lichti, Research Associate and Project Manager at FSBC and Benjamin Schaub, Senior Consultant at INTAS.tech, break down the numbers and suggest that the benefits of Proof of Work are poorly understood.

One of the major criticisms of bitcoin in recent years relates to its power consumption and the associated CO<sub>2</sub> equivalent (CO<sub>2</sub>eq) emissions that result from maintaining the bitcoin network. Bitcoin investors who either invest directly via crypto exchanges or who build exposure to bitcoin through financial products such as Exchange Traded Notes (ETNs) or funds could therefore come under pressure in the future, as new regulations contain significantly stricter sustainability and disclosure requirements.

It is important that electricity consumption should not be moralised over, the concept of a personal carbon footprint is a thorny topic after all. Rather, our question should be: which type of electricity should be used for bitcoin mining: renewable or non-renewable? It is a fact that the consumption profile of the bitcoin network is no different to any other consumption profile, it is no less "brown" or "green".

Bitcoin is beneficial to people in countries that do not have such stable institutions as do Europe and the US. Bitcoin serves as a "technology institution" to people in countries with very high inflation or with unstable or corrupt regimes. This may surprise many, which suggests that there is a greater wealth of prejudice than in-depth specialist knowledge around bitcoin. The electricity consumption or, more accurately the consumption profile of the electricity in the bitcoin network has, therefore, to be weighed against the special benefits bitcoin has for many people on Earth.

The European Union's Sustainable Finance Disclosure Regulation (SFDR), which has been in force since 10 March 2021, obliges asset managers and financial market participants to disclose ESG<sup>1</sup>-relevant information and to categorise their products according to certain sustainability criteria. The EU's aim is to increase transparency regarding sustainability risks and negative sustainability impacts from financial products. From July 2022 financial market players will be obliged to collect and disclose relevant data on their products. It is important to consider that other industries and companies are also affected by these stricter sustainability regulations. Technology companies that operate large data centres or power intensive infrastructures could also be affected. It should be noted that all financial products offered by EU market participants are subject to the disclosure requirements of the SFDR. Therefore, in order to make a fair assessment, the carbon footprint of bitcoin must be compared to the carbon

footprint of gold production, which requires use of diesel, excavators and chemicals.



## Bitcoin's power consumption - curse or blessing?

It has to be pointed out that the energy problem doesn't apply equally to all blockchain technology and crypto currencies in general because most blockchain solutions are not power guzzlers. On the contrary, they can even facilitate energy savings in certain processes. However, blockchains with a proof-of-work (PoW) consensus mechanism, such as bitcoin, do consume a lot of electricity. This consensus mechanism fulfills two important functions; on the one hand, transactions are invariably verified and securely stored in the blockchain. On the other hand, in the case of bitcoin, new bitcoins continue to be generated until all 21 million bitcoins are in circulation. This is expected to occur in 2140. The latter function is often compared to mining for gold, as gold miners invest resources in finding new gold rather than preserving gold or enabling gold transactions. The requirement for high power-consumption ensures the maintenance and integrity of the network. It is therefore very important for network security. To some extent it would be fair to say that bitcoin is backed by the electricity it consumes. This aspect is extremely important: it is the PoW consensus mechanism that protects the bitcoin network from cyberattacks and hence is an essential part of bitcoin's security architecture. The resulting extremely high level of security is the basis for the survival of bitcoin.

A neutral perspective is crucial for the consideration of bitcoin's CO<sub>2</sub>eq footprint resulting from its electricity consumption. In this context, it is important to know from where the electricity consumed originates. In terms of carbon emissions, it is important to distinguish between renewable sources of electricity and fossil fuels. Only then will it be possible to overcome bitcoin's shortcomings, strengthen its role as an alternative, ESG-compliant financial product and make bitcoin a more sustainable investment.

While bitcoin itself could theoretically be mined using 100% renewable, carbon-neutral energy, it is not today, as miners only have an incentive to optimise their profitability by keeping their costs as low as possible. According to the polluter pays principle, it would be obvious that the CO<sub>2</sub>eq emissions of mining companies would be offset by them when buying electricity for their operations (in line with the GHG Scope 2 guidance<sup>2</sup>). However, this approach is not feasible, because all parties who invest in bitcoin - be it directly via crypto exchanges or indirectly via financial products such as ETNs or crypto funds – benefit from the mining operation and the associated electricity consumption. We would, therefore, like to introduce two approaches that were recently published in a joint study by FSBC and INTAS.tech and that we've tested using a bitcoin ETP<sup>3</sup>.

## Transaction-based network usage

The transaction-based approach distributes responsibility for bitcoin's CO<sub>2</sub>eq footprint based on the benefits enjoyed by those involved. Since, as previously mentioned, bitcoin mining has the function of adding new transactions to the blockchain, a quantifiable method is required to calculate the CO<sub>2</sub>eq emissions of transactions. The most accurate approach is to determine the proportion of storage space used within the blockchain in relation to the overall growth of the bitcoin blockchain during a certain period of time. This proportion is then multiplied by the CO<sub>2</sub>eq emissions that result from the electricity mix consumption of the entire bitcoin network during this period.

## Proprietary-based calculation approach

A shortcoming of the transaction-based approach is that it excludes many parties who do not have access to their transaction-related data. Additionally, a significant part of bitcoin's utility derives from its long-term macroeconomic model: store of value. In view of these facts, we propose a calculation model that focuses on the proportion of bitcoins held in relation to the bitcoins in circulation for a certain period of time.

