TO: Office of Science and Technology Policy (OSTP).
DigitalAssetsRFI@ostp.eop.gov

FROM: Jorge Daniel Taillant, Executive Director
The Center for Human Rights and Environment
https://center-hre.org
Advocacy Group / Non-Profit Organization (501C3)

RE: RFI Response: Climate Implications of Digital Assets

DATE: May 9, 2022

Background:

On March 9, 2022, concerned with the high energy intensity use of the mining of digital assets, as well as the implications of digital asset blockchain mining on US attainment of greenhouse gas emissions reduction and achieving zero emissions, President Biden signed an Executive Order on Ensuring Responsible Development of Digital Assets[i], which outlines a whole-of-government strategy to harness the benefits of and mitigate the risks of digital assets, including the implications for energy use and the climate of technologies employed to verify digital asset blockchains.

These comments respond to the Office of Science and Technology Policy (OSTP)'s request for comments on the protocols, hardware, resources, economics, and other factors that shape the energy use and climate impacts of all types of digital assets as well as on the relationship between digital assets to mitigate climate harms and reduce energy use associated with digital assets, potential energy or climate benefits from digital assets and opportunities for natural asset or emissions accounting, likely future developments or industry trajectories related to digital assets, and implications that digital assets have for U.S. policy including as it relates to electricity grid reliability and greenhouse gas intensity.

General Comment

The use of digital assets (including digital currencies such as Bitcoin, and/or Non-Fungible Tokens (NFTs))[ii] in the financial sector is rapidly rising and becoming a common element in the financial sector for many types of operations, and because of their significant and intense impacts on energy use and subsequent rise in related greenhouse gas emissions due to the intense use of this energy which is generally not the cleanest energy available, *the federal government must urgently consider regulating digital assets in terms of their associated energy consumption and to ensure that their use does not hinder national priority to rapidly achieve national climate goals and emissions reductions targets.*

From a climate perspective, and particularly considering the importance of keeping to key temperature targets set forth by the Paris Agreement, namely to limit global warming to 1.5°C, which necessarily implies the aggressive reduction of GHG emissions in the short term and particularly before 2030 and before mid-century, the rising use of digital assets, poses significant energy concerns as the majority of the specific technology utilized today to verify digital assets in the process known as *blockchain verification*, is highly energy-intensive. If *digital asset verifications procedures* (used interchangeably with *crypto mining*) are accelerated, its electricity demand is capable of producing total emissions sufficient to surpass 1.5°C, and potentially 2°C of global warming in the coming decades, which would

take the United States, and possibly the planet off of the critically urgent and necessary climate warming containment pathway we are trying keep to.

The Context for Digital Assets Expansion Relative to the Latest Climate Science

The acceleration and uptake of digital assets and its highly energy-intensive verification practices are taking place in the context of rapidly approaching climate tipping points, a scenario in which climate change deterioration and its impacts to global ecosystems, says the Inter-Governmental Panel on Climate Change (the IPCC), may be irreparable and irreversible. The latest science from the world's leading climate scientists is very clear that catastrophic and irreversible tipping points, augmented by self-reinforcing feedback loops, are suddenly closer than we had expected and may be reached in just a few years, even as early as 2030. The IPCC has confirmed in its latest reports that previous estimates of the timeline for surpassing these irreversible climate tipping points were off, and they are rapidly approaching[iii]. We must act now to limit global warming by 2030 in order to avoid climate collapse, that's just 7.5 years away, and there is no time to lose.

Unfortunately, the collection of current climate policies around the world, centered mostly on decarbonization strategies and targets, put the world on track for about 3.2°C of warming by 2100. That's simply too much. At this stage in the deepening of our climate crisis, every additional 1/10 of a degree of warming makes a significant difference in the state of the climate and for the deterioration of interrelated ecosystems[iv]. In short, at the pace we're going, we're going to miss the train for climate repair, and we won't be able to get back on track, *ever*. It is essential that the large-scale adoption of digital assets and the related intense of use of energy, particularly climate-impacting energy such as coal, methane gas, or other fossil fuels, do not deepen or exacerbate the climate crisis that we are already in, particularly for the people and areas most affected by climate change.

