

# McCULLOUGH RESEARCH

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PRINCIPAL

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To: McCullough Research Clients

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Subject: Are Bitcoin Miners Suitable Electric Loads?

Recent press reports indicate that a substantial electric market may be emerging for these tariff sensitive, highly mobile loads. Given North America's falling energy prices, some utilities may find these attractive customers. There may also be significant downsides as well.

Bitcoin, the first of these digital currencies, arrived on the scene in January 2009. The unknown developer combined two creative ideas -- giving the currency away for free to anyone who could solve increasingly difficult mathematical puzzles and the distributed accounting system named "blockchain".

These ideas play off of each other. The blockchain serves as a public, distributed ledger of all Bitcoin transactions, while the puzzle, known as a cryptographic hash, serves to prove that a given blockchain is valid. Without the puzzle, users of Bitcoin could send fraudulent blocks to other users and spend the same Bitcoin multiple times.<sup>1</sup> For this reason, the developer incentivized users to solve this puzzle by supplying them with a cache of Bitcoins for a successful computation.

Bitcoins are engineered to have increasing scarcity over time. The number of hours necessary to "mine" a bitcoin with a given speed of computation has increased dramatically over time. Bitcoin has a parameter called "difficulty," which defines the amount of time it takes, on average, to generate a cache of Bitcoins. This number is generated by the Bitcoin network approximately every two weeks.<sup>2</sup>

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<sup>1</sup> While the concept is presented as an integral part of blockchain creation, the reality is that alternative methods to verify blockchains exist and may well be required as the cost effectiveness of bitcoin mining declines over time.

<sup>2</sup> <http://bitcoin.sipa.be/>. Accessed February 20, 2018.

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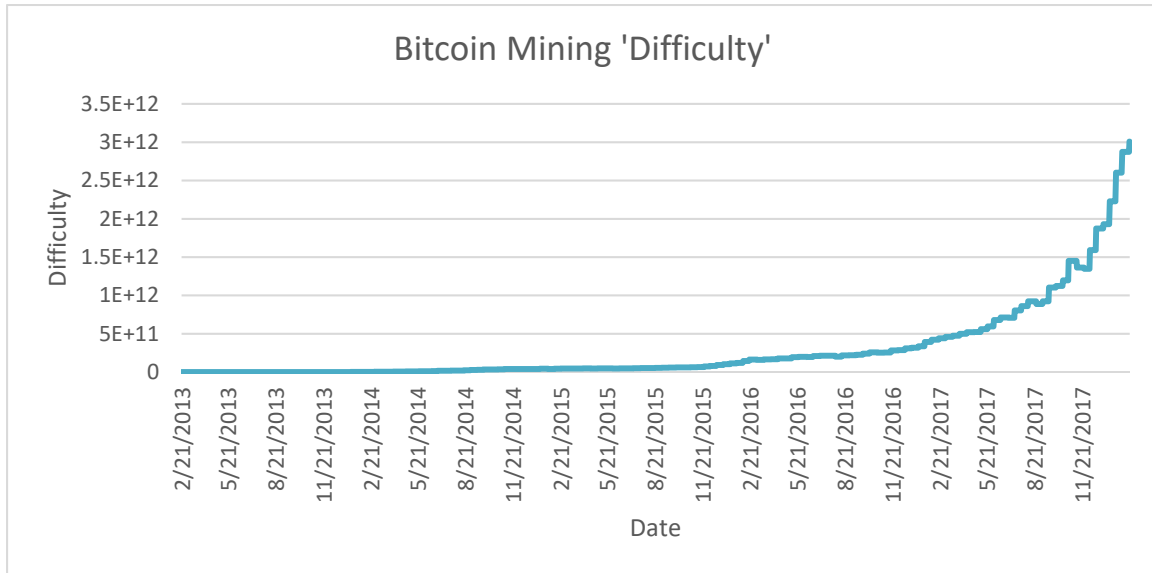


Figure 1 Algorithm Difficulty

To put this difficulty parameter in perspective, if McCullough Research stopped all energy consulting work today and set all of the computers at McCullough Research to mine bitcoins, it would take over 34,000 years before we generated a single one. If we pursued this course of action back on 1/1/2014, then this would have merely taken 13 years. In areas with cheap energy, whole datacenters with vastly more processing power have appeared to pursue the evasive crypto currency.

Bitcoin mining creates the need for more electrical energy. The end of the energy crisis has created a boon for bitcoin miners. Quebec and the Pacific Northwest have increasingly low energy costs and abundant supplies. The dramatic fall in natural gas prices, not to mention the 70% fall in wind and solar capital costs since 2010, have brought wholesale electric prices to all-time lows.

China, which hosts many bitcoin miners, has recently decided to discourage the process since it consumes energy, has potential environmental impacts, and faces a doubtful future as more and more cryptocurrencies are announced (over 1,300 different cryptocurrencies at last count). The Chinese are also probably not enamored with the spread of an unregulated currency.

