



Measurement Study of Energy Impact of Blockchain Technologies: Cryptocurrency



Qaylin Holliman, Jackson State University

Center for Cybersecurity and Research, Old Dominion University

Abstract

Blockchain technology facilitates the flow of information and the speed of information through a faster and more decentralized network. It has its advantages as compared to more centralized networks and legacy networks. With the evolution of mainstream technology, blockchains is predicted to be more effective and sufficient to consumers and commercial companies. In this paper, blockchains will be scaled to cryptocurrency mining, where cryptocurrencies utilize blockchain technology to record transactions and orders. Mining will also be examined through energy consumption, the algorithms behind some cryptocurrencies, their sustainability issue, and resolutions to combat high energy consumption. While the pace of energy consumption has changed since the beginning of cryptocurrencies, particularly Bitcoin, conventional energy has been constantly consumed drastically, and this paper will observe the sources behind this consumption and the alternatives to create a greener world amidst a crackdown on bitcoin taken as a source of currency to major companies.

Keywords: Blockchain, Cryptocurrency, Proof of Work, Mining, Bitcoin

Introduction

Objective

- Discuss the reemergence of Bitcoin & Ethereum mining
- Research different cryptocurrencies & their respective consensus algorithms
- Compute energy consumption for mining & its environmental impact
- Observe alternative energy sources for mining & the cost to implement

Background

- Blockchains, is a ledger system that records the transactions
- A consensus algorithm is a process used to reach an agreement on data in a distributed system
- Proof of Work is the first and most popular consensus algorithm in the world
- Hash rate is a measure of power utilized when mining or simply the speed of mining
- GPUs, CPUs, & ASICs can be used to mine cryptocurrencies.
- Bitcoin's main sustainability issue is the huge amount of energy used in bitcoin mining.
- Renewable Energy Sources plan to be the next alternatives for energy consumption

Significance

- Fossil Fuels can only sustain short term conditions of cryptocurrency mining.
- Bitcoin's energy consumption is about as much as countries Colombia & Bangladesh.
- Although there is a GPU/CPU shortage, mining equipment will be obsolete in upcoming years.

