Bitcoin Policy Institute

GREENING BITCOIN WITH INCENTIVE OFFSETS

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ABOUT THE AUTHORS

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ABOUT THE BITCOIN POLICY INSTITUTE

The Bitcoin Policy Institute (BPI) is a non-partisan, non-profit think tank. It is dedicated to educating policymakers and the public on Bitcoin and disruptive digital technologies, providing research-based insights to inform sound policy in the United States.

The BPI team comprises experts in economics, law, philosophy, energy, and environmental science, working together to explore the impacts of new technology on existing US public policy interests. The views expressed in this publication do not necessarily reflect the views of all Bitcoin Policy Institute management or its affiliated scholars.

POLICY BRIEF

BITCOIN POLICY INSTITUTE:
GREENING BITCOIN WITH INCENTIVE OFFSETS

Executive summary

We propose a way to invest in bitcoin without contributing, even slightly, to unsustainable bitcoin mining. If one co-invests in sustainable mining operations in proportion to the size and duration of one's bitcoin holdings, one's bitcoin and green mining investments together will produce no net incentive to mine bitcoin in a carbon-intensive way. We estimate that, given current price, hashrate, issuance, and transaction fee levels, a quarterly allocation of approximately .28% of one's bitcoin investment into green mining will suffice. Unlike other proposals to green bitcoin, ours preserves bitcoin's fungibility and costs nothing. In fact, it provides a positive return.

We begin with two assumptions. First, bitcoin is an attractive investment, environmental impact aside; second, carbon-intensive bitcoin mining is to be minimized. Readers who think bitcoin has no value whatsoever, or who think any focus on carbon reduction is a mere distraction, may look elsewhere for guidance. For readers who do share our assumptions, we will:

1. explain how owning bitcoin incentivizes mining, including carbon-intensive mining;

2. show how green mining, given bitcoin's issuance structure, provides a disincentive to other miners, including carbon-intensive miners;

3. show how to balance these two incentives;

4. calculate the cost to balance a given bitcoin investment;

5. discuss possible financial products and services to achieve this balance for investors;

6. introduce a novel pairing of BitBonds, a proposed U.S. Treasury product, with investments in bitcoin mining;

7. explain and defend, in brief, a proportional rather than marginal approach to carbon accounting;

8. compare our proposal, favorably, to other options;

9. show that the strategy described here applies across other domains too; many investors with distinctive values who are interested in holding bitcoin can implement those values with co-investments in bitcoin mining.

1. Bitcoin investment incentivizes mining

All mining revenue comes in the form of block rewards and fees. Currently, 164,250 bitcoin in block subsidies are claimed by miners annually, while roughly 2,500 bitcoin are collected in transaction fees. The value of these rewards and fees, which are denominated in bitcoin, depends on bitcoin's price, for which investors—who hold bitcoin and thus suppress available supply—are collectively responsible. What can appear to be inert (merely holding) is in fact an active ingredient in bitcoin price discovery and mining profitability. Thus, mining's externalities are the indirect result of bitcoin ownership.

