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ENVIRONMENTAL RESOURCES AND ENERGY COMMITTEE
ON THE ENVIRONMENTAL IMPACT OF CRYPTOCURRENCY

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Thank you, Chairman Vitali, Chairman Causer, and members of the committee, for the opportunity to testify today on the energy and environmental impacts of proof-of-work cryptomining in Pennsylvania. My name is Robert Altenburg, and I am the Senior Director for Energy and Climate at Citizens for Pennsylvania's Future (PennFuture). We are a nonprofit environmental advocacy organization with offices across Pennsylvania that is committed to leading the transition to a clean energy economy in Pennsylvania and beyond.

I've worked at PennFuture since 2014 and, before that, spent nearly 22 years at the Pennsylvania Department of Environmental Protection working in both the Bureau of Air Quality and the Policy Office on a wide range of issues impacting air pollution and energy. In the last few years, I've been following the growth of Bitcoin and other proof-of-work cryptocurrency operations with significant concern.

I. Introduction:

What is proof-of-work mining, and why it is a problem?

Bitcoin[1], and blockchain technology in general, was invented to make digital currency possible.

It might be convenient if we could exchange packets of digital data in place of paper bills, but that has some challenges. Unlike our paper money, which includes anti-counterfeiting measures that make it very challenging, and very expensive, to make passable copies, making exact copies of digital data is trivial. To prevent fraud, and make digital currency useful, there must be some way to ensure no one can spend the same bit of digital currency more than once.

The solution is straightforward—we maintain an open record, like a bank statement, that anyone can view. This ledger and it keeps track of all transactions involving our digital currency from the moment each unit is created. When a person uses digital currency, the ledger notes that a unit of currency has left one person's digital "wallet" or account and has moved into another wallet. The process is equivalent to transferring money between bank accounts.

[1] S. Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System, (2008) (*available at: https://www.bitcoin.com/satoshi-archive/whitepaper/)*

No matter how many copies a person makes of this digital currency, they can't use it once the ledger shows it's no longer in their wallet. This is because the ledger, and not any actual copies of the currency, determines who owns the currency.

Although we often refer to digital currencies as 'coins', there are no physical coins to handle or copy. What we call a 'coin' is the series of entries in the ledger that record its creation and all subsequent transactions. It's like the history of a banknote's movement from person to person but recorded in a ledger for everyone to see.

To make sure that our digital currency system functions effectively, we must prevent people from manipulating the transaction records in the ledger.

We do this using a mathematical tool known as a 'hash.' In practical terms, a hash is a piece of computer code that, when given any data, produces a unique number that acts like a digital fingerprint for that data. We use this hash to create a unique fingerprint for each page (or 'block') of the ledger that records our digital transactions. This makes it much harder for anyone to tamper with the records, because any change to the data would also change its hash, and thus its digital fingerprint.

While that is a good start, that shifts the problem from keeping the ledger secure to keeping the fingerprints secure. Instead of depending on centralized authorities like governments or corporations to ensure no one can alter the transactions or fingerprits, we use a clever solution where each block of transaction data includes the fingerprint of the block before it. This creates a chain of blocks, or a 'blockchain.'

If someone tries to change a piece of data in the blockchain, they will have to change the data in all the subsequent blocks as well, because changing the data changes its hash, which in turn affects the hashes of all the following blocks. The harder it is for a person to create new blocks, the more secure the system becomes.

Every blockchain, like the one used for Bitcoin, has its own set of rules known as a 'consensus mechanism.' This mechanism helps everyone participating in the blockchain agree on when new blocks (pages of transactions) can be added.

In Bitcoin's system, creating a new block is called 'mining,' and the consensus mechanism used is known as 'proof of work.'

Here's how it works:

A person, who wants to mine[2] a block (we'll call them a 'miner'), gathers a bunch of proposed transactions that people want to add to the blockchain. These transactions represent people trying to send Bitcoins to each other.

[2] Calling the process of creating new Bitcoins “mining” and the creators “miners” is based on an analogy to gold mining (*See:* S. Nakamoto, at 4.)

The miner's job is to quickly check each of these transactions. They must make sure that anyone trying to send Bitcoin really owns that Bitcoin and has the right password to access their digital wallet.

Once the miner has verified all the transactions, they bundle them together with the hash (the unique digital fingerprint) of the last block that was added to the blockchain. They also add some other required information to this bundle. All of this together forms a new potential block.

