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Environmental Impact of Cryptocurrencies

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Sustainability 310: Methods/Tools in Sustainability

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Contents

Thesis

The mainstream use of cryptocurrencies has had many environmental impacts. Cryptocurrency mining consumes significant amounts of energy and generates greenhouse gas emissions, increasing the carbon footprint. Sustainability Development Goals (SDG) 7- Affordable and Clean Energy and SDG 13- Climate Action have been impacted by cryptocurrencies and cryptocurrency mining.

Abstract

Cryptocurrencies have grown and evolved. Since its debut in 2009, the demand for cryptocurrencies has dramatically risen. The emerging technology of Bitcoin and other competitive cryptocurrencies has become significant in the investment world. Since cryptocurrencies are decentralized, they offer new ways to handle digital assets that differ from traditional banking institutions. While the values of cryptocurrencies fluctuate every day, environmental concerns are rising. Cryptocurrency mining is highly energy-intensive, resulting in an increase in carbon emissions and climate change. Bitcoin's carbon footprint has grown tremendously, and due to its rising popularity, this industry must adopt sustainable solutions. While there are many pros and cons to cryptocurrencies, two Sustainable Development Goals (SDG) will be referenced in this paper: Affordable and Clean Energy and Climate Action. SDG 7, affordable and clean energy, is impacted by increased energy use and consumption. SDG 13, climate action, is impacted by its greenhouse gas emissions. This paper will examine the effects of cryptocurrency mining on the environment, evaluate the popularity of cryptocurrencies within South Carolina, Georgetown County, and research potential worldwide solutions.

Literature Review

Much of the literature on this issue agrees that cryptocurrency has impacted the environment. Each transaction within a blockchain consumes a certain amount of energy. Some currencies require larger amounts of energy than others. Bitcoin, for example, is one of the leading consumers of energy. A representative example is the article, *Is Cryptocurrency Bad for the Environment*, by Gerardo Bandera. According to Bandera, it is estimated that 2100 kilowatt-hours (kWh) are used for each Bitcoin transaction[1]. Put simply, it is equivalent to what an average household consumes in 75 days. Each year, Bitcoin uses 91 terawatt-hours (tWh) equaling about 0.5% of the world's electricity consumption. That is seven times more than what Google consumes and is more than all the electricity used by Finland.[1] According to the school of thought represented by Bandera, cryptocurrency is detrimental to the environment.

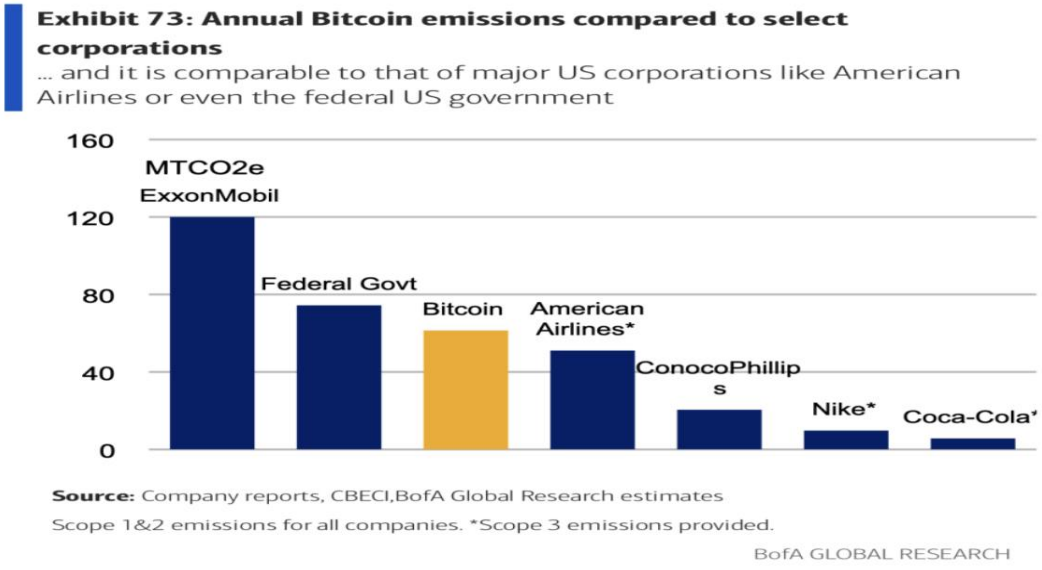
In this context, on January 20, 2022, the House Committee on Energy and Commerce held a hearing to examine the environmental and energy impacts of cryptocurrency mining. It was concluded that the amount of energy needed to hash Ethereum's blockchain, the world's second-leading cryptocurrency, could power a United States (US) home for more than a week, and the amount needed to power Bitcoin could power a US home for over 70 days.[2] In 2021, it was estimated that Bitcoin and Ethereum combined emitted over 78 million tons of CO2 which is equal to 15.5 million car tailpipe emissions annually.[2] The literature published by the House Committee

