

CLIMATE CHANGE, ENERGY AND ENVIRONMENT

# BITCOIN, ENERGY USE AND CLIMATE CHANGE

Global perspectives on cryptoasset mining and its environmental impacts

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## 1

## INTRODUCTION

Despite being a technology considered innovative, due to the freedom it offers in financial transactions and investments, Bitcoin and other cryptocurrencies have serious environmental implications. Bitcoin, the highest representative of cryptoassets based on blockchain technology, is an “energy-hungry” currency, whose sources are not necessarily the cleanest and, therefore, represents a real barrier to efforts to combat climate change.

Given this scenario, this document seeks to present a global perspective on cryptoassets, with emphasis on Bitcoin, and

contribute to the discussion on global environmental impacts, analyzing trends in energy consumption and emissions generation, as well as the consideration of myths and truths surrounding this topic.

To deepen the analysis of the socio-environmental impacts at the country level, an additional issue has been generated to this document, which presents the *Adoption and mining of Bitcoin in El Salvador: deepening inequalities and setbacks in environmental and climate change matters*, as a complement to this document that has a more global perspective.

## 2

## BITCOIN MINING: WHAT IS IT AND HOW DOES IT WORK?

Starting in 2008, Bitcoin and other cryptocurrencies began to attract attention for their innovative technology called blockchain, based on a decentralized and open source system, considered by its adherents as a disruptive process, given the freedom offered through the non-interference of any bank, government or authority to supervise how cryptocurrency transactions are carried out. However, despite the potential revolutions in terms of financial or information transfers from one agent to another, the technology on which the creation of Bitcoin units (and others) is based is related to a global environmental problem: climate change<sup>1</sup>.

Blockchain technology relies on the solution of complex cryptographic problems to validate transactions or records. To solve these problems, thousands of computer nodes attached to the network participate, giving rise to a competition to validate a new transaction and obtain the reward, this is the so-called “cryptocurrency mining”. It is estimated that the Bitcoin network is made up of 10 thousand nodes, and these in turn can be composed of one or several computers (de Vries, 2018). In this race, only one of the nodes solves the problem, while the rest simply consumes energy in vain. The mining process and the maintenance of the sophisticated equipment make this activity intensive in energy use<sup>2</sup>.

<sup>1</sup> Schinckus, C., Phuc Nguyen, C., Chong Hui Ling, F., & Chi Minh, H. (2020). International Journal of Energy Economics and Policy Cryptocurrencies Trading and Energy Consumption. *International Journal of Energy Economics and Policy*.

<sup>2</sup> Badea, L., & Mungiu-Pupazan, M. C. (2021). The Economic and Environmental Impact of Bitcoin. *IEEE*.

In short, the complexity of the mathematical calculations that must be processed to achieve the extraction of a coin or a Satoshi, which is the lowest equivalent of that cryptoasset, requires a high energy consumption. The billions of operations needed to achieve extraction have a reward for the miner,

