

How Digital Currency Impacts Data Centers

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Cryptocurrency stands to improve the energy efficiency (*decrease* energy use) of digital currency management rather than *increase* energy use.^{1,2} Cryptocurrency (crypto), like fiat (traditional) currency before it, is digital currency relying heavily upon digital infrastructure (data centers, telecommunications facilities, etc.) to move money from a buyer to a seller in exchange for physical products and services or other digital assets, currencies, etc. The question is whether cryptocurrency or fiat digital currency is more energy efficient to perform a given “work” product in the exchange of products and services across the digital infrastructure. This column examines this question and presents some challenging questions for the data center industry.

For the data center industry, cryptocurrency represents an area of innovation and continued electrical demand and growth within the digital currency spectrum.

In fact, blockchain technology is estimated to reduce IT and infrastructure costs in the financial industry and is driving innovation in the energy industry to solve data management challenges through automation and smart contracts executed on the blockchain.

Inside the data centers themselves, future data center infrastructure management (DCIM) and data center management as a service (DMaaS) solutions could rely on cryptocurrency and smart contracts to automate management across many tenants and sites without the need for disparate database systems and software to communicate.

Smart contracts could also manage colocation service level agreements, energy contracts with the utilities and other services within the data center.

In all cases, the management of these systems use cryptocurrency consensus methods that eliminate human-induced errors and increase security through transparency and a centralized source of “truth” on the distributed ledger.

Computational power and energy consumption demand for cryptocurrency is growing exponentially due to increasing mining competition.^{3,4} The introduction of application-specific integrated circuits (ASIC) based servers and data centers strategically placed near cheap energy sources by venue is currently an answer to the growing power consumption problem.⁵

The data center industry can expect a surge in power demands globally, followed by a consolidation to more cryptocurrency and, hence, greater digital efficiencies for a given work product produced by the currency exchange.

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Cryptocurrency

Cryptocurrencies use decentralized finance, which excludes middlemen in transaction operations required in fiat currencies. No middlemen is the primary advantage of decentralized finance.

In general, all approaches of cryptocurrency, both traditional and each generation, can be summarized as a question of consensus. Proof of work—PoW (or mining)—can be viewed as a first-generation cryptocurrency. The intent of distributed ledger systems and cryptocurrencies is fundamentally to move the consensus from human-controlled to something transparent and inherently secure.

Several general types of consensus exist. Because it was first-generation, PoW (Bitcoin) has become the most popular in the eyes of the news media and, hence, the largest focus on the data center energy use stage. It's also known to be the most inefficient means of consensus for cryptocurrencies.

Other cryptocurrencies are being added into the mix and use various mining techniques, offering different degrees of security and efficiency (in terms of both work product and energy consumption).

Cryptocurrency is rapidly going through an evolution that will continue for the next decade or more. Mining crypto currently accounts for 90% of energy consumption of all energy spent on first-generation crypto. This may be affected by constantly increasing power consumption per each Bitcoin minted to the point where mining is no longer profitable, which will force a faster transition from PoW to the proof of stake (PoS) consensus (second-generation) or other newer algorithms.

The evolution of crypto is also influenced by other factors outside energy consumption and energy efficiency, including gaining government and public acceptance and popularity, limited vs. unlimited supply options and market saturation.

Digital Currency/Data Center Connection

Digital currencies require forms of data storage, data transmission and data processing. Fiat currencies are stored in many locations. For example, your bank account information is stored within a database in your bank as well as within another platform on your personal computer or in the cloud. Still, other portions of this information are stored in other locations like credit bureaus, tax accountant files and the IRS to name a few.

TABLE 1 Conceptual comparison of energy required for the storage, transmission and processing of digital currencies as a function of ideal useful work.