General Theory

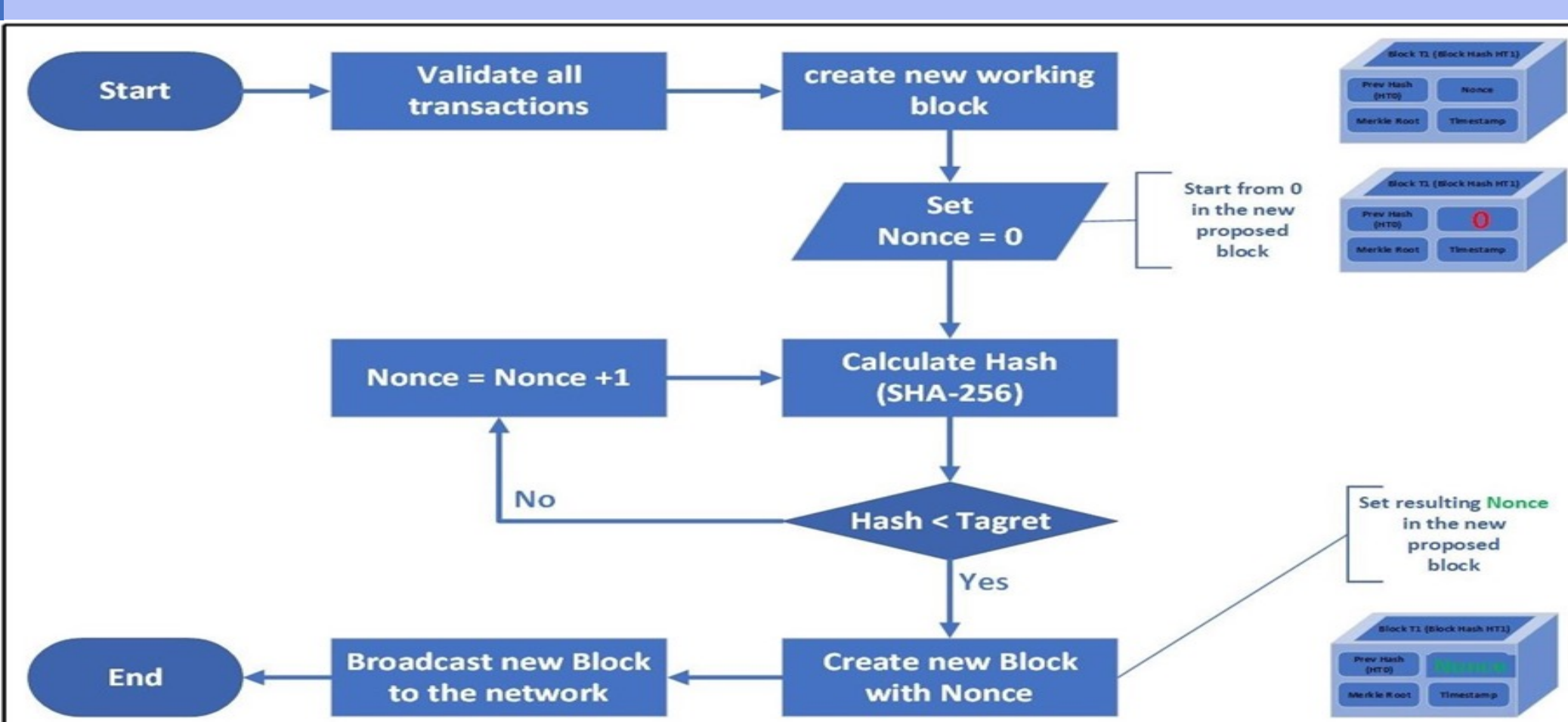


Figure 1 demonstrates the Proof of Work Model in cryptocurrency mining.

Research

ALGORITHMS

Ethash

Ethereum block time – 13 seconds

Pros

- Holds the ability to resist ASICs while being a simple and safe algorithm. ASICs will be discussed later in the paper.
- Use of Directed Acyclic Graph (DAG), making this algorithm an efficient process in the production of blocks.
- Adjustable production time to the needs of the network

Cons

- ASIC resistance was broken in 2018, when Bitmain introduced its first miner to Ethash. Since then, mechanisms have been sought to prevent further centralization of mining on Ethereum. However, the development of Ethereum 2.0 foresees the abandonment of the PoW.
- The high memory consumption of DAG makes it very difficult to mine in more modest equipment.
- Ethereum Network is at a halt, a point where Ethash's difficulty system would make mining impossible for any miner to try. This is a serious risk to the security of the Ethereum blockchain.

Proof of Stake is in development and supposed to be an alternative to PoW for Ethash.

SHA-256

Bitcoin block time – 10 minutes

SHA-256 is a cryptographic hash algorithm that produces a unique 256-bit alphanumeric hash value for any given input, and that is the unique feature of this cryptographic algorithm: Whatever input you give, it will always produce a 256-bit hash.

"SHA-256 is very strong. It's not like the incremental step from MD5 to SHA1. It can last several decades unless there's some massive breakthrough attack. If SHA-256 became completely broken, I think we could come to some agreement about what the honest block chain was before the trouble started, lock that in and continue from there with a new hash function." – Satoshi Nakamoto

BITCOIN CRACKDOWN OF ENERGY SOURCE

Bitcoin's main sustainability issue is the huge amount of energy used in bitcoin mining. Renewable Energy Sources plan to be the next alternatives for energy consumption for bitcoin mining amid Elon Musk's statement to tackle a greener consumption and halt of bitcoin as a method of payment. Energy sources – solar, wind, hydro, bio, geo– are all renewable and can alleviate the consumption of fossil fuels or coal. While it is said to decrease energy consumption of bitcoin mining, that may be necessarily true. The amount of energy may still be the same, if not in a relative range, but the consumption of fossil fuels will be lower.

Results

RENEWABLE SOURCES

Hydropower is the most used renewable energy source in China.

Hydropower, typically in dams, does not emit any greenhouse gases in the environment. The cost to run a dam has little to no maintenance, while dams can run long term for up to 50 to 100 years. Hydropower units also serve as a backup for non-hydro generators..

Solar Power is another renewable energy source in question. Solar energy can convert to electric energy using grids across land. Solar energy has low environmental impact with less emissions of greenhouse gases. It is an affordable source and works in many climates. But solar power is only useful when the sun is out, and countries have different time zones.

Wind Energy can be created immensely using wind turbines, in which would require construction and upfront costs as well as land space. There are low costs to operating the turbines and it is a clean source of energy

Bioenergy is the process of burning organic matter to create energy. This method emits carbon dioxide into the air, one of the greenhouse gases. However, carbon dioxide can be captured by flora in the surrounding areas the carbon dioxide is being released. The practice and its efficiency depend on the technology used to combust this energy and the ability to regrow plants.

