Mining Bitcoin with Nuclear Power

Uses for Surplus Power and Diversifying Revenue

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Cryptocurrency mining is profitable when the cost of the primary production resource needed to mine it is low. Electricity accounts for upwards of 80% of total O&M spending in a typical-mining operation. For this reason, bitcoin miners circle the globe searching for $0.06/kWh. How much more appealing would the cryptocurrency mining business be if the power was acquired at cost?

The Nuclear Energy Institute reports that nuclear power costs $30/MWh or $0.03/kWh to produce. This fact alone makes bitcoin mining a compelling revenue generating opportunity for nuclear power operators. To be clear, significant revenue and profits can be made, and are being made, mining bitcoin today. Waiting for infrastructure to be built or markets to mature is not necessary. All aspects for making profits in bitcoin mining are available, mature, scalable, and being used by large-mining operations in North America and around the world.

To get an idea of the scale of a conceptual mining operation, take a plant that is producing 1 MW surplus power. Diverting that power to a cryptocurrency mining farm could, depending on the model, power anywhere from 300 to 900 individual-mining computers. A continuously operating 1 MW-sized mining operation with the most efficient miners can conservatively generate a top-line revenue of $900,000 per year and profits of $650,000, not accounting for cooling, repairs, or part-time technicians. Our analysis predicts a project like this could break even in approximately 15 months.

This conceptual project was analyzed at a bitcoin price of $9,275. A higher bitcoin price means more profit for the same cost of goods sold (COGS). Also, as the operation scales and consumes more surplus power, revenue and profits will grow at a faster rate than COGS.

Why Nuclear Power Operators Should Consider Mining

There is a congruence of factors urging operators to consider cryptocurrency mining today. Consider a future where portions of nuclear power plant output are made redundant by low-cost renewables. Nuclear power remains one of our most reliable-generating assets. But as grid operators commission additional intermittent generation sources (i.e., wind and solar), the characteristics of these sources will continue to challenge existing baseload plants. When wind and solar are producing at full capacity, a portion of a baseload plant's power may be categorized as surplus.

Baseload power plants will need to adapt their operating model to the new reality of intermittent resources supplying the grid.

If power is not curtailed, the abundance of power on the grid can lead to situations where utilities are paying customers to take electricity (negative power prices). For many reasons, curtailing power from a baseload plant is neither technologically ideal nor economical. Baseload power plants will need to adapt their operating model to the new reality of intermittent resources supplying the grid.

California now consistently experiences negative prices, especially on sunny days and when the hydro plant's reservoirs are full. Europe is wrestling with this phenomenon too. Recently, the spot price for power turned negative for significant periods of time. Germany experienced more than 125 hours of negative prices in 2017 and 2018. The Pacific Northwest saw negative prices due to inflexibility of generating sources as far back as 2011.

These events highlight a growing list of questions that electric power producers will need to address:

- What will the future hold if large-baseload nuclear plants can no longer compete?
- What if only a portion of the power produced by the plant is demanded by the consumer?
- Is there value in maintaining operation of a nuclear plant just for overnight demand and other times of low-renewable supply?

U.S.-based nuclear plants have been focused on production efficiencies without sacrificing safety through an industry initiative called Delivering the Nuclear Promise. This effort overall has been successful, and it will continue to drive costs down. However, there are other ways to increase profit by turning a potential problem of surplus power into a new revenue source.

ScottMadden's team has been researching solutions that go beyond cost-cutting and into new business models for baseload nuclear plants. While researching hydrogen and nuclear cogeneration, we considered other industries that require significant electrical energy, have small footprints, and have low overhead. This paper explores the value proposition of mining cryptocurrency.

Cryptocurrency Is Big (and Power Hungry) Business

Cryptocurrency, contrary to the hype, is big business. The electrical energy alone necessary to support and maintain the bitcoin network today is estimated at 64TWhs per year. That is comparable to the total power consumed by the country of Greece. Bitcoin mining may be responsible for 0.5% of the total electrical power consumed worldwide. Mining cryptocurrency is an international, profitable, and energy-intensive business.

Figure 1: Typical large-scale cryptocurrency mining farm[1]

Bitcoin mining operations are popping up in jurisdictions where electricity is cheap and the climate is cool. It is estimated that the state of Washington hosts 15–30% of global-mining capacity. The eastern area of the state is attractive to bitcoin miners for one reason: the abundant, and very inexpensive, hydropower. Bitcoin miners have been flocking to the eastern part of the state to take advantage of the cheap electricity to run their mining operations. Other locations in North America are thriving as well.

There are reports of Canadian gas companies that are now burning previously flared waste gasses to power bitcoin miners. Other factories, like tire-burning facilities, that have extra power produced above contract quantities are mining bitcoin with the surplus. Layer1, a start-up financed by Peter Theil, has a deal in Texas to mine bitcoin with excess grid electricity.