The Recent Global Evolution of Digital Asset Technology and Relations to Energy Use

The extensive computer hardware and network infrastructure needed to verify digital assets can result in significant draws on local energy grids, which may already be strained during peak consumption periods, particularly in the context of rising global temperatures and the increment of extreme heat days in certain parts of the world. For this reason, governments around the world, including China, while initially welcoming digital asset verifiers (crypto miners) to their localities because they were convinced of the benefits of attracting tax revenues and creating local jobs from this activity, have come to the conclusion that the verification processes employed in digital asset activity, places an unwelcome intense energy strain on their local energy grids and hinders their pathway to achieve climate targets to reduce GHGs.

Some countries, including China, have banned or greatly restricted the use of digital assets and digital asset verification (crypto mining) operations altogether. As a result, digital asset verification activity has largely moved to countries such as the United States, Canada, Iran and Kazakhstan, among others, unfortunately intensifying energy use in these countries for such operations. Of even greater concern is that while once largely located in China where it was carried out with cleaner renewable hydro energy power, the subsequent displacement of digital asset verification, in its quest for seeking cheap, abundant, and available energy, has sought less-than-ideal energy sources such as coal or natural gas, and in some cases, it has revived otherwise defunct coal energy operations in order to carry out blockchain verification. In the United States, blockchain verification is utilizing coal and natural gas-based energy, among others, fostering an unfortunate expansion of fossil fuel energy generation for this activity. It should be noted that methane gas, the primary component of natural gas, has 86 times the global warming impact as compared to CO_2 which is why the use of natural gas-derived-energy for digital asset

verification, or worse, coal energy, is highly troublesome from a climate change and GHG emissions perspective.

It behooves the federal government to strictly regulate digital asset verification, to consider full bans of the activity when employed with intense high energy usage, to regulate which technologies may be employed for blockchain verification (since not all technologies are equally contaminating for the climate), and to ensure that if the practice is permitted, that it is carefully regulated in terms of energy consumption, environmental impacts and its impacts on reaching national and global emissions reductions targets.

Comments on the technologies utilized for digital asset verification:
Proof of Work vs. Proof of Stake

Approximately 2.9 million specialized hardware devices participate in blockchain verification transactions, (de Vries, 2022).[v] Digital currency mining generates 160 quintillion calculations per second for constant verification actions of a single cryptocurrency issuance. For cryptocurrencies to function, multiple mining transactions per operation are necessary, with each transaction utilizing multiple mining devices that operate 24/7.

Because each blockchain verification device is only rewarded when there is a verification of a transaction, it is economically beneficial for the miner to have multiple devices mining at all times, increasing the chance of the miner to make a profit from their verification operations. As more transactions are called for, more blockchain verification will take place, leading to more energy consumption needed to mine the expanding volume.

By some estimates, cryptocurrency mining consumes about 50% of the energy of all of the world's data centers,[vi] with the two largest digital currency verifiers/issuers are Bitcoin and Ethereum. The single company, Bitcoin, has a market cap equivalent to world's 5th largest economy, just behind Japan indicating how large these companies and operations have become.[vii]

The choice of technology utilized for digital currency verification are of two main types, referred to as *"proof of work" and "proof of stake"*. The use of these two different models have very different energy needs, with the "proof of work" model (distributing verification between multiple miners) being highly energy intensive and the "proof of stake" model (assigning verification to a single miner) being less energy intensive.

The predominance of the "proof of work" model, mostly utilized by Bitcoin, is far worse in terms of its climate impacts, and yet has been the sector technology of choice due to larger user trust in the verification process. This has been a constant force to continue to utilize this model for blockchain verification. The *proof-of-work* technology model uses so much energy because there are multiple validating device developers competing to be rewarded with a digital token.

In a very different technological approach, with very different energy use implications, in *proof-of-stake* consensus protocols, a single validator is selected by the blockchain algorithm to complete the verification of a given transaction, which means that far less energy is required to validate each transaction. Miners use their own digital tokens as collateral and are granted authority over the token proportionate to the sum staked. Thus, the more tokens owned by the miner, the greater is the extent of their mining power[viii].

