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How Blockchain Could Change The Energy Industry

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November 21, 2017, 11:40 AM EST


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Blockchain technology, a technology traditionally associated with digital currencies like bitcoin, has expanded far beyond cryptocurrencies and into the energy sphere, ushering in a demand for updated energy technologies and a new legal landscape.

With blockchain, people can buy and sell energy from their neighbors without a third-party intermediary. This peer-to-peer payment system has the potential to catalyze distributed energy resources, leading to a change in the number and type of "generators" adding capacity to the grid.

But implementation of blockchain raises questions such as how to introduce this technology in numerous regions across the United States, each with a unique regulatory scheme. Thus, while blockchain provides exciting opportunities to change the payment system and players in the energy industry, full-scale industry integration will face numerous obstacles, requiring regulators to address reliability, security and stability concerns.

Understanding Blockchain Technology

Blockchain technology is a decentralized, online ledger maintained by computer networks that verify and record transactions, then distribute the ledger to all users. To state it simply, the technology sends details of numerous individual transactions to all users, thus creating a digital ledger. By sending the ledger to all users, the technology enables each user to ensure the validity and accuracy of the transaction and prevents one party to the transaction from lying about the details or failing to perform.

The system incentivizes certain individuals, called miners, to check the accuracy of the transactions by providing monetary rewards. The miners verify the transactions by solving complex math problems. The first to solve wins compensation and adds their transaction, in the form of an encrypted block, to the chain.

Cryptographic encryption is also used to "sign" transactions using a signature that no one can replicate unless they have the key. Because no one can tamper with the chain or sign transactions using another individual's key, encryption provides both accuracy and security.

Thus, through cryptography and incentives, this decentralized ledger system provides a mechanism to

ensure the accuracy of transactions in an open and transparent way, reducing the chance of fraud and allowing people to engage in secure transactions without an intermediary.[1] The uses of this technology do not stop at the doorstep of finance. Rather, parties can create “smart contracts” on blockchain-based computing platforms, which execute transactions exactly as programmed without any potential for downtime, fraud or third-party interference.[2]

Anyone can create these contracts simply by writing the code. As such, the uses of this technology are limitless.

Opportunities for Blockchain to Change the Energy Industry

Blockchain technology is disrupting the foundational premise that all forms of energy require centralized production, transmission and distribution from one single electricity provider. Instead, blockchain allows consumers to buy and sell energy from multiple providers in an open market using transparent and secure payment systems in real time.[3] Thus, most foundationally, blockchain will change the payment system. But this capacity will, in turn, change the industry players and enhance grid security.

For example, in Brooklyn, New York, startup company LO3 Energy Inc. used the technology to sell energy produced from rooftop solar panels directly to customers in a community microgrid.[4] Participants installed blockchain-enabled smart meters in their homes, which tracked the energy they consumed and generated.[5]

Using an app, customers could manage their electricity purchases, choosing both the source of the energy (conventional or renewable) and their price point. Participants carried out the financial transactions over the blockchain, which tracked not only the financial transactions, but also the consumption data, creating a transparent and auditable transaction history.

As another example, using Grid+’s blockchain-enabled technology, a manufactured device registered as a Retail Electricity Provider (REP) can automatically buy and sell energy on the user’s behalf in the wholesale energy markets.[6] The use of a blockchain-enabled device instead of a traditional REP reduces the administrative burdens of processing transactions and pushes market signals to customers, leading to lower costs and increasing efficiency.

Similarly, the Power Ledger platform facilitates peer-to-peer energy trading in real time using an automated and trustless reconciliation and settlement system.[7] The platform allows users to select clean energy sources, trade with neighbors and do it all with minimal settlement costs, leading to lower power bills and improved returns for investment in distributed renewables.[8]

This technological capacity not only uproots the payment system, but also the players within that space. As seen in the Grid+ example, automated devices could replace some inefficient REPs. Significantly, distributed energy resources (i.e., rooftop solar panels) may replace some need for additional generation capacity.

