

Environmental Consequences of Mining Bitcoin: The Carbon Emission in China

Bolun Xie*

Department of Earth, Ocean and Atmospheric Sciences, The University of British Columbia,
Vancouver, Canada

*Corresponding author: bolun.xie@alumni.ubc.ca

Abstract. In recent years, as cryptocurrency has been recognized by more people and the value of the cryptocurrency has increased, many people make money through mining. It leads to mining becoming popular but also creates serious environmental problems. Mining bitcoin will consume much electricity and thus emits more greenhouse gases such as carbon dioxide, which has caused worldwide environmental issues. This paper will focus on figuring out that mining bitcoin will cause how much carbon emission damage in China during these years. The result of this research will provide the change in carbon emission with time and the prediction of the carbon emission trend caused by bitcoin mining in the future. This result of the article aims to focus the society and the government's attention on the damage mining bitcoin does to the environment and also provide suggestions on the measures the governments should take to reduce the unessential energy cost of bitcoin mining.

Keywords: Bitcoin, Carbon emission, Bitcoin mining-related environmental problem

1. Introduction

With the fast development of the world, people have created new things. Over the years, people have been fascinated by blockchain. Cryptocurrencies have grown dramatically as a financial and investment instrument for blockchain in recent years. The value of some currencies has inflated many times. From 2016 to 2021, the price of bitcoin increased 112 times, while the price of Ethereum increased 498 times. As a result, many people regard cryptocurrencies as a quick way to get rich, fuelling a global mining boom [1].

Mining has become a popular topic around us. What is bitcoin? It is a new digital currency created by a person or persons under the pseudonym 'Satoshi Nakamoto' [2]. It is a decentralized electronic cash system that solves cryptographic problems by miners contributing their computing power to achieve the circulation and distribution of cryptocurrencies. How mining bitcoin forms is a process of packaging the new transactions of bitcoin and adding the transaction record into the bitcoin public ledger. Because every user can package and verify their transaction in the bitcoin network. The ledger is also called blockchain in the trade. The total number of bitcoins is 21 million. Miners can earn a set quantity of bitcoin through mining.

Mining uses computer computing power to achieve recording and keeping service. Miners maintain the blockchain's consistency, completeness, and immutability by regularly collecting newly broadcast transactions into a block, which is subsequently broadcast to the specified network and validated by recipient nodes. Each block contains the previous block's SHA-256 cryptographic hash, which connects them and gives the blockchain its name.

A mining pool will frequently pool computing power to decrease miner profits variability. Individual mining rigs usually need to wait extended periods of time to confirm transactions of blocks and receive payment. All participating miners should be compensated whenever a participating server finishes the calculation of a block in a pool. This reward is based on how much work each miner contributed to the discovery of that block.

At first, miners used the CPU to do the mining job with the increasing difficulty of mining bitcoin. Miner tried to use GPU to do the calculation of mining the bitcoin. The increase in the bitcoin price boost miners to use better and stronger equipment to participate in the mining. As the price of bitcoin

has risen dramatically in recent years, there is an increasing number of people engaged in bitcoin mining, and professional miners and mining tools are also growing more prominent. Up until now, bitcoins have an overall price of over \$157.7 billion, and the daily capacity is \$8.9 billion [3]. Figure 1 provides detailed information on the changing market price of bitcoin, hash rate, BTC from mining, and the difficulty of mining from 2017 to 2020. It tells us that when the bitcoin price is at its peak, more people are willing to join this mining activity. Furthermore, over the last two years, the energy consumed by bitcoin mining has surged from 4.8 TWh (Terrawatt hours) to 73.12 TWh [4]. Annual carbon dioxide emissions from the bitcoin system are around 22 and 22.9 Mt [5].