[1] Bandera, Gerardo. "Is Cryptocurrency Bad for the Environment?" FairPlanet, January 27, 2022. https://www.fairplanet.org/story/is-cryptocurrency-bad-for-the-environment/.

[2] "Key House Panel to Review Cryptocurrency's Environmental Impact." Congresswoman Diana DeGette, January 19, 2022. https://degette.house.gov/media-center/press-releases/key-house-panel-to-review-cryptocurrency-s-environmental-impact.

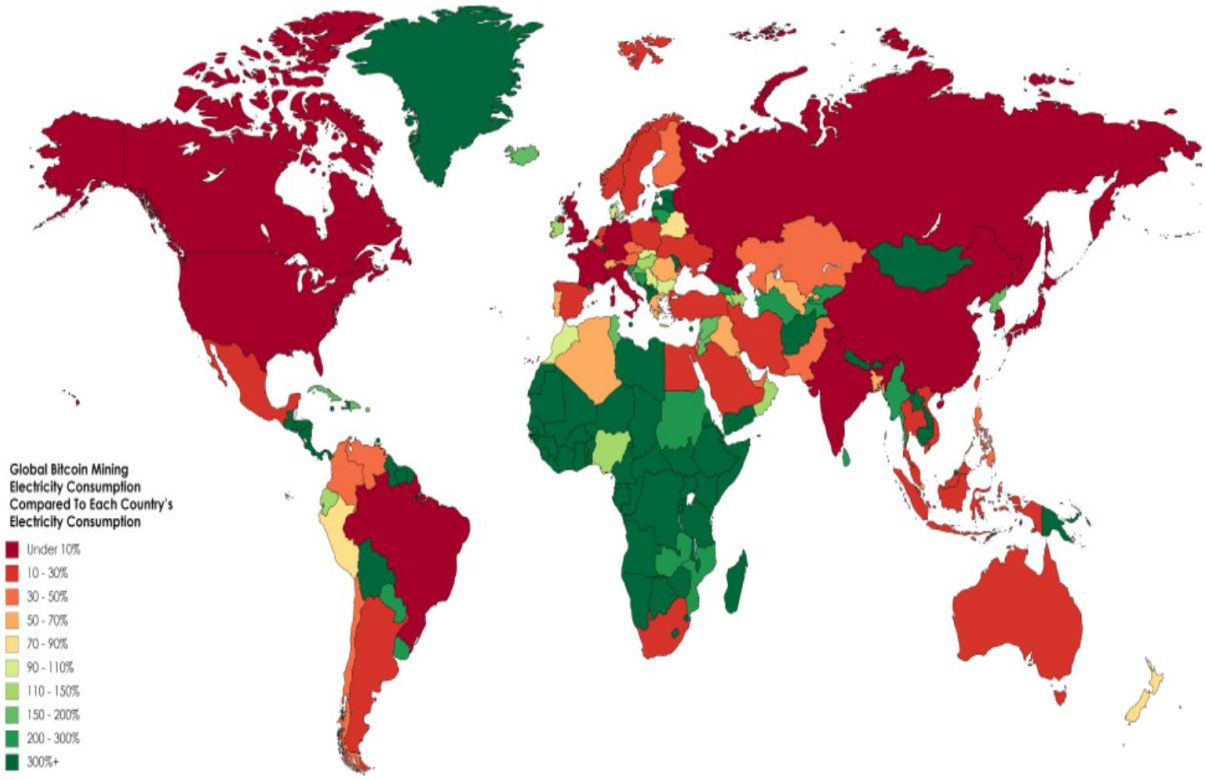
on Energy and Commerce follows the school of thought that cryptocurrency negatively impacts the environment.

