DIGITAL ASSETS: ADVANCING ENVIRONMENTAL REGULATIONS

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Abstract

Digital assets are a disruptive category of intangible assets that include cryptocurrencies, stablecoins, and NFTs. These assets are recorded on distributed cryptographic ledgers run by networks of very powerful computers. In a common proof of work system (e.g., Bitcoin), the networked computers compete against each other to solve complex equations. This is known as "mining," and has resulted in an arms race as network operators seek more powerful computers and cheaper electricity. Although digital assets are subject to great scrutiny regarding their role in U.S. financial markets and potential criminal activity, far less regulatory effort has been aimed at curbing their environmental impact. The expansion of digital assets has resulted in a large spike in energy usage, emissions, and e-waste around the globe.

Some in the industry have made great strides to make digital assets more environmentally friendly, but this does not go far enough. Very recently, environmental regulators in the U.S. started to turn their attention to digital assets; most notably, New York passed a moratorium on new crypto mining facilities at the end of 2022. President Biden's administration has recognized a need for national environmental rules for digital assets, but the scope and likely success of any regulation or laws is unclear. This note pays special attention to the recent Office of Science and Technology Policy's environmental digital asset report and Congress' responsive efforts. After analyzing various methods of regulating digital assets, this note advises a national, and international, approach to reach effective uniform standards and avoid patchwork regulation. While private efforts, such as Ethereum's "Merge," can greatly lower the environmental impact of digital assets, the government should not rely on environmental self-regulation to curb externalities.

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I. *Introduction*

Digital assets, including cryptocurrencies, are increasingly popular financial instruments, but they have unfortunate externalities. Digital assets demand large amounts of electricity and computing power and are responsible for a spike in emissions and waste.[2] Their financial disruption is an opportunity for a new frontier in environmental regulation. This Note seeks to describe the environmental impact of digital assets and argues for their environmental regulation. In doing so, this Note will discuss ongoing tentative forays by states and the Federal government into possible regulation.

Part II will first describe digital assets and detail how they operate. Then it will discuss the ongoing effort to draw attention to the need for environmental regulation. Part III will depict the energy usage and environmental impact of crypto. This impact evaluation will be split between the impact of Bitcoin and the impact of other cryptocurrencies.

Part IV will delve into the preliminary environmental regulatory response to crypto's energy usage, split between federal, state, and international responses. Importantly, this section will discuss a major environmental report by the OSTP, and potential subsequent legislation. The consideration of state responses will focus mostly on New York, which recently partially banned proof of work mining.[3] However, other states have passed regulations that are

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[2] *See, e.g.*, Alex de Vries, *Bitcoin's Energy Consumption is Underestimated: A Market Dynamics Approach*, 70 ENERGY RSCH. & SOC. SCI. 101721, at 1 (2020) ("Studies conducted in 2018 estimated that the network's total electrical energy consumption equaled that of entire developed countries like Ireland, Hong Kong, and possibly even Austria"); OSTP, CLIMATE AND ENERGY IMPLICATIONS OF CRYPTO-ASSETS IN THE UNITED STATES 5 (2022) ("From 2018 to 2022, annualized electricity usage from global crypto-assets grew rapidly, with estimates of electricity usage doubling to quadrupling. As of August 2022, published estimates of the total global electricity usage for crypto-assets are between 120 and 240 billion kilowatt-hours per year, a range that exceeds the total annual electricity usage of many individual countries, such as Argentina or Australia. This is equivalent to 0.4% to 0.9% of annual global electricity usage, and is comparable to the annual electricity usage of all conventional data centers in the world").

[3] *See* French, *infra* note 172 ("The New York Legislature early Friday approved a two-year, limited moratorium on digital currency mining at fossil fuel power plants.").

protective of cryptocurrencies in an attempt to attract business.[4] Section IV's analysis of international regulation will be mainly focused on China's ban and the EU's gestating digital asset regulation, MiCA.

Part V considers potential private actions to "green" crypto and possible avenues for environmental regulation going forward. This includes taxes, moratoriums, and energy premiums, among other options. Finally, Part VI concludes and advocates for international cooperation to accomplish regulatory goals.

II. *Background*

A. **What are Digital Assets?**

"Digital assets" are digital representations of value that are recorded on a cryptographic distributed ledger.[5] This section will describe types of digital assets including cryptocurrencies, along with other digital assets, such as Non-Fungible Tokens (NFT), built using blockchains. This will include a brief history of cryptocurrencies and their uses. The section will also detail how proof of work and proof of stake methods operate and the resulting race for computing power.

Digital assets are gaining permeance. There are many types of digital assets, including cryptocurrencies, NFTs, and stablecoins.[6] The first cryptocurrency, Bitcoin was created in 2009.[7] There are now tens of thousands of cryptocurrencies.[8] Bitcoin's network uses a

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[4] *See infra* Section IV.B.2 (discussing state regulations that encourage growth of crypto mining).

[5] *Digital Assets*, IRS, https://www.irs.gov/businesses/small-businesses-self-employed/digital-assets [https://perma.cc/MG8F-39UG] ("Digital assets are broadly defined as any digital representation of value which is recorded on a cryptographically secured distributed ledger or any similar technology").

[6] Corryanee Hicks, *Different Types of Cryptocurrencies*, FORBES (updated Mar. 15, 2023), https://www.forbes.com/advisor/investing/cryptocurrency/different-types-of-cryptocurrencies/#:~:text=How%20Many%20Cryptocurrencies%20Are%20There,market%20capitalization%20of%20%24850%20billion (describing different types of cryptocurrencies).

[7] De Vries, *supra* note 1, at 1 ("The … Bitcoin network subsequently started running at the start of 2009.").

[8] Hicks, *supra* note 5 ("CoinMarketCap reports that there are approximately 22,932 cryptocurrencies").

decentralized system run by participating computers which create computationally expensive "blocks."[9] This is known as the "blockchain."[10] Whenever digital assets on a blockchain are sold or bought, the information behind that transaction is recorded in a block.[11] Cryptographic calculations are run by a dispersed network of computers to ensure that digital assets are verified, and not counterfeited or double-spent.[12] This distributed system is known as "mining."[13] There are two ways digital assets are typically acquired: they are either bought on a secondary market—somewhat analogous to a stock transaction—or they are created through the blockchain.[14]

The blockchain rewards the computers needed to run the network proportionally to those computers' computing power. There are two main ways computational power is used in cryptocurrency networks: "proof of work" and "proof of stake."[15] Proof of work systems, like Bitcoin, operate by verifying blocks through a competitive race to solve complex math puzzles and reward miners by giving them coins.[16] Proof of stake cryptocurrencies are run by validators who "stake" their currency to try to verify transactions on

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[9] De Vries, *supra* note 1, at 1 ("Bitcoin protocol makes the process of creating a block computationally expensive.").

[10] *Id.* ("In this network, anyone can join their computer hardware . . . to help creating new blocks of transactions for Bitcoin's blockchain.").

[11] TODD PHILLIPS, CTR. FOR AM. PROGRESS, THE SEC'S REGULATORY ROLE IN THE DIGITAL ASSET MARKETS 3 (2021) ("When digital assets are bought, sold, or traded, information about that transfer – including the wallet the asset was transferred from, the wallet it was transferred to, and a timestamp of the transaction – is recorded in a new "block" that is added on to the end of the online "chain.").

[12] *Id.* ("[C]ryptographic calculations are then conducted by computers around the globe, known as 'miners' or 'validator pools,' to ensure that assets cannot be counterfeited or double-spent.").

[13] De Vries, *supra* note 1, at 1 ("The whole process of creating new blocks via this proof-of-work system is known as 'mining.'").

[14] PHILLIPS, *supra* note 10, at 3 (explaining the way that digital assets are transferred and purchased by consumers).

[15] Jeffrey M. Kelly & Jeffrey E. Joseph, *Crossing the Wires of Energy and Cryptocurrency Policy: U.S. Congress Investigates the Environmental Impact of Crypto Mining*, NAT. L. REV., Feb. 4, 2022, at 1 (elaborating on the verification processes behind the computational power employed in cryptocurrency mining).

[16] *Id.* (elucidating the nature of proof of work systems employed in popular cryptocurrencies like Bitcoin).

the network and update the blockchain.[17] Unlike proof of work networks, proof of stake networks do not rely on raw computational power.[18] In addition to these two main consensus protocols, there are also networks that use "delegated proof of stake" (DPoS) and "delegated Byzantine fault tolerance" (DBFT) models.[19] In the DPoS protocol, token holders vote for qualified block producers which ensures a faster, more energy efficient network.[20] DBFT blockchains let nodes assign "delegates" who approve blocks and a "speaker" who proposes blocks.[21] Although more platforms are now using proof of stake, many dominant cryptocurrencies are still using the more energy intensive proof of work calculations.[22]

While much attention is paid to cryptocurrencies, other digital assets run on the same, or similar blockchains. For example, NFT's operate on Ethereum's network.[23] Other digital assets include "stablecoins," which are cryptocurrencies which are pegged at a certain value, such as the U.S. dollar.[24] Networks like Ethereum are open source, allowing for additional automated programs like smart contracts to be added.[25] As uses for blockchains grow, digital assets will likely continue to require increasing computer power.

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[17] *Id.* (expounding upon proof of stake systems used in cryptocurrency mining verification).

[18] *Id.* ("This method rewards long-term investment in a particular blockchain, rather than raw computing power.").

[19] Peter Howson & Alex de Vries, *Preying on the Poor? Opportunities and Challenges for Tackling the Social and Environmental Threats of Cryptocurrencies for Vulnerable and Low-Income Communities*, 84 ENERGY RSCH. & SOC. SCI. no. 102394, 2022, at 2 (elaborating on alternative cryptocurrency systems to the proof and stake and proof of work systems).

[20] *Id.* at 3 (describing DPoS protocols).

[21] *Id.* at 3, n. 6 ("Similarly, DBFT blockchains allow nodes to assign delegates (who can approve blocks), and a speaker (who proposes the next block.").

[22] *See id*. (explaining the different computing power calculation processes that cryptocurrencies employ).

[23] *Learn About Ethereum*, ETHEREUM, https://ethereum.org/en/learn/ [https://perma.cc/7WSV-9L26] (describing the function and purpose of the Ethereum platform and cryptocurrency).

[24] Hicks, *supra* note 5 (explaining the nature of stablecoins like Tether, which is pegged to a $1 value).

[25] *Learn about Ethereum*, *supra* note 22 (explaining the nature of the Ethereum token and platform).

B. **Emerging Calls for Regulation and Change**

This subsection will address crypto's unregulated nature and growing calls for various forms of regulation.[26] Afterwards, this subsection will introduce recent calls for environmental regulation.[27]

Government regulation of cryptocurrencies and digital assets is currently in flux, given the overlapping and conflicting spheres of regulation.[28] The SEC, the CFTC, FinCEN, and the FTC have potential jurisdiction over digital assets.[29] These agencies regulate traditional aspects of our financial system.[30] However, digital assets, and cryptocurrencies especially, disrupt typical categorization.[31] Some equate cryptocurrencies to precious metals such as gold, whose values are driven by scarcity and demand.[32] Conversely, others argue that they are akin to U.S. dollars, fiat currency, offering fungibility and ease of use.[33] However, the volatility and difficulties of transacting in cryptocurrencies belies that particular notion.[34] Regulation in the U.S. has traditionally evolved to ensure stable prices and orderly and efficient investments, protect investors, and serve the public interest.[35] These traditional regulatory motives

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[26] PHILLIPS, *supra* note 10, at 5–7 (highlighting issues in digital asset market due to lack of regulation).

[27] *See* Kelly & Joseph, *supra* note 14 (discussing the unaddressed issues surrounding cryptocurrency's relationship with the environment); de Vries, *supra* note 1 (arguing that Bitcoin is having a massive negative effect on the environment).

[28] *See, e.g.*, PHILLIPS, *supra* note 10, at 4 (introducing a need for digital asset regulation).

[29] *See id*. (discussing the jurisdictional issues surrounding administrations and cryptocurrency).

[30] *Id.* at 5–7 (describing the SEC's regulatory authority).

[31] *Id*. at 3 ("Further complicating the issue is that despite operating on a common underlying technology (the blockchain), not all digital assets have the same fundamental properties and can be used for the same purpose.").

[32] *Id.* at 3 (discussing the problems with categorizing cryptocurrency under the current understanding of assets).

[33] *See id.* at 4 (elaborating on the different arguments in support of cryptocurrencies status among U.S. regulations).

[34] *Id.* at 4 ("Yet currencies are only useful if they can be used as a medium of exchange.").