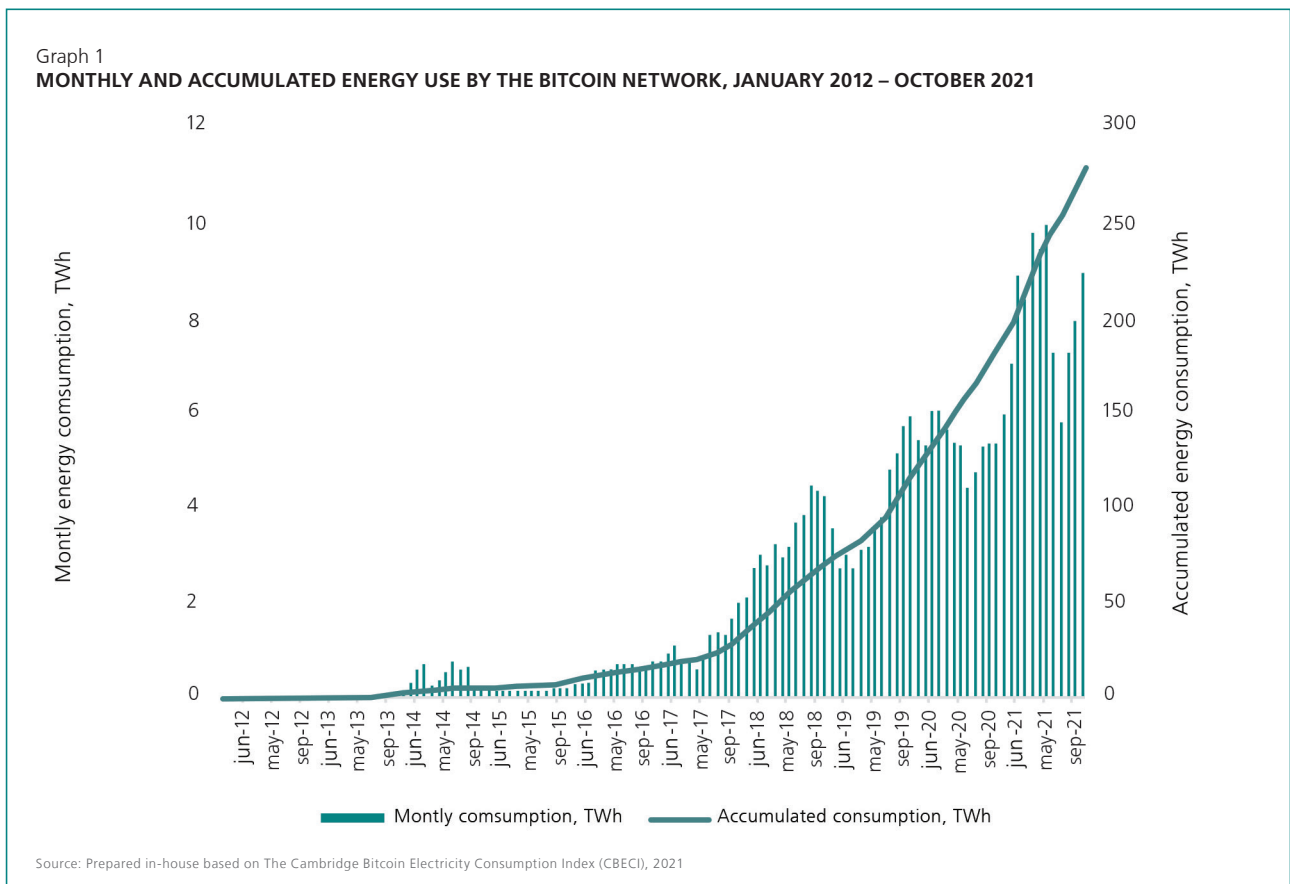
however, the environmental cost is very high, considering that to compete and that the mine does not lower its performance, computers must be overexploited at levels where energy consumption becomes exorbitant.

### 3

## THE DEEPENING OF THE ENVIRONMENTAL RISKS DERIVED FROM BITCOIN MINING

Bitcoin mining is not a virtual or invisible enemy of the environment at all, but rather, it is essentially an unavoidable reality, since it attempts against environmental integrity in all areas and at all levels. The growing energy problem linked to cryptoassets and the technology on which it underlies is latent. It is estimated that, to October 2021, the total energy utilization of the Bitcoin network has been 83.91 terawatt-hour (TWh)<sup>3</sup>, while in previous years, annual consumption was between 73.1 and

78.3 TWh<sup>4</sup>. This consumption is approaching and even exceeding the annual energy use of countries such as Chile (76.6 TWh); Colombia (69.9 TWh) or Austria (68.5 TWh)<sup>5</sup>. For countries like El Salvador, the energy consumption of the Bitcoin network represents about 13 times what the entire country uses in a year. Graph 1 shows the evolution of the energy consumption of this network, on a monthly and cumulative basis between January 2012 and October 2021.



3 The University of Cambridge. (2021). *Cambridge Bitcoin Electricity Consumption Index (CBECI)*. The University of Cambridge.

4 Badea, L., & Mungiu-Pupazan, M. C. (2021).

5 The University of Cambridge. (2021)

As it can be seen in Graph 1, the trend is completely increasing, this is due to the intensification of the demand for the incursion of more miners who are attracted by the rewards and potential compensations, which are possible thanks to the permanent operation of equipment, which works mining efficiently and without stopping 24 hours a day.

The worrying thing about this situation, besides the constant and accelerated growth in the use of energy, are the sources from which this good comes. Some studies traced up to 2019 the origin of the energy used by the grid, and identified that coal is a significant fuel source, given that at least until 2019, China was emerging as the country where between 60% and 70% of Bitcoin were extracted, using energy from coal. That miners are located in China is not a coincidence, since profit maximization depends on the costs incurred to operate and keep equipment working. Chinese energy is therefore attractive as it is extremely cheap<sup>6</sup>.

In environmental terms, this scenario implies considering the issue of carbon emissions, knowing that, the generation and use of Bitcoin in 2017 generated 69 million tons of carbon equivalent (MtCO<sub>2</sub>e)<sup>7</sup> and, it is considered that, if the trend of accelerated use of Bitcoin continues (not including the impact of other cryptocurrencies), the accumulated emissions will cross the threshold of 2°C within 22 years, in an optimistic scenario, and within just 2 years, if the adoption of this technology expands. This scenario represents a clear barrier

to the goals of limiting global warming to 1.5 °C in the coming years; otherwise, the world’s population faces more dangerous consequences of climate change.