And technology firms may attempt to capitalize on their grasp of blockchain by entering the energy markets. Firms like Apple Energy LLC and Googlealready sell energy in the wholesale markets and could expand their reach using blockchain, fostering greater competition and efficiency in the markets.[9]

Blockchain can increase efficiency across many sectors of the energy industry. Because all data is recorded on the blockchain, recordkeeping and accounting can be streamlined as numerous processes

can be automated. When combined with the internet of things, blockchain can also significantly improve the response time for outages.

Currently, when a power line falls, utilities depend on customer reports to identify the location and time of the outage. Once a power line is equipped with a sensor running on the blockchain, it can transmit details of its functioning directly to the utility, alerting them immediately and reducing the time it takes to fix the outage.

Blockchain also has the potential to enhance security. First, it can improve security of consumer transactions. Recording all financial transactions on the blockchain will create a more secure and auditable transaction history. Second, blockchain can improve accuracy and tracking in the supply chain by updating each move in the supply chain immediately, reducing delays from paperwork, improving inventory management and reducing courier costs and errors.[10]

Perhaps more importantly, blockchain could be used to make energy infrastructure less susceptible to cyberattack. The U.S. Department of Energy has requested proposals for how blockchain could provide energy security through new measurement tools designed to manage complexity, perform robust monitoring and enable real-time optimization of power generation and fossil-fuels-based systems.[11] Implementing a blockchain-based ledger of "all actuation commands ever made by a hardware component may then make it possible to detect and mitigate false comment signals (i.e., from hackers) and other cybersecurity threats for the achievement of a robust, reliable system."[12]

The examples described above are only a fraction of blockchain's use in the industry. Blockchain could be used in countless ways, from tracing land titles to commodities trading.[13] The pressing issue, however, is determining how to incorporate this technology in a highly regulated industry. Doing so will require regulators and blockchain developers to overcome numerous obstacles, from overcoming regulatory uncertainty in the short run to addressing ratemaking concerns and reliability in the long run.

As seen above, a full-scale implementation of blockchain in the energy industry could mean an entirely new payment system, and potentially, new energy providers and intermediaries. This change prompts questions, chief among them is whether or how this implementation will be regulated. And although regulatory uncertainty may hinder blockchain developers, regulators themselves must address the other obstacles to a full-scale implementation of blockchain. These issues include how to maintain reliability and grid stability in the face of new generation sources, how to establish the proper fees for peer-to-peer transactions and how to maintain security in the face of a new payment system.

Regulatory Uncertainty

The electric industry is subject to a patchwork of regulation. The retail power market is governed by the public utility commission of each state. The wholesale market is mostly regulated by the Federal Energy Regulatory Commission (outside of Texas).

However, the regulation of the wholesale market is not uniform. Much of the country is divided into regional transmission organizations, each with its own set of market rules and business practices. The remainder of the country (particularly in the South and the West outside of California) continues to operate under the traditional monopoly utility model.

Finally, responsibility for overseeing the reliability and scheduling of the system lies with the North American Electric Reliability Corporation and its eight regional reliability entities. These state-by-state

differences obstruct blockchain developers from creating widely applicable technologies. Further, despite the clear interest in blockchain applications to the energy industry, neither Congress nor regulatory agencies have said whether they will regulate them, spawning uncertainty among developers.

At this point, regulators are researching the technology, but have yet to give guidance. For instance, the New York Public Service Commission, which actively worked with LO3 Energy to unroll the Brooklyn microgrid, is researching ways to align electricity markets and regulations with the explosion in distributed energy resources.[14] The state of Washington's Technology & Economic Development Committee in the House of Representatives outlined research paths for "electric utilities to prepare for the distributed energy future."[15] And major regulatory bodies like the Southwest Power Pool are exploring how distributed energy resources might impact the grid and how regulators should react.[16]

Even so, no one has shed any light on whether blockchain applications will require concrete regulatory change. This uncertainty is a primary obstacle to blockchain developers trying to unroll new technology in a highly regulated space.