[35] *Id.* at 4 ("Importantly, products with these functions—and the infrastructure developed around them—have traditionally been regulated in the U.S. financial system to ensure that prices are stable; that investments are driven fairly and in an orderly and efficient manner to their most

currently drive much of the discussions about digital assets.[36] For example, because digital assets are mostly unregulated, their prices are subject to manipulation, fraud, and theft.[37] Additionally, determining taxes owned on cryptocurrencies is often difficult.[38] Finally, digital assets are used to fund illicit activities such as ransomware and drug trafficking.[39] Less recognized is a need for environmental regulation of digital assets.[40] Some academics have been pushing recently for greater acknowledgement, and regulators and players in the market are beginning to respond.[41] In 2018, studies estimated that Bitcoin's total energy consumption rivaled countries like Ireland and Austria.[42] This led to increased attention in the sphere and the creation of the Cambridge Bitcoin Electricity Consumption Index.[43] Alex de Vries has been a major voice in academia, offering more exacting estimates of energy usage and emissions of cryptocurrencies.[44] In particular, early estimates of

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productive uses; that investors are protected; and that the public interest is served").

[36] *See, e.g.*, Franklin R. Edwards et al., *Crypto Assets Requite Better Regulation: Statement of the Financial Economists Roundtable on Crypto Assets*, FIN. ANALYSTS J., Second Quarter 2019, at 14 ("In some incidents of fraud, legitimate participants in crypto asset markets have incurred substantial losses, which has raised the issue of whether more effective regulatory oversight of crypto markets is needed, and if so, what kind of regulation and by whom").

[37] *Id.* (arguing for regulation of cryptocurrency); PHILLIPS, *supra* note 10, at 4. (discussing the problems of unregulated cryptocurrency markets).

[38] PHILLIPS, *supra* note 10, at 4 (explaining many of the difficulties in regulating cryptocurrency).

[39] *Id.* (discussing the risks currently at issue in the cryptocurrency market).

[40] *See* de Vries, *supra* note 1, at 1 ("While the network had of course been consuming resources since inception, it was this peak in growth that put the topic of the resource intensity of running Bitcoin in the spotlight.").

[41] *See id.* ("Various organizations need this for multiple purposes like properly addressing the urgency of the problem, implementing the right policy response in the right location and setting up mitigation programs.").

[42] *Id.* ("Studies conducted in 2018 estimated that the network's total electrical energy consumption equaled that of entire developed countries like Ireland, Hong Kong, and possibly even Austria.").

[43] *Id.* at 1–2 ("This led to a spark of debate and interest among academics. The University of Cambridge even added a new source, the Cambridge Bitcoin Electricity Consumption Index (CBECI), for daily estimates of the electricity consumption by the Bitcoin network.").

[44] For example, see *id.*

emissions seem to have been unrealistic, and de Vries called for more precise methodologies, finding that in 2019, Bitcoin's real energy usage far outstripped common estimates.[45] More recently, in October 2021, a large group of national and international organizations sent a letter to Congress urging leaders to take steps towards mitigating the environmental impacts of cryptocurrency.[46] Calling out proof of work mining, the letter specifically calls attention to e-waste and the massive amounts of emissions produced in powering computer calculations.[47] Within the past year, regulators and Congress have begun to look into potential environmental regulation for cryptocurrencies.[48]

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[45] *Id.* at 2 ("As per September 30, 2019, these two estimated the network was consuming 73.1 to 78.3 terawatt-hours (TWh) of electrical energy annually. For a single Bitcoin transaction this translates to an electrical energy footprint roughly equal to the electrical energy consumption of a British household in two months.").

[46] Letter from National and International Organizations to, Nancy Pelosi, Speaker of the House, United States House of Representatives, Chuck Schumer, Majority Leader, United States Senate, Kevin McCarthy, Minority Leader, United States House of Representatives, and Mitch McConnell, Minority Leader, United States Senate (Oct. 7, 2021) [hereinafter *Organizations Letter*] ("We, the more that 65 climate, economic, racial justice, business and local organizations write to you today to urge Congress to take steps to mitigate the considerable contribution portions of the cryptocurrency markets are making to climate change and the resulting greenhouse gas (GHG) emissions, environmental, and climate justice impacts it will have.").

[47] *Id*. at 2 ("The reason for this considerable GHG and e-waste footprint is rooted in the deeply energy intensive 'Proof of Work' process used by the two largest cryptocurrencies, Bitcoin and Ethereum. With Proof of Work cryptocurrencies, miners compete to validate transactions on their blockchains. In the case of Bitcoin, about every ten minutes, the first miner to correctly identify a 64-digit hexadecimal number associated with the new block receives 6.25 Bitcoins as a reward—and to do so requires massive computing capacity.").

[48] *See, e.g.*, Kelly & Joseph, *supra* note 14, at 1 ("As with most emerging technologies, policymakers are still exploring the best approaches to regulating these new digital assets and business models."); *see also* Brad Plumer, *Climate Change is Speeding Toward Catastrophe. The Next Decade is Crucial, U.N. Panel Says.*, N.Y. TIMES (Mar. 20, 2023), https://www.nytimes.com/2023/03/20/climate/global-warming-ipcc-earth.html (discussing how the UN has recently added more urgency and warned that greater global cooperation is needed to cut emissions by half by 2030 or else face global warming above 1.5º C).

In the private sector, many actors are moving towards a greener future of their own volition. Less energy intensive proof of stake models are increasingly popular and many propose a natural, greener future in crypto.[49] For example, the Crypto Climate Accord was released by the Bitcoin Mining Council, proposing net-zero emissions by 2030.[50] Likewise, Ethereum's long awaited switch to a proof of stake model represents a landmark in private efforts to be more energy conscious.[51]

III. *Environmental Impact of Cryptocurrencies*

This section will focus on the deliberately energy intensive operation of Bitcoin.[52] It will also study other top cryptocurrencies such as Ethereum. In doing so, this section will consider scientific debate over how large of an impact crypto mining is having on the

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[49] *See* PHILLIPS, *supra* note 10, at 9 ("Bitcoin operates on a very energy-intensive "proof of work" blockchain; new blockchains, meanwhile, are beginning to use a "proof of stake" model that reduces the energy required to record new transactions.").

[50] *Id*. ("The Bitcoin Mining Council, a coalition of bitcoin miners, has released the Crypto Climate Accord to work towards net-zero emissions from digital assets by 2030, and some bitcoin miners are moving their operations to locales that are powered by solar power or hydroelectricity.").

[51] *The Merge*, ETHEREUM (Mar. 30, 2023), https://ethereum.org/en/upgrades/merge/ [https://perma.cc/T6SQ-WUL3] ("The Merge reduced Ethereum's energy consumption by ~99.95%").

[52] *See* Cory Kilgannon, *The Climate Cost of a Bitcoin Boom*, N.Y. TIMES, (last updated Dec. 6, 2021), https://www.nytimes.com/2021/12/05/nyregion/bitcoin-mining-upstate-new-york.html ("The
prospectors in this digital gold rush need lots of cheap electricity to run thousands of energy-guzzling computer rigs."); *Comparisons*, CAMBRIDGE BITCOIN ELECTRICITY CONSUMPTION INDEX, https://ccaf.io/cbeci/index/comparisons [https://perma.cc/3NMU-ALD7] (displaying Bitcoin's high rate of electricity usage).

environment.[53] It will also describe the environmental costs outside of energy usage, such as e-waste.[54]

C. **Impact of Bitcoin**

In America, Bitcoin miners have set up shop by, or in, old and often unused energy plants seeking the cheapest electrical rates.[55] Around the nation, Bitcoin miners are using coal power plants, especially in places like New York, Texas, and Pennsylvania.[56] The higher the value of Bitcoin, the more incentive miners have to use less efficient hardware, or more electricity, in an effort to drive up the "hash rate."[57] As a result, Bitcoin mining results in huge amounts of energy usage and emissions.[58] Bitcoin mining consumed 107.65

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[53] *See* Sergio L. N. Alonso et al., *Cryptocurrency Mining from an Economic and Environmental Perspective. Analysis of the Most and Least Sustainable Countries*, ENERGIES, 14, 2021, at 1 ("There is also an ongoing debate about the pollution generated by cryptocurrency mining, and whether or not the use of renewable energies will solve the problem of its sustainability.").

[54] *See, e.g.*, Howson & de Vries, *supra* note 18, at 2 ("As mining operations use vast amounts of highly
specialized and short-lived hardware, obsolete equipment is likely to cause additional damage to the environment and human health, especially in developing areas where much of this hazardous electronic waste (e-waste) is disposed.").

[55] *Organizations Letter*, *supra* note 45, at 3 ("Other power plants across the country are repowering to mine Bitcoin as well. Stronghold Digital Mining has purchased and begun mining at three coal waste plants in Pennsylvania, while Marathon Digital is partnering with once-struggling coal-fired plants in Montana.").

[56] *Id.* at 2–3 ("In Seneca Lake, New York, the private equity firm Atlas Holdings has been utilizing a natural gas plant owned and operated by Greenidge Generation LLC to mine Bitcoin . . . . [f]ollowing a crackdown on cryptocurrency miners in China, many miners are moving to Texas . . . [o]ther power plants across the country are repowering to mine Bitcoin as well. Stronghold Digital Mining has purchased and begun mining at three coal waste plants in Pennsylvania, while Marathon Digital is partnering with once-struggling coal-fired plants in Montana.").

[57] *See* de Vries, *supra* note 1, at 3 (explaining that "Hash rate" is the speed at which cryptographic calculations operate at).

[58] *See id.* at 2 ("For a single Bitcoin transaction this translates to an electrical energy footprint roughly equal to the electrical energy consumption of a British household in two months.").

terawatt-hours (TWh) of electricity in 2022.[59] While the value of bitcoin crashed in the wake of FTX[60], monthly energy consumption only temporarily fell from about 10.67 TWh in May 2022, to 7.63 TWh in January 2023—in fact energy consumption has now returned to at least pre-FTX crash levels.[61] Bitcoin mining is currently estimated to lead to the yearly emission of 70.5 million tons of CO_2 equivalent greenhouse gasses.[62] This is comparable to the yearly emissions of Austria.[63]

Bitcoin mining also leads to large amounts of e-waste.[64] While historically miners could use laptops or desktop PCs to successfully mine blocks, miners now uses highly specialized hardware—Application Specific Integrated Circuit (ASIC) units.[65] Bitcoin uses the SHA-256 algorithm which allows for these ASICs.[66]

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[59] *Bitcoin Network Power Demand*, CAMBRIDGE BITCOIN ELEC. CONSUMPTION INDEX, https://ccaf.io/cbeci/index [https://perma.cc/2Z8G-6Z8V]. As of April 11, 2023, Bitcoin's energy usage is increasing, and is estimated to use a total of 139.2 TWh in 2023. *See id.*

[60] *See* Ryan Browne, *The FTX Disaster has set Back Crypto by 'Years'—Here are 3 Ways it Could Reshape the Industry*, CNBC (updated Dec 19, 2022, 7:01 AM), https://www.cnbc.com/2022/12/19/three-ways-the-ftx-disaster-will-reshape-crypto.html [https://perma.cc/5ZGY-VCY2] (explaining the collapse of FTX, a thirty-two billion dollar crypto exchange, and investor fears).

[61] *Bitcoin Network Power Demand*, *supra* note 58.

[62] *Bitcoin Greenhouse Gas Emissions*, CAMBRIDGE BITCOIN ELEC. CONSUMPTION INDEX, https://ccaf.io/cbeci/ghg/index [https://perma.cc/R3HH-ZR5G].

[63] *Greenhouse Gas Comparisons*, CAMBRIDGE BITCOIN ELEC. CONSUMPTION INDEX https://ccaf.io/cbeci/ghg/comparisons [https://perma.cc/6NMA-S7EE].

[64] *See, e.g.*, Howson & de Vries, *supra* note 18, at 2 ("As mining operations use vast amounts of highly specialized and short-lived hardware, obsolete equipment is likely to cause additional damage to the environment and human health, especially in developing areas where much of this hazardous electronic waste (e-waste) is disposed.").

[65] *Id*. ("While only 10-years ago, competing miners could successfully win blocks with an average laptop, today, viable operations require significant investment in specialized hardware known as Application Specific Integrated Circuit (ASIC) units4 to avoid spending more money on electricity than can be gained through mining.").