Elon Musk, investor, and CEO of Tesla, used to allow people to purchase Tesla's using the cryptocurrency, Bitcoin. However, in May of 2021, they suspended the action due to environmental concerns and public backlash.[3] Sophia Mellor noted that critics voiced the hypocrisy of the eco-friendly vehicle accepting energy-intensive payments. Musk stated, "We are concerned about rapidly increasing use of fossil fuels for Bitcoin mining and transactions…Cryptocurrency is a good idea on many levels, and we believe it has a promising future, but this cannot come at great cost to the environment." Following his statement, BofA Securities, the wealth management division of Bank of America, calculated the annual number of emissions compared to large corporations. [3] The report found that Bitcoin emits more carbon emissions than American Airlines, one of the largest airlines in the world.[3]



[3] Mellor, Sophie. "Elon Musk Is Right: Bitcoin Mining Is Bad for the Planet." Fortune. Fortune, May 13, 2021. https://fortune.com/2021/05/13/musk-bitcoin-mining-bad-planet-heres-how-bad/.

About 80% of all global energy consumption is through fossil fuels.[4] When fossil fuels are burned, high numbers of CO2 are released which causes climate change. Bitcoin's energy consumption has reached an all-time high and requires more energy than what most countries consume.[4] According to Wang *et al.*, although cryptocurrencies have many advantages, the world needs to assess the environmental impacts, such as high energy consumption, air pollution, and climate change.[5] There are many sustainability concerns, and the data is essential for policy makers around the globe and investors that are worried with ethical implications of their investment choices.[5]



[4] DİLEK, Şerif, and Yunus FURUNCU. "Bitcoin Mining and Its Environmental Effects." *Journal of Economics and Administrative Sciences* 33, no. 1 (July 2, 2019): 91–106.

[5] Wang, Yizhi and Lucey, Brian M. and Vigne, Samuel and Yarovaya, Larisa, An Index of Cryptocurrency Environmental Attention (ICEA) (June 14, 2021). Available at SSRN: https://ssrn.com/abstract=3866535 or http://dx.doi.org/10.2139/ssrn.3866535

Empirical Data

A study was conducted in January 2022 by Sinan Erdogan, Maruf Ahmed, and Samuel Sarkodie to analyze the effects of cryptocurrency demand on environmental sustainability. Cryptocurrency mining for coins such as Ethereum, Bitcoin, Litecoin, and Monero is likely associated with 3 to 5 million tons of global carbon emissions.[6] The empirical evidence implies that over 13 million metric tons of carbon emissions are tied to the cryptocurrency Bitcoin alone. China is home to large cryptocurrency mines.[6] It is one of the world's leading cryptocurrency miners and is estimated to reach 296.59 tWh and 130.50 million tons of carbon emissions by 2024.[6] Since the currencies are unregulated and have no institutional framework, transactions can be made at low costs with no added tax. The study indicated that due to this, transactions may increase over time which will lead to more energy consumption with long-term implications.[6]

According to data from SlushPool, there are almost 200,000 active Bitcoin miners.[7] That is roughly 563,328 kWh a day and 205,615,000 kWh per year in electricity consumption.[6] This means that each Bitcoin miner emits almost 0.406 metric tons a year in carbon emissions per capita, equal to 8.92% of global average carbon emissions per capita.[6] CoinMarketCap also reports