Congress likewise has expressed an interest in the technology without indicating whether it will legislate on the issue. On Feb. 9, 2017, a bipartisan collective comprised of Congressmen Jared Polis and David Schweikert announced the creation of the Congressional Blockchain Caucus.[17] The caucus seeks to advance "sound public policy toward blockchain-based technologies and digital currencies," and to "implement smart regulatory approaches to the issues raised by blockchain-based technologies and networks."[18]

And on Sept. 7, 2017, the Blockchain Caucus introduced the Cryptocurrency Tax Fairness Act in Congress, which creates a de minimis exemption for cryptocurrency transactions for goods and services to prevent those who pay for goods and services with Bitcoin from having to pay taxes on any gains.[19] Although the caucus clearly intends to harness the technology, it has given no indication of how or when it intends to do so, compounding the uncertainty surrounding blockchain technology.

The second installment of this article will consider how a blockchain-enabled distributed energy framework will need to address issues including reliability, ratemaking, long-term grid stability, security and more.

Blockchain technology has expanded far beyond cryptocurrencies and into the energy sphere, enabling peer-to-peer payment and potentially catalyzing distributed energy resources. But implementation of blockchain raises many questions, and full-scale industry integration will face numerous obstacles.

The first part of this article considered the opportunities for blockchain in the energy industry, and the regulatory disparities and uncertainties faced by the technology. This installment will consider how a blockchain-enabled distributed energy framework will need to address issues including reliability, ratemaking, long-term grid stability, security and more.

Reliability and Ratemaking

One of regulators' primary responsibilities is to ensure grid reliability, but as blockchain technology stimulates the deployment of distributed energy resources, the traditional means of ensuring reliability may be challenged.

New generators like solar panels may displace some traditional generators altogether, leading to a decrease in the utilities' rate base. But owners of rooftop solar lack the capacity to ensure a consistent electric supply and cannot replace existing generators who fulfill that role.

Regulators must therefore accommodate distributed energy resources made possible by blockchain, while still ensuring that existing utilities recoup their investment and remain available to supply the grid when renewables are unavailable. Any peer-to-peer power sales must overcome this hurdle, as regulators will likely push back against any proposals that do not accommodate utilities.

One option is to write the code behind the smart contracts to include a small fee to the utility for use of the utility's distribution facilities. The blockchain enables utilities to charge micropayments, or payments much smaller than what the traditional financial system can handle, on every single power purchase or sale.

Such a fee could vary by volume and potentially grid congestion. Alternatively, it could be a flat fee for use of the wires, which might introduce fairness concerns about the disparate impact on different customers. Regardless of the choice, the fee would enable utilities to continue to recoup their investment, all the while facilitating a new model for energy generation and payment.

In the long run, however, utilities might not fully recover their costs under a fee system. Some economists have already begun researching this issue, finding that the problem lies in traditional ratemaking.[20] Because rates for specific customers do not always align with the associated service costs, utilities may over- or under-recover their cost of service. Thus, rates do not reflect the underlying costs and, in turn, send the wrong pricing signals to customers.

One way of addressing this rate design "cross-subsidization," according to economists at the Brattle Group, is to design rates to align more closely with costs and abolish "one size fits all" pricing models.[21] In the end, though, any change in the ratemaking process would take significant amounts of time and resources, and effecting this change presents a serious obstacle to a large-scale integration of blockchain.

Long-Term Grid Stability

Another obstacle regulators must address is how to maintain grid stability. With so many individuals adding capacity to the grid, regulators must oversee the grid to ensure that utility-scale generators, in combination with numerous individual generators, do not overload the system.

Indeed, rooftop solar has become so popular in some areas that more energy is pushed back into the grid than the grid can handle, resulting in overvoltage.[22] Regulators must therefore be aware of all suppliers transmitting energy on the grid so they can monitor the grid and align supply with demand.

The challenge is threefold: (1) registering numerous distributed energy resources without subjecting them to hefty regulations; (2) creating a marketplace for these smaller generators to interact with buyers; and (3) predicting demand in a way analogous to the day-ahead electricity markets.

Blockchain technology provides potential solutions. As the New York Public Service Commission and economists have already envisioned, regulators could create a market-driven platform, accessible by both suppliers and consumers, that would work in conjunction with traditional, centralized energy resources.[23] The platform would not only register numerous individuals, but also unite energy sellers

and energy consumers, both of whom could determine the transaction's terms.[24]

By using a market mechanism, the platform could ensure the appropriate deployment of resources, preventing grid overload. Blockchain technology can take this platform theory a step further and assist with predicting demand.

