

# How Much Energy Does Bitcoin Actually Consume?

by Nic Carter

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**Summary.** Today, Bitcoin consumes as much energy as a small country. This certainly sounds alarming — but the reality is a little more complicated. The author discusses several common misconceptions surrounding the Bitcoin sustainability debate, and ultimately argues... [more](#)

How much energy does an industry deserve to consume? Right now, organizations around the world are facing pressure to limit the consumption of non-renewable energy sources and the emission of carbon into the atmosphere. But figuring out how

much consumption is too much is a complex question that's intertwined with debates around our priorities as a society. The calculation of which goods and services are "worth" spending these resources on, after all, is really a question of values. As cryptocurrencies, and Bitcoin in particular, have grown in prominence, energy use has become the latest flashpoint in the larger conversation about what, and who, digital currencies are really good for.

On the face of it, the question about energy use is a fair one. According to the Cambridge Center for Alternative Finance (CCAF), Bitcoin currently consumes around 110 Terawatt Hours per year — 0.55% of global electricity production, or roughly equivalent to the annual energy draw of small countries like Malaysia or Sweden. This certainly sounds like a lot of energy. But how much energy *should* a monetary system consume?

How you answer that likely depends on how you feel about Bitcoin. If you believe that Bitcoin offers no utility beyond serving as a ponzi scheme or a device for money laundering, then it would only be logical to conclude that consuming any amount of energy is wasteful. If you are one of the tens of millions of individuals worldwide using it as a tool to escape monetary repression, inflation, or capital controls, you most likely think that the energy is extremely well spent. Whether you feel Bitcoin has a valid claim on society's resources boils down to how much value you think Bitcoin creates for society.

If we're going to have this debate, however, we should be clear on how Bitcoin actually consumes energy. Understanding Bitcoin's energy consumption may not settle questions about its usefulness, but it can help to contextualize how much of an environmental impact Bitcoin advocates are really talking about making. Specifically, there are a few key misconceptions worth addressing.

## Energy Consumption Is Not Equivalent to Carbon Emissions

First, there's an important distinction between how much energy a system consumes and how much carbon it emits. While determining energy consumption is relatively straightforward, you cannot extrapolate the associated carbon emissions without knowing the precise *energy mix* — that is, the makeup of different energy sources used by the computers mining Bitcoin. For example, one unit of hydro energy will have much less environmental impact than the same unit of coal-powered energy.

Bitcoin's energy consumption is relatively easy to estimate: You can just look at its hashrate (i.e., the total combined computational power used to mine Bitcoin and process transactions), and then make some educated guesses as to the energy requirements of the hardware that miners are using. But its carbon emissions are much harder to ascertain. Mining is an intensely competitive business, and miners tend not to be particularly forthcoming around the details of their operations. The best estimates of energy production geolocation (from which an energy mix can be inferred) come from the CCAF, which has worked with major mining pools to put together an anonymized dataset of miner locations.

Based on this data, the CCAF can guess about the energy sources miners were using by country, and in some cases, by province. But their dataset doesn't include all mining pools, nor is it up to date, leaving us still largely in the dark about Bitcoin's actual energy mix. Furthermore, many high profile analyses generalize energy mix at the country level, leading to an inaccurate portrait of countries such as China, which has an extremely diverse energy landscape.

As a result, estimates for what percentage of Bitcoin mining uses renewable energy vary widely. In December 2019, one report suggested that 73% of Bitcoin's energy consumption was carbon neutral, largely due to the abundance of hydro power in major

mining hubs such as Southwest China and Scandinavia. On the other hand, the CCAF estimated in September 2020 that the figure is closer to 39%. But even if the lower number is correct, that's still almost twice as much as the U.S. grid, suggesting that looking at energy consumption alone is hardly a reliable method for determining Bitcoin's carbon emissions.

## **Bitcoin Can Use Energy That Other Industries Can't**

Another key factor that makes Bitcoin's energy consumption different from that of most other industries is that Bitcoin can be mined anywhere. Almost all of the energy used worldwide must be produced relatively close to its end users — but Bitcoin has no such limitation, enabling miners to utilize power sources that are inaccessible for most other applications.

Hydro is the most well-known example of this. In the wet season in Sichuan and Yunnan, enormous quantities of renewable hydro energy are wasted every year. In these areas, production capacity massively outpaces local demand, and battery technology is far from advanced enough to make it worthwhile to store and transport energy from these rural regions into the urban centers that need it. These regions most likely represent the single largest stranded energy resource on the planet, and as such it's no coincidence that these provinces are the heartlands of mining in China, responsible for almost 10% of global Bitcoin mining in the dry season and 50% in the wet season.

Another promising avenue for carbon neutral mining is flared natural gas. The process of oil extraction today releases significant amount of natural gas as a byproduct — energy that pollutes the environment without ever making it to the grid. Since it's constrained to the location of remote oil mines, most traditional applications have historically been unable to effectively leverage that energy. But Bitcoin miners from North Dakota to Siberia have seized the opportunity to monetize this otherwise-wasted resource, and some companies are even

exploring ways to further reduce emissions by combusting the gas in a more controlled manner. Of course, this is still a minor player in today's Bitcoin mining arena, but back of the envelope calculations suggest that there's enough flared natural gas in the U.S. and Canada alone to run the entire Bitcoin network.