[66] Ulrich Gallerdorfer et al., *Energy Consumption of Cryptocurrencies Beyond Bitcoin*, 4 JOULE, 1839, 1843 (2020) ("Bitcoin, for instance, uses the SHA-256 algorithm that allows for mining with highly specialized,

While ASICs are more powerful and energy efficient than general purpose computing chips, they are designed to only run Bitcoin's SHA-256 algorithm.[67] The hardware cannot be used for any other purpose.[68] When the economy is stable and miners efficiently use cheap electricity, there is a computing arms race to mine ever more Bitcoin.[69] This arms race leads to ASICs being replaced with newer, more powerful models, every one to two years.[70] As these computers do not do anything other than run the SHA-256 hash function, the obsolete models are thrown away.[71] In 2021, redundant ASICs led to

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ASIC-based devices, which are considerably more energy efficient than conventional graphic processing units (GPUs).").

[67] Howson & de Vries, *supra* note 18, at 2 ("Bitcoin's global network of tailored ASIC units, more powerful than all the world's super-computers put together many times over, cannot be repurposed to do anything else, besides running the SHA-2565 hash function used to mine a cryptocurrency that few will ever use, beyond short term speculation.").

[68] This is unlike other cryptocurrencies like Ethereum (when it used a proof of work model), where GPU's are often used and then repurposed once obsolete. *See* Kyle Orland, *The end of Ethereum mining could be a bonanza for GPU shoppers,* ARS TECHNICA (Sep. 16, 2022), https://arstechnica.com/gaming/2022/09/the-end-of-ethereum-mining-could-be-a-bonanza-for-gpu-shoppers/ [https://perma.cc/NC6L-L26E] ("For most of the world, yesterday's long-awaited Ethereum "Merge"—which took the cryptocurrency from proof-of-work mining to a proof-of-stake model—is notable for cutting Ethereum's energy consumption by 99.95 percent. But for gamers, the Merge has already contributed to a dramatic shift in the market for GPUs and could continue to drive down graphics card prices going forward.").

[69] Howson & de Vries, *supra* note 18, at 2 ("In stable market conditions, where miners use the world's cheapest electricity, the global PoW arms race still requires ASIC units to be replaced for newer and more efficient models approximately every 12–24 months.").

[70] *Id.* ("In stable market conditions, where miners use the world's cheapest electricity, the global PoW arms race still requires ASIC units to be replaced for newer and more efficient models approximately every 12–24 months."); *see also* Michael Taylor, *The Evolution of Bitcoin Hardware*, 50 COMPUTER 58 (2017) (describing the successively more powerful generations of computers used to mine Bitcoin).

[71] Howson & de Vries, *supra* note 18, at 2 ("Bitcoin's global network of tailored ASIC units, more powerful than all the world's super-computers put together many times over, cannot be repurposed to do anything else, besides running the SHA-256 hash function used to mine a cryptocurrency that few will ever use, beyond short term speculation.").

30.7 kilotons of e-waste, mostly in developing countries.[72] Given Bitcoin's recent market crash, many miners are likely trying to exit the mining business, leading to more e-waste.

D. **Other Cryptocurrencies' Impact**

This section will focus on the energy usage of cryptocurrencies other than Bitcoin, mainly that of Ethereum.[73] Importantly, this will include a discussion Ethereum's transfer to the more efficient proof of stake model.[74] In addition, this section will discuss other coins and estimates of their energy consumption and emissions.[75]

After Bitcoin, Ethereum is the most valuable cryptocurrency by market capitalization.[76] Long delayed, Ethereum switched from its current proof of work model to proof of stake in a process called "the Merge."[77] The Merge occurred on September 15, 2022.[78] While

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[72] *Id*. ("Redundant units created around 30.7 kilotons of e-waste in 2021 [22], much of which was disposed of in developing countries").

[73] *See, e.g*., Gallerdorfer et al., *supra* note 65 (discussing top players in the cryptocurrency market); *Ethereum Energy Consumption Index*, DIGICONOMIST (April 11, 2023), https://digiconomist.net/ethereum-energy-consumption [https://perma.cc/7JZ8-WGYJ] (discussing Ethereum's energy consumption).

[74] *See* Kelly & Joseph, *supra* note 14, at 1 ("The second form is "proof of stake," which newer platforms like Cardano and ETH2 use, promises to require considerably less energy to operate. With this method, validators "stake" their currency for a chance at verifying new transactions and updating the blockchain").

[75] *Organizations Letter, supra* note 45, at 1 ("With the market off its May peak, Bitcoin mining is estimated to consume some 91 terawatt-hours of electricity annually—more than Finland, a nation of approximately 5.5 million.").

[76] Ethereum has a market of about $194 billion, as opposed to Bitcoins $446 billion. *Today's Cryptocurrency Prices*, https://crypto.com/price [https://perma.cc/W7FL-BKK3]; *see also* Gallerdorfer et al., *supra* note 65 (providing a chart of the cryptocurrencies with the most market share).

[77] *See* Francisco Pires, *Ethereum Looks Set to Undergo The Merge in August*, TOM'S HARDWARE (May 20, 2022), https://www.tomshardware.com/news/ethereum-to-undergo-the-merge-in-august-2022 [https://perma.cc/4WVA-XQ5T] (discussing the Merge generally).

[78] *The Merge*, *supra* note 50 (describing the Merge).

Ethereum was a proof of work cryptocurrency, in 2022 it was using at a minimum about seventeen TWh per year, if not an estimated eighty TWh per year.[79] By switching to proof of stake, Ethereum has lowered its energy usage by 99.84 percent.[80] The Merge was almost mythical in the crypto world, given that it took eight years to come to fruition.[81] Unlike many cryptocurrencies, a nonprofit called the Ethereum Foundation helps supervise Ethereum.[82] However, there is no direct authority and a loose group of engineers around the world orchestrated the shift to proof of stake.[83] These programmers worked for about four years to create a new blockchain and test security issues and bugs that could occur during the transition.[84] In December 2020, Beacon Chain, something of a beta for proof of stake Ethereum, was released.[85] Beacon Chain was a separate network created to integrate with Ethereum, hence "the merge."[86] Given that most proof of work miners' systems were made obsolete by the Merge, there was controversy and some resistance leading up to the transition.[87]

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[79] *Ethereum Energy Consumption Index*, *supra* note 72 (charting Ethereum's energy consumption by TWh per year).

[80] Charts provide a clearer picture of just how severe the drop in energy usage was. *Id.*

[81] David Yafe-Bellany, *The Crypto World Can't Wait for 'the Merge'*, N.Y. TIMES (Aug. 2, 2022), https://www.nytimes.com/2022/08/26/technology/crypto-ethereum-the-merge.html ("But if all goes according to plan, the Merge will take place around Sept. 15, more than eight years after it was initially discussed.").

[82] *Id.* ("A nonprofit called the Ethereum Foundation helps supervise the platform."); ETHEREUM FOUNDATION, https://ethereum.foundation/.

[83] Yafe-Bellany, *supra* note 80 ("But in reality, Ethereum is run by a loose group of engineers across the world; no top-down authority orchestrated the Merge.").

[84] *Id.* ("Engineers had to construct a new blockchain, and run tests to check for security holes or other technological bugs that might disrupt the transition.").

[85] *Id.* ("In December 2020, Ethereum programmers took a big step toward the Merge by releasing a crypto platform called the Beacon Chain, a proof-of-stake system designed to provide the foundation for an upgraded Ethereum.").

[86] *Id.* ("After two years of testing, the Beacon Chain is finally set to integrate with Ethereum in mid-September—the merge that gives the process its name.").

[87] *Id.* ("In a recent corporate report, Hive Blockchain, a crypto mining firm that draws revenue from both Bitcoin and Ethereum, said a switch to proof

While Bitcoin now accounts for much of the current total cryptocurrency energy usage, attention also needs to be focused on other coins. Many cryptocurrencies use differing mining algorithms. Some algorithms allow for ASIC devices like Bitcoin, but other algorithms (like pre-Merge Ethereum) only allow for Graphics Processing Units (GPUs), which although powerful, are less energy efficient.[88] These ASIC-resistant cryptocurrencies, like Monero, require far more energy per operation than other coins.[89] In 2020, Monero used about a third as much energy as Ethereum to operate, while only having a market cap less than a fifteenth that of Ethereum and a hashrate orders of magnitude smaller.[90] The estimates of energy consumption of other coins are likely underestimated given the wide variety of types of computers and locations.[91]

IV. *Forays into Environmental Crypto Regulation*

This part will discuss regulatory actions taken by the federal government, the states, and foreign countries. The various forays demonstrate the patchwork nature of current digital asset environmental regulation.

A. Actions Taken by the Federal Government

As of yet, no concrete action regarding crypto regulation has been taken by the Federal government. However, 2022 was a monumental year as policymakers appeared to be earnestly looking at possible environmental regulations on digital assets. This section will discuss Executive Orders, along with lobbying efforts. Additionally, this section will delve into House and Senate meetings. Importantly, this section will also examine the recent OSTP report on

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of stake 'may render our mining business less competitive or less profitable.'").

[88] Gallerdorfer et al., *supra* note 65, at 1 ("It is important to note that currencies with ASIC-resistant algorithms consume an overproportionate amount of energy in relation to their market capitalization.").

[89] *Id.* ("A second example is Monero, which became ASIC-resistant after an update in March 2018.").

[90] *Id.* at 1, 3 (discussing Monero's market share and amount of power used).

[91] *Id.* at 2 ("Including outdated and unprofitable mining devices in the estimate has been found to
distort the energy demand estimate and overvalue the resulting carbon emissions by a factor of 4.5.").

environmental regulation of digital assets. Finally, this section will discuss potential legislation.

In January 2022, the House Energy and Oversight Subcommittee held a hearing with five industry experts to address crypto's energy consumption.[92] Experts noted that crypto's energy inefficiency is "a feature, not a bug."[93] Agreeing that crypto should be more energy efficient, the experts diverged in discussing paths forward.[94] For example, John Belizaire thought that crypto could help the transition to renewable energy by operating when renewable energy is not being used and would otherwise be wasted.[95]

Following this hearing, on March 9, 2022, President Biden signed the Executive Order "Ensuring Responsible Development of Digital Assets," a sweeping command requiring Federal agencies to study and issue policy recommendations regarding digital assets and cryptocurrencies.[96] While much of the order was focused on a foundation for financial regulation and combating potential crime, it

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[92] Kelly & Joseph, *supra* note 14, at 2 ("On January 20, 2022, the U.S. House of Representatives Committee on Energy and Commerce's Subcommittee on Oversight and Investigations held a hearing, where the externalities of cryptocurrency mining were the focus of the agenda . . . . The five industry experts testifying . . . had competing views on how regulators should address the energy consumption of cryptocurrencies . . . .").

[93] *Id.* ("[E]xperts opin[ed] that the computational demands were a "feature, not a bug.").

[94] *See id.* ("The five industry experts testifying before the House Energy and Commerce Oversight Subcommittee had competing views on how regulators should address the energy consumption of cryptocurrencies . . . .").

[95] *Id.* ("John Belizaire . . . said that cryptocurrency mining could further accelerate the transition to renewable energy sources from an energy perspective . . . . Belizaire highlighted that . . . cryptocurrency miners can turn their systems off when necessary, giving miners the ability to absorb excess energy from a given area's electrical grid rather than straining it. This ability to start and stop or pause computing processes can increase grid resilience by absorbing excess energy from renewable resources that provide more power than the grid can handle.").

[96] Exec. Order No. 14,067, 87 Fed. Reg. 14147 (Mar. 14, 2022) ("[T]he Secretary of the Treasury . . . shall submit to the President a report . . . on the implications of developments and adoption of digital assets . . . . The report shall also include policy recommendations . . . .").

also contemplated environmental impacts.[97] The now stated policy of the United States is to reduce "negative climate impacts and environmental pollution, as may result from some cryptocurrency mining."[98]

The order required the Director of the Office of Science and Technology Policy (OSTP) to consult with the EPA, the Secretary of Energy, and the National Climate Advisor and submit a report on crypto and the environment to the President within 180 days of the order.[99] The report was required to consider connections between distributed ledger technology and economic and energy transitions over multiple time frames.[100] Additionally, it needed to consider the environmental impact of digital assets along with their potential to impede or advance climate change solutions globally and in the U.S.[101] Also, the report had to study the differing energy usage of cryptocurrencies' consensus mechanisms.[102] Specifically, in doing so,

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[97] *Id*. at 14148 ("[T]he Director of the Office of Science and Technology Policy… shall submit a report to the President on the connections between distributed ledger technology and… the potential for these technologies to impede or advance efforts to tackle climate change at home and abroad; and the impacts these technologies have on the environment.").

[98] *Id.* at 14145.

