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Tragedy of the Energy Commons: How Government Regulation Can Help Mitigate the Environmental and Public Health Consequences of Cryptocurrency Mining

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I. INTRODUCTION

A. The Tragedy of the Commons

Economic theory has long recognized the problems that arise when individuals in a society have free and unlimited access to a common resource. In 1832, William Foster Lloyd first identified and explained what would later be termed the "tragedy of the commons"[1] in his "Two Lectures on the Checks to Population," in which he described the problem of cattle herders in England sharing a common parcel of land on which they were each entitled to let their cows graze.[2] According to Lloyd's theory, each herder could receive an added benefit by letting additional cattle graze on the common pasture while the whole group of herders shared in the resulting damage to the pasture.[3] Lloyd states, "if he puts more cattle on a common, the food which they consume forms a deduction which is shared between all the cattle, as well that of others as his own, in proportion to their number, and only a small part of it is taken from his own cattle."[4] Elaborating upon Lloyd's theory, Garrett Hardin declared,

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[1] *See generally* William Foster Lloyd, *W.F. Lloyd on the Checks to Population*, 6 POPULATION AND DEV. REV. 473 (1980); W.F. LLOYD, TWO LECTURES ON THE CHECKS TO POPULATION (The University of Oxford 1832), https://philosophy.lander.edu/intro/articles/lloyd_commons.pdf [https://perma.cc/E797-ADEH].

[2] Lloyd, *supra* note 1, at 483.

[3] *Id*.

[4] *Id*.

> [T]he rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another.... But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all.[5]

Ultimately, these two economic scholars conclude that a common resource available and accessible to all leads people to pursue their own self-interest without regard for the damage and costs imposed on the greater community.

Much like the herdsman in England, a similar issue is emerging in local communities throughout the world when cryptocurrency miners use cheap energy and public utility infrastructure to pursue economic self-interest at the expense of the local communities in which they operate. If cryptocurrency miners have no incentive to invest in the energy resources they utilize and can simply move from one cheap energy source to another, then the economic, environmental, and public health deterioration in the local communities that provide this cheap power will continue. To solve this problem, federal and state legislators and regulators must work together to create a systematic and uniform regulatory scheme to control the enormous energy use by cryptocurrency miners. Otherwise, much like William Foster Lloyd argued, the invisible hand of the free market will fail when it comes to private actors utilizing common resources.

B. A Case Study About the Problem

A recent example from the Mid-Columbia River Basin in Eastern Washington provides a poignant case study on the effects of cryptocurrency mining on local communities, public utility infrastructure, and the environment. This case study is important because it highlights the tangible effects of a process that is often seen as existing only in cyber-space. This region of the country is particularly attractive to cryptocurrency miners because the Columbia River provides a nearly limitless energy source.

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[5] Garret Hardin, *The Tragedy of the Commons*, SCI. MAG., Dec. 13, 1968, at 1244, https://science.sciencemag.org/content/sci/162/3859/1243.full.pdf [https://perma.cc/34LY-ZA4N].

For example, the city of East Wenatchee, Washington, sits along five hydro-electric dams that straddle the Columbia River.[6] These dams provide an enormous amount of energy for the city and region.[7] As a result, energy from these dams is readily available, cheap, and easy to abuse by cryptocurrency miners.

Initially, mining for cryptocurrencies did not require as much power as it does now. Mining one Bitcoin required roughly 1200 watts of electricity, which is the equivalent of the amount of energy required to power a hairdryer or microwave.[8] At this rate, miners could spend roughly two dollars to mine one bitcoin worth twelve dollars.[9] This extremely profitable return on investment, combined with Bitcoin's skyrocketing price, incentivized miners to find cheaper and cheaper power sources to run their mines.[10] Thus, miners began to turn their attention to the Mid-Columbia River Basin, where electricity was available for about two-and-a-half cents per kilowatt.[11] Comparatively, this price is about a quarter of the price of electricity in Seattle, which is the closest urban center.[12] The five hydro-electric dams generate nearly six times the amount of energy used by the region's residents.[13] Before the mining craze took off in the early part of 2017, local public utility companies exported surplus energy to urban regions like Seattle and Los Angeles, allowing utility companies to sell power locally at well below its cost of production.[14] Given this incredibly cheap and plentiful source of power, miners began to flock to the region at a quicker pace, renting out old warehouses and abandoned business in order to set up shop.[15]

By 2014, the energy use in East Wenatchee was skyrocketing—the regional public utility companies received requests from current and potential miners for a total of 220 megawatts of power.[16] This request was larger than the amount of energy used by the region's 70,000 residents.[17] Furthermore, by the end of 2017, when the price of bitcoin hit all-time

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[6] Paul Roberts, *This Is What Happens When Bitcoin Miners Take Over Your Town*, POLITICO MAG. (Mar./Apr. 2018), https://www.politico.com/magazine/story/2018/03/09/bitcoin-mining-energy-prices-smalltown-feature-217230 [https://perma.cc/SSN9-QREV].
[7] *See Dams: history and purpose*, NORTHWEST POWER & CONSERVATION COUNCIL, https://www.nwcouncil.org/reports/columbia-river-history/damshistory [https://perma.cc/5YUW-F65C].
[8] Roberts, *supra* note 6.
[9] *Id.*
[10] *Id.*
[11] *Id.*
[12] *Id.*
[13] *Id.*
[14] *Id.*
[15] *Id.*
[16] *Id.*
[17] *Id.*

highs, the miners coming into the region were no longer interested in building five-megawatt mines; instead, they were building fifty-megawatt mines.[18] This development represented enough power for about 22,000 homes, which is more energy than an Amazon Web Services' data center uses.[19] The combination of cheap power, cheap space, and rising prices of Bitcoin led to the creation of a mining Mecca that was drawing more and more people to the Mid-Columbia River Basin to exploit its resources for explosive economic gain.

This explosion of individual miners in the region had a disastrous effect on the public utility infrastructure. The local utility grid was not prepared for such an increase in use. The regional mining operations quickly overwhelmed the residential power grid, and, in one example, a miner overloaded a transformer and caused a brush fire.[20] Further, public utility resources were drained in order to hunt down miners who did not possess the requisite permits to operate cryptocurrency mines.[21] Combined, both individual and commercial miners drained the region's power at an alarming rate without realizing the grave consequences of their use or paying for the damage which they caused. The dams in the region currently yield about 3,000 megawatts, which is enough electricity to power Los Angeles; however, cryptocurrency mines now use roughly 70% of that output.[22] Considering that the region used to sell 80% of its output to other areas of the country, these mining operations have severely limited the energy that the region can sell to other municipalities to help offset the cost of energy for its residents.[23] Accordingly, in order to subsidize the growth in mining operations, the public utility companies will have to raise rates, build new infrastructure, and buy power from outside sources, all at the expense of local taxpayers.

C. Apparent Implications

The case study from the Columbia River Basin raises the specter that cryptocurrency miners, inadvertently or not, will exploit towns with access to cheap power for their own economic gain without imparting an equivalent benefit on the communities they exploit. Further, the considerable costs of mining operations will likely fall on the local taxpayers. To mitigate the effects that unregulated mining has on both the environment

[18] *Id.*
[19] *Id.*
[20] *Id.*
[21] *Id.*
[22] *Id.*
[23] *Id.*

and public health of local communities, the United States government needs to implement a federal regulatory scheme that seeks to internalize the external costs of mining activity to control the energy use required for the mining of cryptocurrencies. Crafting a federal regulatory scheme instead of multiple state regulatory schemes helps avoid the classic "race to the bottom" scenario that has seemingly plagued areas of the law such as corporate law, where one state, through lax regulatory, statutory, and judicial schemes, has created a more accommodating environment for large corporations.[24] Accordingly, if left to the states to regulate, states would simply compete with one another to be more attractive to miners, putting their own economic interest above the interests of their various communities. Furthermore, because the Securities and Exchange Commission (SEC) and other financial regulatory agencies have failed to adequately regulate bitcoin as a currency or commodity, this article proposes using environmental and public utility regulations to control the energy use of mining.

This article will first discuss how cryptocurrency mining works and why it is so energy-intensive. It will next analyze both the origins of this problem and the ongoing effects of cryptocurrency mining proliferation. Then this article considers the impact such energy use has on the environment, public utility infrastructure, and public health. Next, it examines and analyzes existing regulatory schemes in the United States as well as in individual states and localities currently regulating cryptocurrency transactions and mining. Additionally, this article evaluates and compares the current regulations in China and Iran. Finally, it will propose three distinct regulatory schemes of which cost internalization will best achieve the policy goal of decreasing the impact mining has on the environment, public health, and public utility infrastructure.

II. CRYPTOCURRENCIES EXPLAINED

In order to fully understand the impacts that cryptocurrency mining has on both the United States' public utility infrastructure and the environment, it is critical to define cryptocurrency mining and explain what it entails. The typical economic transaction involves using a credit or debit card for payment to a vendor. This type of payment uses a third party, often a bank, as a middleman to transmit monies from one account to another account. Inherently, such a transaction involves a significant amount of trust between both parties and the banks. Satoshi Nakamoto, the creator

[24] Mark J. Roe, *Delaware's Competition*, 117 HARV. L. REV. 588, 594-95 (2003) (discussing the evolution and significance of corporate law's race to the bottom).

of Bitcoin, inspired by the complex relationship among consumers, businesses, and banks, created "an electronic payment system based on cryptographic proof instead of trust."[25] Accordingly, a cryptocurrency is a peer-to-peer electronic payment system that removes the middleman from the equation.[26] However, without a third party to verify transactions, the problem of double-spending arises, whereby parties can spend the same amount twice because there is no authority debiting your account. Cryptocurrencies solve that problem by using the blockchain.

In its simplest form, a blockchain is a database shared across a network of computers.[27] This database underlies a cryptocurrency and serves as a public ledger for every transaction made via the specific cryptocurrency.[28] Each transaction is recorded in the blockchain; however, before the transaction can go through, it must be verified against the ledger to ensure its validity.[29] This process replaces the need for a third party to certify that there is no double-spending or fraud by any party involved in the transaction.[30] Cryptocurrency mining is this verification process. Because mining adds transaction records to the Bitcoin's public ledger, called the Blockchain, "it exists so that every transaction can be confirmed, and every single user of the network can access this ledger."[31] By competing with each other, miners serve the cryptocurrency community "by confirming every transaction and making sure that every single one of them is legitimate."[32] Miners, therefore, serve as the third party, verifying every transaction made via the cryptocurrency and adding that transaction to the blockchain, in exchange for a payment of the cryptocurrency.