Steps are in place to shift to a "proof of stake" model, through such companies as Ethereum, but the shift is slow. Social pressure fails to encourage a proof model switch to a less energy-intensive blockchain verification procedure. Platforms are reluctant to change (Bitcoin, for example) because their technology is tried and tested, and it is an integral part of their reputation/trust which creates "path dependence" (it's just how things are done).

Some jurisdictions are starting to move the digital blockchain verification sector towards "proof of stake". For example, New York State has issued a moratorium on "proof of work" practices[ix]. However, counter to this trend is the race of miners to jurisdictions where energy is cheap and high emissions and high energy use are tolerated

Without incentives or regulations to change, digital asset verification activity will continue to use the most widely accepted technology, the proof of work method, which is bad for climate. This is where the federal government can make an important contribution to guide the technological switch-over to less energy-intensive technology.

Comments on Emissions of Digital Asset Verification

Part of the problem of digital asset verification is the energy intensity of mining. Reliable data on emissions is scarce and inconsistent, however by some estimates, Bitcoin mining alone results in about 65.4megatones of CO_2e per year (for comparison, the entire country of Greece emits about 56.6mt CO2e per year)[x].

While digital asset mining was largely located in China, the Chinese ban on the practice shifted energy use for mining to countries where fossil fuels are employed to mine digital assets (natural gas and coal in the United States, coal energy from Kazakhstan, of gas energy from Russia, for example). This move after the Chinese ban has resulted in increased methane emissions percentage from 15% to 38%[xi]. It is estimated that per transaction emissions can be as high as 884kg CO_2 for the most energy intense technologies, and about 85kg CO_2 per transaction for lower energy intensive technologies[xii].

One problem with the calculation of emissions from digital asset verification is that emissions are calculated based on theoretical factor emissions and not on actual emissions, which likely is resulting in a vast underestimate of total emissions from the activity.

Comments on the Social and Environmental Impacts of Digital Asset Mining

New research attempts to corelate emissions from digital asset verification to social and environmental impacts utilizing globally established inter-relationships between emissions and social impacts. According to Truby et al, Bitcoin's 2021 CO_2 emissions alone can be attributed to 18,818 future deaths through impacts such as resulting poor air quality. Ethereum's attributed yearly deaths are about 8,300 future deaths due to CO_2 emissions volumes[xiii].

E-waste is also a key issue in crypto mining due to heavy computer use (about 20% of computer waste is recycled properly, the rest is a problem for ultimate waste disposal). Older mining machines quickly become obsolete and ends up as landfill waste. Digital asset mining generated more e-waste at the start of 2021 than many countries alone, according to economist Alex de Vries[xiv].

Comments on Emerging Regulations of Digital Asset Mining (Globally and in the US)

While the initial interest from policy makers on inviting digital asset verification activity to their jurisdictions was grounded on the practice as a source for generating tax revenue and creating new jobs, the problem of energy consumption becomes quickly apparent, and is now leading the way for new regulations of the sector, particularly at sub national levels. The US government has invited comments both due to concerns over financial safety of markets but also many governments have rising concerns over energy intensity and consumption and potential complications with achieving GHG emissions reduction targets. Several countries have followed this pathway, initially welcoming digital asset verification operations and later responding with regulatory actions to limit the practice, including bans or strict energy regulations, to control energy consumption (China, Iran, et.al).

Inner Mongolia province became first jurisdiction to cite environmental concerns of mining bitcoin, while the Chinese provinces of Sichuan and Xingjiang banned bitcoin mining after having welcomed it due to the resulting intense draw on their hydropower energy grids. A new law in Kazakhstan imposing extra taxes for crypto mining per kilowatt was recently introduced, after the country previously granted tax incentives for the practice. Quebec, Canada limited renewable energy for crypto miners to 688 megawatts in 2019 (de Vries, 2022, p.500).

In Europe, the EU finance regulator is calling for a ban on digital asset mining. Erik Thedéen, the vice-chair of the European Securities and Markets Authority, told the Financial Times that bitcoin mining had become a "national issue"[xv] for his native country Sweden and warned that cryptocurrencies posed a risk to meeting climate change goals in the Paris Agreement and has banned crypto mining because of concerns over its targets to zero emissions. Iceland, concerned with energy impacts for digital asset verification, sources 100% of mining from renewable sector

The country of El Salvador offers tax incentives for digital asset mining, but also takes taxes from crypto mining and puts them back into green energy.