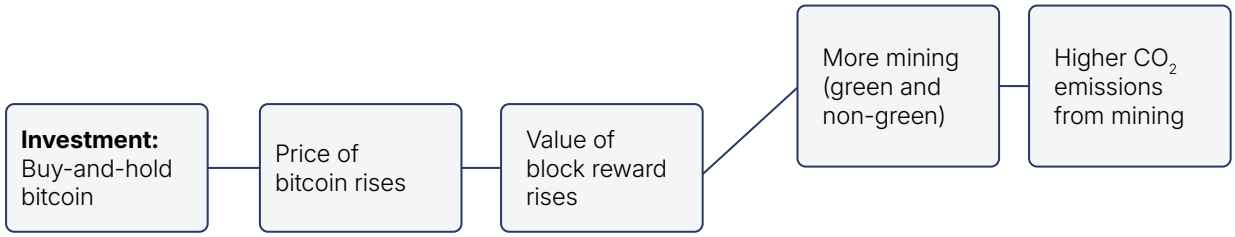


Figure 1: *Price Incentive*

2. Green mining disincentivizes mining

Investors can counterbalance this incentive to mine by mining themselves, sustainably and in the right proportion to their bitcoin investment.[2] Here's how. Mining is a zero-sum game. More computing power does not produce more bitcoin. Rather, the protocol fixes bitcoin's issuance per block—currently 3.125 bitcoin—and adjusts the difficulty of mining to keep blocks coming, on average, every 10 minutes. The result is that over time, the expected reward for a given amount of computing power is inversely proportional to the total amount of computing power in the network: the greater the total hashrate of the network, the lower the payout, in bitcoin, at any given hashrate.

[1] "Sustainable mining" or "green mining" here is a variable: our proposal is compatible with various definitions. For instance, some will think mining with flared gas—which transforms methane into a far less potent greenhouse gas, carbon dioxide—is a green form of mining. Others will exclude it. Nuclear energy, we imagine, will spark a similar divide. Highly flexible consumption, which allows for significant downtime and therefore improves grid stability and efficiency for renewable-heavy grids may qualify as sustainable for some but not others. By "green" we mean whatever you, the reader, take to be green. Investors with specific ESG mandates may plug their own institution's definition of "E" into our proposal.

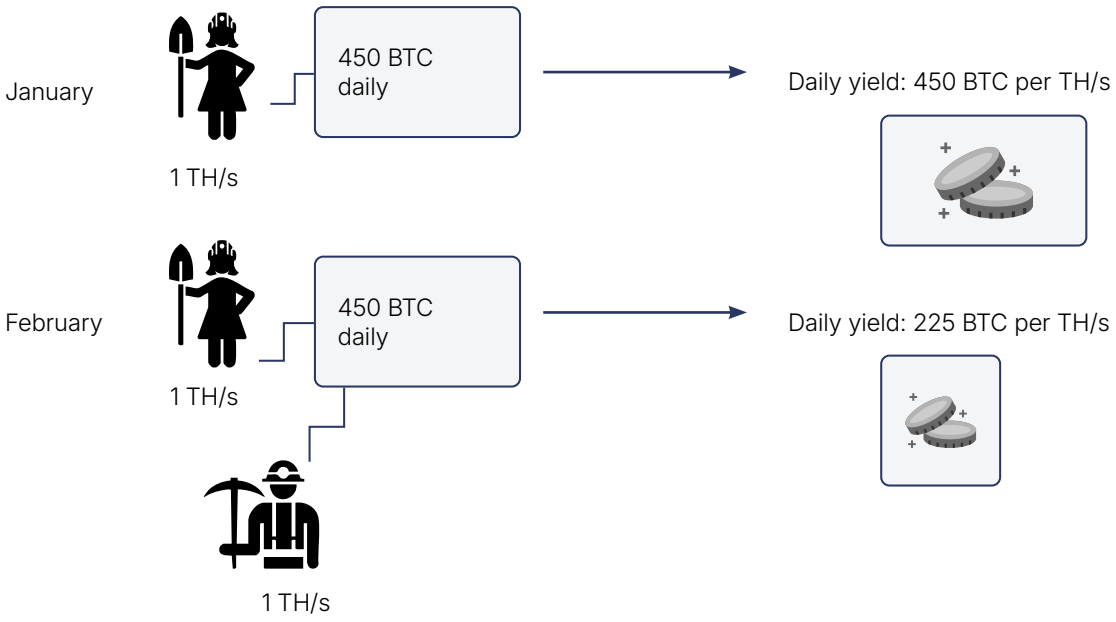


Figure 2: *Mining Rewards*

New green mining means faster block discovery, which makes mining difficulty go up, which drives up the energy and hardware costs required to mine a given amount of bitcoin, lowering the incentive to mine, and thus lowering emissions from mining.