Bitcoin, the first decentralized cryptocurrency, began operating in 2009; however, today, hundreds of cryptocurrencies are being traded as part of peer-to-peer transactions.[33] As of 2017, the current number of

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[25] SATOSHI NAKAMOTO, BITCOIN: A PEER-TO-PEER ELEC. CASH SYS. 1 (2008), https://bitcoin.org/bitcoin.pdf [https://perma.cc/VQ5S-YGD6].
[26] *Id.*
[27] Maryanne Murray, *Blockchain Explained*, REUTERS GRAPHICS (June 15, 2018), http://graphics.reuters.com/TECHNOLOGY-BLOCKCHAIN/010070P11GN/index.html#:~:targetText=A%20blockchain%20is%20a%20database,is%20very%20difficult%20to%20change.&targetText=The%20records%20that%20the%20network,previous%20block%20in%20the%20chain [https://perma.cc/S6UR-GA8D].
[28] GARRICK HILEMAN & MICHEL RAUCHS, Global Cryptocurrency Benchmarking Study 15 (2017), https://cdn.crowdfundinsider.com/wp-content/uploads/2017/04/Global-Cryptocurrency-Benchmarking-Study.pdf [https://perma.cc/AQ9M-ZKQB].
[29] *Id.*
[30] *Id.*
[31] *What is Bitcoin Mining*, COINTELEGRAPH, https://cointelegraph.com/bitcoin-for-beginners/what-is-mining#complications [https://perma.cc/C9V9-D5JA] [hereinafter "*What is Bitcoin Mining*?"].
[32] *Id.*
[33] HILEMAN & RAUCHS, *supra* note 28, at 15.

unique active users of cryptocurrencies worldwide is estimated to be between 2.9 million and 5.8 million.[34] This number has undoubtedly increased since then and will likely continue to increase as cryptocurrencies attract more users around the world. Even more staggering, from 2016 to 2017, the total cryptocurrency market capitalization nearly quadrupled from a mere $7 billion in 2016 to more than $27 billion in April 2017.[35] Moreover, in 2016, mining revenue eclipsed $2 billion worldwide,[36] while the industry employed nearly 2,000 full-time workers.[37] These statistics demonstrate how quickly the industry is growing and how big of a role the cryptocurrency industry will likely play in the future.

Miners must use computers to put every listed transaction through a highly complex mathematical formula that takes the information from a transaction and turns it into a much shorter series of letters and numbers, called a "hash."[38] At its core,

> The lack of a centrali[z]ed, trusted authority means that blockchain needs a 'consensus mechanism' to ensure trust across the network. In the case of bitcoin, consensus is achieved by a method called 'Proof-of-Work' (PoW), where computers on the network – 'miners' – compete with each other to solve a complex math puzzle. Each guess a miner makes at the solution is known as a 'hash,' while the number of guesses taken by the miner each second is known as its 'hashrate.' Once the puzzle is solved, the latest 'block' of transactions is approved and added to the 'chain' of transactions.39

To secure the information, each "hash" includes information from the previous block, and all "hash" sequences are the same length.[40] Further, if someone attempts to erase information from a block of transactions in order to use those bitcoins again, i.e., counterfeiting, the "hash" sequence will immediately change.[41] These attributes of the blockchain make it nearly impossible to penetrate.

As a reward for serving as the de facto "ledger-keeper" of the blockchain, miners receive "coins" in return.[42] The process incentivizes

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[34] *Id*. at 27.
[35] *Id*. at 16.
[36] *Id*. at 89.
[37] *Id*. at 25.
[38] George Kamiya, *Bitcoin energy use – mined the gap*, INT'L ENERGY AGENCY (July 5, 2019), https://www.iea.org/newsroom/news/2019/july/bitcoin-energy-use-mined-the-gap.html [https://perma.cc/4V9S-2CCQ].
[39] *Id*.
[40] *What is Bitcoin Mining?*, *supra* note 31.
[41] *Id*.
[42] *How Bitcoin Mining Works*, BITCOINMINING.COM, https://www.bitcoinmining.com/ [https://perma.cc/4WU8-T9G3].

miners to compete with one another to solve the puzzles.[43] Mining will inevitably become more competitive and will require miners to become ever more sophisticated while employing more energy-intensive computer systems. This adverse incentive, which is embedded into all cryptocurrency systems, will lead to bigger mines, more computers, and more energy being utilized by miners to beat one another in the race for fewer and fewer cryptocurrency coins.

III. ENERGY USE IN CRYPTOCURRENCY MINING

One of the most significant flaws of a cryptocurrency system is the enormous amount of energy necessary to mine the coins. Unfortunately, as alluded to before, the amount of energy a cryptocurrency system uses is a "side effect of relying on the ever-increasing computing power of competing miners to validate transactions through PoW."[44] Further, the energy use involved is caught in a vicious cycle. As the difficulty in solving the puzzle increases with each block added to the chain, the energy that is required to power the computers of miners to solve those puzzles also increases.[45] Globally, computers just on the Bitcoin network are currently crunching 26 quintillion hashes every second of every day in order to continue mining more coins.[46] This number will only increase as the puzzles get harder and harder to solve. Moreover, 83% of cryptocurrency mining is conducted in North America and Asia, meaning that the United States should be especially concerned with the amount of energy required to continue these practices.[47] The current processes for sustaining a viable cryptocurrency network rely on an inordinate amount of computing power which, inevitably, requires a continuous and abundant supply of energy.

A cryptocurrency network of computers uses an astronomical amount of power. Alex de Vries, a Bitcoin specialist at Pricewaterhouse-Coopers, estimates, "that the current global power consumption for the servers that run Bitcoin's software is a minimum of 2.55 gigawatts (GW),

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[43] *What is Bitcoin Mining?*, *supra* note 31; one wrinkle in the process is that there only exists a finite number of the cryptocurrency. For example, only 21 million bitcoins will ever exist, and, as of 2018, 17.3 million of those have been mined. Ben Brown, *How Many Bitcoins Are There? (Hint: Not That Many…)*, BLOCKEXPLORER NEWS (Sept. 10, 2018), https://blockexplorer.com/news/how-many-bitcoins-are-there-hint-not-that-many/#:~:targetText=There%20are%2017.3%20million%20bitcoins,there%20is%20much%20more%20complicated [https://perma.cc/6FME-B87A]. Furthermore, the number of bitcoins that a miner is rewarded after successfully completing a block in the blockchain halves after 210,000 blocks are mined. *Id.*

[44] Kamiya, *supra* note 38.

[45] HILEMAN & RAUCHS, *supra* note 28, at 99.

[46] Pete Evans, *Bitcoin is an energy hog: New numbers suggest how big a problem it is*, CANADIAN BROAD. CORP. (May 21, 2018), https://www.cbc.ca/news/business/bitcoin-electricity-1.4668768 [https://perma.cc/QE39-MT8X].

[47] HILEMAN & RAUCHS, *supra* note 28, at 22.

which amounts to energy consumption of 22 terawatt-hours (TWh) per year—almost the same as Ireland. Google, by comparison, used 5.7 TWh worldwide in 2015."[48] Furthermore, de Vries observes that Bitcoin miners in 2018 will consume about five times more power than they did in 2017 and that there is no sign of a slowdown given the rising price of Bitcoin as well as the increased computing power required to solve the puzzles that are becoming more and more difficult every day.[49] Alternatively, a single Bitcoin transaction uses as much electricity as a typical Canadian home would consume in a month — and there are 200,000 transactions being processed each day.[50] Thus, the amount of energy being used to conduct Bitcoin transactions in a single day would be enough to power entire cities for a month.

When you look at the amount of energy used for cryptocurrencies beyond just Bitcoin, the numbers are even more eye-popping. For instance, from January 1, 2016 to June 30, 2018, cryptocurrency networks consumed an average of eleven MegaJoules to generate one U.S. dollar.[51] Comparatively, conventional mining of aluminum consumed an average of 122 MegaJoules to generate one U.S. dollar.[52] Given this reality, if we are concerned about the environmental effects of traditional mining activities, then cryptocurrency mining should give us more concern.

As aforementioned, cryptocurrency mining is incredibly energy-intensive because the systems are designed to require more and more computing power as less of the currency becomes available. Indeed, "the way the bitcoin algorithm works is that it's designed to waste as much electricity as possible. And the more popular Bitcoin becomes, the more electricity it wastes," said Keith Stewart, a spokesperson for Greenpeace.[53] Because there is a fixed number of coins available of any cryptocurrency, the system is set up to require more complex computing to solve the necessary equations to mine the coins. For example, "[t]he Bitcoin system is designed, so only a limited number of the cryptocurrency can be mined every

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[48] G.F., *Why bitcoin uses so much energy*, ECONOMIST (July 9, 2018), https://www.economist.com/the-economist-explains/2018/07/09/why-bitcoin-uses-so-much-energy [https://perma.cc/8925-99L2].
[49] *Id*.
[50] Evans, *supra* note 46.
[51] Max J. Kraus & Thabet Tolaymat, *Quantification of energy and carbon costs for mining cryptocurrencies*, 1 NATURE SUSTAINABILITY 711, 712 (2018).
[52] *Id*.
[53] Kyle Bakx, *Bitcoin mining uses so much electricity that 1 city could curtail facility's power during heat waves*, CANADIAN BROAD. CORP. (Sept. 24, 2018), https://www.cbc.ca/news/business/hut8-medicine-hat-bitcoin-mining-1.4834027 [https://perma.cc/HWW3-JDAQ].

day. Over time, as more miners compete for a decreasing number of available bitcoins, facilities will have to use more electricity compared to the amount of the cryptocurrency they collect."[54]

More specifically, "[e]very 2016 blocks (roughly every two weeks), the system is recalibrated. Miners are obliged therefore to keep upgrading in order to earn rewards as fast as competitors. And more computing power requires more electricity."[55] Since over time the calculations needed to verify a block of transactions become more difficult, more and more computing power is necessary to solve it. Further, Bitcoin's market price currently remains extremely volatile—although, as with all commodities, volatility can change over time.[56] Accordingly, "[t]hese factors have created an arms race to develop better computer hardware to more rapidly verify transactions and a push to devote ever-increasing amounts of electricity to the task."[57] It is essential to keep the evolving difficulty of cryptocurrency mining in mind when determining how best to regulate cryptocurrencies going forward because the amount of energy used is inextricably linked to the current design of the system. Without taking this into account, there is no way to effectively regulate the amount of energy that cryptocurrency systems use.

IV. THE IMPACTS OF CRYPTOCURRENCY MINING

The exorbitant amount of energy used to mine cryptocurrencies has many different impacts. First, this section will address the negative impacts of cryptocurrency mining on public health and infrastructure. It will then focus on the wide range of adverse environmental impacts that cryptocurrency mining has on the planet. Finally, this section will explore the ways in which cryptocurrency mining positively impacts investment in renewable energy sources.