Geothermal energy is the usage of power through the heat of the earth, usually used to create electricity. It has a consistent generation of power no matter the season. Geothermal power can be scaled according to needs, whether residential or commercial.

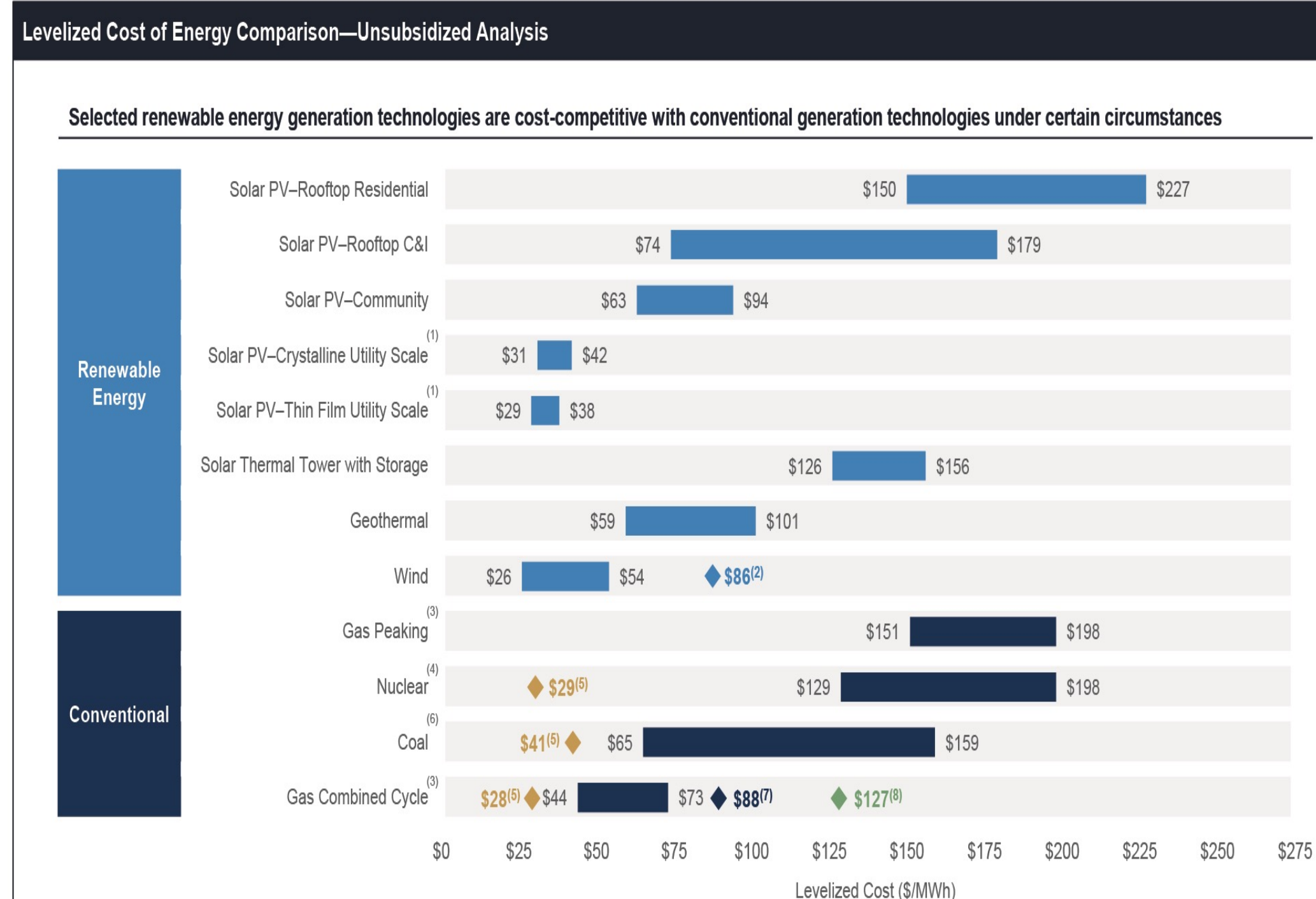


Figure 2 analyzes the unsubsidized cost of energy for renewable energies and conventional energy.