[99] *Id.* at 14148 ("Within 180 days of the date of this order, the Director of the Office of Science and Technology Policy, in consultation with . . . the heads of other relevant agencies, shall submit a report to the President on the connections between distributed ledger technology and . . . the potential for these technologies to impede or advance efforts to tackle climate change at home and abroad; and the impacts these technologies have on the environment.").

[100] *Id.* ("[T]he Director of the Office of Science and Technology Policy, in consultation with . . . the heads of other relevant agencies, shall submit a report to the President on the connections between distributed ledger technology and short-, medium-, and long-term economic and energy transitions . . . .").

[101] *Id.* ("[T]he Director of the Office of Science and Technology Policy . . . shall submit a report to the President on the connections between distributed ledger technology and . . . the potential for these technologies to impede or advance efforts to tackle climate change at home and abroad; and the impacts these technologies have on the environment.").

[102] *Id.* ("The report should . . . address the effect of cryptocurrencies' consensus mechanisms on energy usage, including research into potential mitigating measures and alternative mechanisms of consensus and the design tradeoffs those may entail.")

the report was meant to address potential uses of blockchain to support technologies that could monitor or mitigate climate impacts, along with any implications for energy policy regarding grid management, efficiency, and energy sources.[103] Finally, within one year of the submission of the report, the report will be updated, reflecting the fast-paced evolution of digital assets.[104]

In response to President Biden's March 9 Order, the OSTP issued a request for information (RFI) on the energy and climate implications of digital assets on March 25.[105] The RFI sought comments on the "protocols, hardware, resources, economics, and other factors" shaping the energy usage and climate impact of all forms of digital assets.[106] Additionally, the RFI sought comments on "attempts to mitigate climate harms and energy usage associated with digital assets."[107] The RFI closed on May 9, 2022.[108]

The OSTP issued its report, *Climate and Energy Implications of Crypto-Assets in the United States*, in September 2022.[109] The report seeks to answer four main questions: (1) "How do digital assets affect energy usage, including grid management and reliability, energy efficiency incentives and standards, and sources of energy supply?"; (2) "What is the scale of climate, energy, and environmental impacts of digital assets relative to other energy uses, and what innovations and policies are needed in the underlying data to enable robust comparisons?"; (3) "What are the potential uses of

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[103] *Id.* ("The report should specifically address: (A) potential uses of blockchain that could support monitoring or mitigating technologies to climate impacts . . . and (B) implications for energy policy, including as it relates to grid management and reliability, energy efficiency incentives and standards, and sources of energy supply.").

[104] *Id.* ("Within 1 year of submission of the report . . . the Director of the Office of Science and Technology Policy, in consultation with . . . the heads of other relevant agencies, shall update the report . . . including to address any knowledge gaps identified in such report.").

[105] Notice of Request for Information on the Energy and Climate Implications of Digital Assets, 87 Fed. Reg. 17105 (Mar. 25, 2022) ("[T]his RFI seeks comments on the . . . factors that shape the energy use and climate impacts of all types of digital assets.").

[106] *Id.*

[107] *Id.*

[108] *Id.* at 17106 ("Interested persons and organizations are invited to submit comments on or before . . . May 9, 2022.")

[109] OSTP, *supra* note 1, at 3.

blockchain technology that could support climate monitoring or mitigating technologies?"; and (4) "What key policy decisions, critical innovations, research and development, and assessment tools are need to minimize or mitigate the climate, energy, and environmental implications of digital assets?"[110] The OSTP observes climate change as a key priority of the Biden administration, citing multiple executive orders, along with the Inflation Reduction Act's investments in clean energy, and finds that digital asset usage must not impede these efforts.[111]

The OSTP report references an EPA study that analyzed the multiple regional electric grid networks spanning the U.S. to estimate emissions from the largest cryptocurrencies.[112] They estimate that crypto activity in the U.S. will result in twenty-five to fifty million metric tons of CO_2 being emitted each year.[113] This is about 0.4–0.8% of total U.S. emissions.[114] Special attention is paid to Texas, which uses the mostly independent Electricity Reliability Council of Texas

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[110] *Id.* at 4 ("This report explores the challenges and opportunities of crypto-assets for energy and climate change issues in the United States, and answers four main questions asked in Executive Order 14067 . . . .").

[111] *Id.* at 9 ("Given the United States' commitment to reduce emissions, the federal government must ensure that use of digital assets in the United States does not impede our ability to meet our climate objectives.").

[112] *Id.* at 22 (citing *Emissions & Generation Resource Integrated Database (eGrid)*, EPA (2022), https://www.epa.gov/egrid) ("An authoritative and accessible source of regional electricity emissions information is the Emissions & Generation Resource Integrated Database (eGRID), produced by the EPA . . . . According to a published study, in 2021, U.S. electricity generation for mining crypto-assets with the largest market capitalizations (Bitcoin, Ethereum, and Dogecoin) generated GHGs at a rate of approximately 15 Mt CO2/year.").

[113] *Id.* at 6 ("Crypto-asset activity in the United States is estimated to result in approximately 25 to 50 Mt

CO_2/y . . . .").

[114] *Id.* ("Crypto-asset activity in the United States is estimated to result in approximately . . . 0.4% to 0.8% of total U.S. GHG emissions, [which is] similar to emissions from diesel fuel used in railroads in the United States.").

grid.[115] This grid's electricity demand generally peaks at around 76 gigawatts.[116] Crypto currently accounts for two gigawatts of Texas' grid.[117] However, the OSTP warns that this may soon grow.[118] The report notes that there are potentially seventeen gigawatts worth of crypto facilities being designed and connected to the grid.[119] While not all of these will become operational, the OST predicts new crypto mining facilities to demand five to six additional gigawatts from Texas' grid within the next twelve to fifteen months.[120]

The OSTP considered more exotic ways to make digital assets more energy efficient. The report posits using "stranded methane gas" to power crypto mining.[121] Methane is produced in drilling for natural gas, and also by agriculture, landfills, and oil wells.[122] The OSTP notes that methane is a very potent greenhouse gas and that the EPA and the Department of the Interior are contemplating rules to further limit methane emissions.[123] In drilling for natural gas, methane is either vented or flared; the OSTP proposes that crypto miners capture the venting methane and use it to power their operations.[124] This would replace methane flares that burn methane without contributing to the grid.[125] Long term, a future

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[115] *See id.* at 17–18 ("Many crypto-asset miners have moved their operations to Texas. The Electricity Reliability Council of Texas (ERCOT) is the grid system operator for the majority of Texas . . . .").

[116] *Id.* at 17 ("The Electricity Reliability Council of Texas (ERCOT)… has a peak summer electricity demand of about 76 gigawatts (GW) . . . .").

[117] *Id.* ("[C]urrent crypto-asset mining activity of about 2 GW.").

[118] *Id.* ("ERCOT has about 17 GW of crypto-asset facilities that are in the process of connecting to the grid, with an expected 5 to 6 GW of new demand in the next 12 to 15 months.").

[119] *Id.*

[120] These new developments are equivalent to the energy demand of Houston. *Id.* at 17–18.

[121] *Id.* at 23 ("The crypto-asset industry can potentially use stranded methane gas, which is the principal component of natural gas, to generate electricity for mining.").

[122] *Id.* (describing sources of methane).

[123] *Id.* at 23–24 ("Methane is a potent GHG [(greenhouse gas)].").

[124] *Id.* at 23 ("Crypto-asset companies are now exploring ways to use electricity generation from vented and flared methane at oil and gas wells and at landfills.").

[125] *Id.* at 24 ("Mining operations that replace existing methane flares would not likely affect CO2 emissions, since this methane would otherwise be flared and converted to CO2.").

net-zero emissions policy would lead to methane venting and flaring to cease.[126] However, the OSTP finds that in the short term, having miners use the otherwise wasted methane will help the U.S.' climate objectives.[127]

The OSTP also analyzed the environmental impacts other than emissions that result from crypto mining. First are local noise and water impacts.[128] Crypto mining requires cooling for the heat generated by computers.[129] Each rack of servers uses about the same amount of water as a U.S. household.[130] Similarly, reactivated fossil fuel plans typically use local water for cooling, which, when released back into the environment, can harm wildlife, interfere with recreation, and impair water quality.[131] Water released in these processes is typically warmed, raising surrounding water temperature, potentially leading to "toxic conditions in local waterways."[132] Meanwhile, air-cooled mining computers generate noise pollution from their high-velocity fans.[133] The OSTP found that "numerous media reports describe loud, irritating, and nearly continuous noise caused by fans at crypto-asset mining centers."[134]

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[126] *Id.* ("Climate policy aligned with achieving net-zero emissions would have zero methane venting and zero methane flaring.").

[127] *Id.* ("While such operations can reduce wasted methane, another option is low-cost recovery of methane using existing vapor capture technologies at oil and gas wells, which can reduce global methane emissions up to 50% by 2030.").

[128] *Id.* at 6 ("Besides purchased grid electricity, crypto-asset mining operations also cause local noise and water impacts from operations . . . .").

[129] *Id.* at 13 ("[M]ost studies have focused on estimating the electricity usage of computing devices, including the additional electricity required for cooling.").

[130] *Id.* at 25 ("In standard computer data centers, a single, typical 10 kW rack of servers will require around 63,000 gallons of potable water per year for air cooling—an amount comparable to the average indoor water use of an individual U.S. household each year.").

[131] *Id.* ("At thermal power plants with traditional once-through cooling systems, water is withdrawn from rivers or lakes, and the withdrawal process and the warmed water released back into the environment (including chemicals used to clean the cooling system) can harm fish and wildlife, and can negatively impact recreation and water quality.").

[132] *Id.* at 25–26 (discussing potential algal blooms, and reduced oxygen levels in local waters).

[133] *Id*. at 26 ("Air-cooled mining computer contain high-velocity fans that can generate noise pollution.").

[134] *Id.* at 26.

The OSTP also looked into the e-waste, finding that ASIC disposal happens faster than typical data centers.[135] Due to the rapid pace of improvements in ASIC processing speeds, ASICs are often discarded after one year and four months on average, as opposed to the three to five years of data center servers.[136] The OSTP found that bitcoin mining produced 35,000 tons of e-waste per year by June 2022.[137] However, the OSTP mentions two existing electronic recycling standards, which can reduce e-waste in the U.S.[138]

Next, the report explores potential uses of blockchain that support climate monitoring or mitigation.[139] The OSTP hypothesizes that distributed ledger technologies can be used in carbon markets.[140] Essentially, a crypto-like system could help the operation of cap-and-trade programs, enabling a market for carbon credits.[141] However, the feasibility of crypto cap-and-trade seems uncertain. Compliance markets are centralized, and there seems to be no clear advantage to a distributed ledger. Furthermore, the anonymization that crypto provides seems to counter the point of carbon markets—they are not meant to be anonymous; they are meant to track individual corporations' emissions.[142]

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[135] *Id.* ("This [discarding] is shorter than standard data center servers, which last three to five years.").

[136] *Id.* ("Currently, ASICs cannot be used for any other purpose, so companies often discard, sell, or reduce the use of older generations of ASICs after approximately one year and four months.").

[137] *Id.* ("Bitcoin mining activity produced electronic waste at an estimated rate of 31,000 tons per years, increasing by June 2022 to 35,000 tons per year.").

[138] Namely, the Responsible Recycling Standard for Electronics Recyclers and the e-Stewards Standard for Responsible Recycling and Reuse of Electronic Equipment. *Id.*

[139] *Id.* at 27 ("Blockchain and DLT may have a role to play in enhancing market infrastructure for a range of markets, including environmental markets.").

[140] *Id*. ("Blockchain and DLT may have a role to play in enhancing market infrastructure for a range of markets, including environmental markets.").

[141] *Id.* at 28 ("Blockchain and DLT may have a role to play in enhancing market infrastructure for a range of markets, including environmental markets.").

[142] *Id*. ("To the extent blockchain-based trading hides the identity of the end-user of carbon credits, they would be antithetical to high-integrity VCMs and broader efforts to promote progress towards net-zero objectives.").

The OSTP takes special notice of California's Flex Alert system, an energy grid system that allows operators to "push out requests for energy conservation," and interact with customers while maintaining their anonymity.[143] This smart grid technology can potentially use "distributed energy resources," like electric cars, solar systems, and battery systems to increase grid stability.[144] The OSTP posits the use of distributed ledger technology to serve as a ledger for smart grids, as traditional electricity consumers become providers feeding back into the system.[145] A future smart grid could be more automated and decentralized; using smart contracts, distributed energy resources could automatically negotiate and execute agreements allowing millions of privately owned devices that store electricity to feed back into the grid in a coordinated manner.[146] The ledger would also allow grid operators to verify transactions in real time, making the smart grid more tamper-resistant, while also ensuring that electrical usage and payment for that usage is tracked accurately.[147] Likewise, the anonymous nature of distributed ledgers

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[143] *Id.* at 29 ("Emerging uses of blockchain technologies for energy management include enabling California's Flex Alert System. This system enables the electricity grid operator to push out requests for energy conservation during a grid emergency, securely interact with customers, and understand participation rates while maintaining customer anonymity.").