A. Public Health and Utility Infrastructure Impacts

Cryptocurrency mining often uses enough energy to power entire countries.[58] Miners often target smaller and more rural towns, such as East Wenatchee, in the Mid-Columbia River Basin, to set up shop because

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[54] *Id*.
[55] G.F., *supra* note 48.
[56] *Bitcoin Price Index*, COINTELEGRAPH, https://cointelegraph.com/bitcoin-price-index [https://perma.cc/G3ND-TU4D].
[57] Umair Irfan, *Bitcoin is an energy hog. Where is all that electricity coming from?*, VOX (June 18, 2019), https://www.vox.com/2019/6/18/18642645/bitcoin-energy-price-renewable-china [https://perma.cc/V8HR-HA3N].
[58] *See* G.F., *supra* note 48.

those towns often offer cheap rent and cheap energy.[59] This combination leads to an influx of miners on small towns who use a disproportionate amount of the locality's energy supply.[60] Moreover, most of these affected town's energy grids were not constructed with such use in mind.[61]

First and foremost, the heavy energy usage by miners directly impacts the amount of energy available to local residents; as the local surplus decreases, the price of energy for residents dramatically increases to cover the cost of not being able to sell to foreign municipalities.[62] In fact, by the end of 2018, 15% to 30% of all mining operations in the world could be traced to mining pools located in the Mid-Columbia River Basin.[63] In this region, five hydro-electric dams generate up to six times as much electricity than residents in the region consume, and most of the surplus energy is exported at higher prices.[64] This surplus enabled the residents to pay 26% less for the energy than the national average and commercial businesses to pay 21% less than the national average.[65] However, as miners continued to travel to the region searching for cheap energy and began to operate mines that consumed large amounts of this energy, exports of energy surpluses decreased and significantly raised the cost of residential electricity prices.[66] From 2012 through 2020, the average cost of residential electricity increased from 2.70 cents per kilowatt to 3.22 cents per kilowatt—this represents a nearly 20% increase in electricity prices in an eight-year period.[67] Accordingly, this increase in prices for residents has a real human cost associated with it—residents, who are often less financially secure, will now have to devote more money from a limited income to pay for

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[59] Roberts, *supra* note 6.
[60] *Id*.
[61] *Id*.
[62] *Id*.
[63] Roberts, *supra* note 6.
[64] *Id*.
[65] Wendy Culverwell, *Power is what powers the Mid-Columbia economy*, TRI-CITY HERALD (Aug. 5, 2017), https://www.tri-cityherald.com/news/local/article165721382.html [https://perma.cc/5864-V42G].
[66] Heidi Samford & Lovely-Francis Domingo, *The Political Geography and Environmental Impacts of Cryptocurrency Mining*, UNIVERSITY OF WASHINGTON HENRY M. JACKSON SCHOOL OF INTERNATIONAL STUDIES (July 10, 2019), https://jsis.washington.edu/news/the-political-geography-and-environmental-impacts-of-cryptocurrency-mining/ [https://perma.cc/CEA6-MRED].
[67] I calculated the percentage increase by comparing the historical electricity rates in Chelan County, Washington published on the following websites: Public Utility District No. 1 of Chelan County, *Electric Rate Schedules* (2011), https://www.chelanpud.org/docs/default-source/default-document-library/electric-rate-schedules-2019.pdf; *Chelan, WA Electricity Statistics*, ELEC. LOCAL, https://www.electricitylocal.com/states/washington/chelan/#:~:text=The%20average%20residential%20electricity%20rate%20in%20Chelan%20is%203.22%C2%A2,rate%20of%2011.88%C2%A2%2FkWh [https://perma.cc/8V9P-NCU4] (Oct. 1, 2020).

energy as opposed to a number of other needs such a food, health insurance, and housing.[68]

In addition to the financial impacts to residents, there is also a risk that, given the extreme levels of energy consumed by cryptocurrency mines, energy will be diverted away from actual consumers. As of June 2018, the world's seven biggest mines are located in Washington State; Iceland; Dalian, China; Linthal, Switzerland; and Russia.[69] Each of these mines, because of its location, is susceptible to extreme heatwaves, especially as climate change raises average temperatures around the globe.[70]

Heatwaves are often unpredictable until weeks or days before they occur. In response, local municipalities often fail to account for the uptick in energy required for the use of air-conditioning in residential homes and commercial buildings that is essential to withstand the intolerable heat.[71] Inevitably, this uptick in air-conditioning usage requires much more energy than normal. If cryptocurrency mines are consuming a disproportionate amount of energy, then there is a risk that there will not be enough energy to provide habitable shelter for residents and businesses. This risk was recognized by the city of Medicine Hat in Alberta, Canada, which is also a locality on which cryptocurrency miners have converged in order to take advantage of its cheap energy supply.[72] According to the Mayor of Medicine Hat, "[t]hat's why, in the event of a summer heat wave, the city has provisions in place to pull the plug on the electricity it provides to [it's

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[68] *See* Richard Florida, *Wages Are Higher in Urban Areas, But Growing Faster in Rural Ones*, CITYLAB (Oct. 23, 2018), https://www.citylab.com/life/2018/10/wages-are-higher-urban-areas-growing-faster-rural-ones/571534/ [https://perma.cc/D9TD-5MZ4].

[69] Julia Magas, *Top Five Biggest Crypto Mining Areas: Which Farms Are Pushing Forward the New Gold Rush?*, COINTELEGRAPH (June 23, 2018), https://cointelegraph.com/news/top-five-biggest-crypto-mining-areas-which-farms-are-pushing-forward-the-new-gold-rush [https://perma.cc/F5HB-3QCC].

[70] Evan Bush, *Seattle unprepared for deadly heat waves made worse by global warming, researchers say*, SEATTLE TIMES (June 14, 2019), https://www.seattletimes.com/seattle-news/environment/heat-waves-could-kill-hundreds-more-in-seattle-as-globe-warms-researchers-say/ [https://perma.cc/3TJE-XAHV]; Andie Sophia Fontaine, *Heat Wave Broils Iceland This Week*, REYKJAVIK GRAPEVINE (June 4, 2018), https://grapevine.is/news/2018/06/04/heat-wave-broils-iceland-this-week/#:~:targetText=Temperatures%20are%20set%20to%20climb,itself%20for%20a%20heat%20wave.&targetText=The%20sun's%20rage%20is%20expected,the%20afternoons%20all%20this%20week [https://perma.cc/UV63-8Q27]; *Heatwave latest: No relief as Switzerland continues to swelter*, THE LOCAL (June 27, 2019), https://www.thelocal.ch/20190626/swiss-heatwave-set-to-reach-record-breaking-peak-weather [https://perma.cc/56CR-RUHB]; Li Lei, *Heat wave devastates sea cucumber farmers*, CHINA DAILY (Aug. 7, 2018), http://www.china-daily.com.cn/a/201808/07/WS5b68f137a3100d951b8c8f2c.html [https://perma.cc/92GP-LMPA]; Hannah Hoag, *Russian summer tops 'universal' heatwave index*, NATURE (Oct. 29, 2014), https://www.nature.com/news/russian-summer-tops-universal-heatwave-index-1.16250 [https://perma.cc/H53F-KDJ7].

[71] *See* Kendra Pierre-Louis, *The World Wants Air-Conditioning. That Could Warm the World.*, N.Y. TIMES (May 15, 2018), https://www.nytimes.com/2018/05/15/climate/air-conditioning.html [https://perma.cc/3NZY-PASR].

[72] Bakx, *supra* note 53.

cryptocurrency mines], so there won't be any blackouts for residents."[73] Although this one city has taken proactive measures to prevent harm to its residents in the event of heatwaves, the risk remains an active threat to regions of the world that are home to the largest cryptocurrency mines. Furthermore, the threat of this harm and the ease of the solution should provide an incentive for elected leaders everywhere to act similarly.

As long as the prices of cryptocurrencies keep rising, more and more individuals will set up mining operations in regions that provide the cheapest supply of power. If these regions are not prepared for the influx of miners, then public utility districts can quickly become overwhelmed, and, as a result, effective and responsible operation of the power grids becomes untenable.[74] For example, the Chelan County Public Utility District (PUD) in Washington State reported in 2018 that the unprecedented demand for electricity, particularly from these new cryptocurrency mining operations, overwhelmed the public utility district's ability to support the large volume of applications for crypto-mining operations, threatened the district's electrical grid infrastructure capacity, and caused a number of public health and safety concerns.[75] Furthermore, the attractiveness of easy money and quick returns that cryptocurrencies often offer incentivizes individuals to set up small-scale cryptocurrency mines in homes and residential areas, instead of commercial areas.[76] These operators, attracted to the promise of exponential returns, pose a unique risk to the communities in which they reside because continual electricity usage at peak levels places a substantial strain on residential power grids.

Consider another example out of Chelan County, Washington: after discovering multiple unauthorized cryptocurrency mines in apartment buildings, homes, and mini-storage units, the Chelan County PUD determined that "[e]ach operation was using enough power to create fire risks for neighbors and damage grid equipment not sized for the load."[77] The incentives created by the easy returns from mining increase both the unauthorized consumption of exorbitant amounts of power as well as the fire risk to communities.

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[73] *Id*.
[74] Kimberlee Craig, *PUD commissioners halt work on applications from bitcoin & similar data operations*, CHELAN CNTY. PUD (Mar. 19, 2018), http://www.chelanpud.org/about-us/news-room/news/2018/03/20/pud-commissioners-halt-work-on-applications-from-bitcoin-similiar-data-operations [https://perma.cc/YA5M-TY2T].
[75] *Id*.
[76] *Id*.
[77] Kimberlee Craig, *PUD Board acts to halt unauthorized bitcoin mining*, CHELAN CNTY. PUD (Apr. 2, 2018), https://www.chelanpud.org/about-us/newsroom/news/2018/04/03/pud-board-acts-to-halt-unauthorized-bitcoin-mining [https://perma.cc/YV97-KGJ9].

Chelan County and the Mid-Columbia River Basin are not the only regions in the United States to experience the negative impacts of cryptocurrency mining energy consumption.[78] Plattsburgh, New York, is an extremely attractive place for cryptocurrency miners to set up shop since residents pay about four-and-a-half cents per kilowatt-hour (compared to the national average of ten cents per kilowatt-hour) and industrial enterprises only pay two cents per kilowatt-hour.[79] Since the influx of miners began, this small town of about 30,000 residents was forced to purchase additional electricity and, accordingly, much like in Chelan County, electric bills for residents skyrocketed by $100 or $200.[80] These two examples demonstrate how fast and effectively miners monopolize regions of the country that provide cheap and plentiful power to the severe detriment of both the residents and public utility infrastructure.