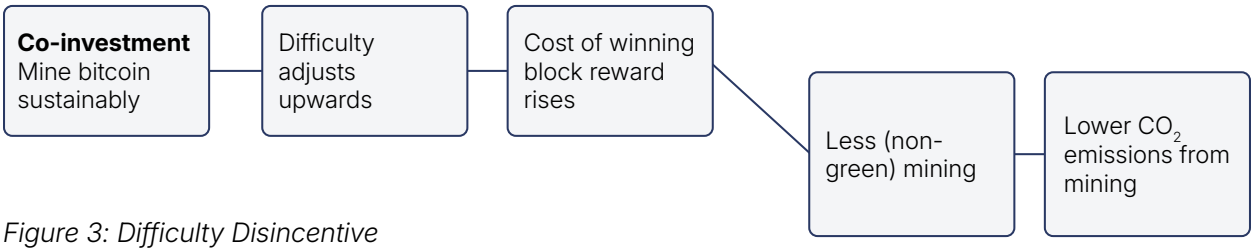


Figure 3: Difficulty Disincentive

There is an equilibrium where the incentive to mine created by our investment in bitcoin is precisely balanced by the disincentive to mine created by our own mining. This is the point at which what we give to the carbon-intensive miner with one hand (increased value of block reward through holding bitcoin) we take away with the other (increased costs to win a block reward through green mining). Our two investments together have made no difference to miners' profitability even though we are now in possession of bitcoin.

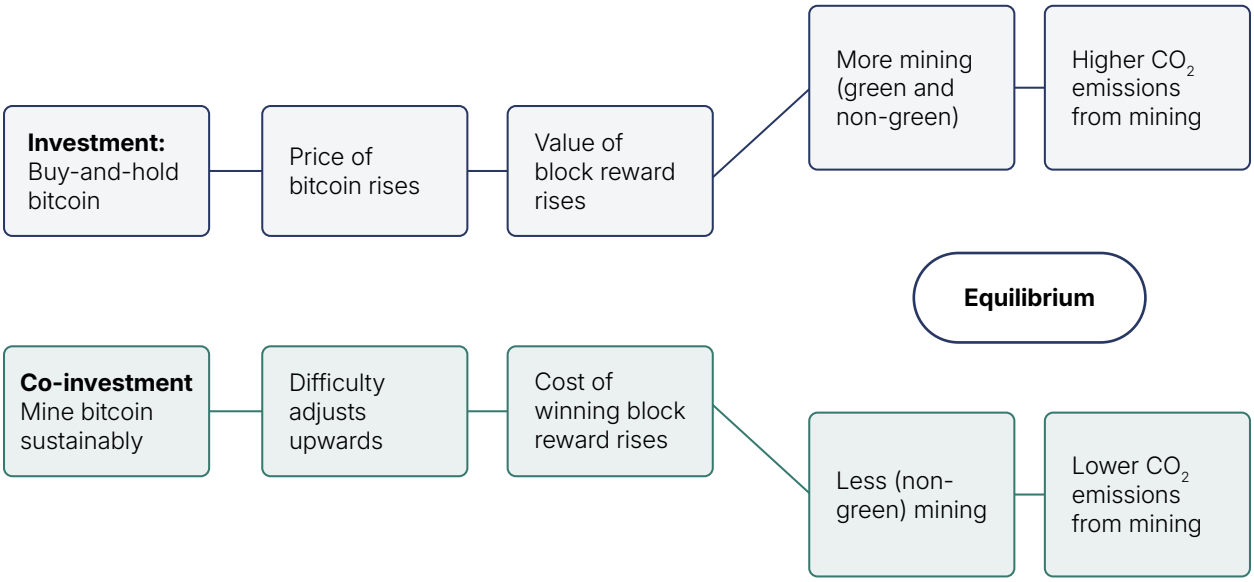
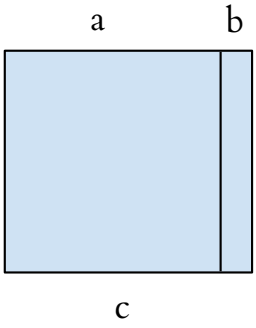


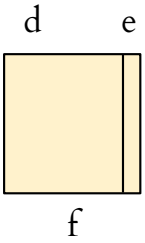
Figure 4: *Price Incentive + Difficulty Disincentive*

