Towards an Adequate Energy Policy Response to the Environmental Threat of Cryptocurrency Mining*

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Friday, December 2, 2022

Introduction Cryptocurrencies, for better or worse, allow their users to conduct payments anonymously, without the need for central oversight or intermediaries [2]. Bitcoin is the most popular cryptocurrency with a growing user base [3] and a market capitalization of 373 billion, at the time of writing. Yet, this archetypal digital asset faces perpetual criticism for its electricity demand [4]. This is unsurprising given the devastating effect its energy requirements have: they were found to lead to the production of up to 65.4 Mt CO$_2$ annually [5]–the equivalent of the overall emissions of Greece. While many alternative cryptocurrencies provide similar benefits to Bitcoin and consume orders of magnitude less electricity [6], Bitcoin continues to dominate the cryptocurrency market [7]. Regulators have undertaken many attempts to address the energy needs of cryptocurrencies through a plethora of different approaches. Despite these best efforts, regulating cryptocurrencies remains challenging and, ultimately, fruitless [8] as policymakers seem to consistently underestimate the technical complexity involved in efficiently targeting this novel phenomenon.

In this presentation, recent approaches to cryptocurrency regulation are discussed and a novel proposition, built on consumer education, is made. The effectiveness of this approach is illustrated through a user-focused perspective on cryptocurrency regulation that challenges the common “top-down” perspective.

The Role of Consensus Mechanisms in Cryptocurrency Energy Consumption In contrast to the traditional monetary system in which centralized entities, such as commercial banks, record account balances on behalf of their customers, cryptocurrencies, by design and ideology, reject reliance on trusted third parties. This makes establishing a canonical view of all balances on a digital currency system consisting of distrusting parties an engineering challenge. Bitcoin has first solved this challenge through a cryptography-based incentive system called Proof-of-Work (PoW): Bitcoin’s PoW protocol probabilistically releases rewards and redistributed fees to those network participants who provide the solution to a complex cryptographic puzzle. The difficulty of this puzzle is not pre-defined but adapts depending on demand. Under the assumption that a rational network participant would use their expected rewards to offset their costs for solving the cryptographic puzzle, it stands to reason that the costs participants are willing to incur align with the rewards. And indeed, a high positive correlation between Bitcoin electricity consumption and Bitcoin price has been observed [9].

Alternative Consensus Mechanisms Recognizing this issue, a plethora of alternative consensus mechanisms have been proposed [10]. Amongst the most popular ones is Proof-of-Stake (PoS). While there are debates about tendencies of centralization in PoS that PoW avoids, from an end-user perspective, the protocols provide identical benefits. Here, no costly cryptographic puzzle-solving is needed. Instead, the likelihood of a participant being selected aligns with their cryptocurrency holdings. Thus, the electricity consumption of PoS was found to be three orders of magnitude lower than that of PoW [1]. Still, PoW, in many ways, remains the dominant cryptocurrency consensus mechanism.

*This document leans heavily on earlier work led by the author [1] and re-uses some text fragments from it.
**Regulatory Approaches**  Regulators have begun to target cryptocurrency activity, predominantly to prevent criminal activity and capital outflows, but also to address sustainability. Measures of the past have predominantly focused on fiscal interventions [11] and prohibitive regulations [12] addressing the operators of cryptocurrency networks. Less popular proposals included design-side policies, such as pushing for voluntary re-designs of highly electricity-consumptive protocols [12]. Consumer-focused policies were rarely introduced, and where they were, often made unrealistic assumptions, such as sovereign control over internet traffic [13].

**Failures of National Regulation**  Many examples of unsuccessful regulation targeting cryptocurrency operations exist. A case study that can be used to illustrate regulatory challenges globally is China. The Chinese government have undertaken multiple initiatives to stop cryptocurrency activities, starting with severely restricting the use of cryptocurrencies in 2017. These activities culminated in a ban on cryptocurrency network operations in 2021, enforced with reference to environmental concerns. However, while this ban had a temporary effect on domestic cryptocurrency activity, it led to a mere relocation of operators to other regions: predominantly the U.S. and Kazakhstan. Despite this regulatory intervention, cryptocurrency electricity consumption, and with it its CO\(_2\) production remained at record levels throughout 2021. This shows that it is not constructive for regulators to engage in outright bans of cryptocurrencies to effect global improvements in their sustainability.

**Cryptocurrency Users**  In countries of the Global North, cryptocurrencies are primarily pursued as speculative forms of investment [14], [15]. Countries of the Global South, on the other hand, yield a different user profile: Nigeria, Africa’s “Crypto Capital”, for example, experiences economic stress due to an ongoing recession coupled with rising inflation. This underlying condition, combined with an outdated banking sector [16], led many Nigerians to regularly and routinely employ cryptocurrencies as a means of payment [17] despite a rejective stance of the government [18].

**User Expertise and User Concerns**  An under-researched topic that contributes to cryptocurrency regulation effectivity is user expertise: particularly the question of whether users of cryptocurrencies understand the dramatic environmental effects of these instruments. The results of recent fieldwork in Nigeria [1] show that, on average, Bitcoin users *underestimate* its electricity consumption. They also demonstrate a correlation between participants’ ability to estimate the electricity consumption of Bitcoin correctly, and their support of measures to counteract Bitcoin’s CO\(_2\) footprint. The data furthermore suggest that even those users that consider themselves experts often lack a basic understanding of the mechanisms behind Bitcoin. The results align with consumer knowledge assessments in the wider financial products space that showed that consumers often had little knowledge of the key properties of the products they were using [19], [20].

**Consumer Education**  To develop effective strategies to reduce the popularity of PoW cryptocurrencies, and thereby, ultimately, their electricity demand, decision-makers must realize that such strategies cannot be targeted at operators. More effective strategies, instead, must focus on the end users of cryptocurrencies and empower them to make more sustainable choices. Energy labelling, i.e., providing key sustainability metrics to cryptocurrency users at the point of exchange, is one potentially suitable measure to achieve customer education. Ultimately, regulators need to work creatively and embrace the principle of *thinking global and acting local* to address cryptocurrencies that transcend national borders.
References


