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Edison Explains

Bitcoin's investment thesis

Part five: Carbon footprint

Negative **Positive**

Cryptocurrencies – irrational hype or financial revolution?

Bitcoin (BTC) and other digital assets have been making the headlines in recent months, polarising the investment community with an equal number of strong advocates and fierce critics (even within the same financial institution or research house). Moreover, valid analysis, backed by in-depth research, is mixed up with ideological, poorly researched conclusions both for and against the theme. We have decided to look at both sides of the same (Bit)coin to extract the investment thesis behind this new asset class. Each part of this Edison Explains series looks at one feature of BTC and the broader cryptocurrency landscape (broadly referred to as 'altcoins'). We conclude by summarising our subjective view on how positive or negative we believe the feature is for BTC's investment thesis.

High energy consumption – flaw or foundation of the network?

One of the alleged main flaws of the Bitcoin network that has come under the spotlight (especially recently) is its high energy consumption and carbon footprint. We believe these two aspects need to be evaluated separately, with energy intensity being an inherent characteristic of the Bitcoin network, while its carbon footprint is an issue that can be addressed by increasing the proportion of renewable energy sources utilised by the network.

Bitcoin relies on a consensus mechanism (used to validate transactions on the network) known as 'proof of work' (PoW), where block miners compete with their computing power for rewards in the form of newly minted BTC and transaction fees. This consumes a significant amount of energy which, alongside expenses for specialised mining equipment (so-called application-specific integrated circuits, or ASICs), is the key operating cost item for BTC miners. As a result, based on the current hashrate, the annual energy consumption of the Bitcoin network stands at 81.66TWh (or 0.37% of global electricity consumption), according to the Cambridge Bitcoin Electricity Consumption Index, close to the annual electricity consumption of an entire country like Belgium.

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Bitcoin's high energy consumption is not a design flaw, but an inherent feature underpinning the security of the network. Nevertheless, investors concerned about Bitcoin's energy consumption and carbon footprint can turn to alternative blockchains, in particular those utilising a 'proof-of-stake' (PoS) algorithm.

However, Bitcoin's high energy consumption is not a flaw of the system, but a feature deliberately embedded in its design and underpinning the security of the network. Whether the added value provided by the network outweighs its high energy cost may of course be subject to debate (but this is also true for other energy-consuming projects). Some conclude that the Bitcoin network is inefficient based on energy consumed per transaction, which is significantly above traditional payment processors such as Visa or Mastercard. However, it is important to emphasise that Bitcoin is not merely a new payment processing system based on traditional currencies, but an alternative, incorruptible and independent monetary system. Consequently, its efficiency should be evaluated in the context of the cost associated with maintaining the status of traditional currency as legal tender. While this is difficult to quantify, it goes far beyond the cost associated with the minting and payment infrastructure, and includes expenses related to maintaining the stability and trust in the monetary system and the country issuing the currency. Interestingly, Bitcoin's energy consumption is below the annual energy use of the global mining industry at 131TWh per year, according to the Cambridge Centre for Alternative Finance.

Moreover, Bitcoin's energy use should also be looked at in the context of the energy consumed by other human activities, especially those with no or disputable added value. For instance, the Cambridge Centre for Alternative Finance estimates that the electricity consumed annually

by idle (always on but inactive) home devices in the US could power the Bitcoin network for more than three years.

How 'dirty' is the Bitcoin network?

Bitcoin is often accused of being a significant environmental polluter on account of its considerable energy use, coupled with an alleged high proportion of energy generated from fossil fuels in its mix. According to the 3rd Global Cryptoasset Benchmarking Study published by the Cambridge Centre for Alternative Finance in September 2020 (ie before China's recent crackdown on BTC mining), coal energy has indeed been part of the energy mix for a meaningful group of miners, with 38% of entities globally relying at least partially on coal energy. Moreover, 15% of BTC miners have been using energy generated from oil to some extent. Consequently, according to Digiconomist, a service created by the data scientist Alex de Vries, the Bitcoin network's carbon footprint currently stands at 69.28m tonnes of CO_2 emissions annually (comparable with Israel).