To be fair, the monetization of excess natural gas with Bitcoin does still create emissions, and some have argued that the practice even acts as a subsidy to the fossil fuel industry, incentivizing energy companies to invest more in oil extraction than they otherwise might. But income from Bitcoin miners is a drop in the bucket compared to demand from other industries that rely on fossil fuels — and that external demand is unlikely to disappear anytime soon. Given the reality that oil is and will continue to be extracted for the foreseeable future, exploiting a natural byproduct of the process (and potentially even reducing its environmental impact) is a net positive.

Interestingly, the aluminum smelting industry offers a surprisingly relevant parallel. The process of transforming natural bauxite ore into useable aluminum is highly energy intensive, and the costs of transporting aluminum often aren't prohibitive, so many nations with a surplus of energy have built smelters to take advantage of their excess resources. Regions with the capacity to produce more energy than could be consumed locally, such as Iceland, Sichuan, and Yunnan, became net energy exporters through aluminum — and today, the same conditions that incentivized their investment in smelting have made those locations prime options for mining Bitcoin. There are even a number of former aluminum smelters, such as the hydro Alcoa plant in Massena, NY, that have been directly repurposed as Bitcoin mines.

## **Mining Bitcoin Consumes a lot More Energy Than Using It**

How energy is produced is one piece of the equation. But the other area where misconceptions are common is in how Bitcoin actually consumes energy, and how that's likely to change over time.

Many journalists and academics talk about Bitcoin's high "per-transaction energy cost," but this metric is misleading. The vast majority of Bitcoin's energy consumption happens during the mining process. Once coins have been issued, the energy required to validate transactions is minimal. As such, simply looking at Bitcoin's total energy draw to date and dividing that by the number of transactions doesn't make sense — most of that energy was used to mine Bitcoins, not to support transactions. And that leads us to the final critical misconception: that the energy costs associated with mining Bitcoin will continue to grow exponentially.

### **Runaway Growth Is Unlikely**

Because Bitcoin's energy footprint has grown so rapidly, people sometimes assume that it will eventually commandeer entire energy grids. This was the premise of a widely-reported 2018 study that was recently cited in the New York Times, making the shocking claim that Bitcoin could warm the earth by two degrees Celcius. But there's good reason to believe this won't happen.

First, as has become common in many industries, the energy mix of Bitcoin grows less reliant on carbon every year. In the U.S., publicly-traded, increasingly ESG-focused miners have been gaining market share, and China recently banned coal-based mining in Inner Mongolia, one of the largest remaining coal-heavy regions. At the same time, many organizations within the mining industry have launched initiatives like the Crypto Climate Accord — inspired by the Paris Climate Agreement — to advocate for and commit to reducing Bitcoin's carbon footprint. And of

course, as renewable options such as solar grow more efficient and thus more viable for mining, Bitcoin could end up serving as a serious incentive for miners to build out these technologies.

In addition, miners are unlikely to continue expanding their mining operations at the current rates indefinitely. The Bitcoin protocol subsidizes mining, but those subsidies have built-in checks on their growth. Today, miners receive small fees for the transactions that they verify while mining (accounting for around 10% of miner revenue), as well as whatever profit margins they can get when they sell the bitcoins they have mined.

However, the protocol is built to halve the issuance-driven component of miner revenue every four years — so unless the price of Bitcoin doubles every four years in perpetuity (which economics suggests is essentially impossible for any currency), that share of miner revenue will eventually decay to zero. And as far as transaction fees, Bitcoin's natural constraints on the number of transactions it can process (fewer than a million per day) combined with users' finite tolerance for paying fees limit the growth potential of this as a revenue source. We can expect some miners to continue operating regardless, in exchange for these transaction fees alone — and in fact, the network depends on that to keep functioning — but if profit margins fall, the financial incentive to invest in mining will naturally decrease.

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Of course, there are countless factors that can influence Bitcoin's environmental impact — but underlying all of them is a question that's much harder to answer with numbers: *Is Bitcoin worth it?* It's important to understand that many environmental concerns are exaggerated or based on flawed assumptions or misunderstandings of how the Bitcoin protocol works.

That means that when we ask, “Is Bitcoin worth its environmental impact,” the actual negative impact we’re talking about is likely a lot less alarming than you might think. But there’s no denying that Bitcoin (like almost everything else that adds value in our society) does consume resources. As with every other energy-consuming industry, it’s up to the crypto community to acknowledge and address these environmental concerns, work in good faith to reduce Bitcoin’s carbon footprint, and ultimately demonstrate that the societal value Bitcoin provides is worth the resources needed to sustain it.

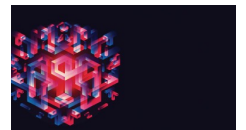
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