Establishing a platform on a blockchain would record energy generation and usage in a cryptographically secure and auditable way. Companies, regulators and individuals alike could comb through the blockchain data to compile production and demand forecasts. Thus, the blockchain would not only allow more generators and consumers access to the marketplace, but also enable regulators to ensure the grid operates safely and efficiently.

Security

As shown above, blockchain can enhance security in numerous ways, from consumer transactions to cybersecurity. But it will also introduce a few security risks specific to the blockchain.

Despite the blockchain's decentralized nature, a need might arise for a central authority who could intervene to provide basic services like assisting consumers with accessing personal account information if they lose it. This could be accomplished by establishing a platform marketplace on a private blockchain.[25]

Regulators could serve as a central authority to protect against hacking. For instance, in the infamous DAO Heist,[26] a hacker exploited a loophole in a smart contract running on top of Ethereum, and began stealing the digital currency, Ether.[27] The only way to stop the hacker required consensus from the entire Ethereum community. Inserting a regulatory authority into this role would not only deter future hackers, but also make it easier to prevent any attempted hacking down the road.

Additional Considerations

Widespread deployment of blockchain technology would disrupt numerous existing facets of the energy industry, forcing both the industry and the entities that regulate it to adapt.

One change might be net metering. Because the autonomous and real-time components of blockchain better capture the temporal and locational value of solar power, blockchain could replace the need for net metering, which was only a rough approximation of solar power's value at the moment it was used.

Blockchain may also replace the need for renewable energy credits, which people buy to ensure they will take power from renewable generators rather than fossil fuel plants. Unlike renewable energy credits, blockchain makes it feasible to buy directly from the renewable source.

The use of blockchain in electric transactions will also introduce additional regulatory hurdles that do not yet have easy answers. As financial transactions move to a peer-to-peer system without an intermediary, regulators must first determine who will bear the responsibility for ensuring that financial transactions settle properly. Hand-in-hand with this, regulators must either create bright-line rules for liability in the event of payment defaults and technical failures, or they must establish a forum for resolving disputes regarding such issues.

Regulators must further establish clear emergency plans in the event of cyber-attacks or loss of critical

infrastructure. And as described above, regulators may eventually have to fundamentally redesign the ratemaking process to account for the substantial increase in distributed energy resources.

Conclusion

As described above, incorporating blockchain technology into the existing regulatory framework poses considerable challenges. Blockchain developers must proceed in the face of regulatory uncertainty, while regulators must address reliability, stability and security concerns in a rapidly changing environment.

In the end, it is likely that the opportunities will outweigh the obstacles, and blockchain technology will make decentralized, secure systems available in the energy industry.

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[1] See What is Blockchain Technology, CoinDesk, https://www.coindesk.com/information/what-is-blockchain-technology/.

[2] "Smart contracts contain code functions and can interact with other contracts, make decisions, store data, and send [digital currency] to others." See Building a Smart Contract Using the Command Line, Ethereum, https://www.ethereum.org/greeter. Anyone can create their own smart contract using Ethereum's platform. Id.

[3] Elizabeth Woyke, Blockchain Is Helping to Build a New Kind of Energy Grid, MIT Technology Review, https://www.technologyreview.com/s/604227/blockchain-is-helping-to-build-a-new-kind-of-energy-grid/.

[4] Diane Cardwell, Solar Experiment Lets Neighbors Trade Energy Among Themselves, N.Y. Times (Mar. 13, 2017), available at https://www.nytimes.com/2017/03/13/business/energy-environment/brooklyn-solar-grid-energy-trading.html.

[5] Elizabeth Woyke, Blockchain Is Helping to Build a New Kind of Energy Grid, MIT Technology Review (April 19, 2017) https://www.technologyreview.com/s/604227/blockchain-is-helping-to-build-a-new-kind-of-energy-grid/.

[6] Gride+, Whitepaper, https://drive.google.com/file/d/0Bz90riPGRHquNDVXVE81RmppaUk/view.