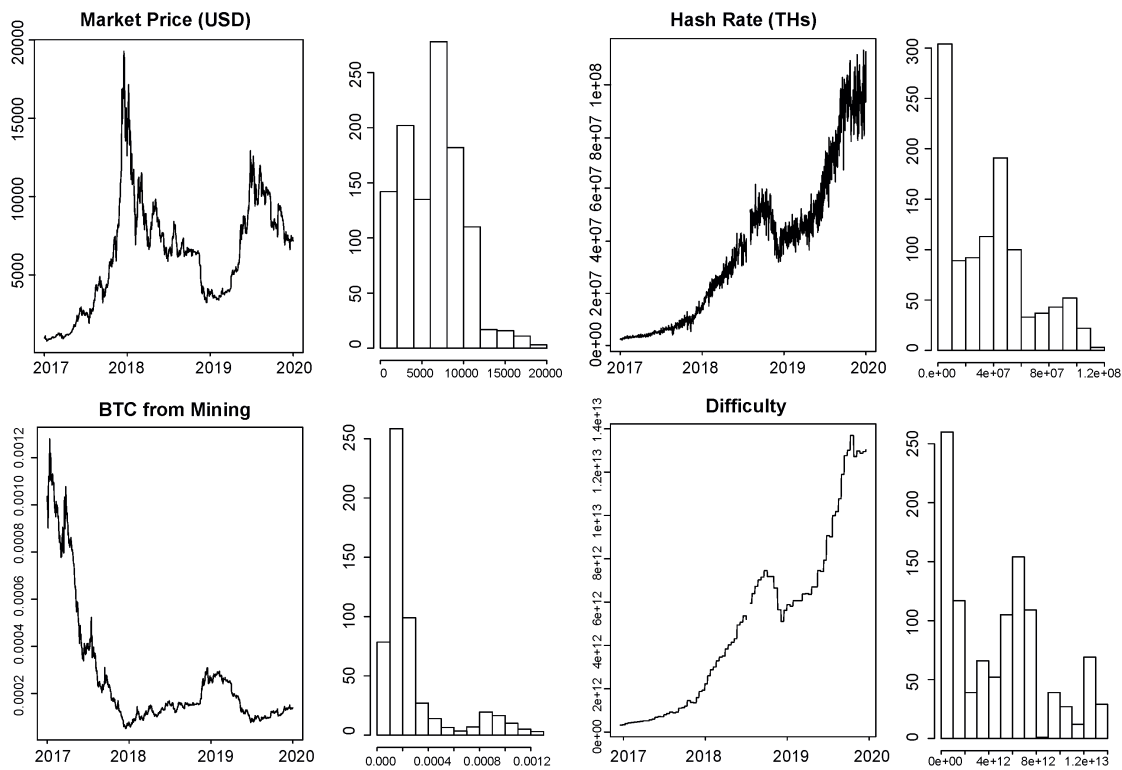


Figure 1. Neural network structure [6]

Moreover, bitcoin's power consumption may be just one tiny part of the whole blockchain. Including estimates for the other three cryptocurrencies, the annual assessment for bitcoin has increased by 30 TWh. The additional 618 coins might potentially add more than 40 TWh of electricity demand if it is assumed that only minable coins are considered. The above finding proves that the energy consumption of bitcoin power is even more than doubled. Bitcoin would definitely continue to be the greatest energy consumer on public blockchain systems, consuming a significant amount of energy.

Increasing demand for cryptocurrencies will bring immeasurable consumption. If the electricity supply is not renewable, this high usage will raise emissions. This is an environmental concern as China relies heavily on coal and natural gas-based electrical generation, which emits far more pollution than alternative energy sources. Over the last decade, cryptocurrency has emerged as a crucial technological innovation and has become a widespread financial vehicle. However, mining these coins consumes a significant amount of electricity, and there are growing environmental concerns. China is heavily influenced by the interaction between the environment and cryptocurrencies because China's electricity generation primarily relies on coal and natural gas, and its maximal computing capacity needs a large amount of electricity.

2. Electricity consumption and carbon emission analysis

However, the increasing power demand and carbon emissions linked with bitcoin mining may threaten global sustainability. It is vital to consider the harm produced by bitcoin mining. With the rise in the value of bitcoin, the annual electricity usage of bitcoin mining has climbed dramatically in recent years, and global carbon emissions from mining now likely exceed those of individual wealthy countries. In 2024, the annual energy consumption of the bitcoin blockchain in China is expected to reach its peak - 296.59 Twh, which will release 130.50 million metric tonnes of carbon dioxide into the atmosphere [7]. Moreover, more electricity used is estimated to bring more carbon emissions. Excessive mining will have a negative impact on considerable social and economic benefits if more sustainable development of prospective blockchain applications is not promoted. So this paper will try to figure out how much carbon emission will be produced during the bitcoin mining in Xinjiang in China.

One article shows that Inner Mongolia, China, shares 12.3% mining and 26.2% contribution to the carbon footprint. Xinjiang, China, shares 10.7% mining and 16.5% contribution to the carbon footprint. Sichuan, China, shares 30.5% mining and 4.6% contribution to the carbon footprint. Sichuan has a low carbon footprint because of fewer carbon-intensive energy blends in these locations [8]. The four largest mining pools can provide about half of the total hash rate for bitcoin calculation. Figure 2 depicts the distribution of the total hash rate in China, and it shows where the production capacity is high and low.