The miner then calculates the hash of this new block. But here's where it gets tricky. According to Bitcoin's rules, the hash of the new block can't be just any number. It must be a relatively low number to be accepted by the rest of the Bitcoin network.

How low? That depends on how much computing power all the miners in the world are using at the time. The more effort (in terms of computing power) being used to mine, the lower the required number becomes. This also means that the chances of any one potential block being valid (i.e., having a low enough hash) become smaller. This is what makes Bitcoin mining difficult and ensures the security of the system.

Right now, the odds of any one prospective block being valid are less than one chance in a two-hundred billion trillion. That is much worse than the odds of a single person winning the Powerball lottery on two consecutive days. If their potential block is no good, the miner must change something in the block, find a new hash, and check it again. To maximize their chances, miners race to test as many potential blocks as possible.

Since the Bitcoin network needs miners to validate transactions and maintain the ledger, they need to provide some incentive for all this effort. Currently, when a miner finds a new block, the first transaction it lists will create 6.25 new Bitcoin, worth around $170,000 at today's prices, and put that new Bitcoin in their wallet in addition to any transaction fees paid by the people wanting their transactions validated. All the other miners get nothing for their effort and start again from scratch to find the next block.

Because the chances of finding a valid block are incredibly low and the stakes are high, miners buy special-purpose computers called Application Specific Integrated Circuits (ASICS) that can each calculate around a hundred trillion of these hashes every second. But, in the process, they use a lot of energy. A single ASIC these days uses around three times as much electricity as an average household, and a single mining operation may use tens-of-thousands of these devices in massive racks.

Combined, the entire Bitcoin mining network uses over a hundred trillion watt-hours each year[3]. That is more electricity than we consume in about 80 percent of our states, and more than many entire countries.

For Bitcoin, wasting this much energy is part of the design, but it's just not necessary. We can think of proof-of-work as "Version 1.0" and, like many products, newer innovations have been developed to accomplish the same things faster and cheaper.

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[3] Cambridge Bitcoin Energy Consumption Index (*available at: https://ccaf.io/cbeci/index).*

In this case, non-proof-of-work blockchain systems have been successfully operating for over ten years[4] and, in many cases, these alternate systems offer more capabilities than the Bitcoin blockchain while having a tiny fraction of the energy demand.

II. Bitcoin Mining is Causing Increased Pollution

With no specific reporting requirements and inconsistent permitting, we often rely on media reports, or reports from residents, to discover new Bitcoin mining operations. What we have seen, however, represents a disturbing trend.

Waste coal

In July of 2021 a company by the name of Stronghold Digital Mining (Stronghold) filed an S-1 report with the Securities and Exchange Commission (SEC) disclosing plans to purchase three waste coal fired power plants and install 57,000 Application Specific Integrated Circuits (ASICs) dedicated to mining bitcoin. To date, Stronghold has purchased the 94-megawatt (MW) circulating fluidized bed (CFB) Scrubgrass power plant in Venango County and the 94 MW Panther Creek CFB facility in Carbon County. Strongholds initial plans also contemplated the purchase a third facility bringing their total generating capacity to 300MW.[5] As of March 24, 2022, the company operated approximately 20,500 pieces of mining hardware and had purchase agreements in place for an additional 29,400 miners.

Waste coal is a low-energy-value product that, before environmental restrictions were passed, was often dumped in piles near mining sites. Pennsylvania has approximately 840 such sites and operators such as Stronghold claim that burning it for energy is environmentally beneficial because it encourages the removal of these piles, and the waste ash can be used for fill and reclamation projects. Despite these claims, burning waste coal is still just burning fossil fuel and results in the emissions of significant amounts of air pollution including ozone precursors, fine particulates, acid gasses, heavy metals, and vast amounts of carbon pollution. The impacts of increased air pollution should not be ignored—particularly at these sites, since the Scrubgrass plant is located within ten miles of a designated Environmental Justice area and the Panther Creek plant is within three miles of such an area.

Burning a low-energy-value fuel source also requires subsidies to be profitable and the Pennsylvania state legislature has provided significant incentives to burn polluting waste coal. These incentives include $4/MWh from the Coal Refuse Reclamation tax credit and a claimed $16/MWh from the Tier II Alternative Energy Portfolio Standard Program. Altogether, Stronghold has claimed 60 percent of their generation costs will be covered by subsidies from taxpayers and ratepayers.[6]

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[4] Peercoin implemented a proof-of-stake system in 2012.