[7] Power Ledger, Whitepaper, https://powerledger.io/media/Power-Ledger-Whitepaper-v3.pdf.

[8] Id. at 15.

[9] See Letter order accepting Apple Energy LLC's June 6, 2016 filing of an application for market-based rate authority with an accompanying tariff under ER16-1-887 (Aug. 4, 2016).

[10] See, e.g., IBM Blockchain for Supply Chain, IBM, https://www.ibm.com/blockchain/supply-chain/.

[11] U.S. Dep't Of Energy, Small Business Innovation Research (Sbir) And Small Business Technology Transfer (Sttr) Programs 64 (2016), https://science.energy.gov/~/media/sbir/pdf/TechnicalTopics/FY2017_Phase_1_Release_2_Topics_Combined.pdf.

[12] Id.

[13] The NASDAQ rolled out blockchain technology to trade advertising contracts, which could be expanded to energy commodities. Announcing NYIAX, The World's First Advertising Contract Exchange, Nasdaq (Mar. 14, 2017), http://ir.nasdaq.com/releasedetail.cfm?releaseid=1017259.

[14] Reforming the Energy Vision, New York State DPS (Aug. 10, 2017), http://www3.dps.ny.gov/W/PSCWeb.nsf/All/CC4F2EFA3A23551585257DEA007DCFE2?OpenDocument.

[15] Technology & Economic Development Committee, Washington State House of Representatives Office of Program Research, H.B. 1233 (Jan. 2017) http://lawfilesext.leg.wa.gov/biennium/2017-18/Pdf/Bill%20Reports/House/1233%20HBA%20TED%2017.pdf.

[16] Southwest Power Pool, Inc., Oversight Committee Meeting Minutes No. 59 at 66-69 (April 13, 2017), available at https://www.spp.org/documents/49899/oc%20minutes%2020170413.pdf.

[17] Press Release, Jared Polis 2nd Dist. of Colorado (Feb. 9, 2017), http://polis.house.gov/news/documentsingle.aspx?DocumentID=398291 [https://perma.cc/K72D-3NBC].

[18] Id.

[19] Cryptocurrency Tax Fairness Act, https://coincenter.org/pdf/CTFA.pdf.

[20] Bill Zarakas and Frank Graves, How the Utility of the Future Will Evolve: Part 1, Law360, https://www.law360.com/energy/articles/962264/how-the-utility-of-the-future-will-evolve-part-1.

[21] See id.

[22] Anne C. Mulkern, "A Solar Boom So Successful, It's Been Halted," Scientific American (Dec. 20, 2013), https://www.scientificamerican.com/article/a-solar-boom-so-successfull-its-been-halted/. When solar production is too high, the California Independent System Operator actually pays solar generators not to produce energy.

[23] Reforming the Energy Vision, NYS Department of Public Service (April 24, 2014); Bill Zarakas and Frank Graves, How the Utility of the Future Will Evolve: Part 2, Law360, https://www.law360.com/energy/articles/962276/how-the-utility-of-the-future-will-evolve-part-2 (hereinafter "Zarakas & Graves, Part II").

[24] See Zarakas & Graves, Part II.

[25] A private blockchain loses the benefit of the decentralized system, but it retains the cryptographic auditing features that ensure no one tampers with the data.

[26] DAO stands for Decentralized Autonomous Organization. The DAO was a crowdfunding venture capital firm that chose new ideas and businesses in which to invest. Unlike traditional venture capital firms, the organization was decentralized and autonomous, meaning that it run using a network of machines that operated under the same basic principles that drive cryptocurrencies. Thus, each person's financial contribution to the DAO determined the amount of votes he or she had in investment decisions. See Cade Metz, The Biggest Crowdfunding Project Ever — the DAO — is Kind of a Mess, Wired (June 6, 2016), https://www.wired.com/2016/06/biggest-crowdfunding-project-ever-dao-mess/.

[27] Klint Finley, A $50 Million Hack Just Showed that the DAO Was All Too Human, Wired (June 18, 2016), https://www.wired.com/2016/06/50-million-hack-just-showed-dao-human/.