Iran meanwhile, banned digital asset verification for four months because of spike in energy consumption when Iran took in new crypto miners.[xvi] Presently, Iran has a licensing agreement for crypto mining which defines what energy can be used. Digital currency mining bans have also been issued in Bolivia, Ecuador, Egypt, Algeria, Qatar, Oman, Morocco, Tunisia, and Bangladesh.

In the United States, while Rhode Island, Kentucky, Iowa, Montana, Wyoming have offered incentives to digital asset mining, other jurisdictions have already decided to curtail the activity. The County of Missoula Montana became wary of crypto mining because it was utilizing one third of its cheap hydropower energy and now requires miners to purchase 100% clean energy (via offsets to build new renewable projects). Pennsylvania has introduced energy regulations for digital asset mining, and New York State Senate (Bill S6486) has recently passed a bill halting Proof of Stake verification methods so as not to impede NY's targets under Paris Agreement, and until an EIA can be carried out[xvii]. The Common Council of Plattsburgh NY issued a moratorium on new crypto mining operations in the city. The New York Public Service Commission allowed municipal authorities to issue tariffs on high density load energy customers. Meanwhile, on the opposite coast, some public utility districts in Washington State have issued moratoriums on digital asset mining.

Finally, it is noteworthy to mention that several US federal agencies are debating and considering regulations on digital asset verification. The US Senate Committee on Banking, Housing and Urban Affairs held a meeting in 2021 on crypto currencies, and there were many calls for tighter regulations. The recent proposed infrastructure bill recognized the role of digital assets as "digital asset broker". These

very comments are a product of the Executive Order from the White House on Ensuring Responsible Development of Digital Assets, calling for action/attention on crypto and climate/energy[xviii]. The US Congressional Research Services proposes "proof of stake" and "proof of authority" as more sustainable consensus mechanism than "proof of work"**.**

Final Comments and Recommendations for Moving Forward to Regulate Digital Asset Verification with respect to environmental and climate impacts.

If digital asset verification activity is to become a permanent element of the financial sector, federal regulations must foster the cleanest and least climate-impacting technology available for the practice and move blockchain verification towards less energy-intensive models than those that currently dominate the market.

This implies a move away from the "proof of work" technology utilized primarily by companies like Bitcoin to "proof of stake" technologies employed by companies such as Ethereum. These comments should not be construed to indicate a support for any specific technology or company, but rather to stress that a continuous move towards less energy-intensive solutions in digital asset verification is needed to keep our societies on a sustainable pathway to ensure that we not surpass dangerous and irreversible global warming limits in the near, medium and long term.

Federal regulations should be introduced with the possibility of placing outright bans on blockchain verification technologies that are considered too energy-intensive or that result in excessively high GHG emissions, such as verification activity carried out with the use of coal energy, natural gas or other fossil fuels. *Considerations for linking the practice with renewable, cleaner and most preferably zero emissions technology energy is critical.* Disincentives could be utilized, such as high taxes on high energy intensity technologies such as "proof of work" options. Another possibility is to incentivize pooling of technology and operators to minimize miner activity for single transactions. Another option could be regulating the use of digital asset mining according to energy peak demand, for example, prohibiting intense energy use during especially hot days or other situations where the energy grid is already excessively relied upon for essential, life-saving services like cooling. Yet another option is to mandate energy back up power for digital asset verification so as not to unduly place strain on already strained grids. As is clear from this list of options, many pathways can be considered to promote the reduced energy load of digital asset verification activity.

In sum, the federal government should take all considerations necessary, and work to ensure that any digital asset verification processes (crypto mining) that is permitted or regulated, does not place undue strains on our efforts to thwart and reverse climate change, and contain global warming in the near, medium and long term, and that if the practice is to be permitted, that it be done utilizing only renewable, cleaner and most preferably, zero-emissions energy technology.