3. How to find the point of incentive equilibrium

The equilibrium is where one's proportion of bitcoin's effective market cap equals one's proportion of hashrate. If you own x% of all bitcoin and also do x% of all mining of bitcoin, then regardless of what x is, the expected value of mining at any given hashrate will be just the same as if you neither owned any bitcoin, nor mined yourself. You will have, in effect, mined all of the incentive to mine that was created by your investment.



a = value of others' bitcoin holdings
b = value of your bitcoin holding
c = market cap = a+b



d = mining incentivized by a (in hashrate)
e = mining incentivized by b (in hashrate)
f = mining incentivized by c (in hashrate) = d+e

Figure 5: *Proportion of market cap = proportion of hashrate*

In Figure 5, provided b and e scale together, d remains constant. Miners do not "see" your investment, because although price is higher than it otherwise would be, difficulty is also higher in equal measure.

4. How much to invest in green mining

We now calculate the required co-investment in green mining. Begin with the source of all price incentives: the effective market cap of bitcoin. The total amount of bitcoin that has not been lost is approximately 15 million. At $100,000 per bitcoin that yields an effective market cap of $1.5 trillion. Next consider the total incentive to miners, on a quarterly basis. Their expected quarterly mining revenue is 41,062.5 bitcoin in block subsidies and 625 bitcoin in fees, or $4.16 billion. So total quarterly mining revenues are about .28% of effective market cap. So, each individual investor is also providing an incentive to miners, quarterly, worth about .28% of their own holdings. A $100,000 investment across 90 days thus incentivizes $280 worth of mining rewards.

.Assuming green mining has an expected net return of zero, we recommend a quarterly co-investment in green mining worth .28% of one's bitcoin allocation. At the end of each quarter, one folds the returns from mining back into more mining and adjusts as needed, since market cap, hashrate, the profitability of green mining, and one's own investment size may all have changed in the meantime. The co-investment suggested here is modest and compares to what investors already pay when securing their bitcoin (50 basis points is a standard OTC fee, for example).

5. How to invest in green mining

Questions remain: how, exactly, should investors allocate towards green mining, and how does our proposal stack up against green alternatives?

What's needed here is a financial product—call it a Green Co-investment Instrument (GCI)—that takes as inputs: effective market cap, hashrate, fees, block rewards, the profitability of green mining, and the size of an investor's bitcoin holdings. As these variables change, the GCI must change with them, to calibrate price incentive with difficulty disincentive, keeping them in balance. We imagine, then, a quarterly subscription service tied to an investor's bitcoin allocation. The service computes the other inputs and charges a fee, which is then allocated toward green bitcoin mining. Proceeds from that mining are then distributed back to investors either as a dividend or toward their future GCI subscription fees. Investors would subscribe to a GCI service only as long as they held bitcoin. If less churn is desired, one might set aside 1.12% for a GCI and adjust annually.

There is room here for variety and competition. Some GCI providers will cater to accredited investors or institutions. Others will go bitcoin-native, serving pseudonymous accounts with subscription intervals marked in blocks rather than quarters and fees denominated in bitcoin. Some investors will prefer to self-custody their bitcoin and want a "mining-only" subscription. Others will subscribe to an integrated product that custodies bitcoin and automates regular GCI adjustments that minimize green mining as a percentage of total investment given transaction costs and tax considerations.

There are, in short, a variety of ways to implement our proposal. All will green bitcoin, all will strengthen the security of the bitcoin network, and in different ways, all will serve the disparate needs of bitcoin holders.

6. Green BitBonds

BitBonds are a proposed class of U.S. Treasury securities that combine traditional bond mechanics with strategic bitcoin acquisition.[2,3] For each bond issued, 90% of proceeds fund standard government operations, and 10% is used to purchase bitcoin for a strategic bitcoin reserve. Investors receive a reduced fixed coupon in exchange for some degree of upside exposure to bitcoin's performance. The result is a bond with both fiscal and strategic advantages: lower borrowing costs, no new taxes, and asset accumulation with long-term appreciation potential.