In the short term, there is no perceived radical change in the trend of energy use and its origin from sources with a significant carbon footprint; a more recent study indicates that for 2020, only 39% of the energy used in cryptoasset mining came from renewable sources<sup>8</sup>.

As shown in Graph 1, although hydropower is the most common source in the different regions where crypto mining takes place, non-renewable and polluting energy sources such as coal and petroleum-based fuels still have a considerable weight in consumption.

For example, in the case of Asia-Pacific, which is the region with the most crypto miners in the world, 65% of miners use hydroelectric energy, but, at the same time, 12% also use energy produced from petroleum derivatives. In other words, cryptominers do not use a single source of energy, so one same miner can be mining bitcoin with renewable and non-renewable sources at the same time.

In summary, it is important to note in Table 1 that, although renewable sources have a considerable weight, more-polluting energy is always present in the cryptoasset mining process.

Table 1  
RATIO OF CRYPTOMINERS BY ENERGY SOURCE IN FOUR REGIONS OF THE WORLD

Energy source	Asia-Pacific	Europe	Latin America and Caribbean	North America
Hydroelectric	65%	60%	67%	61%
Natural gas	38%	33%	17%	44%
Coal	65%	2%	0%	28%
Wind	23%	7%	0%	22%
Petroleum derivates	12%	7%	33%	22%
Nuclear	12%	7%	0%	22%
Solar	12%	13%	17%	17%
Geothermal	8%	0%	0%	6%

Source: University of Cambridge, mentioned in (Lu, 2021)  
Editor's Note: The numbers in each column are not meant to add to 100% as cryptominers can use combined sources of energy simultaneously.

6 Badea, L., & Mungiu-Pupazan, M. C. (2021).

7 Mora, C., Rollins, R. L., Taladay, K., Kantar, M. B., Chock, M. K., Shimada, M., & Franklin, E. C. (2018). Bitcoin emissions alone could push global warming above 2°C. *Nature Climate Change* 2018 8:11, 8(11), 931–933.

8 Lu, M. (2021, April 20). *Visualizing the Power Consumption of Bitcoin Mining*.

The direct environmental impact is reflected above all in the need to have an uninterrupted source of energy, taking into account that renewable energies are not stable enough for the supply to be constant and at low cost, which other polluting sources such as coal or fossil fuels achieve. It should be noted that with climate change this situation will become increasingly common; for example, it is common to see cases in regions of Europe where wind energy is not an option at certain times of the year, given the climatic variability that causes a lack of wind sufficient to drive the turbines, which brings us back to the point that to solve the shortage, countries resort to polluting

fuels, something counterproductive with the mitigation goal of the Paris Agreement, which establishes the urgency and need to maintain average global temperature below 1.5°C.

Bitcoin mining constitutes a transcendental challenge for the environment, and although the trend can be modified in the medium and long term, either by improvements in the efficiency of processes, or by the diversification of energy sources, it is a fact that currently, miners continue to be guided by cost reduction and profit maximization, which prevents certainty of a reduction in the carbon footprint that this activity generates.

## 4

# MYTHS AND TRUTHS ABOUT BITCOIN MINING

According to [www.digieconomist.net](http://www.digieconomist.net), the portal specializing in Bitcoin mining, the energy consumption for cryptoassets will be increasingly higher, considering that the level of difficulty in mining new coins or their equivalents is growing and becoming increasingly complex.

An interview conducted by journalist Martin Walker with Alex de Vries<sup>9</sup> in March of this year has revealed a relevant fact, which is not a myth, but a tangible reality. In the post, he stated that after reading for the first time in 2015 an article that estimated that a single Bitcoin transaction could power one American household for 1.5 days, he decided to dive into the subject and subsequently create the Bitcoin Energy Consumption Index (BECI), a model created to understand and estimate, based on data and updated information, the implications of the energy consumption of this technology.

An important myth to clarify is that it is mistakenly believed that miners are the ones who pay the energy bills for Bitcoin to work, something that is not entirely true, if we consider that they use fuels that are subsidized by the States, both those that come from renewable energy sources and those that are from coal or fossils. Besides, a much more relevant fact is that the large mining companies that operate in the world are multina-

tional corporations that seek cheap energy and that do not assume the environmental impacts or costs generated by their extractive activity, but, when the conditions to operate in a certain place are exhausted, they look for another that allows them to keep their equipment in operation.