Nuclear power, facing redundancy, is in a position today to enter this market and begin to diversify its sources of revenue.

It has also been suggested that renewable energy facilities investigate on-site bitcoin farms that can generate revenue from surplus energy. Nuclear power is in a position today to enter this market and begin to diversify sources of revenue. The goal is simple—secure the operating asset so it can keep producing safe, reliable, and carbon-free power for decades to come.

[1] www.sebfor.com

Mining Cryptocurrency Means Generating Hashes

Mining bitcoin is a guessing game. Miners are attempting to guess a code or hash that will decrypt a collection of previously executed bitcoin transactions. When a miner guesses correctly and decrypts the collection of transactions, they are rewarded with new bitcoin. This is the main source of profits for mining companies.

A guess or hash is a line of letters and numbers that represents an actual text string. This is useful in encrypting data like an email so other users on the network cannot see or read the data being transmitted. When text is written and encrypted, a mathematical algorithm takes that text which is arbitrary in size and converts it to a string of text that is a fixed size. For instance, if you were to convert this sentence into a SHA-256 hash, the result would be:

D007C61C83FD08150A2F66D03B576163E96F54602AF4C0AE947620C2B097EFD9

Cryptocurrency-mining computers work in reverse. They use tremendous amounts of energy to randomly generate hashes in order to guess the hash that represents the actual text string. In other words, miners are attempting to decrypt a list of bitcoin transactions. Once a miner guesses the correct hash, the transactions are verified and actual bitcoins are awarded to the miner's account.

Producing guesses requires computing power. The more computing power you have, the more guesses you can produce, and the more bitcoin you can "mine." Once bitcoins are acquired, they are sold on any number of exchanges for any world currency. Market prices for cryptocurrency are known to be volatile. Profit in mining relies heavily on the price of the cryptocurrency being mined and the number of users transacting on the cryptocurrency network.

Depending on the operation, there are levels of cryptocurrency prices at which mining is not profitable. A miner may be forced to sell cryptocurrency into a market where profits are not assured based on price volatility. To address the risk of low cryptocurrency prices impacting business operations, the CBOE and CME offer bitcoin futures contracts. Larger mining operations use CBOE or CME hedging products to insure their investments against any wild price swings that could damage profits.

Figure 2: CBOE bitcoin futures[2]

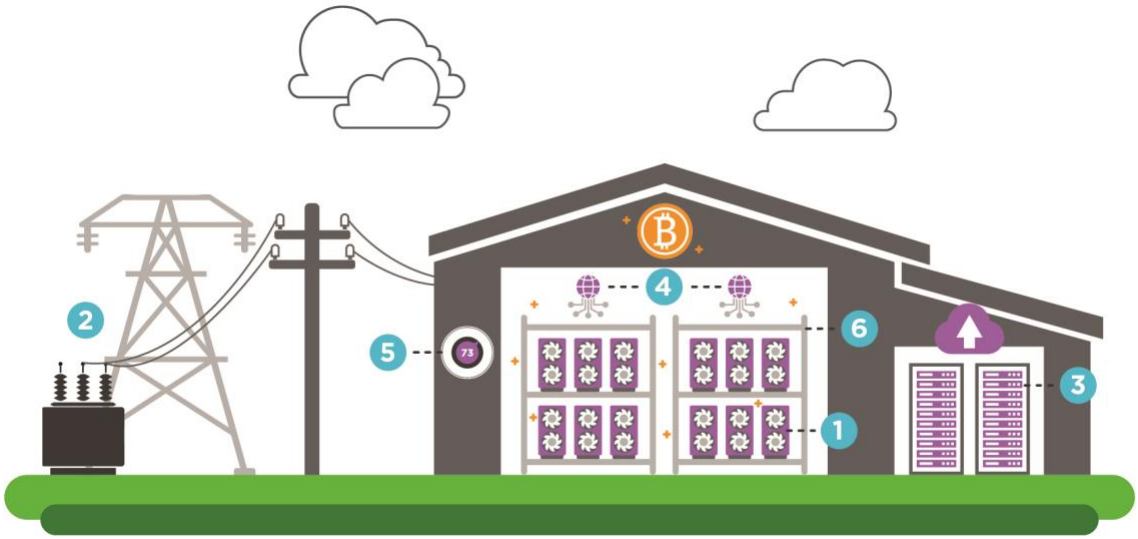
[2] CBOE

How to Enter the Cryptocurrency-Mining Industry

Starting a mining operation is like building a data center or server farm. Prior to the popularity of cloud computing, many companies built and housed their own data centers and computing operations. Indeed, data centers use a tremendous amount of computing power and electricity. The difference is that data centers prefer to be located close to urban areas since they are transmitting enormous amounts of data. Cryptocurrency-mining operations can be located anywhere.