B. Environmental Impacts of Mining

In addition to the impacts on electricity prices, public health, and public utility infrastructure, the excessive energy consumption of cryptocurrency mines also poses a unique environmental threat, especially when the energy used comes from coal-powered facilities. As previously mentioned, cryptocurrency mining is incredibly energy-intensive. For example, Bitcoin alone currently uses about seventy-seven billion kilowatts of electricity per year.[81] This amount of energy consumption is roughly equivalent to the amount of energy the country of Venezuela consumes in an entire year, which is roughly seventy-four billion kilowatts, according to the most recent data from the Central Intelligence Agency.[82] For perspective, Venezuela is a country of nearly twenty-nine million people.[83] More astonishing is that this amount of energy consumption represents a nearly 100% increase from January 2018 to March 2020.[84] These statistics beg the question: from where is this energy coming? In short, the answer is China.

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[78] Thuy Ong, *Plattsburgh has become the first city in the US to ban cryptocurrency mining*, THE VERGE (Mar. 16, 2018), https://www.theverge.com/2018/3/16/17128678/plattsburgh-new-york-ban-cryptocurrency-mining [https://perma.cc/72EJ-CTQ8].
[79] *Id.*
[80] *Id.*
[81] *Bitcoin Energy Consumption Index*, DIGICONOMIST, https://digiconomist.net/bitcoin-energy-consumption [https://perma.cc/GAU7-PSFF] (Mar. 3, 2020) (there are one billion kilowatts in one terawatt).
[82] *The World Fact Book*, CENTRAL INTEL. AGENCY, https://www.cia.gov/library/publications/the-world-factbook/rankorder/2233rank.html [https://perma.cc/ZB9X-UMRD].
[83] *Venezuela Population*, WORLDOMETER (2020), https://www.worldometers.info/world-population/venezuela-population/ [https://perma.cc/WGM8-ZWAZ].
[84] DIGICONOMIST, *supra* note 81.

According to a report by EndCoal, a worldwide organization that advocates for renewable energy and tracks the amount of coal-powered power plants around the world, as of January 2020, China currently operates 1,004,948 coal plants with another 99,710 under construction and 106,176 either announced, pre-permitted, or permitted.[85] As a result, in total, China is on track to operate nearly 1.2 million coal-powered power plants in the coming years. Comparatively, the United States currently operates 246,187 coal-powered power plants, with zero coal-powered power plants planned or under construction, and over 28,000 planned coal-powered power plants canceled in last year.[86]

China's bullish attitude towards coal as a power source has attracted many cryptocurrency mining operations to consider China because it provides access to cheap power.[87] Accordingly, "the [current] majority of … bitcoin miners are located in China and that makes sense because electricity is cheap in China, especially coal-based electricity is cheap in China…. That's where it gets really painful. All of this coal-based electricity is going into the bitcoin network and coal electricity has a massive carbon footprint."[88] Moreover, it is likely that as cryptocurrency prices remain volatile, miners will continue searching for cheaper power.[89] Mining organizations' sole concern for the bottom line creates an energy race to the bottom and only incentivizes countries like China to return to producing "dirty energy" to attract more miners and boost economic activity.

Given its heavy reliance on coal-powered energy sources, cryptocurrency mining leads to an increase in carbon-dioxide (CO_2) emissions into the Earth's atmosphere.[90] The amount of CO_2 emitted, however, is difficult to precisely determine, but, according to one source, the electricity used for Bitcoin produces about twenty-two megatons of CO_2 annually, which is equivalent to the CO_2 emissions of Kansas City, Missouri.[91] Another source estimates that the number is actually much higher. According

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[85] *Coal Plants by Country*, ENDCOAL (Jan. 2020), https://docs.google.com/spreadsheets/d/1W-gobE-QugqTR_PP0iczJCrdaR-vYkJ0DzztSsCJXuKw/edit#gid=0 [https://perma.cc/C3WA-2F7U].
[86] *Id.* This halt on power plant construction could be reversed now that the Trump Administration has announced its plan to withdraw from the Paris Climate Accords and has signaled its intention to renew construction of these power plants. *Trump Administration Weakens Climate Plan To Help Coal Plants Stay Open*, NATIONAL PUBLIC RADIO (June 19, 2019), https://www.npr.org/2019/06/19/733800856/trump-administration-weakens-climate-plan-to-help-coal-plants-stay-open [https://perma.cc/XJ39-K3HF].
[87] *Is bitcoin an environmental hazard?*, CANADIAN BROAD. CORP. (Jan. 2, 2018), https://www.cbc.ca/radio/thecurrent/the-current-for-tuesday-january-2-2018-1.4469360/is-bitcoin-an-environmental-hazard-1.4469361 [https://perma.cc/97SJ-EUZK].
[88] *Id*.
[89] *Id*.
[90] Christian Stoll, Lena Klaaßen, & Ulrich Gallersdörfer, *The Carbon Footprint of Bitcoin*, 3 JOULE 1647, 1655 (2019).
[91] *Id*.

to a study published in late 2018 by Nature Climate Change, a journal dedicated to publishing the most significant and cutting-edge research on the nature, underlying causes, or impacts of global climate change and its implications for the economy, Bitcoin alone produced nearly sixty-nine million metric tons (sixty-nine megatons) of CO_2 emissions in 2017.[92] Based on the research currently available, it appears that cryptocurrency mining has a significant impact on global warming and climate change.

It is important to keep in mind that predictions regarding the environmental impact of cryptocurrency mining are at best speculative and based on current data that varies wildly from study to study. However, regardless of degree, the science is unequivocal in that mining based on coal-intensive energy resources is increasing emissions of CO_2 into the Earth's atmosphere. Some critics argue that the degree of environmental damage is highly uncertain and hinges on efficiency improvements in hardware, cryptocurrency price trends, and regulatory restrictions on mining and cryptocurrency usage in markets throughout the world.[93] However, these critics concede that more needs to be done to monitor the environmental effects of mining to determine the best course of action to tackle the problem. Consistent with this argument, George Kamiya, a Digital Energy Analyst for the International Energy Agency, asserts that, "[s]ensational predictions about bitcoin consuming the entire world's electricity – and, by itself, leading our world to beyond 2°C – would appear just that…sensational. That said, this is a very dynamic area that certainly requires careful monitoring and rigorous analysis – particularly, a careful monitoring of local hotspots."[94] There is no debate over the amount of electricity consumed by cryptocurrency mining and its effect on the environment—the only debate is to what degree mining is negatively impacting our environment by furthering reliance on coal-intensive power sources that continue to emit massive amounts of CO_2 into the atmosphere.

In addition to the increased CO_2 emissions related to cryptocurrency mining activity, it is also important to consider the effect of the con-

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[92] Camilo Mora et al., *Bitcoin emissions alone could push global warming above 2°C*, 8 NATURE CLIMATE CHANGE 931, 931 (2018). Given this amount of emissions, the researchers predict that bitcoin alone could push global temperatures over the 2ºC catastrophic threshold in less than three decades if the cryptocurrency gets adopted at the same pace as other broadly used technologies. *Id.*; *See generally* David Titley, *Why is climate change's 2 degrees Celsius of warming limit so important?*, CONVERSATION (Aug. 22, 2017), https://theconversation.com/why-is-climate-changes-2-degrees-celsius-of-warming-limit-so-important-82058 [https://perma.cc/VZ2G-RWWA].

[93] Kamiya, *supra* note 38.

[94] *Id.*

tinuous consumption and disposal of electronic waste on our environment.[95] Currently, Bitcoin mining activity alone creates on average, roughly eleven kilotons of electronic waste per year.[96] That metric is roughly comparable to the amount of electronic waste created by the country of Luxembourg.[97] This number likely increases when you add together the electronic waste emitted by every single cryptocurrency aside from just Bitcoin. Moreover, and in addition to mining activity, each bitcoin transaction generates roughly ninety grams of electronic waste—essentially the size of two golf balls.[98] Although seeming small, there are over 366,000 Bitcoin transactions per day.[99] The astonishing amount of electronic waste generated by cryptocurrencies is due, in part, to the fact that the mining devices used by most miners quickly go obsolete, often in just two years, and they cannot be effectively repurposed for anything other than mining.[100] Considering that cryptocurrency programing makes it harder and harder to mine each additional coin, miners are consistently engaged in a never-ending cycle whereby they must continually upgrade their machinery in order to stay competitive. This cycle provides a strong incentive for miners to disregard environmental concerns in favor of economic gain, and no amount of green energy can fix the increasing amount of electronic waste.

Currently, there is a mixed consensus among both large and small miners about whether the negative environmental externalities of mining should be a cause for concern. For instance, 64% of large mining operations believe that negative environmental externalities are only a minor concern compared to fossil fuel extraction and mining of precious metals. Additionally, 73% of large mining operations believe that the negative environmental externalities are necessary for maintaining a secure distributed computer system (i.e. blockchain).[101] However, it is more comforting to know that only a small minority of miners—9% of large miners and

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[95] *What is E-Waste?*, CALRECYCLE, https://www.calrecycle.ca.gov/electronics/whatisewaste [https://perma.cc/LJV8-MGCR] (June 23, 2020) (explaining that electronic waste is a popular, informal name for electronic products nearing the end of their "useful life." Computers, televisions, VCRs, stereos, copiers, and fax machines are common electronic products).

[96] *Bitcoin Electronic Waste Monitor*, DIGICONOMIST, https://digiconomist.net/bitcoin-electronic-waste-monitor/ [https://perma.cc/UE9S-TZFH] (Mar. 3, 2020).

[97] *Id*.

[98] DIGICONOMIST, *supra* note 96.

[99] *Blockchain Charts*, BLOCKCHAIN, https://www.blockchain.com/en/charts#:~:targetText=Transactions%20per%20Day%20323%2C552%20Transactions,in%20the%20past%2024%20hours [https://perma.cc/JY9C-PXA4] (Mar. 3, 2020).

[100] Irfan, *supra* note 57.

[101] HILEMAN & RAUCHS, *supra* note 28, at 99.

17% of small miners—do not believe that the negative environmental externalities of mining are an issue at all.[102] This industry-wide understanding means that there is plenty of room in the mining community to accept certain environmental regulations over mining operations if access to and cost of power remains at consistent levels. Furthermore, the study provides us with guideposts about how to successfully regulate a growing industry without interfering with economic growth.[103]

C. Alternative Positive Impacts

Although coal is a major source of the energy used to power cryptocurrency mines causing many of the environmental hazards mentioned above, more miners are turning towards renewable energy sources to operate their mines. According to a recent study by CoinShares, a cryptocurrency asset management and analysis firm, the Bitcoin network gets nearly 75% of its electricity from renewable energy sources making it "more renewables-driven than almost every other large-scale industry in the world."[104] These renewable energy sources include wind, solar, and hydropower.[105] For example, if we return to the Mid-Columbia River Basin region of Washington State, most of the electricity produced and used by miners there is from hydro-electric dams.[106] If this is the case, and this trend continues, then some of the vast environmental problems posed by cryptocurrency proliferation can be rendered moot.