[144] *Id.* (describing distributed energy resources).

[145] For example, solar panels on houses, or plugged-in electric cars could feed power into the electric grid when demanded; a distributed ledger could track the energy contribution and potential payment or credit for that energy. *See id.* ("DLT could potentially serve as the digital ledger for the registration, authentication, and participation of these DERs in a smart grid, enabling flexible grid operations as more variable renewables are adopted . . . . Today, the electricity grid and markets are highly centralized systems, where a small number of providers sell electricity to a large number of consumers. This dynamic could change in the decade ahead, as more electricity consumers also become providers.").

[146] *Id.* (citations omitted) ("DLT-supported innovation could help digitize, automate, and decentralize the operation of the electricity grid. A key feature of mature DLT is the ability to automatically negotiate and execute an agreement, a process known as smart contracting.").

[147] *See id.* ("DLT could enable verification by allowing the grid-operators and aggregators to audit, in real-time, the services provided by every DER within the pool through analysis of the tamper-resistant distributed ledger. This is important because grid-operators will require verification that aggregators are providing the contracted services.").

would protect the identities of and information regarding the owners of electrical devices.[148]

Not only could this technology be used on a national level, distributed ledgers could also be used in micro-grids, restricted to single communities.[149] Using a peer-to-peer system to enable a community operated grid, cryptography-based user authentication could enable local market operation through smart contracts, and a tamper resistant, auditable, ledger of energy transactions.[150] Potentially, this system could use proof of stake and ensure low energy consumption while facilitating the grid.[151]

Finally, the OSTP offers policy recommendations to "ensure the responsible development of digital assets."[152] First, the OSTP recommends that the EPA and the DOE provide technical assistance and collaborate with the states and digital asset industry to create environmental performance standards for the design and usage of digital assets.[153] The OSTP conceives of standards that strengthen over time to drive increasingly carbon-free operation.[154] If this process is ineffective, the OSTP recommends executive actions, and potentially Congressional action, to limit intensive energy usage by

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[148] *Id.* ("DLT could potentially provide these services, while also protecting the identity and privacy of the aggregator and DER owners, such as information related to the type of DER, capacity, location, ownership, and contract arrangements.").

[149] *Id.* at 29–30 ("As DERs increase in abundance, they could also enable community-created microgrids where resources are shared peer-to-peer (P2P) within the community. DLT could be helpful in managing the P2P relationships on these microgrids.").

[150] *Id.* at 30 (describing cryptographic micro-grids).

[151] *Id.* ("P2P energy trading on networks could use low-energy consumption consensus mechanisms, such as PoS.").

[152] *Id.* at 7.

[153] *Id.* ("The Environmental Protection Agency (EPA), the Department of Energy (DOE), and other federal agencies should provide technical assistance and initiate a collaborative process with states, communities, the crypto-asset industry, and others to develop effective, evidence-based environmental performance standards for the responsible design, development, and use of environmentally responsible crypto-asset technologies.").

[154] *Id.* ("These should include standards for very low energy intensities, low water usage, low noise generation, clean energy usage by operators, and standards that strengthen over time for additional carbon-free generation to match or exceed the additional electricity load of these facilities.").

crypto mining.[155] Additionally, the OST advocates for the DOE to coordinate with the Federal Energy Regulatory Commission and the North American Electric Reliability Corporation to conduct reliability assessments of our electric grids, as affected by both current and potential future crypto mining.[156] The DOE would then develop reliability standards and emergency procedures as needed to ensure grid stability as crypto grows.[157] Similarly, the report recommends regulators like the DOE promulgate energy conservation standards for crypto mining equipment and operations.[158] Finally, the OSTP recommends that the National Science Foundation, DOE, and EPA promote and support research focused on digital assets' environmental sustainability, including grid management and environmental mitigation.[159]

Following the OSTP's report, in December 2022, Senator Markey introduced a bill in the Senate to direct the EPA to report the energy usage and environmental impact of crypto-miners.[160] The

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[155] *Id.* at 7 ("Should these measures prove ineffective at reducing impacts, the Administration should explore executive actions, and Congress might consider legislation, to limit or eliminate the use of high energy intensity consensus mechanisms for crypto-asset mining.").

[156] *Id.* at 7–8 ("DOE, in coordination with the Federal Energy Regulatory Commission, the North American Electric Reliability Corporation and its regional entities, should conduct reliability assessments of current and projected crypto-asset mining operations on electricity system reliability and adequacy.")

[157] *Id.* at 8 ("If these reliability assessments find current or anticipated risks to the power system as a result crypto-asset mining, these entities should consider developing, updating, and enforcing reliability standards and emergency operations procedures to ensure system reliability and adequacy under the growth of crypto-asset mining.").

[158] *Id.* at 8 ("The Administration should consider working with Congress to enable DOE and encourage other federal regulators to promulgate and regularly update energy conservation standards for crypto-asset mining equipment, blockchains, and other operations.").

[159] *Id.* (listing several research recommendations to improve analytics).

[160] Rep. Jared Huffman, Opinion, *Oversight of Cryptocurrency—Particularly its Environmental Impacts is Long Overdue*, HILL (Dec. 8, 2022, 2:30 PM), https://thehill.com/opinion/congress-blog/3767417-oversight-of-cryptocurrency-particularly-its-environmental-impacts-is-long-overdue/ [https://perma.cc/GZ95-9WCT] ("We've gathered a coalition of congressional colleagues to call on EPA Administrator Michael Regan to evaluate these facilities' compliance with the Clean Air Act and Clean

Crypto-Asset Transparency Act of 2022 was read and referred to the Committee on Environment and Public Works on December 7, 2022.[161] The bill responds to the OSTP's call for more data surrounding crypto mining's environmental impact.[162] The bill would instruct the EPA to classify certain crypto-asset mining operations as "covered facilities" under part 98 of title 40 of the CFR (the Clean Air Act).[163] The bill defines "qualifying crypto-asset mining operation" as individual facilities that use five or more megawatts of power, or multiple smaller facilities that total five or more megawatts if owned by the same company.[164] Covered crypto operations would be subject to greenhouse gas reporting requirements and monitoring regardless of actual emissions from the operation.[165] So, even miners

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Water Act, sent letters to OSTP, EPA, and DOE to share our findings on cryptomining's environmental impacts, and worked to uncover exactly how much crypto is impacting energy consumption, emissions, and costs for Texans.").

[161] *S.5210 – Crypto-Asset Environmental Transparency Act of 2022*, CONGRESS, https://www.congress.gov/bill/117th-congress/senate-bill/5210/actions (recording the bill's introduction).

[162] *See* THE CRYPTO-ASSET ENVIRONMENTAL TRANSPARENCY ACT OF 2022 ONE-PAGER, Ed MARKEY, https://www.markey.senate.gov/imo/media/doc/crypto-asset_environmental_transparency_act_summary.pdf ("A recent report by The White House Office of Science and Technology Policy called for more data on factors such as cryptomining energy usage, fuel mix, co-located generation, power purchase agreements, and emissions.").

[163] Crypto-Asset Environmental Transparency Act of 2022, S.5210, 117th Cong. § 4(a)(1) (2022), https://www.congress.gov/117/bills/s5210/BILLS-117s5210is.pdf ("[T]he Administrator shall issue a notice of proposed rulemaking to revise part 98 of title 40, Code of Federal Regulations . . . to require qualifying crypto-asset mining operations to report as covered facilities.").

[164] *Id.* at § 3(9) ("The term 'qualifying crypto-asset mining operation' means . . . an individual crypto-asset mining facility that has a power load that is greater than or equal to 5 megawatts.").

[165] *Id.* at § 4(a)(1) (designating "qualifying crypto-asset mining operations" as being "subject to greenhouse gas reporting requirements and related monitoring, recordkeeping, and reporting requirements . . . regardless of whether a qualifying crypto-asset mining operation emits at least 25,000 metric tons of carbon dioxide-equivalent").

using fully renewable energy would need to report to the EPA.[166] Additionally, the bill would amend the Energy Independence and Security Act of 2007 to include crypto-mining operations in the energy efficiency standards required for data center buildings.[167]

Besides gathering data on crypto mining operations, the Act would also require the EPA to conduct a study on the environmental impact of those operations.[168] The proposed study would be detailed, and would include analyses of emissions from the operations, their current locations, sources of energy, and ecological impact from e-waste.[169] The study would also include a "geospatial assessment of the extent to which crypto-asset mining operations are located within environmental justice communities."[170]

B. States are Contemplating and Enacting Environmental Regulations

While the Federal government is potentially moving towards regulating digital assets, states have already been making moves in this field. Some states have taken actions to encourage mining and the use of cryptocurrencies,[171] while others, notably New York, have taken drastic steps towards strict regulations.[172] This section will discuss New York's forays into the environmental regulation of crypto, along with those of other states.

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[166] *See id.* (establishing that, regardless of whether an operation uses renewable energy, it is still treated as a carbon dioxide-emitting operation when it comes to reporting).

[167] *Id.* at § 6 (adding "a facility in which 2 or more computers perform logical operations to mine or create crypto-asset" as falling under the energy efficiency requirements for data center buildings proscribed in the Energy Independence and Security Act of 2007).

[168] *Id.* at § 5 ("[T]he Administrator, in consultation with the Secretary, the Administrator of the Energy Information Administration, the Federal Energy Regulatory Commission, and the head of any other Federal agency the Administrator or the Secretary determines appropriate, shall conduct a study on the environmental impacts of crypto-asset mining in the United States.").

[169] *Id.* at § 5(b) (listing the requirements pertaining to the study's content).

[170] *Id.*

[171] *See generally infra* Section IV.B.2 (listing examples of state regulations that attract crypto miners due to less restrictions and reduction in costs).

[172] *See generally infra* Section IV.B.1 (summarizing New York's actions in regulating mining and use of cryptocurrencies).

1. *New York is the First State in the Nation to Create Environmental Regulations for Digital Assets*

In 2021 and 2022, New York became a hot spot in crypto regulation. Crypto mining operations moved into old buildings and power stations in upstate New York seeking cheap electricity.[173] Environmentalists and lawmakers were opposed to this development.[174] A moratorium was proposed in 2021, which would have banned proof of work mining powered by fossil fuels for three years.[175] However, this proposed moratorium on crypto mining was derailed.[176] After passing the State Senate, the bill died in the Assembly.[177] Despite the odds, the bill made a comeback a year later in 2022.[178] The new version of the bill was modified to essentially

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[173] Marie J. French, *Cryptocurrency Industry Fights Proposed NY Moratorium. Here is What's at Stake*, POLITICO (Jan. 29, 2022, 7:00 AM), https://www.politico.com/news/2022/01/29/cryptocurrency-industry-fights-proposed-ny-moratorium-here-is-whats-at-stake-00001994 [https://perma.cc/EMG5-8536] ("New York appears to be a leading state for cryptocurrency mining . . . Upstate New York has proved an attractive location for cryptocurrency mining, with companies taking advantage of low-cost hydropower, cheap land and underused transmission infrastructure").

[174] *Id.* (explaining the views of environmental advocacy groups who warn that "unchecked cryptocurrency mining endangers the state's climate goals" and lawmakers concerned that crypto mining use of the grid will add to the state's dependence on fossil fuels).

[175] *Id.* ("Lawmakers in New York . . . are pushing for a three-year moratorium on permits for power plants that burn fossil fuels to mine Bitcoin.").

[176] *New York Crypto Mining Bill Dies in Assembly After Passing State Senate*, COINDESK (Sept. 14, 2021, 9:10 AM), https://www.coindesk.com/markets/2021/06/11/new-york-crypto-mining-bill-dies-in-assembly-after-passing-state-senate/ [https://perma.cc/29ZC-6UTJ] (reporting that proposed moratorium failed to pass).

[177] *Id.* (stating that the proposed moratorium passed in the State Senate, however failed to pass in the New York State Assembly).

