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RESEARCH BRIEF

The Carbon Footprint of Bitcoin

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Blockchain has its roots in the cryptocurrency Bitcoin, which was the first successful attempt to validate transactions via a decentralized data protocol. Participation in its validation process requires specialized hardware and vast amounts of electricity, which translate into a significant carbon footprint.

In 2008, Satoshi, the pseudonymous founder of Bitcoin, published a vision of a digital currency, which only a decade later reached a peak market capitalization of over $800 billion (CoinMarketCap, 2018; Nakamoto, 2008). The revolutionary element of Bitcoin was not the idea of a digital currency in and of itself, but the underlying blockchain technology. Instead of a trusted third party, incentivized network participants validate transactions and ensure the integrity of the network via the decentralized administration of a data protocol. The distributed ledger protocol created by Satoshi has since been referred to as the 'first blockchain' (Yaga, Mell, Roby, & Scarfone, 2018).

During 2018, the computing power required to solve a Bitcoin puzzle increased more than threefold, and heightened electricity consumption accordingly (Blockchain.com, 2018; de Vries, 2018). Speculations about the Bitcoin network's source of fuel have suggested, among other things, Chinese coal, Icelandic geothermal power, and Venezuelan subsidies (The Economist, 2018). In order to keep global warming below 2°C – as internationally agreed in Paris COP21 – net-zero carbon emissions during the second half of the century are crucial. (UNFCCC, 2015). To take the right measures, policy makers need to understand the carbon footprint of cryptocurrencies.

We present a techno-economic model for determining electricity consumption in order to provide an accurate estimate of the carbon footprint of Bitcoin. Firstly, we narrow down the power consumption, based on mining hardware, facilities, and pools. Secondly, we develop three scenarios representing the geographic footprint of Bitcoin mining, based on pool server IP, miners' IP, and device IP addresses. Thirdly, we calculate the carbon footprint, based on the regional carbon intensity of electricity consumption. In comparison to previous work, our analysis is based on empirical insights. We use hardware data derived from recent IPO filings, which are key to a reliable estimate of power consumption as the efficiency of the hardware in use is an essential parameter in this calculation. Furthermore, we include assumptions about auxiliary factors which determine the power usage effectiveness (PUE). Losses from cooling and IT-equipment have a significant impact, but have been largely neglected in prior studies.

Besides estimating the total power consumption, we determine the geographical footprint of mining activity based on IP addresses. This geographical footprint allows for more accurate estimation of carbon emissions compared to earlier work.

We show that, as of November 2018, the annual electricity consumption of Bitcoin ranges between 35.0 TWh and 72.7 TWh, with a realistic magnitude of 48.2 TWh. We further calculate that the resulting annual carbon emissions range between 21.5 and 53.6 $MtCO_2$; a ratio which sits between the levels produced by Bolivia and Portugal.

The magnitude of these carbon emissions, combined with the risk of collusion and concerns about control over the monetary system, might justify regulatory intervention to protect individuals from themselves and others from their actions.

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