However, the Cambridge Centre for Alternative Finance also estimated that, on average, 39% of proof-of-work mining was powered by renewable energy. This is above the 29% share of renewables in global electricity generation in 2020 (according to the International Energy Agency). At the same time, 76% of BTC miners were using renewable sources as part of their energy mix, most notably hydropower (62% of miners surveyed). Furthermore, there are significant differences in the energy mix used by miners across regions, with a higher share of Asia-Pacific players using energy produced from coal (65%, especially China outside the rainy season, see chart below) than Europe (20%) and North America (28%).

The impact of the shift in regional hashrate distribution following the Chinese ban on BTC mining operations remains to be seen. Based on the above, an increase in the share of European and North American miners (which has already started to materialise) could potentially improve the Bitcoin network's carbon footprint, although it depends on the energy sources used by the incremental hashrate. Having said that, some Chinese miners seem to have been migrating to Kazakhstan lately (attracted by surplus energy capacity and the government's acceptance of BTC mining), whose energy production has a high carbon footprint as it is mostly powered by coal and gas. However, we note that Kazakhstan has recently introduced a new law to tax the crypto mining industry starting in 2022.

It is also worth considering the amount of electronic waste generated by the industry. This is because ASICs represent single-purpose hardware which becomes e-waste once it is not used for mining anymore. According to Digiconomist, the BTC mining sector generates 7.18kt of e-waste annually, comparable to the amount of e-waste produced by Luxembourg.

BTC miners – a flexible energy consumer

It is worth noting that BTC miners represent a very flexible demand for energy – mobile (eg some Chinese miners used to move their operations to provinces with abundant hydro energy during the rainy season) and easily interruptible. They are largely location- and energy source-agnostic, searching for the cheapest electricity available, and can be located close to the energy source (without having to connect to the wider grid). This is why they have often chosen 'stranded' energy infrastructure (ie the part of the output that cannot be sent where it is demanded at competitive prices), eg conventional power plants in the Rust Belt in the United States, stranded gas in Texas or North Dakota, or hydropower plants in China (most notably the Sichuan and Yunnan provinces) or Siberia (near aluminium production sites). It is also worth highlighting that some oil producers (eg Gazprom and Equinor) have started selling energy generated from unwanted dry gas to BTC miners, thus minimizing routine flaring and in turn reducing greenhouse emissions. According to the Cambridge Centre for Alternative Finance, annual global gas flaring recovery potential stands at 688TWh, which represents 8.4 times Bitcoin's annual energy consumption.

The Bitcoin Clean Energy Initiative and the US asset management company ARK Invest (focused on disruptive technologies) have even suggested in a recent publication that BTC miners could potentially act as a flexible 'load option' ('an energy buyer of last resort') to tackle the intermittent supply of renewable energy – coming to the fore when there is excess power from renewables versus demand in the grid (and thus energy prices are lower), while reducing its activity when the excess supply diminishes (and prices go up). This (together with the roll-out of utility-scale batteries) would allow countries to accommodate a higher proportion of renewable energy in the grid, while maintaining both the required baseload capacity (without having to rely extensively on conventional power plants) and being able to utilise excess supply during peak times. At the same time, this would increase the share of green sources in Bitcoin energy consumption. However, we note that this would require a change in the behaviour of BTC miners, who we believe normally run their operations in an uninterrupted way at present, increasing baseload demand on a grid rather than being a flexible 'load option'.

Beyond Bitcoin: PoS blockchains consume much less energy

The energy-consuming PoW consensus mechanism utilised by the Bitcoin network is only one of many different available algorithms. One particular alternative is becoming ever more important – the 'proof-of-stake' (PoS) algorithm discussed in our previous report, Blockchain adoption: Implications for the financial services sector, which consumes a fraction of the energy used by the Bitcoin network. This is because the block creators are selected based on the amount of native cryptocurrency 'staked', ie locked on the network as a kind of 'collateral'. Notable examples of blockchains using different variations of a PoS

algorithm are Cardano, EOS, Tezos, Polkadot and Solana. Furthermore, Ethereum (the second-largest public blockchain network and most important smart contract-enabled blockchain) is in the process of migrating from a PoW to a PoS framework.