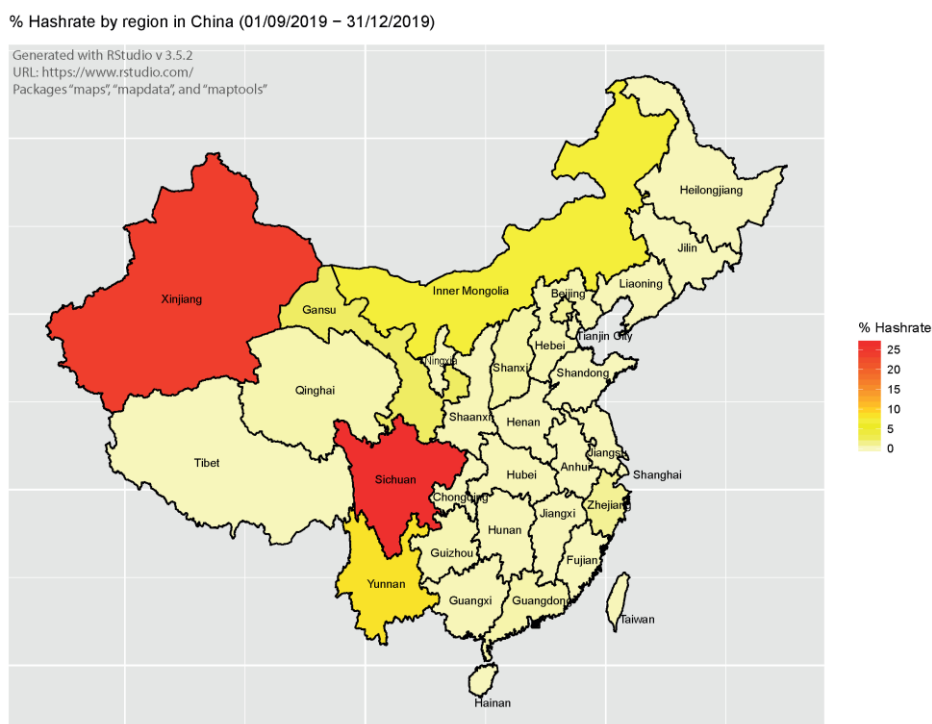


Figure 2. Hash rate distribution in China [6]

According to the Cambridge Centre for Alternative Finance (CCAF) data, by 2022, bitcoin will consume 131 TWh per year or 0.29% of global energy production. According to CCAF, the majority of bitcoin mining will take place in China until 2021. Chinese miners in Xinjiang relied on cheap coal electricity throughout the late fall, winter, and spring, as well as from May to October. China has already banned bitcoin mining in June 2021. Regarding The New York Times, bitcoin's utilization of renewable energy ranges from about 40% to 75% as of September 2021. The rate of loss in clean resources could be significant in the short term. Hydropower generates over 80% of the electricity generated in Yunnan and Sichuan provinces in Southwest China. 22 Yunnan lowered hydropower by 31.2 TWh in 2016, accounting for 11.6% of total electricity produced in the province [9].

China has the characteristic that its energy is very cheap, so mining costs are meager. These advantages have led many people to prefer China as their mining site. Furthermore, as of April 2020, China accounted for more than 75% of global bitcoin blockchain operations. Especially rural areas tend to be considered ideal for bitcoin mining, owing to lower energy costs and a huge amount of undeveloped space for pool construction [7].

As of 2016, due to a lack of precipitation, China's eastern and northern provinces primarily use coal-based energy for wind power in these mountainous areas. Almost 100% of electricity in Shanghai and Tianjin is generated by nonrenewable thermal power, while 90% is generated in Inner Mongolia and Xinjiang. On the opposite end of the scale, the provinces of Yunnan and Sichuan obtain 83% and 87% of their energy from hydropower. Correspondingly, with surplus hydropower during the rainy season, Tibet gets 97% of its electricity through clean energy, while Qinghai is the greatest solar-producing province [6].

3. Future harms of unbounded bitcoin mining

According to the Paris Agreement. However, based on the BBCE model simulation results, the carbon emission from the bitcoin blockchain can be a potential obstacle for China in meeting its greenhouse emission reduction objective if the government does not intervene. Bitcoin mining would be the 10th greatest emitter among China's 42 major industrial sectors, accounting for approximately 5.41% of China's electricity generation emissions. China is committed to reducing carbon emissions per GDP by 60% by 2030 compared to 2005 levels. To fulfill the goal of the Paris Agreement and protect the world, governments must strike a balance between bitcoin mining and the environment around the world, as well as pass legislation to avoid environmental degradation.