Shifting the cryptocurrency networks onto renewable energy sources can help revitalize underused renewable energy projects and incentivize communities to invest in such projects. According to the findings of the CoinShares study,

> Bitcoin mining is acting as a global electricity buyer of last resort and therefore tends to cluster around comparatively under-utilized renewables infrastructure. This could help turn loss making renewables projects profitable and in time—as the industry matures and settles

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[102] *Id*.
[103] *See generally* HILEMAN & RAUCHS, *supra* note 28.
[104] CHRISTOPHER BENDIKSEN & SAMUEL GIBBONS, THE BITCOIN MINING NETWORK 2 (CoinShares Research, 2019), https://coinsharesgroup.com/assets/resources/Research/bitcoin-mining-network-june-2019-fidelity-foreword.pdf [https://perma.cc/9SRZ-JMBW].
[105] *Id*.
[106] Roberts, *supra* note 6. It is important to note that while the Environmental Protection Agency considers "Low-impact small hydropower" a renewable energy source, some in the scientific community criticize its use because of the resulting negative environmental impacts. ENV'T PROT. AGENCY, *Renewable Energy at the EPA*, https://www.epa.gov/greeningepa/renewable-energy-epa [https://perma.cc/8T62-RYJM]; *see also* UNION OF CONCERNED SCIENTISTS, *Environmental Impacts of Hydroelectric Power* (Mar. 5, 2013), https://www.ucsusa.org/resources/environmental-impacts-hydroelectric-power [https://perma.cc/37JL-8CVE].

> as permanent in the public eye—could act as a driver of new renewables developments in locations that were previously uneconomical.[107]

This theory suggests that as cryptocurrencies continue to catch on with the general public, rural communities with plenty of land will choose to invest in renewable energy projects to attract cryptocurrency miners to the area. In turn, this will help drive competition in the renewable energy space and boost the production of renewable energy sources around the world. However, if competition for mining operations helps push renewable energy prices down, then increased demand for renewables will help push the price right back up and drive miners to consider coal-powered energy sources again. In an industry, like cryptocurrencies, that is dominated by an extremely volatile price, reducing costs, such as the price of electricity, will always be the primary goal of miners in order to maximize their return on investment. Therefore, the same factors that drove cryptocurrency miners to use renewable energy could again easily lead them back to coal-powered energy sources.

Although promising, renewable energy will likely never be a complete substitute for "dirty" energy sources because of seasonality and the amount of energy that cryptocurrencies demand. Hydropower, in particular, is mostly a seasonal source of energy, which increases in the wet season and decreases during the dryer seasons.[108] As a result, cryptocurrency miners must use energy produced from fossil fuels to supplement their energy use when renewable sources fail to provide sufficient amounts of energy. In addition, both wind and solar energy are also extremely seasonal energy sources.[109] Altogether, renewable energy resources only amount to roughly 15% of global energy production, and the U.S. alone only produced roughly 742 TWh of renewable energy in 2018.[110] Given that Bitcoin alone will use roughly 75 TWh this year, the total amount of renewable energy production is not large enough to sustainably power the entire cryptocurrency industry.[111] As a result, until the United States and other countries around the world commit to producing more renewable

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[107] BENDIKSEN & GIBBONS, *supra* note 104, at 10.
[108] Irfan, *supra* note 57.
[109] *Id*.
[110] *Case Study: World Energy Use*, LUMEN, https://courses.lumenlearning.com/boundless-physics/chapter/case-study-world-energy-use/#:~:targetText=In%20the%20US%2C%20only%2010,oil%2C%20natural%20gases %20and%20coal [https://perma.cc/MK83-DCDK] (last visited Mar. 3, 2020); *Electric Power Monthly*, U.S. ENERGY INFO. ADMIN. (Feb. 26, 2020), https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_1_01 [https://perma.cc/42NE-HAZD].
[111] DIGICONOMIST, *supra* note 81.

energy, cryptocurrency miners will continue to supplement their renewable energy use with fossil fuel-powered energy, and the impact on the environment that cryptocurrency mining is causing will largely go unresolved.

V. CURRENT CRYPTOCURRENCY MINING REGULATIONS

Although researchers, activists, and commentators are drawing more attention to the cryptocurrency energy crisis, federal regulators have done little to address the growing adverse effects on the environment. Currently in the United States, there are no major regulatory schemes in place at the federal level to address this emerging crisis. Furthermore, most countries around the world have also shown a reluctance to regulate this emerging industry in any meaningful way—the only major countries that have currently shown an interest in such regulation are China and Iran. This section will first look at the current federal regulatory schemes, or lack thereof, that the United States government has adopted. Then it will look at both the multiple regulatory schemes adopted by several states as well as the different regulatory schemes adopted by countries around the world.

A. Current Federal Regulations in the United States

In recent years, both federal and state lawmakers in the United States have begun to focus more attention on cryptocurrencies. However, the United States Congress has yet to take any meaningful steps to address the impact that cryptocurrency mining has on our environment.[112] Instead, the focus remains on protecting consumers from fraud, preventing money-laundering, and ensuring the United States remains competitive in this emerging industry.[113] In a statement by two Members of the House of Representatives, Representatives Darren Soto (D-FL) and Ted Budd (R-NC) declared,

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[112] Jason Brett, *Congress Considers Federal Crypto Regulators In New Cryptocurrency Act Of 2020*, FORBES (Dec. 19, 2019), https://www.forbes.com/sites/jasonbrett/2019/12/19/congress-considers-federal-crypto-regulators-in-new-cryptocurrency-act-of-2020/#42c0a6985fcd [https://perma.cc/2858-JV36]. The Crypto-Currency Act of 2020, introduced in the House of Representatives on March 9, 2020 has not passed through the House of Representatives at the times of this writing; the bill would clarify which federal agencies regulate digital assets and require those agencies to notify the public of any federal licenses, certifications, or registrations required to create or trade in such assets, and for other purposes. Crypto-Currency Act of 2020, H.R. 6154, 116th Cong. (2020).

[113] Kate Rooney, *Bipartisan lawmakers seek cryptocurrency rules to protect consumers and keep US competitive,* CNBC (Dec. 6, 2018), https://www.cnbc.com/2018/12/06/bipartisan-lawmakers-seek-cryptocurrency-rules-to-keep-us-competitive-.html [https://perma.cc/WT2Y-ATCL].

> [v]irtual currencies and the underlying blockchain technology has a profound potential to be a driver of economic growth. That's why we must ensure that the United States is at the forefront of protecting consumers and the financial well-being of virtual currency investors, while also promoting an environment of innovation to maximize the potential of these technological advances.[114]

These concerns, although well-founded and important, fail to recognize the environmental hazards of leaving mining activities alone while focusing on the transactions and underlying technology.

Although many lawmakers have expressed concern over cryptocurrencies and the underlying technology, much of the federal government's focus has been at the administrative and agency level, including the Securities and Exchange Commission (SEC), the Commodities and Futures Trading Commission (CFTC), the Federal Trade Commission (FTC), and the Department of the Treasury, at both the Internal Revenue Service (IRS) and the Financial Crime Enforcement Network (FinCEN).[115] This regulatory focus suggests that the federal government and most lawmakers believe that cryptocurrencies pose little threat outside the financial sector and that the United States must be careful not to over-regulate the industry so as not to drive investment in the technology overseas. In a joint statement in October 2019 by the heads of the CFTC, FinCEN, and the SEC, the leaders emphasized that their primary focus is to enforce the Bank Secrecy Act in order to prevent money laundering schemes and the financing of terrorism.[116]

In a White House briefing in July 2019, the Secretary of the Treasury reiterated his concerns over the threat that cryptocurrencies pose to national security because of how they can be used to fund illicit activity.[117] Echoing the concerns of the heads of the CFTC, FinCEN, and the SEC, the Secretary said that cryptocurrencies must comply with the Bank Secrecy Act and register with the Financial Crimes Enforcement Network, while also meeting the same anti-money laundering and counterfeiting

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[114] *Id*.
[115] Joe Dewey, *Blockchain & Cryptocurrency Regulation 2020 | USA*, GLOBAL LEGAL INSIGHTS, https://www.globallegalinsights.com/practice-areas/blockchain-laws-and-regulations/usa [https://perma.cc/W8SC-NJ22].
[116] U.S. SECURITIES AND EXCHANGE COMMISSION, LEADERS OF CFTC, FINCEN, AND SEC ISSUE JOINT STATEMENT ON ACTIVITIES INVOLVING DIGITAL ASSETS (Oct. 11, 2019), https://www.sec.gov/news/public-statement/cftc-fincen-secjointstatementdigitalassets [https://perma.cc/LD83-LE36].
[117] Alan Rappeport & Nathaniel Popper, *Cryptocurrencies Pose National Security Threat, Mnuchin Says*, N.Y. TIMES (July 15, 2019), https://www.nytimes.com/2019/07/15/us/politics/mnuchin-facebook-libra-risk.html?searchResultPosition=2 [https://perma.cc/VQD2-9FSS].

standards as traditional financial firms.[118] This concern primarily reflects the attitude of the entire Trump Administration.[119] To date, however, there have been no major pronouncements by lawmakers or administration officials about the threat that mining activity could pose to either the environment or the well-being of our communities.

Even given this well-intentioned concern among legislators and policy makers, there is a wide-spread understanding of the difficulty of applying current financial regulatory laws to digital assets such as cryptocurrencies. According to a joint statement by leaders of the SEC and the Financial Industry Regulatory Authority (FINRA),

> [a]s a threshold matter, it should be recognized by market participants that the application of the federal securities laws, FINRA rules and other bodies of laws to digital assets, digital asset securities and related innovative technologies raise novel and complex regulatory and compliance questions and challenges. For example, and as discussed in more detail below, the ability of a broker-dealer to comply with aspects of the Customer Protection Rule is greatly facilitated by established laws and practices regarding the loss or theft of a security, that may not be available or effective in the case of certain digital assets.[120]

More importantly, however, it seems that even if current statutes do apply to digital assets, such as cryptocurrencies, enforcement remains the main barrier to regulation under securities laws. The leaders of these regulatory authorities are at a loss about how to go about enforcing current regulations other than by simply asking nicely. The former CFTC's Director of Enforcement commented: "While there is a lot of excitement surrounding Bitcoin and other virtual currencies, innovation does not excuse those acting in this space from following the same rules applicable to all participants in the commodity derivatives markets."[121] Given the federal government's inaction, it is no surprise that a report created by the Law

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[118] *Id*.

[119] Billy Bambrough, *The U.S. Treasury Secretary Made A Dire Warning Over The Future Of Bitcoin*, FORBES (July 27, 2019), https://www.forbes.com/sites/billybambrough/2019/07/27/the-u-s-treasury-secretary-made-a-dire-warning-over-the-future-of-bitcoin/#3b21798a2c93 [https://perma.cc/PZ3Z-BCM2].