[5] Stronghold Digital Mining, SEC Form 10-k, (filed Mar. 29, 2022).

[6] Stronghold Digital Mining, SEC Form S-1, (filed Jul. 27, 2021).

Utilizing waste coal to generate electricity for Bitcoin mining is one of the most detrimental options available. According to data from the Energy Information Administration (EIA)[7], waste-coal fired power plants in Pennsylvania had average CO2 emissions of over 2,760 pounds per megawatt-hour, ranking them as the second most carbon-intensive fuel source after residual fuel oil. Burning waste coal doesn't solve the pollution problem, it moves pollution from the ground into the air, exacerbating air quality issues. This negative impact is amplified because Bitcoin mining facilities operate at significantly higher capacity factors than plants supplying energy to the grid. Additionally, there are nine other facilities in Pennsylvania where such mining operations could potentially expand. There exist more effective, safer, and often cheaper methods to manage waste coal than burning it for Bitcoin mining. For instance, some waste piles have been stabilized by planting American beachgrass[8], which helps reduce environmental impact. In other situations, it may be more beneficial to extract the waste material and dispose of it at a suitably permitted facility. These alternative methods reduce both ground and air pollution, offering a more sustainable approach to waste coal management.

Fracked gas

Pennsylvania is already seeing methane gas fired generators being installed directly at fracked gas well sites and, in certain market conditions these facilities could see significantly more revenue that would be obtained selling the gas on the wholesale market. Assuming no action by regulators, this would be expected to raise wholesale prices for methane gas which we currently rely on for 53% of their electricity generation and a significant portion of home heating. In addition to the consumer impacts, methane is 86 times more potent a greenhouse gas than carbon dioxide over a 20-year period, so any leakage from these operations would also be particularly dangerous for our climate.

In January of 2022, inspectors from the Pennsylvania Department of Environmental Protection (DEP) found 30 methane-gas-fired generators with an estimated capacity of more than 10MW at the "Hegarty A" well operated by Big Dog Energy, LLC and located in Clearfield County, PA within two miles of a designated Environmental Justice area. These generators were installed without authorization from the DEP in violation of Pennsylvania regulations and the resulting energy was being used to mine bitcoin.

While the DEP issued a Notice of Violation (NOV) for this operation[9], it is unknown how many of Pennsylvania's many thousands of methane gas wells–many in rural and low-income areas–are hosting similar mining projects. Big Dog Energy alone has 38 other active well permits across Pennsylvania.[10]

In addition to Big Dog Energy, another company, Pin Oak Energy, has purchased a midstream gathering system capable of 25,000 MMBtu/day. Given available ASIC mining hardware, that

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[7] US EIA, Emissions by Plant and Region, 2020 (*available at: https://www.eia.gov/electricity/data/emissions/)*
[8] R. Glennon, S. DePue, Succession on a Coal Mine Gob Pile Stabilized with 'Cape' American Beachgrass (*available at: http://www.energyjustice.net/coal/wastecoal/beachgrass*)
[9] PA DEP, Notice of Violation to Big Dog Energy, LLC., (Jan. 7, 2022).
[10] PA DEP, eFacts information system (*available at: https://www.ahs.dep.pa.gov/eFACTSWeb/default.aspx/default.aspx*)

could represent fifteen to twenty thousand miners, and again, there are questions as to whether the required air quality permits have been obtained.[11]

Finally, in late 2022, Diversified Production LLC applied for an air quality plan approval to install five methane-gas fired generators to support bitcoin mining operation in Elk County, PA.[12] This site is particularly problematic as it is in a region known as the Pennsylvania Wilds—a rural area that heavily depends on nature tourism, and the impacts of the noise from this facility on wildlife has not, to our knowledge, been considered.

Nuclear

In August of 2021, Talen Energy Corp. announced a joint venture with TeraWulf Inc. that would result in the construction of the 180MW Nautilus Cryptomine bitcoin mining facility adjacent to the Susquehanna nuclear power generating station in Columbia County, Pennsylvania.[13] It has since been reported that this facility will benefit from significant state subsidies in the form of Pennsylvania's datacenter tax exemption.[14]

While claims are made that this will use carbon-free nuclear generation, we reject any suggestion that this is environmentally neutral. In 2020, nuclear generation was responsible for more than 33 percent of Pennsylvania's energy generation and represented more than 92 percent of the carbon free energy generated. Diverting carbon free energy to wasteful Bitcoin mining virtually guarantees that demand will be backfilled with fossil resources.