[178] Stephen Alpher, *Bitcoin Mining Ban Bill Makes It Out of New York State Assembly Committee*, COINDESK (Mar. 22, 2022, 3:17 PM), https://www.coindesk.com/policy/2022/03/22/bitcoin-mining-ban-bill-makes-it-out-of-new-york-state-assembly-committee/ [https://perma.cc/F57N-6DEF] (stating that state assembly's Environmental Conversation Committee voted to move proposed moratorium along).

ban new proof of work mining for two years.[179] On June 3, 2022, the New York Senate approved the first-in-the-nation, two-year partial ban on crypto mining at fossil fuel plants.[180] The bill modified New York's environmental conservation law by halting the approval and issuance of permits to carbon-based electrical generating facilities that provide whole, or in part, "behind-the-meter" electricity which is consumed or used by cryptocurrency mining operations using proof of work methods.[181] Permits for these already existing generators and operators will also not be renewed during the two-year period.[182] The bill also starts a New York Department of Environmental Conservation study on the crypto industry and its environmental impacts.[183] The crypto industry lobbied hard against the bill, arguing that it would have a chilling effect and made misrepresentations, and said the bill was a total ban on crypto mining.[184]

The bill was sent to Governor Hochul; however, it was unclear if Hochul would actually sign the bill.[185] The crypto industry

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[179] *Id.* ("It would effectively ban proof-of-work (PoW) mining—the energy-intensive process used to secure the Bitcoin (BTC) network—for a period of two years.").

[180] Marie J. French, *New York lawmakers pass first-in-nation cryptocurrency moratorium*, POLITICO (June 3, 2022, 9:09 AM), https://www.politico.com/news/2022/06/03/new-york-pass-cryptocurrency-moratorium-00036946 [https://perma.cc/F57N-6DEF] ("The New York Legislature early Friday approved a two-year, limited moratorium on digital currency mining at fossil fuel power plants.").

[181] S.B. 6486--D, Senate, Reg. Sess. (N.Y. 2021), https://legislation.nysenate.gov/pdf/bills/2021/S6486D (summarizing bill modifications such as pausing approval of new applications and permits to facilities described).

[182] *See id.* ("For the period commencing on the effective date of this section and ending two years after such date, the department shall not approve an application to renew an existing permit or issue a renewal permit.").

[183] *See* French, *supra* note 172 ("The bill would also require a study of the industry and its environmental impacts by the Department of Environmental Conservation.").

[184] *See id.* ("The cryptocurrency industry and business groups pushed back hard on the measure, arguing it would have a chilling effect and misrepresenting it as a wholesale ban on mining digital currencies.").

[185] *See* Luis Ferre-Sadurni et al., *Fight Looms Over New York's Bid to Slow Crypto-Mining Boom*, N.Y. TIMES (June 7, 2022), https://www.nytimes.com/2022/06/07/nyregion/cryptomining-ban-ny.html ("It is not clear, however, whether Gov. Kathy Hochul will sign the bill.").

invested heavily in an effort to persuade Hochul to reject the bill.[186] Hochul's campaign received a $40,000 donation from Ashton Soniat, CEO of Coinmint, which has a crypto mining facility in upstate New York.[187] Furthermore, a super PAC supported by FTX's founder spent about one million dollars on lieutenant governor, Antonio Delgado's campaign.[188] Governor Hochul delayed and did not commit to signing the bill.[189] Finally, the governor signed the bill in November 2022—after the midterm elections.[190]

The new ban has affected some operations more than others. Coinmint operates a 160 megawatt mining operation in upstate New York and reports no impact from the moratorium.[191] However, Blockfusion's cryptocurrency mining facility in Niagara Falls is currently idling due to a city order and lost insurance coverage because of the moratorium.[192] Despite this, Blockfusion's CEO

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[186] *Id.* ("The cryptocurrency industry is expected to invest heavily in efforts to persuade her to reject the measure and to seek to influence other industry-friendly regulations in Albany.").

[187] *See id.* ("Ms. Hochul's campaign has already received $40,000 from Ashton Soniat, the chief executive of Coinmint, which has a crypto-mining operation on the grounds of a former aluminum plant in Massena, N.Y., a small-town northeast of Niagara Falls.").

[188] *See id.* ("A far larger political gift has gone to Ms. Hochul's lieutenant governor, Antonio Delgado . . . . A super PAC, backed by the founder of FTX . . . has spend roughly $1 million on digital ads in the last few weeks in support of his campaign.").

[189] *See id.* ("The governor . . . has been noncommittal on whether she would sign the bill.").

[190] *See* Anna Gronewold, *Hochul Signs Partial Cryptocurrency Mining Ban into New York Law*, POLITICO (Nov. 22, 2022, 8:36 PM), https://www.politico.com/news/2022/11/22/cryptocurrency-mining-ban-new-york-00070613 [https://perma.cc/RP6Z-Y8SJ] ("Gov. Kathy Hochul on Tuesday signed the controversial measure into law . . . . Hochul, who had punted on the issue for months after the Legislature passed the bill in June, was elected to a full term Nov. 8.").

[191] *See* Marie J. French, *New York Partially Banned Cryptocurrency mining. Now Environmentalists Want More.*, POLITICO (Jan. 7, 2023, 7:00 AM), https://www.politico.com/news/2023/01/07/new-york-cryptocurrency-mining-ban-00072564 [https://perma.cc/26T4-K52K] ("The legislation has no impact on our operations, and we continue to invest and create good jobs at our facility," said David Fogel, the CEO of Coinmint, which operates the up to 160 megawatt cryptocurrency mining facility in Massena.").

[192] *See id.* ("Blockfusion, which owns a cryptocurrency mining facility in Niagara Falls that is currently idle due to an order by the city, lost insurance

supports the moratorium and banning fossil fuel usage for crypto mining.[193] Other operators like Fortistar and Greenige are in precarious positions and may potentially fail to get approval from the DEC.[194] Eyes are also on the DEC's "generic environmental impact statement" on crypto mining, due by November 22, 2023.[195] New York lawmakers will likely use the impact statement as a basis for increased regulations on the industry; the same occurred in 2014 when New York banned fracking after receiving an impact statement from the DEC.[196]

2. *Other States are Encouraging the Growth of Crypto Mining*

In contrast to New York, some states have taken actions to make crypto cheaper with a looser regulatory environment to draw in miners. For example, Kentucky has sought to attract crypto miners through favorable legislation.[197] In March 2021, Kentucky passed

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coverage because of the statewide moratorium, despite not being impacted.").

[193] *See id.* ("[Martini-LoManto] supported the moratorium but said it should have gone further and prohibited any fossil fuel plants coming back online for any reason."). Blockfusion runs primarily on hydroelectric power.

[194] *See id.* (stating that Fortistar and Greenidge both have permits pending however no new applications to run fossil fuel power plants for cryptocurrency mining will be approved by the DEC under this law).

[195] *See id.* ("The legislation directs DEC to finalize a "generic environmental impact statement" considering a range of issues related to cryptocurrency mining that uses the energy-intensive "proof of work" methodology underpinning Bitcoin by Nov. 22.").

[196] *Id.* ("[A] generic environmental impact statement on hydraulic fracturing for natural gas was a key step toward New York's prohibition on the practice in 2014—also a first in the nation at the time.").

[197] Jacquelyn Melinek, *Bitcoin Miners are Dusting Off Kentucky Coal Towns, Spurred by State Crypto Tax Incentives*, TECHCRUNCH (Mar. 30, 2022, 9:43 AM), https://techcrunch.com/2022/03/30/bitcoin-miners-are-dusting-off-kentucky-coal-towns-spurred-by-state-crypto-tax-incentives/ [https://perma.cc/GL4A-A3V3] ("Senate Bill 255 extends the commonwealth's clean energy-based incentives to miners who provide a minimum capital investment of $1 million, while Kentucky House Bill 230 provides miners a number of tax breaks.").

Senate Bill 255 and House Bill 230.[198] Senate Bill 255 amended the state's clean energy-based incentives to include "cryptocurrency facilities" with a minimum capital investment of one million dollars.[199] Miners with large operations receive numerous tax breaks as a result.[200] House Bill 230 adds an additional package of tax breaks for all miners, not just large operations.[201] As a result, by October 2021, Kentucky accounted for 18.7 percent of the United States Bitcoin hashrate, just under New York's 19.9 percent.[202]

Texas is also trying to attract mining operations, however the state faces difficulties with its power grid.[203] Texan bitcoin operations currently use about 3,000 megawatts a day, four percent of peak demand, and operations continue to expand.[204] Total power usage is expected to be around equal to that of Houston in a few years.[205] To counter the risk of too much demand on the power grid, the Electric Reliability Council of Texas (ERCOT) is incentivizing miners to

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[198] *Id.* ("Senate Bill 255 extends the commonwealth's clean energy-based incentives to miners who provide a minimum capital investment of $1 million, while Kentucky House Bill 230 provides miners a number of tax breaks.").

[199] S.B. 255, 2021 Senate (Ky. 2021), https://legiscan.com/KY/text/SB255/2021 ("For a cryptocurrency facility, the minimum capital investment shall be one million dollars ($1,000,000).").

[200] *See id.* (listing tax breaks).

[201] *See* H.B. 230, 2021 House, Reg. Sess. (Ky. 2021), https://legiscan.com/KY/text/HB230/2021 (enumerating potential tax credit opportunities).

[202] Melinek, *supra* note 196 ("As of October 2021, Kentucky accounted for 18.7% of the United States' total Bitcoin hashrate, second to 19.9% in New York, according to data from Foundry Digital, a subsidiary of the crypto giant Digital Currency Group.").

[203] David Green & Siddhartha Kazi, *Cryptocurrency in Texas*, TEXAS COMPTROLLER, https://comptroller.texas.gov/economy/fiscal-notes/2022/aug/crypto-tx.php ("Cryptocurrency mining's largest appetite for energy is certainly a concern for Texas, especially in the wake of Winter Storm Uri and the state's electric grid vulnerabilities.").

[204] *Id.* ("Experts believe that, per day, about 3,000 megawatts (MWs) of mining operations operate in Texas, or about 4 percent of peak demand (i.e., demand for electricity on its hottest days).").

[205] *See id.* ("[B]y 2030, mines in Texas could demand as much energy as the city of Houston.").

participate in demand response programs.[206] In these programs, when the grid is strained, ERCOT moves to turn off or reduce miners' power to free up energy for the rest of the state.[207] For example, Riot Blockchain was shut down seventy-two times from June–September 2021 because of peaks in demand.[208]

3. *Other Countries have Taken Steps to Environmentally Regulate Digital Assets*

Outside the U.S., other nations are confronting the environmental regulation of digital assets. This section will consider these international efforts. Some countries, like China, have totally banned crypto mining.[209] Others, including nations in the EU, are working on a sweeping regulatory scheme.[210]

China used to be the largest producer of processing power dedicated to crypto mining, providing two-thirds of the world's Bitcoin hash rate.[211] However, China banned domestic crypto mining in June 2021, averring concern over the environmental impact of Bitcoin.[212] Whether sincere, or more concerned about illicit finance and the protection of their CBDC, China's move has prompted other

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[206] *Id.* ("[M]iners can participate in demand response programs, incentives offered by ERCOT to quickly turn off miners' power during periods of peak demand.").

[207] *Id.* ("When electricity prices are high or supply is straining to meet demand, miners can reduce their energy use.").

[208] *Id.*

[209] Kelly & Joseph, *supra* note 14, at 2 ("In June 2021, however, China banned all domestic cryptocurrency mining operations, citing the environmental impacts of Bitcoin mining energy demands among its concerns.").

[210] Press Release, Council of the EU, Digital Finance: Agreement Reached on European Crypto-Assets Regulation (MiCA) (Jun. 30, 2022), https://www.consilium.europa.eu/en/press/press-releases/2022/06/30/digital-finance-agreement-reached-on-european-crypto-assets-regulation-mica/ ("The EU brings crypto-assets, crypto-asset issuers and crypto-asset providers under a regulatory framework for the first time.").

[211] Kelly & Joseph, *supra* note 14, at 2 ("For several years, China was the cryptocurrency mining capital of the world, providing an average of two-thirds of the world's processing power dedicated to Bitcoin mining through early 2021.").

[212] *Id.* ("In June 2021, however, China banned all domestic cryptocurrency mining operations, citing the environmental impacts of Bitcoin mining energy demands among its concerns.").

countries to follow suit.[213] As of 2021, eight other countries, including Egypt, Tunisia, and Qatar have banned crypto mining.[214]

While some countries are banning cryptocurrencies, the EU is instead creating guardrails for the industry. The EU is currently crafting the Markets in Crypto-Assets (MiCA) proposal, an overarching regulation of the crypto-asset industry.[215] As part of the proposal, the EU reached a provisional deal that would require crypto companies selling tokens to detail their environmental impact.[216] MiCA will put issuers of crypto-assets and exchanges under a single regulatory framework in the EU.[217] With regard to environmental regulation, MiCA will require the European Securities and Markets Authority (ESMA) to draft technical standards on the form and content of the environmental and climate impact statements.[218] MiCA will also lead the European Commission to develop both an environmental report on crypto-assets, and more forcefully, introduce mandatory minimum sustainability standards.[219]

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[213] *Id.* ("With some countries experiencing negative impacts from cryptocurrency mining operations, several countries have following China's lead in banning cryptocurrencies.").