We propose that each BitBond purchase be paired with a GCI proportional to the bitcoin acquired. The goal would be to purchase enough green hashrate to counterbalance any incentive to mine created by the Treasury's new bitcoin position.

In their current proposed form, BitBonds create an incentive to mine. By purchasing and holding bitcoin, the Treasury contributes to bitcoin's price and thus to miner profitability. The thing to do, for bond investors interested in carbon neutrality, is to offset that incentive: for whatever fraction of total bitcoin supply a given bond's bitcoin purchase represents, invest in an equivalent fraction of the global hashrate, produced by green bitcoin mining operations.

Despite obvious attractions of GCI-paired BitBonds, there are significant trade offs to consider in implementation.

The U.S. Treasury could issue GCIs itself, mine bitcoin with the proceeds, and bundle the product with BitBonds. This approach is straightforward, and could serve a triple purpose: protecting private and public American bitcoin holdings from double-spending, promoting energy independence, and neutralizing any negative carbon externalities associated with a strategic bitcoin reserve. But the approach is likely hazardous to bitcoin's value proposition. Though some nation states already mine bitcoin[4], concentrating hashrate under U.S. federal government management is almost certainly a risk to bitcoin's censorship-resistance, and thus to its usefulness and value.

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[2] Hohns, A., & Pines, M. (2025). *Bitcoin-enhanced treasury bonds: An idea whose time has come*. Bitcoin Policy Institute. https://www.btcpolicy.org/articles/bitcoin-enhanced-treasury-bonds-an-idea-whose-time-has-come.

[3] New York City has proposed its own BitBonds, the terms of which have yet to be precisely defined: NBC Palm Springs. (2025). Eric Adams announces New York City's bitcoin-backed bond plan at Bitcoin 2025 Conference in Las Vegas. https://www.nbcpalmsprings.com/2025/05/30/eric-adams-announces-new-york-citys-bitcoinbacked-bond-plan-at-bitcoin-2025-conference-in-las-vegas

[4] Cross, T., & Bailey, A. M. (2023). Carbon-neutral Bitcoin adoption for nation states. In A. Essex (Ed.), Financial cryptography and data security (pp. 55–65). Springer.

Some of these hazards could be avoided through Treasury investments in privately operated green bitcoin mining operations by, for example, buying equities in publicly traded bitcoin mining firms. But this path is fraught, too. The Treasury would effectively be picking winners and losers in any allocations it made.

A better route would be for private firms to offer GCIs custom-built for pairing with BitBonds. "Buying $10,000 in BitBonds? Here's the GCI for you, to be renewed quarterly using a portion of coupon payments or proceeds from mining, for as long as you hold the bond." An opt-in and privately offered solution along these lines would avoid the pitfalls noted above and could be bundled with the BitBonds in a single financial product.

Reinvestment is a challenge. Difficulty, price, and hashrate all shift. Offset targets must be recalculated periodically. But this challenge is similar to familiar portfolio rebalancing or treasury reserve management. With standardized instruments such as green mining ETFs, tokenized hashrate contracts, or subscription-based GCIs, automation and convenience for BitBond buyers are eminently achievable.

7. Marginal and proportional accounting

It is now time to situate the present proposal with respect to the persistent and vexed fault line between proportional and marginal approaches to carbon accounting.

A proportional framework allocates emissions based on an actor's share of participation—ownership, use, or investment—regardless of whether their involvement changed any outcomes. It treats emissions as jointly produced by the relevant actors. An auto plant using 50% of the electricity from a given grid, for example, would be assigned 50% of grid emissions. Other users of the grid would take on the remaining 50%. Responsibility never sums to more than 100%, and never less than it either—a pleasing result.

By contrast, a marginal framework assigns responsibility based on causal impact. It asks whether an actor's decision made a difference to whether emissions occurred and attributes the resulting emissions accordingly. If a data center expands its operations and thereby increases demand on a fossil-heavy grid, a marginal approach would hold that expansion responsible for the additional emissions that wouldn't have occurred otherwise — say, from dispatching a gas plant that would have remained idle. Such attribution hinges on a counterfactual condition: would the gas plant have stayed idle, had the data center not scaled up? The focus is not on the data center's total share of electricity but on the emissions induced by the specific decision to scale up.