Given Pennsylvania's grid mix, diverting 180MW of carbon free generation from the grid could result in over one million tons of additional carbon pollution per year, in addition to thousands of tons of NOx and other dangerous air pollutants.

III. Wasting Energy on Proof-of-Work Mining Causes Additional Problems

Bitcoin mining operations are likely to raise wholesale electricity prices.

While most of the large Bitcoin mining operations in Pennsylvania are operating "behind the meter" and not drawing power from the wholesale power grid, there are still potential impacts for energy prices and reliability.

To the extent that miners are using electricity that would otherwise flow to the grid, that energy would, by definition, have been priced below PJM's market clearing price. By diverting that energy into wasteful Bitcoin mining, the energy markets will clear at a higher price. These increases in wholesale prices may ultimately be absorbed by consumers.

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[11] B. Stockman, PA DEP Looking into Pin Oak Bitcoin Mine in Ridgeway Township, Ridgeway Record (Mar. 21, 2022) (*available at: https://www.ridgwayrecord.com/news/pa-dep-looking-into-pin-oak-bitcoin-mine-in-ridgway-township/article_5713036c-b136-11ec-bb37-2f666479782b.html).*

[12] Plan Approval Application 24-00195A, 52 Pa.B. 7143 (Nov 19, 2022).

[13] Press Release, *Talen Energy Corp. announces Bitcoin Mining Joint Venture with TeraWulf Inc.* (Aug. 3, 2021)

[14] Caruso, S., *Pa. passed a tax break for data centers. Now crypto-miners are taking advantage*, Penn-Capital Star, (Mar. 13, 2022).

The claim that miners could provide a service to the grid as a source of interruptible load is highly suspect. Given current Bitcoin prices and network conditions, miners using competitive hardware can gross more than $100 per MWh.[15] According to PJM's Market Monitor[16], average monthly wholesale prices in 2021 never exceeded $92/MWh and averaged considerably less. That suggests that there are limited situations where miners would voluntarily curtail their demand because of price concerns. On the contrary, this makes it very likely that Bitcoin mining operations could be the marginal demand that sets an elevated price for the rest of the grid.

Bitcoin mining does not help clean energy.

A similar strawman argument is to claim that mining Bitcoin could "absorb wasted clean energy." Again, this assumes that the only option is waste and Bitcoin mining is a viable alternative—neither is likely true.

In certain scenarios, energy markets have shown a "duck curve" where high solar generation has driven prices very low—sometimes even negative—for short periods in the mid-day period before ramping up sharply later in the day. This can be addressed in different ways, including increased investment in transmission allowing power to be wheeled to where there is demand, and increased storage allowing the excess energy to be used later.

It's unlikely Bitcoin will do anything to alleviate this issue. First, one of the reasons Bitcoin miners gravitate to more expensive fossil fuels rather than clean renewable generation is because 24/7 operations at high-capacity factors is more profitable. This is driven both by the nature of proof-of-work mining pools where increased hash rates directly translate to increased profits. (Other factors include the relatively short competitive life of ASIC hardware and the extreme market volatility.) It is highly unlikely that miners will invest a significant amount of money in mining hardware and let it sit idle until the energy grid "needs" their load.

It's far more likely that these mining operations will burn fossil fuels for energy to support their 24/7 operations and only curtail that generation and buy from the grid when price signals favor doing so. While there may be rare cases when this might keep grid prices from going negative, that will come at a significant cost. In normal operation, the marginal cost of the Bitcoin miner's behind-the-meter generation will become a floor price for the market and have the effect of raising average wholesale prices for everyone while continuing polluting combustion.

Bitcoin mining isn't a solution to the problem of flared methane gas.

A recent claim noted that using methane gas for mining Bitcoin is a "better" choice than flaring it, but that is yet another strawman argument. An even better choice is investing in energy efficiency, electrification, and clean renewable generation, so we avoid the emissions and risk associated with extracting the fossil fuels in the first place.