Quebec has received over one hundred applications from bitcoin miners but is considering whether selling inexpensive energy to solve puzzles is a good choice -- especially since

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Quebec has offered thousands of megawatts to more lucrative U.S. markets since Massachusetts has recently decided to buy more than a thousand megawatts.<sup>3,4</sup> Hydro-Quebec is currently proposing another 3,000 megawatts of transmission to New York and other parts of New England.

Hydro-Quebec’s relevant wholesale market is New England – particularly Massachusetts. The Pacific Northwest hosts two major trading hubs – Mid-Columbia and the California Oregon Border (COB). In Figure 2 below, forward prices in New England can be found from futures contracts traded on the Chicago Mercantile Exchange:

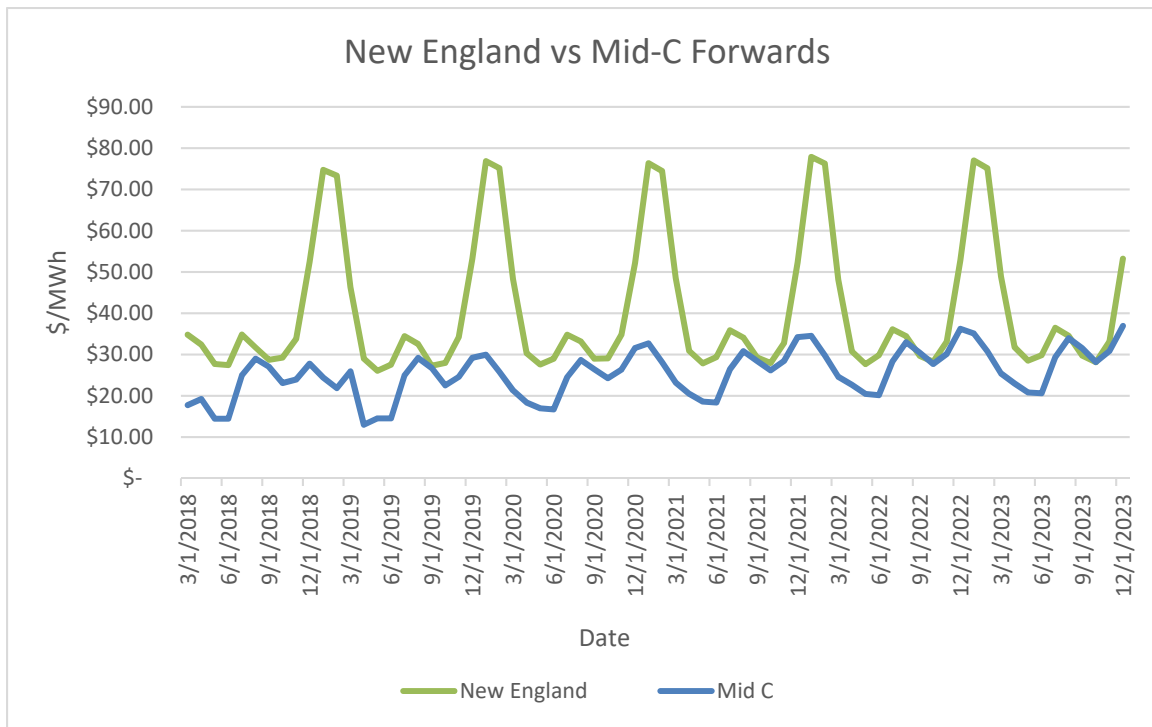


Figure 2 Comparing Futures Contracts<sup>5</sup>

Since Quebec does not have a trading hub, market prices in Quebec reflect the opportunity cost of sales to the United States.

<sup>3</sup> Lecavalier, Charles. *Hydro-Québec faces a spiral of death* Journal de Quebec, January 9, 2018.

<sup>4</sup> Serreze, Mary. *Maine power line will carry Canadian hydro to Mass. if Northern Pass fails to win NH OK by March 27* Masslive.com, February 16, 2018.

<sup>5</sup> This is the all-hours weighted average of prices from the Chicago Mercantile Exchange on February 22, 2018.

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North American utilities are just beginning to consider the issue and we can expect a diverse set of responses. One would be to treat bitcoin miners as any other industrial customer. The bitcoin mining operation may look a lot like server farms, but rather than provide computing infrastructure for businesses, the installation is highly optimized for cryptocurrencies. This might raise policy questions about the value of even having such customers.

The rate for a large industrial customer in Quebec is US\$39.76 per MWh, presenting a significant opportunity cost from prices in New England.<sup>6</sup> Hydro Quebec is thus looking into another response: charging bitcoin miners a higher rate than its preferred industrial customers.<sup>7</sup>

Consumer owned utilities in the Pacific Northwest might well do the same, given their similarly low rates that range from \$45/MWh to as low as \$28/MWh.<sup>8</sup> However, there is a significant difference between the two regions. First it takes a rate case to change a tariff, and it may not be easy for public utility commissions to agree to such price discrimination. Second, the Pacific Northwest's liquid markets would allow Bitcoin miners to buy their power outside regulated utility tariffs.