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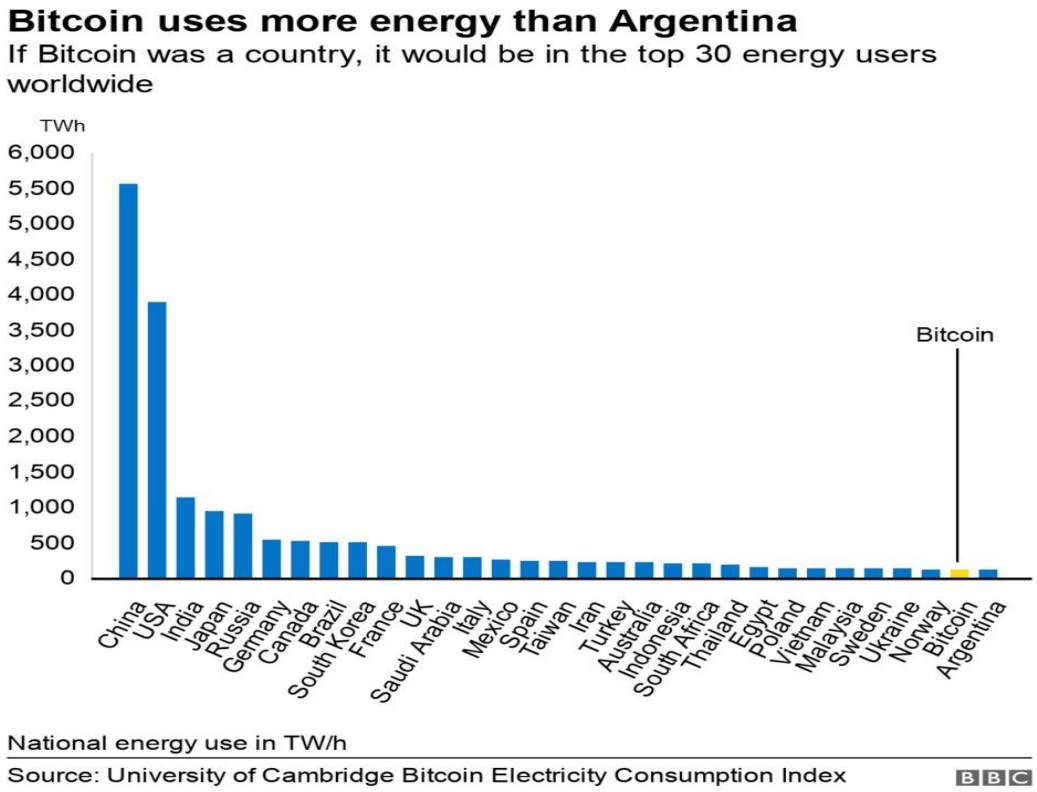
[6] Erdogan, Sinan, Maruf Yakubu Ahmed, and Samuel Asumadu Sarkodie. "Analyzing Asymmetric Effects of Cryptocurrency Demand on Environmental Sustainability - Environmental Science and Pollution Research." SpringerLink. Springer Berlin Heidelberg, January 11, 2022. https://link.springer.com/article/10.1007/s11356-021-17998-y.

[7] "Slush Pool: Pool Statistics." slushpool.com. Accessed April 19, 2022. https://slushpool.com/en/stats/btc/.

almost19,000 different cryptocurrencies in distribution; thus, carbon emissions released by cryptocurrency mining activities and transactions may significantly increase.[8]

The University of Cambridge conducted an analysis that estimated Bitcoin mining consumes over 121.36 tWh annually[9]. In comparison, that is more than the consumption by Google, Apple, Facebook, and Microsoft combined and the entirety of Argentina[9]. The University of Cambridge also predicts that this number is unlikely to fall, and it is equivalent to powering all the kettles within the UK for 27 years[9].



[8] "All Cryptocurrencies." CoinMarketCap. Accessed April 19, 2022. https://coinmarketcap.com/all/views/all/.

[9] Criddle, Cristina. "Bitcoin Consumes 'More Electricity than Argentina'." BBC News. BBC, February 10, 2021. https://www.bbc.com/news/technology-56012952.

South Carolina

A New York company, Greenidge Generation, announced in July 2021 that they intend to open a cryptocurrency mining operation facility in Spartanburg, South Carolina. The company signed a 10-year lease at a former LSC printing plant and officially plans to start operations in 2022[10]. Although Bitcoin mining requires much energy, Greenidge Generation announced in 2021 that it would become fully carbon neutral. The company stated that two-thirds of its electricity is sourced from zero-carbon sources—for example, it plans to use nuclear power and solar energy[10]. Greenidge also plans to invest a portion of mining profits into renewable energy projects. South Carolina Governor, Henry McMaster, stated, "South Carolina is transforming into a hub for tech-focused companies, and we welcome Greenidge Generation to our growing roster of innovative companies. The company's $264 million investment and the 40 skilled jobs they are creating will make a tremendous impact in Spartanburg County and beyond.[10]"

Litchain Corporation, a company that offers mining centers, cryptocurrency education, and blockchain consulting services, announced in January 2022 that it will be investing $80 million and leasing property in Gaffney, South Carolina for cryptocurrency mining operations[11]. CEO and Founder, Tony Tate, states that the business will bring jobs but does not address any environmental

[10] Montgomery, Bob. "Ny Bitcoin Company Plans to 'Mine' at Spartanburg's Former LSC Communications Plant." Spartanburg Herald Journal. Herald-Journal, October 6, 2021. https://www.goupstate.com/story/news/local/2021/10/06/greenidge-lsc-communications-plant-mine-bitcoin-spartanburg-sc/5831242001/.