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[15] See Miner hardware profitability calculations at *https://minerstat.com/coin/BTC/profitability.*

[16] Monitoring Analytics, Components of PJM Price, 2021, (April 12, 2022) (*available at: https://www.monitoringanalytics.com/data/pjm_price.shtml).*

The next logical question is why is there such an excess of flared gas? The 2016 New Source Performance Standards (NSPS)[17] for oil and gas require that many wells utilize reduced emissions completions where gas is either captured and used for some productive purpose or reinjected. Those same standards will also often require low-bleed pneumatic controllers or other technology that further reduces the amount of potentially vented gas. Where flaring is allowed, this tends to be for a limited time and only for a limited number of wells.

Before claiming proof-of-work mining is a solution, we should first be sure the problem is well understood. Using flared methane gas for Bitcoin presupposes that capture of the gas be technically feasible and that enough gas is available that it is economical to use. Assuming that is the case, the question then is why is it not already being captured? The implication is that regulators are allowing oil and gas operators to opt-out capturing the gas for financial reasons. Such exemption forces the citizens to absorb the risk and damage from the polluting industry and acts as a subsidy encouraging pollution. If polluting industries were, instead, required to internalize the costs of their waste, flaring would be less of a problem.

Proof-of-work cryptomining hardware is not energy efficient.

Bitcoin advocates have also attempted to distract from criticism of Bitcoin's enormous energy demand with red herring arguments. One example raised at a 2022 Congressional hearing[18] was the claim that because the ASICs used for mining are highly optimized for hashing blocks of data, they are more efficient—or less energy intensive—than general-purpose computers used in conventional datacenters.

While an ASIC may be the least energy intensive tool available to calculate more than 100 trillion hashes in one second, that cannot be considered an efficient process if an alternate methodology exists that avoids the need to calculate trillions of hashes in the first place. In much the same way, using a single enormous mining truck may be the best way to move 400 tons of dirt, but if the desired results don't require moving dirt at all, the efficiency of the truck is irrelevant.

We also note that ASIC hardware has an extremely limited useful life before it becomes obsolete e-waste. Hardware that was introduced just two or three years ago is often impossible to operate profitably and even newer hardware may be replaced and discarded in favor of the latest and most competitive equipment.

At a time when semiconductor shortages are contributing to higher consumer prices, this wasteful hardware cycle to proliferate is a particularly bad policy choice that disproportionately impacts low- and moderate-income families.

IV. Responding to Bitcoin's Proponents

[17] *See:* 40 CFR 60.5360 *et seq*. (*published:* 81 Fed. Reg. 35824 (Jun. 3, 2016))

[18] U.S. House Committee on Energy and Commerce Hearing, Cleaning Up Cryptocurrency: The Energy Impacts of Bitcoin, (Jan. 20, 2022).

With a market capitalization over $500 billion, and many investors buying bitcoin when market prices were more than twice what they are today, a number of people have very strong motivation to promote continued use of Bitcoin. As such, there are many highly creative arguments being circulated that attempt to justify or excuse the enormous waste of energy it involves.

Mining isn't a benefit to clean renewable generation.

One common argument is that Bitcoin can use clean renewable generation even though experience has shown they generally don't. The race to find new blocks drives miners towards energy sources that can operate at nearly their full capacity 24/7—these are often polluting fossil fuels. Even where miners rely on carbon-free generation like nuclear power or hydro, diverting energy from these sources to wasteful proof-of-work mining isn't clean. We don't have a surplus of clean energy on our grid, so any energy thus diverted is likely to be replaced by more fossil-fuel pollution.

Miners will point out that there are cases where enough wind and solar generation in a region can drive wholesale energy prices negative for a period. They will claim that using this "wasted" clean energy is a benefit, and them doing so can incentivize more renewable generation. Here again, it's important to realize we don't have a surplus of clean energy. If anything, we have inadequate transmission and storage capability to get the clean energy where and when we need it.

Given the short-term profit motive of miners and the extreme volatility of crypto markets, it's also unlikely that mining will incentivize the long-term investment and multi-year development projects necessary to bring new clean renewable generation into operation. Even if it did result in new renewable generation being built, that isn't helpful in reaching our climate goals. We need new clean generation to offset existing polluting resources—building a new solar facility and wasting the energy on crypto mining doesn't do anything to clean up our power grid.

Mining isn't a benefit to our power grid.