# How to price CO2 offsetting?

Corporates could apply the above approaches to transactions and bitcoin ownership to calculate their CO<sub>2</sub>eq footprint, which they can then offset. The following are exemplary results from our study, which relate to the period from 1 September 2020 to 31 August 2021.

Power consumption of the bitcoin network: To maintain the global bitcoin network, 90.86 TWh<sup>4</sup> and 37.97 MtCO<sub>2</sub>eq<sup>5</sup> was required in the specified period. We differentiate between renewable energy sources and fossil fuels by taking into account the entire electricity mix of each country in order to convert bitcoin's electricity consumption into its carbon footprint.

Transaction-based network usage: An average bitcoin transaction is 670 bytes in size, which corresponds to an estimated carbon footprint of 369 kgCO<sub>2</sub>eq. At a market price of 50 US dollars per ton of CO<sub>2</sub>eq<sup>6</sup> on the EU Emissions Trading System, the offsetting of an average bitcoin transaction costs 18.47 US dollars<sup>7</sup>. This number must not be misinterpreted: a single transaction can transfer dollars or hundreds of millions of dollars. In addition, companies such as crypto exchanges aggregate tens of thousands of users on a few bitcoin wallets and only a small subset of the transactions may be carried out on the network (e.g. daily net inflows or outflows). Assessing the carbon footprint of bitcoin transactions must be done with great care. In addition, the price of CO<sub>2</sub> has risen since our calculations meaning that the numbers above are subject to strong fluctuations over time.

Proprietary-based calculation approach: Holding one bitcoin over the examined period of one year corresponds to a footprint of 2.04 tCO2eq8. Therefore, offsetting ownership of one bitcoin for one year would cost 102.20 US dollars.

## **Bitcoin's CO2 emissions in comparison**

For comparison, mining one bitcoin's worth of gold at a bitcoin price of 50,000 US dollars corresponds to a carbon footprint of over 13 tCO<sub>2</sub>eq.

To put this into perspective, a flight from London to Dubai emits around 894 kgCO<sub>2</sub>eq, while the latest estimate of the world's total annual CO<sub>2</sub> emissions is 45,874 MtCO<sub>2</sub>eq. bitcoin thus has a total footprint of 0.08% of the global CO<sub>2</sub>eq.

## Conclusion

It is important not to take these results out of context. These are the best possible estimates. The exact power consumption cannot be determined at the moment due to several factors. For an exact calculation of an investor's carbon footprint, the situation must be considered individually depending on the company's business approach; whether they engage in simple investing, asset management, crypto exchanges or are custodians. It is to be expected that the results of such calculations will have to be verified and checked by specialised service providers in the future.

With this in mind, we see an opportunity for all investors, asset managers, crypto exchanges and custodian banks to get involved and take responsibility for the CO2eq footprint of the bitcoin network. In doing so, the goal should not only be to demonstrate corporate social responsibility, but also to add value by making bitcoin a more sustainable investment.

## About the study

The study can be downloaded in full (pdf 780 kB).

#### About the authors

Constantin Lichti is a Research Associate and Project Manager at the Frankfurt School Blockchain Center and a PhD student at Johannes Gutenberg University Mainz. His research interests include bitcoin and blockchain adoption, as well as the question of how the discourse about blockchain technology is reflected in (social) media. He graduated from the Technical University of Munich with a master's degree in industrial engineering. You can contact him by email (constantin.lichti@fs-blockchain.de) and via LinkedIn (https://www.linkedin.com/in/constantin-lichti-5644b9109/).

Prof. Dr. Philipp Sandner founded the Frankfurt School Blockchain Center (FSBC). From 2018 to 2020 he was named one of the "Top 30" economists by the Frankfurter Allgemeine Zeitung (FAZ), one of the largest newspapers in Germany. In addition, he was one of the "Top 40 under 40" - a ranking by the business magazine Capital. He has been a member of the FinTech Council of the Federal Ministry of Finance since 2017. Prof. Sandner's expertise includes blockchain technology, crypto values such as bitcoin and Ethereum, the digital programmable euro, tokenisation of assets and rights and, ultimately, digital identity. He can be reached via LinkedIn (https://www.linkedin.com/in/philippsandner/) or on Twitter (@philippsandner).

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#### About the Frankfurt School Blockchain Center

is designed as a think tank and research center and deals with the implications of blockchain The technology for corporates and the economy. In addition, the center offers a platform for knowledge exchange for decision-makers, start-ups, technology and industry experts. It will both provide new research impulses and develop courses for students and executives. The center focuses primarily on the areas of banking, energy, Industry 4.0 and mobility.

#### About INTAS.tech

is a blockchain consulting company that was founded by the and and is specially tailored to the needs of financial organisations. INTAS.tech focuses on the integration and handling of digital assets as well as the strategic evaluation of blockchain applications and their implementation.

- <sup>1</sup> Environment, Social, Governance
- <sup>2</sup> the of the Greenhouse Gas Protocol standardises how corporates measure emissions from purchased or acquired electricity, steam, heat and cooling (called "scope 2 emissions")
- <sup>3</sup> Exchange Traded product
- <sup>4</sup> terawatt hours
- <sup>5</sup> megatons of CO2 equivalents
- <sup>6</sup> kilogramms of CO2 equivalents
- <sup>8</sup> metric tonnes of CO2 equivalents

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