With the falling wholesale prices for electricity across the U.S. and Canada, there is effectively no constraint to supplying additional energy to bitcoin miners, but there is a significant issue with the stability of the product and the utility's willingness to build infrastructure for a financial phenomenon with limited viability.

At the heart of bitcoin mining is the assumption of increasing scarcity. While this may be true for a single bitcoin currency, the fact is that the scarcity is only relative. When bitcoins become scarce, their completely competitive alternatives such as Ethereum could constitute a useful alternative.

Compare this to the US Dollar. More \$100 bills are held abroad than inside of the United States.

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<sup>6</sup> Hydro Quebec. "2017 Electricity Rates Effective April 1, 2017" page 61.

<sup>7</sup> Remiorz, Ryan. *Hydro-Québec considers raising rates for Bitcoin miners* The Canadian Press, February 15, 2018.

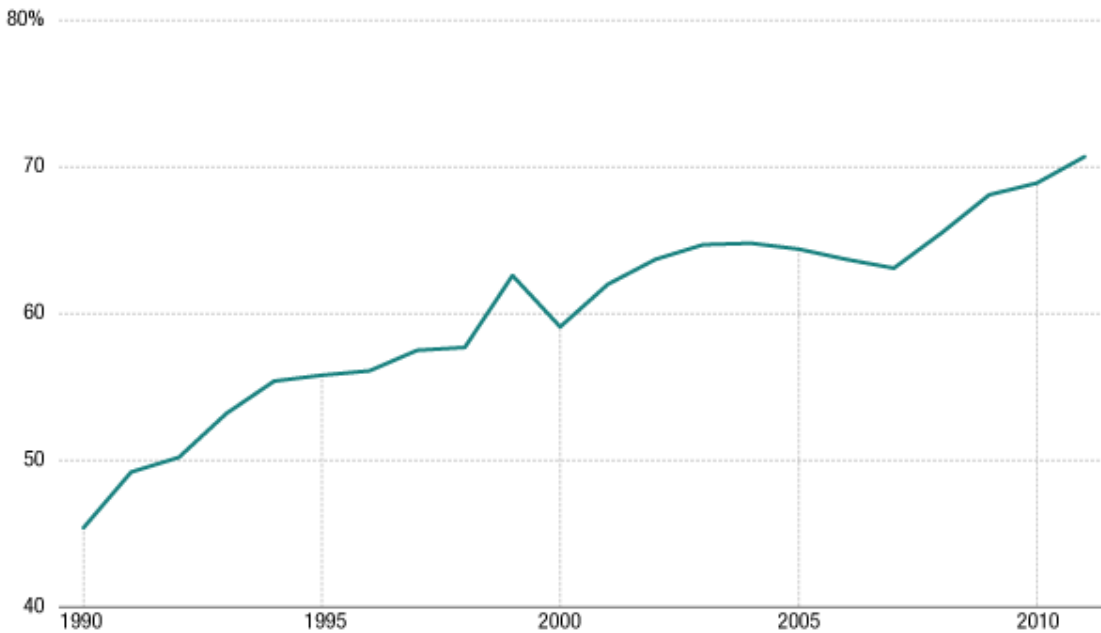
<sup>8</sup> Industrial tariff prices from customer owned utilities in the Pacific Northwest.

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**Percentage Of \$100 Bills Held Outside The U.S. (1990-2011)**



Source: Board of Governors of the Federal Reserve System

Credit: Lam Thuy Vo / NPR

Figure 3 The Growth of \$100 bills held outside the US.<sup>9</sup>

This percentage has been growing since 1990 due to a persistent US current account deficit and the decline in use of cash in domestic transactions. This graphically demonstrates the strong global confidence in the future fungibility of America’s currency. Ultimately, the value of the dollar is backed by its ability to purchase real products at the world’s largest economy. Until we see viable evidence of a similar network effect in the perceived future value of Bitcoin, this experimental currency’s value could one day collapse.

Bitcoins have been compared to the tulip bubble of the early 1600s. There is a fundamental similarity – when the price of bitcoins (or tulips) reaches high levels everyone can start their own cryptocurrency (or plant tulips). Building infrastructure to serve volatile loads may well leave stranded costs for other utility customers.

<sup>9</sup> Jacob Goldstein. “Most \$100 Bills Live Outside the U.S.” April 17, 2013.

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In the end, the location of choice for bitcoin miners may reflect more than fundamental economics. China and Quebec reflect a level of centralization of authority that is not present in the U.S. electric industry. No one authority in the U.S. regulates retail sales. State commissions could (and might) regulate bitcoin mining in the service territories of investor owned utilities, but no similar mechanisms exist for consumer owned utilities.