While it is true that some Bitcoin mining operations can curtail their electricity consumption during periods of high demand, this flexibility isn't without its costs. The added demand from mining operations when they do run will increase wholesale energy costs, and those costs will be paid by consumers.

Furthermore, it is not uncommon for miners to take advantage of grid rules and be paid additional money to curtail their energy usage during periods of high demand—even if it would not be profitable for them to continue running, essentially receiving payment for taking an action they would have likely taken anyway. This situation can again lead to inefficiencies and increased costs for the grid, without providing any tangible benefits to its stability or reliability.

Mining is wasteful and isn't efficient.

Miners often deflect attention from their wastefulness by claiming other uses of electricity, from electric cars to washing machines, are use electricity too—this argument is a red herring as it focuses on energy use and ignores utility.

Electric cars use electricity, but they also provide a less-polluting alternative to fossil fuel vehicles. Using mass transit might be and even better choice where practical, but in many cases, there is no real alternative to using a car. Proof-of-work mining, on the other hand, doesn't fill this kind of need. As was discussed earlier, cryptocurrency and blockchain technology that doesn't rely on wasting energy has been used for over a decade. We don't need to waste energy to have newer technologies.

A better comparison might be comparing proof-of-work crypto to a truck that runs on leaded gasoline without any emission controls. Starting in the 1970's we developed newer trucks that could do all the same jobs the old ones could, but as the technology improved, they have become cleaner and cleaner.

A similar argument used by miners is the claim that because they are making money, the operations aren't wasteful. While it is true that some Bitcoin miners are generating revenue, it is also essential to consider the broader implications of the energy consumption associated with mining. The argument that energy is not wasted if money is being made overlooks the environmental and societal costs associated with such energy use as well as who is paying the price. This narrow focus on profitability fails to account for the broader consequences of energy consumption, which include detrimental effects on the environment, the power grid, and society.

In addition to these arguments, it's also common for Bitcoin miners to engage in blatant cherry-picking. They will point to their mining hardware and claim that since no air pollution is being emitted by that piece of hardware, that their operations don't pollute. To the extent they admit there are upstream emissions from power generation and downstream emissions from the e-waste of outdated hardware, they dismiss that as somebody else's problem and somebody else's responsibility to fix. This sort of behavior isn't unique to cryptomining—polluting industries often try to avoid paying for the external costs of their actions—but, the fact others have managed to shirk their responsibility is no excuse.

V. Conclusion and Policy Recommendations

Reporting and quantifying the problem is essential.

In our discussions with regulators, we often find that they are unable to say with any degree of confidence where proof-of-work mining is happening. Even where permit-applications or local media stories indicate a project is being developed, it may be reported as a "datacenter" or other generic term not associated with crypto-mining. In this regard, requiring cryptominers to report their operations is an essential step toward any future regulation.

We should use the best available technology to reduce pollution and protect public health.

State and federal laws to combat air pollution often incorporate the principle that, before an industrial source is allowed to dump its waste into our air, it first must ensure it's using the best technology available to reduce its emissions. Blockchain technology and crypto-currencies should be no exception and cleaner alternatives than proof-of-work mining are available.

Noise pollution must be systematically addressed.

In establishing a federal noise abatement program in the early 1970's, the EPA stated that "Noise differs from most other environmental pollutants in one very important aspect—the knowledge and technology exists now to control almost every indoor and outdoor noise problem"[19] In spite of this, one of the chief areas of concern we hear regarding crypto-mining is the loud and ceaseless noise created by these operations.[20] Relying on local governments and public nuisance claims has not been effective to stop these operations—particularly in rural areas where the impact may be most acute on wildlife.

Rather than blindly accept justifications for wasteful energy practices, especially in the rapidly evolving field of cryptocurrency. Our future depends on making conscious decisions about our energy consumption. If we wish to continue using cryptocurrencies, it is our responsibility to concentrate on methods that are not only more efficient but also sustainable. The blockchain technology that underpins these currencies may offer some potential for innovation, but we must ensure that its environmental footprint is minimized. Only by prioritizing sustainable practices can we ensure the viability of cryptocurrency and its coexistence with our planet's health.

[19] U.S. EPA, EPA's Noise Abatement Program (May 19, 1971).
[20] Vipal Monga, Bitcoin Mining Noise Drives Neighbors Nuts, Wall Street Journal, (Nov. 12, 2021).