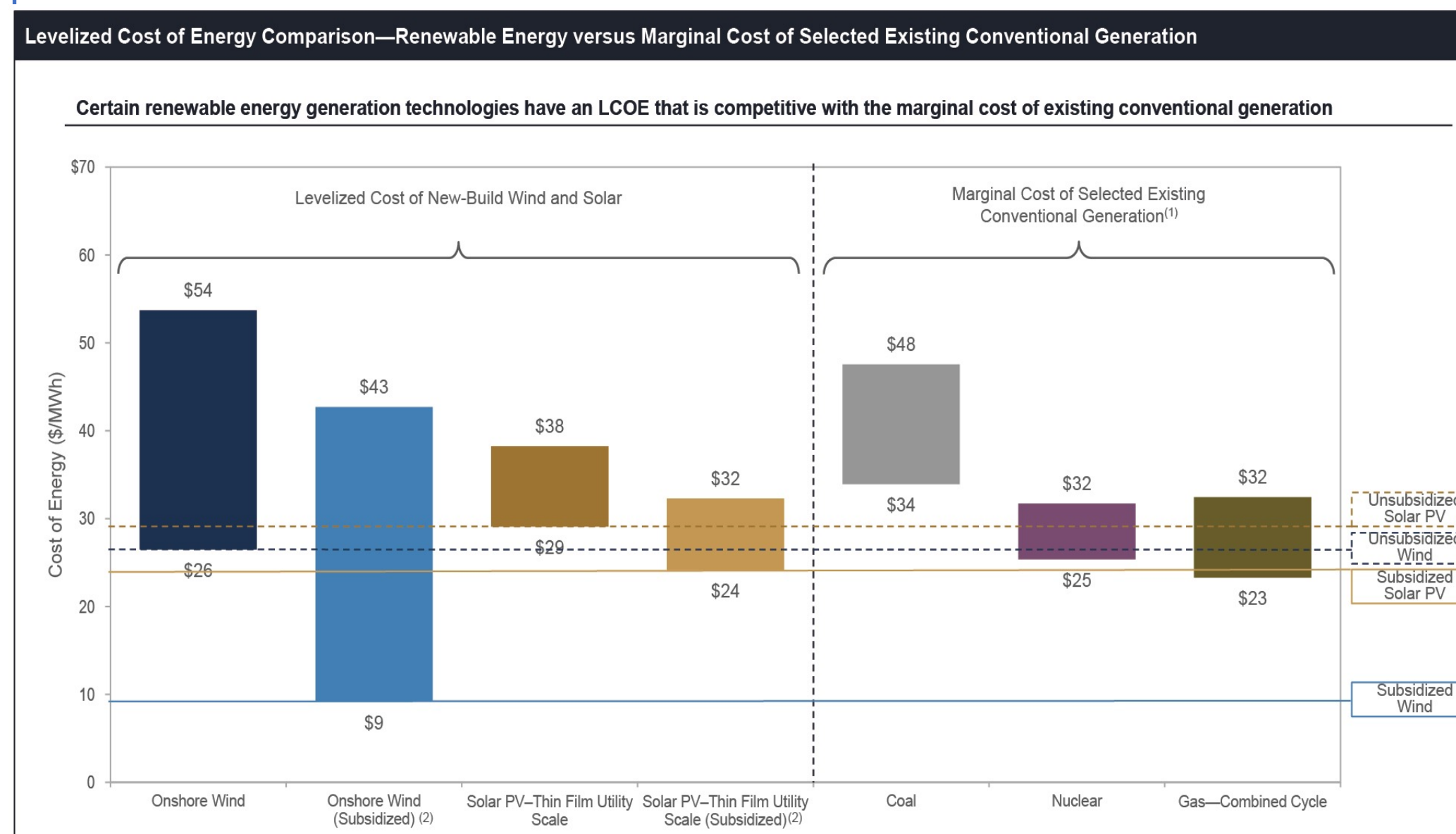


Figure 3 compares marginal cost of energy for wind energy, solar energy, & conventional energies.

Ethereum 2.0 Discussion

There is set to be a new edition to Ethereum, Ethereum 2.0. As for the current Ethereum network, the algorithm within the network tends to get backlogged with transactions, handling 15 to 45 transactions per seconds. While this may sound exceptional, Ethereum is the second most used cryptocurrency network behind Bitcoin. High demand of Ethereum is causing this delay and is not sufficient for all Ethereum users. Nodes in the network exchange data but have been overloaded with excessive volume, and developers say that increasing the size of the nodes would not be the best option.