[11] Montgomery, Bob. "Easley Native to Open Litchain Corp., Bitcoin Mining Operation in Gaffney." Spartanburg Herald Journal. Herald-Journal, January 24, 2022. https://www.goupstate.com/story/news/local/2022/01/24/bitcoin-mining-operation-opens-gaffney-cryptocurrency-south-carolina/9076616002/.

concern[11]. Gerald Dwyer, economics professor at Clemson University stated in a recent interview about the project:

> "Cryptocurrency mining operations are an important part of the operation of bitcoin and most other cryptocurrencies. Mining operations use large groups of dedicated computers to try to solve a numerical problem, which is part of verifying new blocks of transactions. These mining operations use relatively knowledgeable employees who are well paid. Having these mining operations here can be a distinct benefit to the employed workers and help to increase South Carolina's involvement in new advanced technology."[12]

There is a large argument on whether these operations will be beneficial in the long run. Joey Von Nessen, research economist from the University of South Carolina's Darla Moore School of Business, believes there is more risk involved. He stated:

> "These mining businesses are responding to an opportunity in a market that has come into existence. There is room for a company to be successful in this space. However, cryptocurrency is a new phenomenon in recent years without a long-term track record. Whether it will be long term is impossible to know. South Carolina has lower energy costs and there is greater land availability in the southeast. That may be one reason why we've seen several start up in South Carolina. It does rely on consumer perception as a driver of its value. It's hard to predict its value. Like any type of investment, an individual has to make an informed decision."[12]

Although these operations may create more jobs, local and state leaders must consider potential environmental impacts. Many organizations around the world are implementing sustainability goals. However, with technology rapidly changing and evolving, so are potential environmental impacts. For example, when data is not secure, it may threaten the sustainable plans. Malware may also have the dangerous potential to affect the environment.

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[12] Marinoff, Nick. "Litchain Crypto Mining Company Opens in South Carolina." Live Bitcoin News, January 24, 2022. https://www.livebitcoinnews.com/litchain-crypto-mining-company-opens-in-south-carolina/.

Georgetown County

In January 2021, Georgetown County suffered a significant infrastructure breach in which criminals asked for cryptocurrency in return for ransom. The attack shut down technology from Wi-Fi to emails. In addition, the ransomware locked up computer systems and encrypted the files. Instead of paying the ransom, Georgetown County's IT department rebuilt the entire network. Although ransom attacks do not impact the environment directly, the breach of data could potentially harm the environment. For example, consider a ransomware attack on an industrial facility, but the hacker is using the same computer system to retaliate for a late ransom payment. Retaliation could include releasing hazardous chemicals that risk the loss of life or causes pollution to the environment.

There are currently three cryptocurrency ATMs in Georgetown County.[13] Although there is not a significant presence of cryptocurrency users or miners in the county, the understanding and knowledge of it are growing. Georgetown County has advertised a virtual event called "So You Want to Invest in Cryptocurrency." This online event includes information on the history of cryptocurrency, reliable sources of information, where/how to buy it, the explanation of the decentralized exchanges, how mining works, taxing and banking options, how to avoid scams, and the awareness of security issues.[14] The informational session also advertises that at the end of the teaching, you will be ready to set-up a wallet and start trading.[14]

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[13] "Bitcoin ATM Map." Accessed April 25, 2022. https://coinatmradar.com/bitcoin-atm-map/.

[14] "Calendar." WBTW, June 10, 2019. https://www.wbtw.com/community/calendar/?_escaped_fragment_=%2Fshow%2F%3Fser#!/details/So-You-Want-to-Invest-in-Cryptocurrency/8928566/2021-03-31T18.