Global environmental warming is an important issue of concern worldwide. At the same time, blockchain technology is becoming popular with the continuous advancement of technology, and it is a matter of the participation of thousands of miners, which leads to the misuse of electricity and the growth of carbon dioxide emissions. According to analysis, if its adoption rate follows that of widely used technologies, the global average temperature may increase by 2 °C in just a few decades [10]. It may cause many serious problems, such as decreasing the habitats of species, rising sea surface levels, and so on.

4. Implications

This research highlights the relationship between mining bitcoin and carbon emissions. The vast carbon emission caused by bitcoin mining in Xinjiang province is presented, offering a clear image of the negative effect of bitcoin mining on the surrounding environment. Furthermore, using the regression line, researchers may forecast future carbon dioxide emissions in Xinjiang driven by bitcoin mining. The example of detrimental consequences of the Xinjiang Province can let the government know they should implement or enact some policies to limit mining to protect the environment. Keep the world in a state of sustainability. Furthermore, the researcher's formula can not only be suitable for Xinjiang Province if the data of other cities are accessible. Researchers can apply the data to calculate the carbon emission in another place. So it can help us to predict the whole world's carbon emissions caused by mining bitcoin.

The Chinese government implemented a series of "energy conservation and emission reduction" laws prohibiting bitcoin mining from April 2020 until October 2020. According to the most recent data, China's bitcoin computer capacity has been cleared. In contrast, the proportion of bitcoin computing power in the United States and Kazakhstan has significantly increased since July [1]. China's prohibition on cryptocurrency mining, an energy-intensive activity, undeniably benefits the global environment. On the other hand, profit-seeking miners may migrate to locations with "dirtier" power systems, negating the Chinese government's environmental efforts. According to the findings of this study, reasonable mining unions are more likely to pick Central Asian countries to continue

mining after China banned cryptocurrency. The transfer of mining farms after China prohibits cryptocurrencies will result in a -0.2% to 4.4% shift in carbon emissions from the global cryptocurrency industry in 2020, according to the two models given in this study. This is something that researchers have never considered [1].

5. Conclusions

This research focuses on the environmental consequences and issues that bitcoin faces. In general, this research provides insights into the environmental issues that bitcoin mining and trading have caused in China, raising awareness about the harms of bitcoin mining and giving recommendations on green solutions. People should be concerned about sustainability issues and the mining process's environmental impact. The carbon footprint left by cryptocurrencies should cause governments to consider externalities. As the Chinese government has taken action to ban bitcoin trading and mining, there will be fewer markets for bitcoin in China, which is beneficial to promote carbon neutralization. However, with the migration of bitcoin mining to other countries, regulatory intervention regarding the electricity sources for bitcoin mining may be necessary.

References

- [1] Sang X, Leng X, Xue L, et al. Based on the Time-Spatial Power-Based Cryptocurrency Miner Driving Force Model, Establish a Global CO₂ Emission Prediction Framework after China Bans Cryptocurrency[J]. Sustainability, 2022, 14(9): 5332.
- [2] Badea L, Mungiu-Pupăzan M C. The economic and environmental impact of bitcoin[J]. IEEE Access, 2021, 9: 48091-48104.
- [3] Li J, Li N, Peng J, et al. Energy consumption of cryptocurrency mining: A study of electricity consumption in mining cryptocurrencies[J]. Energy, 2019, 168: 160-168.
- [4] Corbet S, Lucey B, Yarovaya L. Bitcoin-energy markets interrelationships-New evidence[J]. Resources Policy, 2021, 70: 101916.
- [5] Mnif E, Lacombe I, Jarboui A. Users' perception toward Bitcoin Green with big data analytics[J]. Society and Business Review, 2021.
- [6] Calvo-Pardo H F, Mancini T, Olmo J. Machine learning the carbon footprint of bitcoin mining[J]. Journal of Risk and Financial Management, 2022, 15(2): 71.
- [7] Jiang S, Li Y, Lu Q, et al. Policy assessments for the carbon emission flows and sustainability of Bitcoin blockchain operation in China[J]. Nature communications, 2021, 12(1): 1-10.
- [8] Köhler S, Pizzol M. Life cycle assessment of bitcoin mining[J]. Environmental science & technology, 2019, 53(23): 13598-13606.
- [9] Stoll C, Klaaßen L, Gallersdörfer U. The carbon footprint of bitcoin[J]. Joule, 2019, 3(7): 1647-1661.
- [10] Mora C, Rollins R L, Taladay K, et al. Bitcoin emissions alone could push global warming above 2 C[J]. Nature Climate Change, 2018, 8(11): 931-933.