Ethereum 2.0 will be designed to broaden the network and its volume with an increase in chains in the network. Data will be broken into smaller groups and into more databases and will ultimately increase transactions per second. Implementing this sharding will create more users while consumers can operate Ethereum on devices such as smartphones. Security will be increased since hackers will have to compromise majority of the nodes within the network, and nodes will require more effort to compromise. Ethereum 2.0 will abandon PoW and implement PoS, or Proof of Stake. Proof of Stake will allow users to 'stake' or forge new tokens from existing tokens, creating energy sufficiency. The more tokens a user have, the more power they have. The hardware requirements are reduced which further decentralizes the mining industry. Ethereum 2.0 will have a beacon chain to validate blocks for staking.

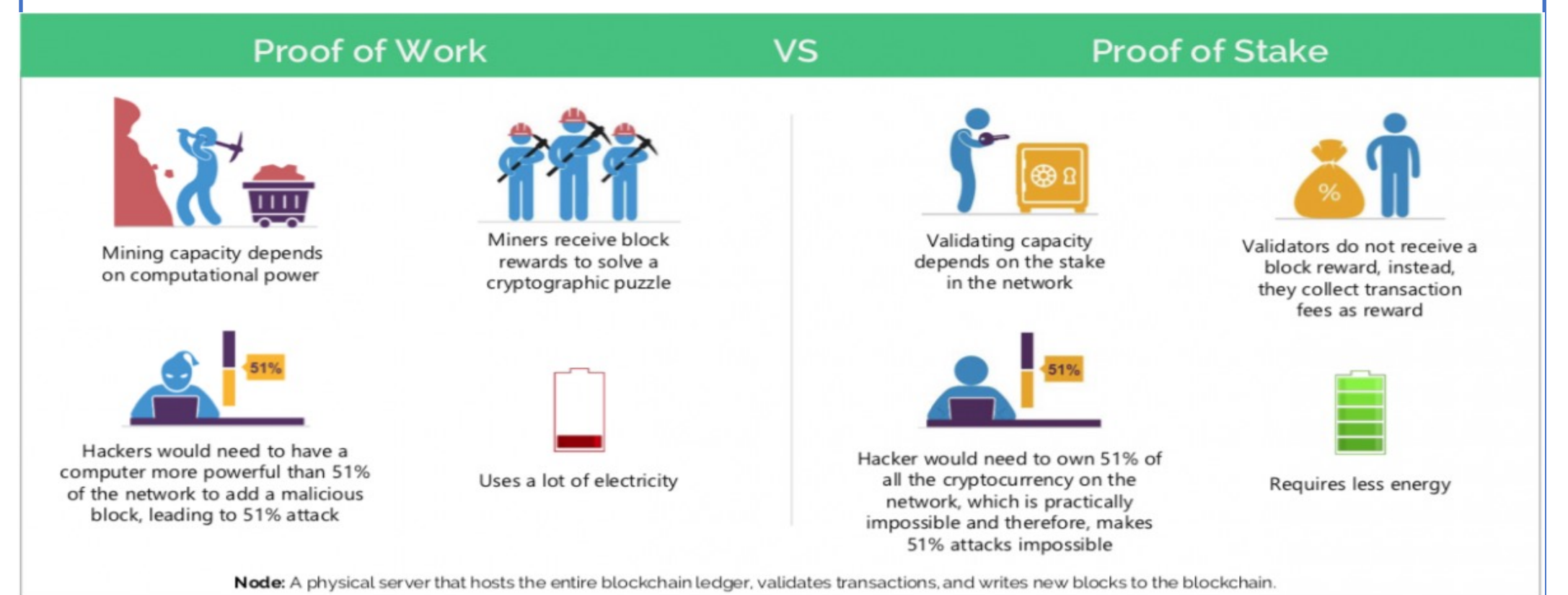


Figure 4 compares the process of Proof of Work and Proof of Stake.

References

- [1] Bit2Me Academy. 2020. What is the Ethash mining algorithm? *Bit2me.com*. Retrieved June 29, 2021 from <https://academy.bit2me.com/en/what-is-the-algorithm-of-ethash-mining/>
- [2] Levelized Cost of energy and of storage. *Lazard.com*. Retrieved July 26, 2021 from <https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2020/>
- [3] SHA-256. *Minerstat.com*. Retrieved June 12, 2021 from <https://minerstat.com/algorithm/sha-256>
- [4] Ethereum staking. *Ethereum.org*. Retrieved June 27, 2021 from <https://ethereum.org/en/eth2/staking/>
- [5] Renewable energy: All about clean power. *Energysage.com*. Retrieved July 23, 2021 from <https://www.energysage.com/about-clean-energy/>

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