Useful Links:

Revisiting Bitcoin's Carbon Footprint
https://www.sciencedirect.com/science/article/abs/pii/S2542435122000861?dgcid=author

Cambridge Bitcoin Energy Consumption Index
https://ccaf.io/cbeci/index/comparisons

Bitcoin's Energy Use Compared To Other Major Industries
https://bitcoinmagazine.com/business/bitcoin-energy-use-compare-industry

The Debate About Cryptocurrency And Energy Consumption
https://techcrunch.com/2021/03/21/the-debate-about-cryptocurrency-and-energy-consumption/

EU Should Ban Energy-Intensive Mode of Crypto Mining, Regulator Says
https://www.ft.com/content/8a29b412-348d-4f73-8af4-1f38e69f28cf

Cryptocurrency Mining Regulations: Is Bitcoin Mining Legal?
HTTPS://EZBLOCKCHAIN.NET/ARTICLE/CRYPTOCURRENCY-MINING-REGULATIONS/

Law professor calls for crypto mining regulation during US Senate hearing
https://cointelegraph.com/news/law-professor-calls-for-crypto-mining-regulation-during-us-senate-hearing

Should Crypto Mining Be Regulated for Energy Consumption?
https://earth.org/should-crypto-mining-be-regulated-for-energy-consumption/

Bitcoin Mining Consumes 0.5% Of All Electricity Used Globally And 7 Times Google's Total Usage
https://www.businessinsider.com/bitcoin-mining-electricity-usage-more-than-google-2021-9#:~:text=Bitcoin%20mining%20consumes%20around%2091%20terawatt%2Dhours%20of%20electricity%20annually.&text=That's%20almost%200.5%25%20of%20all,from%20just%20five%20years%20ago.

Crossing the Wires of Energy and Cryptocurrency Policy: U.S. Congress Investigates the Environmental Impact of Crypto Mining
https://www.jdsupra.com/legalnews/crossing-the-wires-of-energy-and-3316286/

Hearing On "Cleaning Up Cryptocurrency: The Energy Impacts Of Blockchains"
https://energycommerce.house.gov/committee-activity/hearings/hearing-on-cleaning-up-cryptocurrency-the-energy-impacts-of-blockchains

The Crypto Climate Accord
https://cryptoclimate.org/

Bitcoin, blockchain, and the Energy Sector
https://sgp.fas.org/crs/misc/R45863.pdf

[i] See: Biden J. (2022) *Executive Order on Ensuring Responsible Development of Digital Assets*, https://www.whitehouse.gov/briefing-room/presidential-actions/2022/03/09/executive-order-on-ensuring-responsible-development-of-digital-assets/.

[ii] Truby J., Brown R. D., Dahdal A., & Ibrahim I. (2022) *Blockchain, climate damage, and death: Policy interventions to reduce the carbon emissions, mortality, and net-zero implications of non-fungible tokens and Bitcoin*, ENERGY RESEARCH & SOCIAL SCIENCE 88 102499.
NFTS: NFTs are unique and non-replicable digital assets recorded as cryptographic tokens on the blockchain. NFTs provide a secure and innovative means of certifying ownership of either physical or digital assets, which can then be traded. Notably, NFTs are supported by the same blockchain technology utilized for digital currencies, such as Bitcoin. Extensive literature is devoted to applications of blockchain beyond digital currencies, such as in smart contracts, and emergent uses, including NFTs and gaming. While not at the same level as cryptocurrency (bitcoin for example) NFT sales increased eightfold to US$ 10.7 billion in Q3 2021 from the previous quarter

[iii] IPCC. (2022). "Summary for Policymakers". Section C.1. ("Global GHG emissions are projected to peak between 2020 and at the latest before 2025 in global modelled pathways that limit warming to 1.5°C (>50%) with no or limited overshoot and in those that limit warming to 2°C (>67%) and assume immediate action. [Table SPM footnote [#9], FOOTNOTE 38] In both types of modelled pathways, rapid and deep GHG emissions reductions follow throughout 2030, 2040 and 2050 (high confidence). Without a strengthening of policies beyond those that are implemented by the end of 2020, GHG emissions are projected to rise beyond 2025, leading to median global warming of 3.2 [2.2 to 3.5] °C by 2100.").