Bitcoin mining is said to be clean, which is a total lie. A single Bitcoin transaction has the same carbon footprint as 735,000 VISA credit card chain transactions, warns de Vries, and cautions that it will soon consume as much energy as all data centers globally. This confirms that in essence, the Bitcoin's core design provokes energy waste.

Talking about Bitcoin mining is not a matter that depends superficially on perspective, as many groups and sectors that support this technology want you to believe. Energy consumption and the underlying impacts that it generates have very defined faces. On the one hand, it deepens the gap of inequalities with respect to access to energy as a human right and, on the other hand, it imposes again a rationale of commodification of nature as an object to be exploited to generate rewards and compensations for business groups that have the luxury and privilege of investing in this game.

<sup>9</sup> In 2014 Alex founded the blog [digieconomist.net](http://digieconomist.net). This blog is a research platform dedicated to exposing the unintended consequences of digital trends. The blog is best known for presenting Bitcoin's energy consumption index since late 2016, which has played an important role in the global discussion on the sustainability of proof-of-work blockchains. He is also the author of several influential articles such as Bitcoin's Growing Energy Problem,

Renewable Energy Will Not Solve Bitcoin's Sustainability Problem and Bitcoin Boom: What Rising Price Mean for the Network's Energy Consumption for high-impact academic magazines such as *Joule*. His work has been featured by many of the world's leading media outlets such as the BBC, Associated Press, Financial Times, New York Times, Reuters, Economist, Bloomberg and many others.

An unquestionable truth about cryptocurrencies is that in this war that has Bitcoin as its prime example, inequality is still present. This supposed “currency” that claims to be decentralized and that will cause changes in the world of the magnitude that represented the use of the Internet, does not correct in any way the vices that conventional money has provoked, the false advantages that argue financial inclusion do not have evidence to support them, an objective fact is that the use of this technology, even said by its promoters, is not recommended for people who would use it for their subsistence, but for people who can afford to speculate and expect investments to have returns and profits.

The COVID-19 pandemic has accelerated the digitization of economies and within this context, it has happened in the same way with cryptoassets such as Bitcoin that, although they already existed for many years, have come to stay.

The vertiginous rhythm of the digitization of economies and people’s lives globally is indeed true, it will lead to a growing demand for digital money and the borders for this will be less and less, although there have been attempts to regulate cryptoassets by law and in many other countries there are measures to prohibit their circulation, this technology in itself has been created to maintain the decentralization of transactions, creating its own ways of operating outside the chains of banking institutions and state control.

## 5

## CONCLUSIONS

The footprint and ecological debt that industrialized countries have historically accumulated with Greenhouse Gas (GHG) emissions has been pointed out as one of the great generating causes of climate change and its accelerated effects, which before the arrival of Bitcoin mining is being expanded and deepened alarmingly.

In the places where Bitcoin mining has arrived, it has provoked an unprecedented waste of energy, having as a fundamental premise the search for cheap, free and continuous energy to keep the blockchain, the technology that gives life to Bitcoin, working. This sickly competition to create new blockchains is a perverse game that wastes energy 24/7, while millions of people are denied their right to energy as a global common good.

Societies are moving towards a context of severe impacts from extreme weather events and a dramatically changing climate, due to the lack of action by States to achieve mitigation efforts. Besides, it is worrisome that according to the warnings of science, we are reaching limit conditions to achieve adaptation by 2030, which is the year that the Intergovernmental Panel on Climate Change (IPCC) has established as a turning point for climate change to become irreversible.

None of the renewable sources used for Bitcoin mining can guarantee the uninterrupted flow of energy that the technology needs to function. The burden on the planet of keeping an eminently extractive technology running for a precision game in which few win and all humanity loses, proves that the path is wrong. The continuity of life as we know it is in danger; however, according to Bitcoin miners, who have large mining farms with thousands of computers especially in the Global North, the speculation that this competition implies is much more important than the struggle to generate conditions of adaptation and resilience in which many countries of the Global South and small island states are immersed, for whom climate change is a matter of life and death, of survival of their entire cultures and peoples.

However innovative the technology that underlies Bitcoin, it cannot evade environmental responsibilities. Given its expansion, the adoption by more and more economic agents and its virtual legitimization must be accompanied by the search for solutions to reduce the negative impact it generates on the environment. The freedom offered by Bitcoin to a minority must not overcome the global effects for the great majority.



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The struggle to generate conditions of adaptation and resilience to climate change is for countries of the Global South and Small Island States, a matter of life and death, of survival of their entire cultures and peoples.

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