[120] U.S. SECURITIES AND EXCHANGE COMMISSION, JOINT STAFF STATEMENT ON BROKER-DEALER CUSTODY OF DIGITAL ASSET SECURITIES (July 8, 2019), https://www.sec.gov/news/public-statement/joint-staff-statement-broker-dealer-custody-digital-asset-securities [https://perma.cc/64NC-6NGY].

[121] COMMODITY FUTURES TRADING COMMISSION, CFTC ORDERS BITCOIN OPTIONS TRADING PLATFORM OPERATOR AND ITS CEO TO CEASE ILLEGALLY OFFERING BITCOIN OPTIONS AND TO CEASE OPERATING A FACILITY FOR TRADING OR PROCESSING OF SWAPS WITHOUT REGISTERING (Sept. 17, 2015), https://www.cftc.gov/PressRoom/PressReleases/pr7231-15 [https://perma.cc/J7FC-NMKV].

Library of Congress found that the United States is among many countries that currently use neither tax laws nor anti-money laundering/anti-terrorism financing laws to regulate cryptocurrencies.[122] Considering this relative inaction of legislators and policy makers, it is clear why cryptocurrencies currently go unregulated in the United States.

B. Current State-by-State Regulations in the United States

Where the federal government has failed to act, some states have taken it upon themselves to attempt to regulate cryptocurrency use and production. Generally, states have taken one of two approaches to cryptocurrency regulation: (1) promote the technology by exempting cryptocurrencies from state securities laws, money transmission statutes, and other state regulatory requirements; or (2) issue warnings about investment and pass generally restrictive statutes.[123] The Uniform Law Commission has also crafted model legislation that seeks to regulate companies engaged in the business of cryptocurrencies.

States that have adopted the first approach hope to incentivize not only investment in the technology but also, by default, investment in their states. Accordingly, these investments will help stimulate local economies and improve public services. For example, Wyoming passed a bill in March 2018 exempting cryptocurrencies from property taxation.[124] As a result, many have praised Wyoming for becoming the most cryptocurrency-friendly jurisdiction in the United States.[125] In addition, the governor of Colorado signed the "Cyber Coding Cryptology for State Records" bill into law in May 2018, which promotes the use of blockchain technology throughout the state government.[126] In 2018, Ohio became the first state to allow taxpayers to pay state taxes in the form of cryptocurrency.[127] These measures effectively promote cryptocurrencies by citing its many

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[122] THE LAW LIBRARY OF CONGRESS, REGULATIONS OF CRYPTOCURRENCY AROUND THE WORLD 5 (June 2018), https://www.loc.gov/law/help/cryptocurrency/cryptocurrency-world-survey.pdf [https://perma.cc/KZ5G-42ZL].

[123] Dewey, *supra* note 115.

[124] 2019 Wyo. Sess. Laws 485, https://wyoleg.gov/2019/SessionLaws.pdf [https://perma.cc/KMN4-KRBQ]; Rachel Wolfson, *U.S. State of Wyoming Defines Cryptocurrency 'Utility Tokens' As New Asset Class*, FORBES (Mar. 13, 2018), https://www.forbes.com/sites/rachelwolfson/2018/03/13/u-s-state-of-wyoming-defines-cryptocurrency-utility-tokens-as-new-asset-class/#6d2c6a514816 [https://perma.cc/3YJL-MPHJ].

[125] Dewey, *supra* note 115.

[126] COLO. REV. STAT. § 24-37.5-407 (2019); Jared Verner, *Gov. Hickenlooper signs bill for cyber workforce development and research funding*, UCCS COMMUNIQUE (May 30, 2018), https://communique.uccs.edu/?p=32147 [https://perma.cc/49ZY-LKL5].

[127] Paul Vigna, *Pay Taxes With Bitcoin? Ohio Says Sure*, WALL ST. J. (Nov. 26, 2018), https://www.wsj.com/articles/pay-taxes-with-bitcoin-ohio-says-sure-1543161720 [https://perma.cc/DN3R-MXN4].

economic benefits without considering the perverse environmental effects. The varied approaches by individual states further demonstrate the need for standardized federal regulations because states can only be trusted to act in the best interest of their citizenry and not in the best environmental interests of the country as a whole.

On the other hand, some states have taken minor steps to address the growing concern over cryptocurrency use and investment. These states have also issued guidance, opinion letters, and other information from their financial regulatory agencies regarding whether virtual currencies are "money" under existing state rules. Additionally, other states have enacted piecemeal legislation amending existing definitions to either specifically include or exclude digital currencies from the definition.[128] Moreover, whenever states attempt to enact more regulation over the cryptocurrency industry, like New York did with its "BitLicense" scheme,[129] an exodus of blockchain and virtual currency businesses from states attempting to treat all virtual currency operators identically with traditional money transmitters ensues.[130] This result exemplifies the problem that states face in attempting to address the issue of cryptocurrency regulation alone—states compete with one another, and businesses will flock to the states which offer more favorable treatment.

Currently, only one state, Rhode Island, has fully enacted the Uniform Law Commission's Model Regulation of Virtual Currency Businesses Act.[131] The Act provides a statutory framework for the regulation of companies engaging in "virtual-currency business activity," such as exchanging, transferring, or storing virtual currencies.[132] The Act has been endorsed by the American Bar Association and does not attempt to regulate the virtual currencies but rather the people engaged in the use of the

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[128] Matthew E. Kohen & Justin S. Wales, *State Regulations on Virtual Currency and Blockchain Technologies*, CARLTON FIELDS (Aug. 29, 2019), https://www.carltonfields.com/insights/publications/2018/state-regulations-on-virtual-currency-and-blockchain-technologies [https://perma.cc/Z9YL-B7V8].

[129] Under 23 NYCRR 200.3(a), "No Person shall, without a license obtained from the superintendent …, engage in any Virtual Currency Business Activity." Pursuant to this statutory scheme, any individual engaged in storing virtual currencies on behalf of others, buying and selling virtual currencies as a customer business, performing exchange services as a customer business, or issuing virtual currencies must obtain a license from the State of New York. *Virtual Currency Business Activity (BitLicense)*, N.Y. STATE DEP'T OF FIN. SERV., https://www.dfs.ny.gov/apps_and_licensing/virtual_currency_businesses [https://perma.cc/WHS8-6QU2].

[130] Kohen, *supra* note 128.

[131] *Regulation of Virtual-Currency Businesses Act*, UNIFORM LAW COMM'N (2017), https://www.uniformlaws.org/committees/community-home?CommunityKey=e104aaa8-c10f-45a7-a34a-0423c2106778#:~:targetText=The%20Uniform%20Regulation%20of%20Virtual,virtual%20currency%20or%20legal%20tender [https://perma.cc/5EVC-J8J7].

[132] *Id*.

currency.[133] Although the Act does not explicitly regulate cryptocurrency, it establishes and recognizes a uniform set of definitions to help states further adapt their regulatory schemes—without a common understanding of the industry states cannot act together.[134]

All in all, most states have failed to adopt any meaningful regulations over cryptocurrencies, let alone recognize the environmental impacts of cryptocurrency mining. Furthermore, absent federal regulation, states lack an incentive to further regulate cryptocurrencies out of fear that they may miss out on any economic gain derived from cryptocurrency activity in their state. Without federal involvement, most states will refrain from restricting cryptocurrency use further, especially states that are losing main industries and want to capitalize on any economic boom derived from cryptocurrencies. Under threat of any regulation, cryptocurrency business and mining operations will just move from state to state. Thus, the inability of states to adequately address the environmental issues associated with cryptocurrencies is the reason we need to enact a federal regulatory scheme.

C. Current International Regulatory Schemes

Although the United States has failed to regulate either cryptocurrencies or cryptocurrency mining activity and its effect on the environment, other countries, including China and Iran, have taken decisive action, including strict regulation, in order to address these concerns. In recent years, China has taken a hardline approach vis a vis the financial regulation of cryptocurrencies. Nearly two years ago China decided to block all websites related to cryptocurrency trading and initial coin offerings in order to quash the market for cryptocurrencies completely.[135] According to the People's Bank of China, "To prevent financial risks, China will step up measures to remove any onshore or offshore platforms related to virtual currency trading or ICOs."[136] China has become increasingly worried about social unrest that is linked to the increase in use of cryptocurrencies and the outbreak of fraud associated with the blockchain systems.[137] This reasoning largely comports with China's strict control of domestic financial institutions, even though their motivation is similar to the concerns of

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[133] *Id*.
[134] *Id*.
[135] Xie Yu, *China to stamp out cryptocurrency trading completely with ban on foreign platforms*, SOUTH CHINA MORNING POST (Feb. 5, 2018), https://www.scmp.com/business/banking-finance/article/2132009/china-stamp-out-cryptocurrency-trading-completely-ban [https://perma.cc/V88E-VMQE].
[136] *Id*.
[137] *Id*.

officials and regulators in the United States.[138] Even further, in April of 2019, China's central state planning agency, the National Development and Reform Commission (NDRC), revealed it might curb cryptocurrency mining in the country altogether.[139] The draft proposal for a revised list added cryptocurrency mining, including that of Bitcoin, to more than 450 activities the NDRC said should be phased out as they did not adhere to relevant laws and regulations, were unsafe, wasted resources, or polluted the environment.[140] This strict ban on mining, motivated largely by environmental concerns, would be a first for any country around the world and surprising for a country that seemingly always puts economic gain ahead of environmental protection.