[iv] *Discussed in* Borenstein S. (28 February 2022) *UN Climate report: 'Atlas of human suffering' worse, bigger*, AP News.

[v] See: https://www.sciencedirect.com/science/article/abs/pii/S2542435122000861

[vi] See: https://techcrunch.com/2021/03/21/the-debate-about-cryptocurrency-and-energy-consumption/?guccounter=1

[vii] See: https://techcrunch.com/2021/03/21/the-debate-about-cryptocurrency-and-energy-consumption/

[viii] Truby J., Brown R. D., Dahdal A., & Ibrahim I. (2022) *Blockchain, climate damage, and death: Policy interventions to reduce the carbon emissions, mortality, and net-zero implications of non-fungible tokens and Bitcoin*, ENERGY RESEARCH & SOCIAL SCIENCE 88 102499.

[ix] Senate Environmental Conservation Committee (2022) *New York State Senate Bill S6486D*. https://www.nysenate.gov/legislation/bills/2021/s6486/amendment/d.

[x] Tully S. (2022) *Bitcoin mining crackdown led to a 17% rise in carbon emissions, researchers find*, (last accessed 9 May 2022). https://fortune.com/2022/02/25/bitcoin-mining-crackdown-environment-carbon-emissions/.

[xi] Vries A. de, Gallersdörfer U., Klaaßen L., & Stoll C. (2022) *Revisiting Bitcoin's carbon footprint*, JOULE 6(3): 498–502.

[xii] Truby J., Brown R. D., Dahdal A., & Ibrahim I. (2022) *Blockchain, climate damage, and death: Policy interventions to reduce the carbon emissions, mortality, and net-zero implications of non-fungible tokens and Bitcoin*, ENERGY RESEARCH & SOCIAL SCIENCE 88 102499.

[xiii] Truby J., Brown R. D., Dahdal A., & Ibrahim I. (2022) *Blockchain, climate damage, and death: Policy interventions to reduce the carbon emissions, mortality, and net-zero implications of non-fungible tokens and Bitcoin*, ENERGY RESEARCH & SOCIAL SCIENCE 88 102499.

[xiv] Vries A. de, Gallersdörfer U., Klaaßen L., & Stoll C. (2022) *Revisiting Bitcoin's carbon footprint*, JOULE 6(3): 498–502.

[xv] See: https://www.euronews.com/next/2022/01/19/eu-regulator-calls-for-a-ban-on-proof-of-work-bitcoin-mining-to-save-renewable-energy
[xvi] See: https://www.forbes.com/sites/martinrivers/2021/12/31/irans-ban-on-bitcoin-mining-is-supposed-to-stop-electricity-blackouts--it-will-do-the-opposite/?sh=3aef869e314e
[xvii] Senate Environmental Conservation Committee (2022) *New York State Senate Bill S6486D*. https://www.nysenate.gov/legislation/bills/2021/s6486/amendment/d.

[xviii] Biden J. (2022) *Executive Order on Ensuring Responsible Development of Digital Assets*, https://www.whitehouse.gov/briefing-room/presidential-actions/2022/03/09/executive-order-on-ensuring-responsible-development-of-digital-assets/.
"Section 1. Policy. Advances in digital and distributed ledger technology for financial services have led to dramatic growth in markets for digital assets, with profound implications for the protection of consumers, investors, and businesses, including data privacy and security; financial stability and systemic risk; crime; national security; the ability to exercise human rights; financial inclusion and equity; and energy demand and climate change."
"We must take strong steps to reduce the risks that digital assets could pose to … the ability to exercise human rights; financial inclusion and equity; and climate change and pollution"
"(vii) Within 180 days of the date of this order, the Director of the Office of Science and Technology Policy, in consultation with the Secretary of the Treasury, the Secretary of Energy, the Administrator of the Environmental Protection Agency, the Chair of the Council of Economic Advisers, the Assistant to the President and National Climate Advisor, and 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; 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. This report shall be coordinated through the interagency process described in section 3 of this order. The report should also 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 should specifically address:
(A) potential uses of blockchain that could support monitoring or mitigating technologies to climate impacts, such as exchanging of liabilities for greenhouse gas emissions, water, and other natural or environmental assets; 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."