The infrastructure required consists of just a few components:

1. Mining Computers
2. Electrical Infrastructure
3. Network Infrastructure
4. Internet Connection
5. HVAC Temperature Control
6. Racks and Shelving



Multiple models of bitcoin-specific mining computers are available in the market. Older models produce fewer guesses, but they are less expensive. Newer models are more expensive, but they are much more efficient and produce many more guesses.

Once the miners and their associated power supplies are acquired and installed, they must be connected to the internet. Network infrastructure is no more complex than a typical office. In fact, since miners are only guessing strings of text, speed and capacity of the internet connection are modest. The miners are like other computer hardware and perform best under cool conditions. Mining can start once the conditioned space is acquired, miners are purchased, connections to power and internet are made, and the miners are configured to access the network. Now that the farm can produce guesses and receive rewards, how are profits ensured?

Each guess the miner makes has the capability to unlock the next block of transactions and achieve a reward. Today's reward for unlocking the next block in the blockchain is 6.25 bitcoin. At a bitcoin price of $9,275, that is $58,000 rewarded to the miner. However, with a small operation that is only producing a small number of guesses, it may take years to guess the correct string of text and receive a reward. The mining industry has developed a solution for this problem as well.

Mining Pools

To ensure a reward in bitcoin is predictable and steady, mining pools have been created. Pool operators charge a small fee to collect and track the computing power of their members. Only one correct guess can unlock a reward, but when that guesser is part of a pool, all members who contributed in the search will receive a fraction of the reward. The fraction is commensurate with the computing contribution of the member. Across the entire bitcoin network, 150 blocks are discovered each day. Pools allow small operations to contribute computing power to the network and share in the rewards, despite potentially never actually producing a correct guess.

Figure 3: The world's first bitcoin mining pool[3]

Components and Costs of a Mining Farm

Costs of setting up an operation are dependent on a few inputs. The main capital expenditure (CAPEX) is the mining equipment. The sole purpose of these application-specific integrated circuit (ASCI) computers is to produce the guesses needed to mine the bitcoin network. From one supplier, they range in price from under $100 to more than $2,500 each, depending on the vintage. The other major cost is the electrical infrastructure. Other CAPEX includes HVAC cooling, network infrastructure, wiring, shelving, installation, and configuration.

O&M costs are totally dominated by the price of electricity. Besides electricity, the only O&M left to consider is the energy needed to keep the equipment cool, paying a part-time technician to monitor the operation, and replacing faulty or damaged equipment. Most of the monitoring of each miner's performance can be done remotely. Mining pools will alert a member when a miner is not producing, then a technician can investigate.

Conclusion

Expansion of renewable generation will change the way power is produced. Nuclear power is still a necessity for its steady and reliable output. However, not all of the output may be needed all the time, and, potentially, ratepayers will demand only a fraction of total nuclear power plant capacity. What should utilities to do with the extra power? In the hunt for new sources of revenue, nuclear owners should consider cryptocurrency mining as one of their first ideas.

[3] www.slushpool.com

Key Takeaways

Mining bitcoin is profitable today at any size CAPEX.

Owners can prove the concept on a small scale prior to a major investment.

Mining favors businesses that can secure a low cost of electricity.

O&M spending is dominated by the cost of electricity.

If power companies are the miners, a link in the value chain is removed and mining costs are reduced. This would give the power company an instant competitive advantage. In a future where nuclear is challenged to compete, the time for thoughtful consideration of all ideas has arrived.

To learn more about the basics of blockchain and cryptocurrency, MIT's Sloan School of Management published an article called Blockchain, explained. Much more is available at Investopedia.

How We Can Help

ScottMadden helps clients in every aspect of the nuclear power business. We work with our clients to build tailored solutions designed to deliver value from traditional and unexpected parts of the business. Our deep acumen in generation and utilities help operators achieve safe, efficient, and profitable plants.

About ScottMadden

ScottMadden is the management consulting firm that does what it takes to get it done right. We consult in two principal areas—Energy and Corporate & Shared Services. We deliver a broad array of consulting services ranging from strategic planning through implementation across many industries, business units, and functions. To learn more, visit www.scottmadden.com.

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We know energy from the ground up. Since 1983, we have served as energy consultants for hundreds of utilities, large and small, including all of the top 20. We focus on Transmission & Distribution, the Grid Edge, Generation, Energy Markets, Rates & Regulation, Enterprise Sustainability, and Corporate Services. Our broad, deep utility expertise is not theoretical—it is experience based. We have helped our clients develop and implement strategies, improve critical operations, reorganize departments and entire companies, and implement myriad initiatives.

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