We propose a proportional framework. It is the right tool for the job, in part because the marginal alternative is incoherent or intractable, when applied to questions about responsibility.

A case and a brief look at bitcoin markets will demonstrate the inadequacy of marginal accounting.

Suppose your bank hires ten security guards. They sleep through a robbery. An unarmed man that any one of them could have stopped walks off with $10,000. Under marginal reasoning, each guard is responsible for a $10,000 loss. Each guard, after all, satisfies this condition: were she to have done her job, a $10,000 loss would have been prevented. If all ten are held marginally responsible in this way, the bank collects $100,000 in damages from a $10,000 loss. That result strikes us as incoherent. But it is a straightforward consequence of applying a marginal approach to allocating responsibility. Marginal accounting overcounts.

The marginal effect of a given buy-and-hold on bitcoin's price also varies across contexts and is often nonlinear. When order books are unusually thin, a small sale might crash the market. At other times, new demand may be absorbed with no discernible change in price. The identity of the buyer might matter too: news of a purchase by Warren Buffett would move markets differently from another purchase by Michael

Saylor. Similarly, the marginal impact of added hashrate varies considerably. A small addition might push unprofitable miners out, or it might be irrelevant, all depending on market conditions. Marginal carbon accounting is simply not tractable when it comes to bitcoin; it provides no concrete way of tracking how new buyers or sellers influence price or emissions.

A proportional approach, by contrast, guarantees that we neither undercount nor overcount responsibility for emissions, and provides a tractable framework for reasoning about such responsibility. A proportional framework has these pleasing consequences: (i) if everyone did their job in proportion to their holdings, then bitcoin would be 100% green, (ii) no one is required to do more than their job (to invest in more GCIs than is warranted by their holdings), and (iii) everyone is required to do something (every bitcoin holder is on the hook for some share of the total work to be done).

8. Why alternatives fall short

Alternative proposals for greening bitcoin include:

1. Carbon offsets

2. Green coins—colored UTXOs from blocks discovered by mining pools with a known and sufficiently favorable energy mix

3. Hybrid products that integrate (i) and (ii) as a wrapped token on another blockchain

4. Moving bitcoin away from proof of work altogether

Our proposal differs from mere carbon offsetting. We instead suggest an *incentive* offset so that one's bitcoin holdings do not lead to any new carbon-intensive mining which later requires atonement. Unlike carbon offsets, our proposal is also likely net profitable, and thus relies on neither charity nor coercion. Our proposal, finally, does not require knowing the total energy mix of bitcoin mining: how much hashrate derives from burning coal or natural gas, for example. We recommend that bitcoin investors literally mine the entirety of what they incentivize, so an investor only needs to know that the hashrate they are purchasing is green, by their own definition of "green." The broader mix is irrelevant.

Colored UTXOs are a bad idea on ethical, economic, and engineering grounds.

Bad ethics: these schemes presume that having acquired some green UTXOs of known provenance, one's moral work is done. But the procedure doesn't take into account the temporal dimension of the incentive to mine created by holding bitcoin; **the incentivization of unsustainable mining is not just a matter of how much bitcoin one has but for how long**. Our proposal, by contrast, makes ongoing co-investments in green mining to match bitcoin holdings so long as those holdings last.

Bad economics: colored UTXOs do violence to bitcoin's fungibility, which threatens bitcoin's ability to serve as a genuine monetary network. If your investment thesis is that bitcoin is or could become a global monetary network or native currency for the internet, colored coins are not for you.

Bad engineering: there is no fair and technically sound way to track an "individual bitcoin" or an individual UTXO across a tree of transactions. The input UTXOs to a transaction are spent and its outputs are new UTXOs with no certain link to particular inputs; where there are multiple inputs, then, a given colored input can't be linked to a given output.[5]

Lastly, abandoning proof of work is a non-starter. The assurances provided by bitcoin's security model are battle-hardened and a key element of bitcoin's attraction. Hybrid products fail for similar reasons: a wrapped token, created by trusted custodians, with additional attack vectors, and hosted on another blockchain altogether cannot make good on the promises that have attracted capital to bitcoin in the first place. Wise investors want bitcoin, not some simulacrum.