[214] *Id.* ("According to a 2021 report prepared by the Law Library of Congress, at least eight other countries—Egypt, Iraq, Qatar, Oman, Morocco, Algeria, Tunisia, and Bangladesh—have banned cryptocurrencies.").

[215] Council of the EU, *supra* note 209 ("Actors in the crypto-assets market will be required to declare information on their environmental and climate footprint.").

[216] Lisa Jenkins, *EU Agrees on Landmark Crypto and Climate Regulations*, PROTOCOL (July 1, 2022), https://www.protocol.com/bulletins/eu-crypto-rules-climate-energy ("[T]he European Parliament and EU states nailed down an agreement to regulate cryptocurrencies, including a requirement that crypto companies selling tokens on the continent disclose their environmental impact.").

[217] Council of the EU, *supra* note 209 ("The EU brings crypto-assets issuers and crypto-asset service providers under a regulatory framework for the first time.").

[218] *Id.* ("The European Securities and Markets Authority (ESMA) will develop draft regulatory technical standards on the content, methodologies, and presentation of information related to principal adverse environmental and climate-related impact.").

[219] *Id.* ("Within two years, the European Commission will have to provide a report on the environmental impact of crypto-assets and the introduction of mandatory minimum sustainability standards for consensus mechanisms, including the proof-of-work.").

V. *Recommendations*

This section will first discuss private ways to make digital assets more environmentally friendly. Next, this section will discuss potential regulations and methods the government could use to ensure digital assets are environmentally friendly. Even without government regulation, less energy intensive proof of stake models are increasingly popular and many propose a natural greener future in crypto.[220]

If crypto advocates, operators, and users move towards greener and more energy efficient methods, environmental regulation may not be required. However, these private efforts will likely fall short of what is required. Coordinated government regulation should be the gold standard for this industry.

A. **Potential Private Actions to Make Digital Assets Greener**

There are private, voluntary moves towards making cryptocurrencies greener. The Bitcoin Mining Council released the Crypto Climate Accord, which proposes working to reach net-zero emission from digital assets by 2030.[221] This accord was endorsed by the UN High-Level Climate Champions.[222] The accord represents itself as an industry pledge to bring all of crypto to net zero emissions by 2040, using renewables, carbon accounting, and climate offsets.[223] However, the PoW mining signatories accounted for less than .1 percent of crypto's energy usage, and the accord is clearly not

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[220] *See, e.g.*, PHILLIPS, *supra* note 10, at 9 ("Ethereum has indicated that it will transition to a proof-of-stake model in December 2021, reducing its estimated energy requirements exponentially.").

[221] PHILLIPS, *supra* note 10, at 8 ("The Bitcoin Mining Council, a coalition of bitcoin miners, has released the Crypto Climate Accord to work towards net-zero emissions from digital assets by 2030 . . . .").

[222] Howson & de Vries, *supra* note 18, at 3 ("In April 2021, with the endorsement of the UN High-Level Climate Champions, a Crypto Climate Accord was voluntarily established by 3 companies advocating profitable innovations for financial regulation, energy and resource efficiency.").

[223] *Id.* at 4 ("The Accord represented an industry pledge purportedly committing the entire crypto community to a 'net zero' emissions target, using renewable energy generation, 'Proof of Green' carbon accounting, and climate offsets by 2040.").

representative of the whole industry.[224] Indeed, many crypto miners prefer an aura of secrecy and are less accountable than the few signatories.[225] In May 2021, Bitcoin advocates convened a Bitcoin Mining Council focused on the energy usage of Bitcoin.[226] Unfortunately, this move appears to have been more of a public relations move, rather than an actual attempt to change the status quo.[227] Bitcoin advocates argue that crypto will act as a battery, using electricity around the world that would otherwise go to waste.[228] This contention by Bitcoin advocates is unrealistic.

Of their own volition, some miners are relocating to areas powered by renewable energy.[229] However, by using up solar and hydroelectric energy, miners may crowd out other energy users, pushing them to use fossil fuels.[230] Thus, the same amount of fossil fuels will be used, just by different industries.[231] Possibly the largest voluntary move towards a greener system has been Ethereum's transfer from proof of work to a proof of stake model in September 2022.[232] Additionally, capital markets appear to be showing interest

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[224] *Id.* ("This was problematic because the PoW mining signatories represented less than 0.1% of the crypto industry's overall energy usage, and therefore did not represent the interests of bitcoin miners globally . . . .").

[225] *Id.* ("Many of whom continue to value and rely on a climate of secrecy between industry players.").

[226] *Id.* ("Following concerns over potential centralisation of bitcoin regulation in the hands of the Crypto Climate Accord, a Bitcoin Mining Council was convened in May 2021 . . . . the Council focused specifically on the energy footprint of bitcoin.").

[227] Howson & de Vries, *supra* note 18, at 4 ("However, while the Accord aimed to provide a centralised strategy for delivering cleaner cryptocurrencies, the Council explicitly acts purely as a public relations device.").

[228] *Id.* ("Advocates of the Accord and the Council have argued that bitcoin will eventually function like a battery.").

[229] PHILLIPS, *supra* note 10, at 8 ("[S]ome bitcoin miners are moving their operations to locales that are powered by solar power or hydroelectricity.").

[230] *Id.* at 8–9 ("Yet moving these energy-intensive activities to renewable sources comes with an opportunity cost: Digital asset miners can crowd out other productive economic activities from the renewable sector and push them to fossil fuel-based energy.").

[231] *Id.* at 9 ("Essentially, the same amount of dirty energy is used, just by different industries.").

[232] *The Merge*, *supra* note 50 ("The Merge reduced Ethereum's energy consumption by ~99.95%.").

in greener mining; in April of 2021, Gryphon Digital Mining raised $14 million to launch a zero-carbon bitcoin mining operation.[233]

Carbon offsetting is another private avenue through which crypto miners are moving to lessen or negate their environmental impact. Essentially, crypto miners and exchanges can calculate their emissions and pay to offset them by financing forest conservation.[234] Bitcoin mining companies, like Greenridge Generation Holdings, have pledged to offset all of their emissions from their gas power plant.[235] Other companies, like Wrapped, claim to have carbon neutral digital assets.[236]However, proving true carbon neutrality is difficult due to the lack of an international standard for carbon accounting.[237] Similarly, paying to plant trees does not actually cancel out gas and coal emissions, especially as the forests are generally planted far from the company, in a different part of the world.[238]

Developers of digital assets could voluntarily move them away from proof of work, at least in the form that it exists right now. One way is through a so called "proof of useful work" design, where unused computing resources are recycled into validating transactions.[239] Through this design, developers can retain the

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[233] Kelly & Joseph, *supra* note 14, at 3 ("In April of last year, Gryphon Digital Mining raised $14 Million Series A to launch a zero-carbon footprint Bitcoin mining operation powered exclusively by renewables.").

[234] Howson & de Vries, *supra* note 18, at 5 ("Examples [of offsetting services] include Impact Scope, which allows investors the opportunity to donate funds using Bitcoin or Litecoin to finance forest conservation projects in developing countries.").

[235] *Id.* ("The gas-fired power plant operator and bitcoin mining company, Greenridge Generation Holdings, for example, has pledged to tackle its carbon footprint by simply offsetting 100% of the company's emissions from its 40 MW gas plant.").

[236] *Id.* ("Wrapped claims their Eco-BTC (eBTC) token is the world's first carbon-neutral bitcoin-backed asset.").

[237] *Id.* ("However, the lack of an official international standard for carbon accounting means that voluntary offset mechanisms, like that used by Gemini Green, have limited credibility.").

[238] *Id.* ("It is not possible to accurately quantify the capacity of a defined area of tropical forest in sequestering caron over a defined timescale.").

[239] Jon Truby et al., *Blockchain, Climate Damage, and Death: Policy Interventions to Reduce the Carbon Emissions, Mortality, and Net-Zero Implications of Non-Fungible Tokens and Bitcoin*, 88 ENERGY RSCH. & SOC. SCI. 102499, at 7 ("Instead, the paper's 'proof-of-useful-work' design

security benefits of proof of work designs, but gain energy savings advantages. Unfortunately, implementation of this design would require that existing blockchains switch their consensus protocols, an extremely difficult task.[240] Fully redesigning away from proof of work to proof of stake, or a similar design, is still preferable given the energy savings and decreased e-waste. Ethereum's merge is the main example of this switch.[241] Indeed, by switching, Ethereum's emissions may decrease a thousandfold.[242] Ethereum managed the transition smoothly, and it provides a prime example of a voluntary switch without government intervention; it should be held up as a guiding light for other cryptocurrencies.[243] Of course, Ethereum's merge may not be replicable for other cryptocurrencies, which could be more fragmented. Additionally, the Merge may have cut Ethereum's energy usage, but it also left miners with many proof of work focused systems, mainly GPUs. These miners may seek to focus on other cryptocurrencies, keeping the total energy usage up.

B. **Government Action is Required**

Private sector actions are not enough to turn digital assets green, government intervention is required. This subsection will first discuss preliminary information regulators require before taking concrete action; then it will discuss multiple directions to aim regulation. For example, one option to regulate digital assets is to discourage the use proof of work blockchains. [244] Another option is

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utilises the computational power to validate a blockchain transaction to add benefits to the users.").

[240] *Id.* ("However, it still requires developers to switch consensus protocols from proof-of-work which is problematic in itself.").

[241] *See The Merge*, *supra* note 50 ("The Merge reduced Ethereum's energy consumption by ~99.95%.").

[242] Truby, *supra* note 238, at 7 ("Ethereum's planned switch to a proof of stake algorithm, Casper, is expected to be less energy intensive and reduce its emissions a thousand-fold, which is enormously significant.").

[243] *See, e.g.*, *The Merge*, *supra* note 50 (discussing the merge in a positive light, indicating it went smoothly).

[244] Truby, *supra* note 238, at 1 (". . . social pressure has helped to motivate a planned switch in Ethereum, the largest NFT platform, away from the polluting proof-of-work consensus protocol. The article then explores policy intervention options designed to encourage the use and development of more sustainable blockchain.").

energy policy.[245] Digital assets could also be made more energy efficient through taxation.[246] Additionally, the SEC could impose listing standards on digital asset exchanges that encourage a more environmentally friendly market.[247] Most importantly, any regulation of digital assets will probably need to be coordinated internationally to prevent any regulatory arbitrage that could circumvent new environmental rules.

Part of the problem of regulating digital assets is that we lack detailed information. Senators Whitehouse, Warren, Smith, Merkley, and Markey provide a few preliminary policy recommendations in this regard.[248] First, they suggest a national registry of U.S.-based crypto mining plants.[249] Likewise, they suggested mandating transparency and disclosure rules for crypto facilities regarding their energy usage and emissions.[250] Many of their recommendations can be found in the Crypto-Asset Transparency Act of 2022, which should be embraced and enacted.[251] While the bill itself will likely

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[245] *Id.* at 9 ("An alternative type of policy intervention has been less focused on prohibiting mining facilities through regulation, but instead, utilizing fiscal tools and legal requirements to affect the business model of miners. Such market driven tools can compel miners to factor in the high cost of energy or mandate a switch to renewables.").

[246] *Id.* at 11 ("It may be practical to shift demand away from high-energy consuming mining devices by targeting taxes on users.").

[247] PHILLIPS, *supra* note 10, at 9 (describing a potential role for the SEC).

[248] Letter from Sheldon Whitehouse, Elizabeth Warren, Tina Smith, Jeffery Merkley, and Edward Markey, Sens., to Dr. Nelson, Deputy Assistant, OSTP (June 14, 2022), https://www.whitehouse.senate.gov/imo/media/doc/2022-06-14%20response-ostp-rfi.pdf (suggesting multiple policy recommendations and signed by these Senators).

[249] *Id.* ("For example, the federal government could establish a national registry of United States-based cryptomining plants.").

[250] *Id.* ("It could mandate increased transparency and regular disclosures from all cryptomining facilities with respect to their energy sources, emissions, and metering agreements with local utilities.") The senators also suggest energy efficiency standards for crypto mining facilities and even the possibility of requiring miners be powered only by renewable energy. *Id.* ("The United States could direct all domestic cryptomining operations be powered exclusively by verified new, zero-carbon sources of energy or solely rely on excess renewables from extant sources").