In November 2019, China's President Xi Jinping announced a reversal of the two-year ban on cryptocurrency trading and initial coin offerings in an effort to dominate blockchain technology and improve tracking of its citizens.[141] President Xi told Politburo members the following day that China must "seize the opportunity" for blockchain to play "an important role in the next round of technological transformations in areas such as financing businesses, mass transit and poverty alleviation."[142] Furthermore, Chinese authorities have also recently reversed course on proposals to ban mining activity.[143] According to Blockstream CSO Samson Mow, "China's National Development and Reform Commission has removed #cryptocurrency mining from the list of industries they want to eliminate."[144] This announcement is a rapid reversal of a policy that was announced only earlier this year.[145] Even more disheartening is that the reasoning for both reversals is similar to the reasoning proffered by American legislators and policy makers: to capitalize on economic gain and to

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[138] *See generally* DOUGLAS J. ELLIOTT & KAI YAN, THE CHINESE FINANCIAL SYSTEM: AN INTRODUCTION AND OVERVIEW (The John L. Thorton China Center at Brookings 2013), https://www.brookings.edu/wp-content/uploads/2016/06/chinese-financial-system-elliott-yan.pdf [https://perma.cc/3499-PUSM].
[139] Stephen O'Neal, *Will China Ban Crypto Mining?*, COINTELEGRAPH (Apr. 12, 2019), https://cointelegraph.com/news/will-china-ban-crypto-mining [https://perma.cc/DWF7-GGT5].
[140] Brenda Goh & Alun John, *China wants to ban bitcoin mining*, REUTERS (Apr. 8, 2019), https://www.reuters.com/article/us-china-cryptocurrency/china-says-it-wants-to-eliminate-bitcoin-mining-idUSKCN1RL0C4 [https://perma.cc/25W9-JYKW].
[141] Chriss Street, *China Reverses Cryptocurrency Ban and Now Wants to Dominate It*, EPOCH TIMES (Nov. 8, 2019), https://www.theepochtimes.com/china-reverses-cryptocurrency-ban-and-now-wants-to-dominate-it_3140036.html [https://perma.cc/PZ3A-UANU].
[142] *Id*.
[143] William Suberg, *'Bullish for Bitcoin' — China Scraps Plans to Ban Cryptocurrency Mining*, COINTELEGRAPH (Nov. 6, 2019), https://cointelegraph.com/news/bullish-for-bitcoin-china-scraps-plans-to-ban-cryptocurrency-mining [https://perma.cc/7JT8-X4R7].
[144] *Id*.
[145] Goh & John, *supra* note 140.

not lose out on technological innovation. Again, leaders are putting revenue streams ahead of environmental concerns when crafting policies. Although unfortunate, the ban on mining in China would have put additional strain on U.S. cities that provide cheap power as more international miners would have sought out regions, such as the Mid-Columbia Basin, that provide cheap energy.

Iran has also recently taken a stricter approach to cryptocurrency mining than other countries around the world. In June 2019, Iran announced that it was cutting off all power to cryptocurrency mines since the country's power grid had become unstable due to increased mining activity.[146] An Iran Ministry of Energy official revealed that the country had seen a 7% spike in electricity consumption over the course of a single monthly period ending on June 21, 2019.[147] Afterward, the country embarked on a debate over the future of cryptocurrency mining in the country.

In August 2019, Iran announced that mining cryptocurrencies is legal both inside and outside metropolises, in addition to free and special trade zones, provided applicants obtain a permit from the Ministry of Industry, Mine and Trade.[148] The permitting process, however, includes a set of regulations that could serve as a welcome example of how to effectively regulate the industry. First, the electricity price offered to miners will be equal to the average Rial price at which Iran exports its electricity to other nations.[149] Secondly, using electricity or natural gas to mine cryptocurrencies is forbidden in peak consumption times, whereas, using clean and sustainable sources of energy is permitted at all times.[150] Lastly, mining companies are prohibited from using electricity and gas provided at household, agricultural, or industrial grades.[151] Although many critics predict that these regulations will drive many miners to consider operating elsewhere, the regulatory scheme protects consumers and incentivizes miners to use clean energy resources.

Both China and Iran present examples of how to regulate cryptocurrency activity, including mining. However, only Iran has demonstrated

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[146] *Iran blames bitcoin mining for surge in electricity consumption*, IRAN DAILY (June 24, 2019), http://www.iran-daily.com/News/254817.html [https://perma.cc/W2F2-S2PT].
[147] Helen Partz, *Iranian Government to Cut Off Power to Crypto Mining Until Approval of New Energy Prices*, COINTELEGRAPH (June 25, 2019), https://cointelegraph.com/news/iranian-government-to-cut-off-power-to-crypto-mining-until-approval-of-new-energy-prices [https://perma.cc/M8RA-NGNZ].
[148] Maziar Motamedi, *Iran's government recognises cryptocurrency mining with caveat*, ALJAZEERA (Aug. 4, 2019), https://www.aljazeera.com/ajimpact/iran-government-recognises-cryptocurrency-mining-caveat-190804193912792.html [https://perma.cc/XBT9-DVKU].
[149] *Id*.
[150] *Id*.
[151] *Id*.

the ability to enact a set of smart and logical regulations that consider consumer protection concerns and environmental concerns. In contrast, China abandoned all regulatory efforts in favor of capitalizing off of the technology.

VI. ALTERNATIVE CONCERNS REGARDING REGULATORY SCHEMES

Although this article and analysis casts serious doubt on the environmental feasibility of cryptocurrency mining due to the extreme energy use required, when considering regulatory schemes to also take into account the effects such regulations would have on firms and technologies that also use copious amounts of energy that serve a more valuable societal purpose. Primarily, the goal of regulating energy consumption is not meant to inhibit the use of energy to fuel the data centers of big technology companies. Data centers currently play a critical role in our advanced and developing society—powering the internet and subsequently connecting our communities.[152] However, this role comes at a heavy energy price. Currently, the data centers which power the internet consume about 2% of the world's electricity with that number potentially rising to 8% by 2030.[153] The conventional wisdom that this article embraces would suggest that data centers play an equally disastrous role with regard to the environment as cryptocurrency mining and should be regulated as such. However, when you consider the societal function, the benefits to vast populations, and the incentives to invest in renewable energy sources, data centers pose much less of a threat to our environment than the proliferation of cryptocurrency mining.

Data centers are an indispensable part of our lives. As the foundation of cloud computing, which enables the on-demand availability of computer system resources, data centers have an indelible impact on our social lives, education, development, and healthcare.[154] These benefits are largely public benefits that affect everyone and do not discriminate based on where you live, how much money you make, or what you do for a living. Technology firms such as Google, YouTube, and Facebook, which have harnessed the power of data centers, have made this world infinitesimally smaller by connecting not only old friends who have lost touch but

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[152] *Sustainable data centers*, FACEBOOK SUSTAINABILITY, https://sustainability.fb.com/innovation-for-our-world/sustainable-data-centers/ [https://perma.cc/8UUK-AYJT].
[153] Robert Walton, *The rise of cloud computing is having an impact on data center efficiency — and it's not great*, UTILITYDIVE (Dec. 17, 2019), https://www.utilitydive.com/news/the-rise-of-cloud-computing-is-having-an-impact-on-data-center-efficiency/569183/ [https://perma.cc/D3RY-5822].
[154] Maamar Ferkoun, *How cloud computing is impacting everyday life*, IBM (Apr. 4, 2013), https://www.ibm.com/blogs/cloud-computing/2013/04/04/how-cloud-computing-is-impacting-everyday-life/ [https://perma.cc/X69V-3ULP].

also politicians with their constituencies. Moreover, educational institutions that have embraced cloud technology have enabled students to learn from anywhere while using data to reduce administrative expenses.[155]

More importantly, although the direct effects of cloud technology mostly implicate the developed world, citizens from developing countries benefit from these technologies through instantaneous access to educational material.[156] The cloud technology that data centers help power enable developing countries to tap into the data and applications already developed that are essential to building infrastructure programs. Without cloud technology, these programs would otherwise be too costly to invest in.

Data centers also help store and organize healthcare data from patients around the world. This process helps medical professionals research diseases, diagnose patients, and develop more effective treatment plans.[157] The worldwide implications of cloud technology are only made possible by further investment in data centers—data centers that use increasing amounts of energy every day. However, given the largely magnanimous effects that have materialized over the last decade of innovation, there is no doubt that the technology largely helps the global community.

Lastly, data centers help revitalize communities through job creation. According to a report issued by Google in 2018, "…as of 2016, Google data centers generated $1.3 billion in economic activity across the US, and have generated over 11,000 jobs."[158] These statistics depict a world in which the economic benefits of cryptocurrency mining flow to a select population, whereas a large majority of people benefit directly from investment in data centers. Consequently, energy policy should reflect this statistical landscape—cryptocurrency miners should not be able to exploit energy generated by publicly funded utilities for a largely exclusive economic benefit.

The main difference between the benefits of data center energy use and cryptocurrency energy use is the number and size of the populations that ultimately see the benefits. By some estimates, there are currently only about 1,000,000 cryptocurrency miners throughout the world, which represents roughly .014% of the global population.[159] Furthermore,

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[155] *Id*.
[156] *Id*.
[157] *Id*.
[158] Urs Hölzle, *Measuring our impact in data center communities*, GOOGLE (Apr. 23, 2018), https://www.blog.google/topics/environment/measuring-our-impact-data-center-communities/ [https://perma.cc/HRH4-7L8T].
[159] *How Many Bitcoins Are There?*, BUY BITCOIN WORLD, https://www.buybitcoinworldwide.com/how-many-bitcoins-are-there/ [https://perma.cc/3WB3-4V9P] (Mar. 3, 2020).

only about 14% of Americans reported owning a cryptocurrency in 2019.[160] Conversely, 72% of adult Americans reported using a social media platform in 2019, while 90% of adult Americans reported utilizing the internet.[161]

Technology firms that use data centers have a strong economic incentive and the economic scale to invest in renewable energy resources that cryptocurrency miners simply do not have. In the long term, renewable energy sources will be both cheaper and more plentiful than traditional coal powered energy. According to the Bloomberg New Energy Finance Report for 2019, wind and solar energy sources will make up 50% of world electricity by 2050, and by 2030 the cost of wind and solar energy sources will undercut the cost of coal and gas almost anywhere throughout the world.[162] Given this outlook, it makes financial sense for technology firms to invest now in developing renewable energy alternatives that will power their data center operations. However, cryptocurrency miners do not benefit from long-term economic analysis and, as such, will not plan accordingly. This lack of incentive means that miners, as rational economic actors, will use the cheapest available energy source today instead of investing working capital in renewable infrastructure for tomorrow.

Unlike their cryptocurrency counterparts, technology firms such as Apple, Google, Facebook, and Microsoft are using their economic scale to invest in renewable energy alternatives. Although renewable energy resources are limited in the United States, according to Yale researchers, these firms are signing contracts with other countries to receive a dedicated supply from existing wind and solar farms: "The availability of renewable energy is one reason Google and Microsoft have recently built hubs in Finland, and Facebook in Denmark and Sweden."[163] Furthermore, "Google last year also signed a deal to buy all the energy from the Netherlands' largest solar energy park, to power one of its four European data centers."[164]

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[160] Richard Laycock, *A rising number of Americans own crypto*, FINDER (Nov. 20, 2019), https://www.finder.com/how-many-people-own-cryptocurrency [https://perma.cc/77BE-U6L9].
[161] *Social Media Fact Sheet*, PEW RSCH. CTR. (June 12, 2019), https://www.pewresearch.org/internet/fact-sheet/social-media/ [https://perma.cc/X2M6-FJG7]; *Internet/Broadband Fact Sheet*, PEW RESEARCH CENTER (June 12, 2019), https://www.pewresearch.org/internet/fact-sheet/internet-broadband/ [https://perma.cc/3XNL-777P].
[162] Seb Henbest et al., *New Energy Outlook 2019*, BLOOMBERG, https://about.bnef.com/new-energy-outlook/ [https://perma.cc/5Q5W-D94Q].
[163] FRED PEARCE, ENERGY HOGS: CAN WORLD'S HUGE DATA CENTERS BE MADE MORE EFFICIENT? (Yale School of Forestry & Environmental Studies, 2018), https://e360.yale.edu/features/energy-hogs-can-huge-data-centers-be-made-more-efficient [https://perma.cc/8BEN-DLKE].
[164] *Id*.