Analysis

There are five power plants located within Georgetown County and three electricity companies. The five power plants are Georgetown Lfgte, Georgetown Lfgte Main Facility, International Paper Georgetown Mill, Santee Cooper's Winyah Generating Station, and Winyah Main Facility. These power plants provide power to 61,065 people within 814 square miles, and the primary fuel source is coal and black liquor.[15] In total, the county emits 980,044,525 kilograms of CO2 emissions and is ranked 1st out of the 46 counties as the worst for pollution per capita.[16]

The three electricity companies are Santee Cooper, Duke Energy, and Santee Electric Cooperative. The largest electricity company within the county is Santee Cooper.[16] While most of the counties in South Carolina are attempting to decrease non-renewable fuel types, Georgetown County has increased the use by 34.18% in 2021.[16] The county's average rate of residential electricity use is 10.34 cents per kWh.[16] In comparison, this is, fortunately, lower than the national average. The city of Georgetown's electricity consumption totals 34,451,465 kilograms in CO2 emissions, which ranks 70th out of 475 cities within the state.[16]

Currently, Georgetown County is deciding if the Georgetown Liberty Steel Mill will continue operations. When looking at the development from upstate South Carolina of cryptocurrency mining operations, the idea of moving to Georgetown County came to mind. Since Greenidge Generation took over an abandoned printing plant in Spartanburg, it is moderately likely

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[15] "Power Plants - Georgetown County, SC (Power Stations & Utilities)." County Office. Accessed April 25, 2022. https://www.countyoffice.org/sc-georgetown-county-power-plant/.

[16] Hope, Matt. "Georgetown County, SC: 3 Electric Providers." Find Energy. Find Energy, April 17, 2022. https://findenergy.com/sc/georgetown-county-electricity/.

that this could happen within Georgetown County. Although Georgetown County ranks high in energy pollution, there are currently no cryptocurrency policies, and the steel mill could attract operations due to the large facility.

Greenidge Generation seems it is making a beneficial move in becoming carbon neutral. It may be possible for companies to run mining operations on renewable energy, but e-waste problems will remain. Although the idea sounds great, the power plants from Greenidge consume significant amounts of water. These power plants use 139 million gallons of freshwater to cool their systems.[17] It consumes the water and releases it back into their water source. When discharging the water, it is 30 to 50 degrees warmer than when extracted.[17] This could potentially result in warmer water temperatures, killing wildlife, and endangering ecology.

SDG 7 Clean and Affordable Energy is affected by cryptocurrencies and cryptocurrency mining because it consumes enormous amounts of energy. The goal of affordable and clean energy is to become more sustainable, and cryptocurrency mining needs to be reduced and should seek alternative consumption methods. SDG 13, Climate Action, is affected by cryptocurrencies due to greenhouse and carbon emissions. The extent of environmental effects continues to threaten the progress made by these UN SDGs to create clean and safe renewable energy and take action to combat climate change.

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[17] Cho, Renee. “Bitcoin's Impacts on Climate and the Environment.” State of the Planet, September 16, 2021. https://news.climate.columbia.edu/2021/09/20/bitcoins-impacts-on-climate-and-the-environment/.

Conclusion/Recommendations

To reduce carbon and greenhouse emissions, eco-friendly cryptocurrencies could be developed. Rather than cryptocurrency mining, a proof-of-space approach could benefit the environment. For example, instead of large processors and warehouses of computers, proof-of-space mining is powered by smaller hard discs and has shorter blockchains.[18] This process consumes smaller amounts of electricity and can be mined from a laptop or small computer. [18]

More policies should be put in place at the state level and local levels to prevent a significant impact on the environment. For example, cryptocurrency mining operations should only be allowed if they stay below a certain number of carbon and greenhouse emissions. Although policymakers and still exploring the emerging technology, the statistics show the effects of mining on our environment. Although not all cryptocurrencies are bad for the environment, regulating and monitoring the larger ones could prevent them from getting worse. For example, Bitcoin and Ethereum have longer blockchains which require more energy.

Overall, cryptocurrency mining impacts SDG 7 and SDG 13. Since cryptocurrencies can be major investments, many people across the globe profit from them. Financial gain is a prominent goal and as popularity rises, so do environmental concerns. As a result, the carbon footprint produced by cryptocurrencies is increasing, and more attention needs to be brought to the issue.

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[18] "Eco-Friendly Cryptocurrencies: Everything You Need to Know." Times Money Mentor. Accessed April 25, 2022. https://www.thetimes.co.uk/money-mentor/article/eco-friendly-cryptocurrencies/#Is-there-an-environmentally-friendly-crypto?

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