[251] *Compare* Crypto-Asset Environmental Transparency Act of 2022, S.5210, 117th Cong. § 4(a)(1) (2022) (requiring increased disclosures), *with* Whitehouse, *supra* note 247 (suggesting potential requirements).

not lead to reduced energy usage or emissions from digital assets, it will provide policymakers with much more data.[252] If possible, this information could be tied with the crypto climate data gathered by ESMA in Europe to create an even richer worldwide data set. Hopefully, policymakers will then be able to use that richer data to craft sound environmental regulation for digital assets.

A conceptually simple route is to follow China and New York and ban cryptocurrencies. These bans could be total, like China, or partial, like New York. China's crypto ban was effective in reducing its national emissions, and reduced pressure on their grid.[253] At a more local level, Quebec, Canada and Plattsburg, New York's bans did the same.[254] However, it is still too early to see the impact of New York's moratorium, especially as the existing proof of work operations will continue, along with all of the proof of stake operations. Regardless, these unilateral measures do little to stunt global energy usage and emissions.[255] Once banned, miners simply move to other, friendlier jurisdictions and the polluting activities continue.[256] For example, when China banned Bitcoin mining, Chinese mining companies moved to Kazakhstan to use coal-fired powerplants.[257] These powerplants are now being expanded; Enegix, a 180MW coal-powered data center near Pavlodor, is increasing to

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[252] *See* Crypto-Asset Environmental Transparency Act § 4(a)(1) (stating that crypto-asset mining operations will have new reporting requirements including greenhouse gas reporting requirements and related monitoring, recordkeeping, and reporting requirements).

[253] Truby, *supra* note 238, at 9 ("China has managed to both reduce overdependence on its energy grid, as well as maintain its commitment towards its emissions reduction objectives.").

[254] *Id.* (This source indicates Plattsburg and Quebec have implemented partial bans but not that they have had the same effects as China).

[255] *Id.* ("[I]t has shown the macro global effects of introducing such measures unilaterally, resulting in an initial reduction, but heralded by the relocation of mining devices to friendlier alternative jurisdictions.").

[256] *Id.* ("The relative ease of relocating even older, more polluting devices has meant that the problem has simply been shifted elsewhere, and the polluting mining activities would continue.").

[257] Howson and de Vries, *supra* note 18, at 6 ("China has banned Bitcoin mining on explicitly environmental grounds. However, this has had adverse impacts in other countries, including coal rich areas of Kazakhstan where purpose-built coal-fired power plants have been developed catering for Chinese bitcoin mining companies").

500 MW to further host miners.[258] Likewise, miners have moved to territories of Abkhazia to take advantage of subsidized power, which has led to overloaded electrical grids.[259] Although bans may bring local relief, unilateral crypto mining moratoriums only lead to a temporary reprieve at a global level.[260] To be more effective, local bans would need to go even further, possibly by prohibiting or highly taxing the export of mining systems.[261]

An international approach is needed to ensure truly successful moratoriums. Any large-scale regulation needs to be conducted in conjunction with other countries to create a more uniform regulatory environment.[262] The UN Environment Programme and the UN Framework Convention on Climate Change are likely the best venues for a brokered international agreement. Examples of the UN's success in non-market-based solutions include the 1987 global ban of CFCs and the MARPOL ship pollutant convention of 1998.[263] Given the challenge of regulating cryptocurrencies by individual governments, the decentralized nature of cryptocurrencies, and the structural drivers of climate change, a global coordinated ban on proof of work mining is likely the most effective policy to lower the energy usage and emissions of digital assets.[264]

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[258] *Id.* ("[T]he 180 MW Enegix coal-powered data centre near the eastern city of Pavlodor is due to be expanded to 500 MW in order to host miners exiting China's Xinjiang province.").

[259] *Id.* ("Following China's crackdown, bitcoin mining in the Black Sea territory of Abkhazia has been blamed for overloaded electricity lines and power station fires, leaving some areas without power for days.").

[260] *See* Truby, *supra* note 238, at 9 ("[I]t has shown the macro global effects of introducing such measures unilaterally, resulting in an initial reduction, but heralded by the relocation of mining devices to friendlier alternative jurisdictions.").

[261] *See id.* ("Second, it has shown the macro global effects of introducing such measures unilaterally, resulting in an initial reduction, but heralded by the relocation of mining devices to friendlier alternative jurisdictions.").

[262] *See* Howson & de Vries, *supra* note 18, at 7 ("To ensure localised bans do not simply move the problem elsewhere, an international approach could be required.").

[263] *Id.* (listing successful UN environmental programs).

[264] *Id.* (advocating for an international approach).

Policy intervention can also be focused on energy consumption.[265] Market-driven tools can encourage miners to engage with higher costs of electricity or switch to renewable energy.[266] Electricity premiums can be added to high volume energy users. This is based on the fact that miners are making great private gains while avoiding responsibility for the environmental costs of their mining operations that affect locals.[267] Electricity premiums for mining can be accomplished either through market-based price instruments or through taxation.[268] New York provides an example of market-based price instruments. The New York Public Service Commission ruled that municipal power authorities could issue tariffs on high density load energy customers.[269] In 2018, China regulated miners' electricity usage through taxation of electricity consumptions.[270] Both New York's and China's approaches essentially make the cost of electricity higher for miners, and so make miners internalize more of the environmental costs of proof of work mining.[271] Energy consumption approaches lower the demand for proof of work mining and increase the local energy supply.[272] Once again, energy consumption approaches would probably need to be coordinated on an international level to ensure that miners don't keep relocating to places with cheaper, potentially more pollutive electricity.

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[265] Truby, *supra* note 238, at 9 ("Such market-driven tools can compel miners to factor in the high cost of energy or mandate a switch to renewables.").

[266] *Id.* ("Such market-driven tools can compel miners to factor in the high cost of energy or mandate a switch to renewables.").

[267] *See id.* at 10 ("Charging high-volume energy users a premium on the basis that they are making private profits without any social benefit helps to de-socialise both the environmental negative externality as well as the additional cost to residential energy users.")

[268] *See id.* ("It may be practical to shift demand away from high-energy consuming mining devices by targeting taxes on users.").

[269] *Id.* (describing the New York agency ruling).

[270] *Id.* ("Similarly, China's Leading Group of Internet Financial Risks Remediation in 2018 requested that local governments regulated cryptocurrency miners' electricity usage and introduced related taxation towards limiting the extent of mining nationwide.").

[271] *See id.* ("Charging more for electricity consumption through taxation or charges can help internalise the negative externalities caused by mining operations by factoring them into business costs.").

[272] *Id.* ("These additional costs decrease the demand for working with proof-of-work blockchains and are intended to have the supply-side effect of lowering energy consumption.").

Another possible avenue to environmentally regulate digital assets is to use already existing frameworks such as taxation.[273] Taxation can be focused through sales taxes and capital gains taxes.[274] For example, a tax on proof of work crypto transactions could be introduced at a higher rate than other consensus models.[275] Likewise, profits from NFTs could be taxed at a higher rate if the transaction was achieved through proof of work.[276] Conversely, these transactions could be taxed at a lower rate when they use proof of stake.[277]

Finally, digital assets could be environmentally regulated through the regulation of exchanges. A gap in President Biden's Executive Order is that it commands the SEC to draft reports considering financial stability and systemic risks, but it does not specifically command the SEC to consider environmental policy and regulation.[278] The SEC likely can use its authority to help ensure digital assets meet ESG goals.[279] For digital assets that are securities, the SEC could require issuers of those securities to disclose the environmental impact of their blockchains.[280] ESG focused investors would likely take advantage of this information and move their

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[273] Howson & de Vries, *supra* note 18, at 5 ("These pathways include: 1) promoting voluntary private-sector commitments to mining with only renewable energy, 2) encouraging a system of voluntary carbon offsetting for miners and users of PoW cryptocurrencies, 3) using existing financial regulations and tax frameworks, and 4) imposing national and/or international bans on PoW mining.").

[274] Truby, *supra* note 238, at 7 ("Alternatively, any capital gains tax or income tax resulting from profits on NFT or digital currency transactions could be charged at a premium rate if proof-of-work verification is used.").

[275] *Id.*

[276] *Id.*

[277] *Id.* ("An alternative policy intervention to regulation is to introduce varied transaction sales tax or income tax rates depending on the energy consumption level in the transaction type.").

[278] *See* Exec. Order No. 14067, 87 Fed. Reg. 14143 (Mar. 14, 2022) (directing the SEC to focus on financial risks).

[279] *See* PHILLIPS, *supra* note 10, at 8 ("Not only would regulation, oversight, and enforcement provide investors with transparency sufficient to allocate their capital efficiently, but the SEC would also be able to regulate digital assets in ways that support investors' environmental, social, and governance (ESG) goals.").

[280] *Id.* at 9 (advocating for various environmental actions by the SEC).

investments to more energy-efficient digital assets.[281] This would incentivize digital asset issuers to migrate away from energy-intensive technologies and reduce emissions.[282] The SEC could also implement other listing standards. For example, a listing standard could require digital assets to be proof of stake based, instead of proof of work.[283] Listing standards could also require digital assets to meet minimum environmental standards before being listed.[284] The SEC could also require exchanges to record all transactions within the exchange on their own ledger instead of relying on the cryptographic calculations of distributed ledgers.[285] The vast majority of crypto transactions are through exchanges, similar to the stock market.[286] When a cryptocurrency is traded on an exchange, the inefficient blockchain is bypassed, and the exchange records the transaction much more energy efficiently.[287] As with other potential solutions, the SEC should not work in isolation, but should reach out to its counterparts in other countries, such as ESMA in the EU.

VI. *Conclusions*

This Note concludes by reviewing the environmental impact of cryptocurrencies, steps governments are taking towards regulation,

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[281] *See id.* ("This would allow investors to move their capital to the most energy-efficient uses.").
[282] *Id.* ("This would allow investors to move their capital to the most energy-efficient uses.").
[283] *Id.* ("Exchanges could impose listing standards on digital asset exchanges in ways that promote the energy efficiency of the securities; for example, they could list only digital asset securities that operate on blockchains using the proof-of-stake hashing method.").
[284] *Id.* ("First, for those digital assets that are securities ("digital asset securities"), the SEC could require issuers to disclose their blockchains' environmental impacts.").
[285] *See id.* at 10–11 ("This single trustee could record all digital asset security transactions on its own ledger, removing the need for energy-intensive blockchain transactions entirely.").
[286] *See, e.g.*, CRYPTO.COM, https://crypto.com/us.
[287] *See id.* at 10 ("Beyond simply providing information to investors so they can make decisions about where to invest their capital, the movement of capital from energy-inefficient digital assets to more efficient ones would incentivize issuers to migrate their ledgers away from energy-intensive technologies, reducing greenhouse gas emissions.").

and routes of regulating that should be implemented. Digital assets are responsible for an extreme amount of emissions and energy usage.[288] Digital assets are increasingly under regulatory scrutiny as more governments confront their adverse effects on society.[289] While most scrutiny is placed on the criminal and financial aspects of digital assets, detrimental environmental effects are increasingly gaining recognition.[290]

Although some private efforts have worked to make digital assets greener, they do not go far enough. Despite Ethereum's shift to proof of stake, other cryptocurrencies do not appear to be following the same path, and Bitcoin's energy usage, especially, continues to surge.[291] Environmental laws and regulations are required to counter current market forces.[292] Lawmakers should pass Senator Markey's Bill to ensure that a maximum amount of digital asset environmental data can be gathered. With that data, regulators will be better able to implement effective requirements on crypto miners and digital asset issuers. While taxation on individual digital asset transactions will probably be hard to implement, regulators should implement energy policies and SEC listing rules that promote a greener digital asset market. Likewise, moratoriums on proof of work and other efforts that would discourage heavy power usage should be implemented on an international level to successfully achieve climate goals. National and international coordination is key to ensuring uniformity in the environmental regulation of digital assets and prevent regulatory arbitrage that would defeat its purpose. Without this coordination, it is clear that any regulations will only be regionally effective, and will unfortunately fail to confront the global problem.[293]

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[288] *See* discussion *supra* Part III.
[289] *See* discussion *supra* Part II.
[290] *See supra id.* (discussing the increased awareness of the environmental effects of digital assets and calls for regulation).
[291] *See supra* Part III; *see Bitcoin Network Power Demand*, *supra* note 58.
[292] *See supra* Part V.
[293] *See id.*