Google, in particular, is using its artificial intelligence technology to continuously improve its data center efficiency.[165] These artificial intelligence systems analyze how their data centers are working and help the centers adjust accordingly in real time—they learn and evolve to maximize productivity.[166] In addition, by placing data centers in cooler climates like Finland, Google uses cold seawater, instead of energy-intensive cooling systems, to cool their data centers.[167] These solutions require both the ingenuity and financial resources that are rare among major mining operations, and exemplifies why technology firms are better positioned to tackle their carbon footprint on their own than are cryptocurrency miners. Ultimately, the comparison between cryptocurrency mines and data centers in terms of energy usage further highlights the need for mining regulations because miners lack the economic incentive to make the shift towards majority renewable energy use.

VII. PROPOSED REGULATORY SCHEMES

There are currently three primary regulatory schemes that would effectively reduce the largely negative impact that cryptocurrency mining operations currently have on our public utility infrastructure and the environment. These options include (1) a ban on all cryptocurrency mining operations within the United States, (2) a cost-internalization scheme that more effectively places the costs of mining on the miners and not the communities within which they operate, and (3) a system of transaction fees that help control the adoption of a cryptocurrency market as well as raise revenue to help offset the negative externalities of the mining process.

A. Cryptocurrency Ban

The first possible solution is to ban cryptocurrency mining activity altogether. Such bans would effectively halt mining operations everywhere within the United States. Although such a solution seems ideal and practical, an outright ban would be misguided and could have several unintended consequences without considering the possible constitutional implications.

First and foremost, technology bans do not eliminate the technology but actually drive its use, development, and benefits elsewhere. If the

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[165] Michael Isberto, *What is the Environmental Impact of a Data Center?*, COLOCATION AMERICA (May 3, 2018), https://www.colocationamerica.com/blog/data-center-environmental-impacts [https://perma.cc/42BP-UFEU].
[166] *Id*.
[167] *Id*.

United States were to ban cryptocurrency mining operations, the blockchain technology underpinning the mining technology would continue to exist as the technology is decentralized. As such, operations would not halt; rather, they would just move to another country, allowing other governments to capture the benefits and possibly abuse its use. For instance, China just passed a cryptography law aimed at boosting cryptocurrency usage and development.[168] If the United States were to proceed with an outright ban, miners would most likely shift their operations to a more cryptocurrency-friendly country, such as China, and the United States would lose out on any potential economic or technological benefit. In fact, this is the main reason why China suddenly reversed course on its plans for a cryptocurrency ban and instead is seeking to capitalize on its growing popularity.[169] By placing a ban on cryptocurrency mining while at a critical but early stage in its development, the United States would be foreclosing on all possible opportunities of benefiting from the cryptocurrency market in the future. Even though doing so would help further the environmental cause at home while protecting public utility infrastructure, it would do nothing to stop the environmental degradation around the world because miners can simply move their operations abroad.

Furthermore, an outright ban on cryptocurrency mining in the United States would limit the development of blockchain technology at home while abdicating any extraordinary benefits, such as increased digital privacy and security. Moreover, a ban would reduce the chances of miners embracing renewable energy alternatives if mines become more expensive to operate. Additionally, in a world increasingly inundated with scams and fraud, blockchain technology helps businesses secure transactions, recover data, and verify information.[170] The benefits of the blockchain to business are unique and powerful: the technology allows for verification without having to be dependent on third-parties, it uses protected cryptography to secure the data ledgers, the transactions stored in the blocks are contained in millions of computers participating in the chain so there is no possibility that the data if lost cannot be recovered, and the origin of any ledger can be tracked along the chain to its point of origin.[171] Although China's ban on cryptocurrency mining is laudable for its impact

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[168] Ben Blanchard, *China passes cryptography law as gears up for digital currency*, REUTERS (Oct. 26, 2019), https://www.reuters.com/article/us-china-lawmaking/china-passes-cryptography-law-as-gears-up-for-digital-currency-idUSKBN1X600Z [https://perma.cc/ZE6B-83ME].
[169] *Id*.
[170] Ankit Patel, *The Top Advantages Of Blockchain For Businesses*, SMARTDATACOLLECTIVE (Nov. 17, 2018), https://www.smartdatacollective.com/top-advantages-blockchain-for-businesses/ [https://perma.cc/GHQ2-B53Y].
[171] *Id*.

on the environment, it would be unwise for the United States to move forward with such a ban in order to protect the environment and public utility infrastructure because it will inhibit the continued development of such a valuable emerging technology.

B. Transaction Fees

A second policy solution involves issuing transaction fees, i.e., a tax on each cryptocurrency transaction. The proposed fee would make transactions more expensive and subsequently reduce the demand for cryptocurrencies. This proposal, however, is misguided because of the individuals on whom the tax incidence ultimately falls. Coinbase, one of the largest brokerage firms for cryptocurrencies, currently charges exorbitant fees for using cryptocurrencies.[172] In addition to a 0.50% markup on the prevailing market price of the cryptocurrency, also known as the spread fee, broker charges range from $0.99 to $2.99 per transaction for any amount between $0.00 and $200.00. For amounts above $200.00, the firm charges a 1.49% transaction fee.[173] As a result, these transaction fees make using cryptocurrencies in the marketplace very expensive and prohibitive for a lot of potential users. Although these fees reduce the amount of transactions that occur, the fees do little to combat the increase in energy consumption by miners since the cost falls almost entirely on the cryptocurrency users.

A recent study out of Cornell University suggests that transaction fees may be contributing to Bitcoin's energy waste.[174] Transaction fees began as a way for users to pay for their transactions to be added to the blockchain faster than other users' transactions.[175] In theory, this makes sense from a market perspective; however, it has impractical real-life implications. For example, according to the Cornell study, "to use bitcoin to buy a $4 latte at Starbucks, you might have to either wait several hours for the purchase to go through or pay $5 to speed it up."[176] As previously mentioned, the blockchain system forces miners to compete to solve and complete the transaction so that only one miner gets paid. According to the study, "with more [transaction] fees, mining becomes more profitable,

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[172] Matthew De Silva, *Stock trading is virtually free—why isn't crypto?*, QUARTZ (Oct. 31, 2019), https://qz.com/1738595/crypto-trading-fees-remain-high-at-exchanges-coinbase-gemini/ [https://perma.cc/B9QN-D9JA].
[173] *Id*.
[174] Melanie Lefkowitz, *Transaction fees change the culture of bitcoin, study says*, CORNELL CHRON. (Oct. 30, 2019), https://news.cornell.edu/stories/2019/10/transaction-fees-change-culture-bitcoin-study-says [https://perma.cc/PQ4A-CAJ7].
[175] *Id*.
[176] *Id*.

which then induces more miners to enter, which then uses more electricity."[177] In essence, transaction fees make an already competitive ecosystem even more competitive and when more competition means more energy use, it is not necessarily a good thing.

Ultimately, while well-intentioned, transaction fees only place a burden on the consumer and increase the number of miners competing for a financial reward that comes with completing the transaction on the blockchain. Thus, there is no reduction or alteration of mining behavior while energy use continues to increase and consumers continue to pay more to use cryptocurrencies.

C. Cost Internalization

Finally, and most effectively, the United States could adopt a Pigouvian tax scheme on cryptocurrency mining activity. A Pigouvian tax is a tax on any market activity that generates negative externalities. In this case, the market activity, cryptocurrency mining, produces several negative externalities such as environmental degradation and damage to our public utility infrastructure. In order to correct the market failure, the Pigouvian tax is set to equal the social cost of the negative externalities to create a more efficient market outcome.[178] Such a tax scheme forces the cryptocurrency miners (or market participants) to internalize the costs that their activity imposes on the broader community.

A cost internalization regulatory scheme would largely reflect the "polluter-pays principles" in the environmental plan adopted by the European Union in Article 191(2) of the Treaty on the Functioning of the European Union: "Union policy […] shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at the source and that the polluter should pay."[179] Such a scheme raises revenue through the tax and forces miners to take financial responsibility for the harm they inflict on the environment and local public utility infrastructure. This outcome both incentivizes a switch to more renewable energy resources and reduces the costs that society is forced to pay.[180]

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[177] *Id*.
[178] *See* T.H. Tietenberg, *On Taxation and the Control of Externalities: Comment*, 64 THE AM. ECON. REV. 462 (1974).
[179] *Consolidated version of the Treaty on the Functioning of the European Union*, EUR-LEX, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A12008E191 [https://perma.cc/77P3-UCVX].
[180] Jon Turby, *Decarbonizing Bitcoin: Law and policy choices for reducing the energy consumption of Blockchain technologies and digital currencies*, ENERGY RSCH. & SOC. SCI. 3 (2018).

There are many examples of how these taxes have been successfully implemented to reduce the negative effects of certain conduct on the broader society. Taxes on plastic bags, for instance, help increase the use of more environmentally friendly paper bags by making plastic bags the more expensive choice. Likewise, taxes on carbon output help incentivize heavy polluters to invest in alternative energy sources, such as renewables. It is also important to consider who the tax burden ultimately falls on because that will determine whose behavior is changed.[181] In this case, the burden would fall entirely on the miners and traders of cryptocurrencies—the exact population whose conduct the regulation is aimed at controlling.

Given that the United States should prioritize capturing the technological and economic benefits of cryptocurrency mining activity, a cost-internalization scheme will help contain the damage to our environment and infrastructure while incentivizing miners to innovate and use alternative energy sources. Such a regulatory scheme seems like a win-win scenario that can be easily adopted and enforced and poses little political risk.

VIII. CONCLUSION

The proliferation of cryptocurrency mining—which is a direct result of cheap energy, lax regulations, and price volatility—has and will continue to have a devastating impact on the United States' public utility infrastructure and environment. Without a sound regulatory scheme to combat the effects of cryptocurrency mining, the country will continue to see the negative social and environmental impacts of cryptocurrency mining. Given the available solutions, a regulatory scheme that embraces cost-internalization by imposing a Pigouvian tax on mining activity is the best model to combat the negative externalities that inevitably result from cryptocurrency mining. Moreover, although mining has several negative effects on the broader society, an outright ban on mining or increased transaction fees for cryptocurrency use will neither help resolve the environmental problems that mining created nor allow the United States to capitalize on the numerous technological and economic benefits that the development of blockchain technology presents.

[181] *Id*.