[5] Warmke, C. (2022). Electronic coins. *Cryptoeconomic Systems*, 2(1).

9. Mine your values

We have framed the discussion in terms of reconciling environmental goals with investment in bitcoin. But the "green" in "green bitcoin mining" was a stand-in, to be replaced with whatever you, the reader, take to be green. The strategy on offer here—co-investing in bitcoin mining to promote certain values around carbon-neutrality—can be applied in other domains too. Consider other environmental goals an investor might have: reducing e-waste, sticking to one form of sustainable energy over another, reducing noise externalities, and so on. Each of these could be served by Co-investment Instruments (CIs) custom-built to those purposes, or any combinations of them.

The point extends beyond environmental values. Some bitcoin holders treasure its censorship-resistance; they can co-invest in mining operations that demonstrably publish all available valid transactions, regardless of any attempts at censorship. Bitcoin holders interested in expanding bitcoin's monetary usefulness by way of a soft fork or other upgrade can invest in mining operations that support such changes. Yet other bitcoin holders are interested in expanding bitcoin's usefulness for the publication of arbitrary data unrelated to any monetary use; these holders could invest in mining operations that publish such data and provide ready tools for doing so. Bitcoin investors interested in American energy independence and other strategic outcomes can promote those outcomes, alongside the potential upside of a BitBond allocation, by allocating to CIs directed at those outcomes.

We do not raise these examples to praise them. Each is controversial. Not everyone thinks that e-waste is a negative externality, or one worth addressing, for example. But therein lies the use of CIs directed at reducing e-waste; one imagines an operation where, at some expense, mining rigs are dismantled and their components repurposed at the end of their profitable life. If you think that this is an externality worth the trouble of fixing, you should do your part to reduce that externality, in exact proportion to your own bitcoin holdings. Your own convictions about e-waste are no barrier to investing in bitcoin and benefiting from it, since your holding bitcoin will not incentivize the creation of any more e-waste than your not holding any bitcoin at all.

The point is not to suggest that the reader implement our values, but that readers would do well to implement their own. Bitcoin mining is a highly general instrument. CIs can be constructed along any of these dimensions, and serve bitcoin holders who wish to make use of that instrument to bend the world in the direction of values they cherish. [6]

[6] Cross, T., & Bailey, A. M. (2021, July 28). *Love Bitcoin? Mine your values*. CoinDesk. https://www.coindesk.com/markets/2021/07/28/love-bitcoin-mine-your-values

Conclusion

Bitcoin mining's environmental reputation has much improved in recent years, as its unique profile as a price-sensitive, highly-flexible consumer of energy has become more widely appreciated. Still, for many it remains suspect. ESG mandates prevent some institutions from embracing bitcoin, and lingering uncertainty in the matter blocks others—individuals and institutions alike—from entry. Instead of changing bitcoin itself—undermining fungibility, abandoning proof of work, or hosting wrapped bitcoin on a competing blockchain—bitcoin's own inner workings can be used to engineer a financial instrument that eliminates its negative environmental externalities. Bitcoin's difficulty adjustment and fixed issuance allow investors to precisely balance their price-based incentive to mine with an equal and opposite difficulty-based disincentive, simply by mining sustainably themselves. Broad adoption of this practice would further strengthen bitcoin's settlement and security assurances, improve not only bitcoin's environmental reputation but its actual environmental record, and unlock capital currently bound by either ESG mandates or individual conscience.

In sum, we see no real tension, or tradeoff, between an enthusiasm for bitcoin and a thoroughgoing commitment to a low-carbon future. What's true of these environmental values is true for others as well; bitcoin mining is an instrument for channeling bitcoin in the direction of one's own values. Investors concerned with what they take to be bitcoin's externalities may resolve these concerns by cleaning up their own corner of bitcoin, in proportion to their own holdings.

Where others see tradeoffs, we see the possibility for a win for bitcoin, and for the world.

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