DIGITAL CURRENCY	STORAGE	TRANSMISSION	PROCESSING
Fiat (Traditional)	3 Times	2 Times	4 Times
Crypto PoW	2 Times	1.5 Times	2 Times
Crypto PoS	1.2 Times	1.2 Times	1.5 Times
Ideal Scenario	1 Times	1 Times	1 Times

The transmission of that information often has to bridge several middlemen for basic transactions like ATM withdrawals, taking out a loan and/or an online purchase using a credit card and the associated bank withdrawal. Each of the previous transactions requires data processing (authentication of the user to the account, authentication of credit card use, currency exchange fees, processing fees and many data approvals among various middlemen in each process).

Digital currencies in contrast rely on a single distributed database/ledger of the same information, everywhere. Crypto is also a direct client-host currency exchange with no middlemen. As a result, we can speculate that the relative energy cost to perform the same work looks something like *Table 1* for each form of digital currency.

The PoW algorithm used by Bitcoin uses more electrical energy and computing power than second- and third-generation crypto. However, the burden of mining is entirely on private entities who must constantly look for cheap energy resources to stay competitive.

For example, China contributes 70% to 75% of the mining power for Bitcoin,⁶ and the mining operations there are located in a small number of geographical areas that are optimized for this purpose—cheapest electricity, low cost of living and temperate climates. Sichuan is an area ranked second in hashpower (power used for algorithms in the crypto mining process) and also happens to be where a large concentration of hydroelectric power was built to a capacity far beyond the actual demand, in which case the energy produced would only be wasted if it were not now being consumed by the mining operations. In the United States where oil and gas operations frequently need to “flare off” excess natural gas that is produced as part of their normal business, they are now bringing in mobile data centers filled with ASIC mining equipment to generate cryptocurrency from what

would otherwise waste a natural resource and pollute the environment.⁷

In contrast, no such competition or catalyst exists for fiat currency data centers to be efficient. Past data center industry surveys have identified operating power usage effectiveness (PUEs) greater than 1.5 as an industry average, while the banking portion is widely believed to be much higher due to greater system redundancies in both electrical and mechanical system topology.^{8,9}

ASHRAE Standard 90.4-2019 identifies maximum annualized design requirements for mechanical load component (MLC) by climate zone range from approximately 0.12 to 0.28 and maximum design MLCs from approx. 0.21 to 0.33. Maximum electrical load component (ELC) varies based on combinations of UPS redundancy, segments of system and loading scenarios. For reference, MLC and ELC are the design equivalents of the operating metric PUE. An interesting thought experiment would be to introduce additional metrics that may expose the true cost for an average data center operation for various digital cryptocurrencies on the same (one U.S. dollar) equivalent basis. The obvious challenges include a moving baseline currency and challenging means of quantifying/defining the actual work products since there's a combination of storage, processing and transmission of the data.

Finally, the goal is to obtain a carbon-neutral approach (renewable energy sources) regardless of the energy efficiency of the data center. The cryptocurrency sector, particularly mining operations, is far ahead of the data center industry norms, with an estimated 75% percent powered with renewable energy sources for the past two years.¹⁰

Closing Comments

Cryptocurrency stands to improve the energy efficiency of digital currency management rather than *increase* energy use.¹ Fundamentally, it seeks to reduce the amount of data storage, data processing and data transmission associated with the entire ecosystem of centralized digital currencies of today. Concurrently, crypto solves many other important issues like cybersecurity protections of important financial currencies and assets used to manage the global capitalist economy.¹¹

Crypto is still in its infancy despite being more than a decade old. It has already evolved to new forms of

consensus, which are proving more energy efficient for a given work product compared to their first-generation (mining) solution or the fiat currency system in wide use today.¹²

Cryptocurrency, particularly first-generation, has built-in incentives to operate more cost-efficiently without the need for regular oversight. As newer and additional forms of crypto are developed, those too will move the efficiency needle in the work associated with currency and asset management in the global economy. For a time, both fiat and cryptocurrencies will coexist and compete. However, crypto will most likely win out over the long term and drive the data center industry toward a more sustainable future.¹

Crypto is emerging as a superior and necessary means of digital currency in modern times.¹ The focus on the industry should remain on embracing these new technologies and identifying more efficient means to achieve carbon-neutral data center operations through industry collaboration.

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