Peer-to-Peer Energy Trading and Blockchain: The Future of Distributed Energy Resources

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Motivated by concerns over climate change, energy security, and grid resiliency, public policy support for renewable energy has increased dramatically in recent years. Wind and solar power are expected to provide over 10 percent of global electricity supply within the next five years, further diminishing the traditional dominance of fossil fuels in our energy mix. David Livingston et al., *Applying Blockchain Technology to Electric Power Systems* 2 (2018). Meanwhile, the widespread dissemination of smart meters and inverters, along with other infrastructure upgrades, is making the grid more intelligent. An increase in smaller scale renewables on the distribution grid has coincided with a desire for greater customer choice that would allow for less dependence on the monopoly utility, a greater say in the type of resources used to generate the electricity powering one's home, and increased visibility into—and control over—one's energy use.

Against this backdrop, observers have theorized that the application of blockchain technology to the distribution grid could be the next step toward truly enabling customer choice. However, the determination of exactly how to apply blockchain technology to the distribution grid is not inherently obvious. Blockchain is most commonly described as a type of database technology in which data is stored on a network of distributed ledgers in a chain of blocks or "blockchain" that is protected with cryptography, i.e., the practice of solving computer codes to authenticate a transaction. Eric Kinter, *The Blockchain Moment*, Colorado Lawyer, Oct. 2018, at 10. This digital ledger can then be used to automate a wide range of transactions, making them more transparent, secure, verifiable, and—ideally—cost-effective. Caitlin Shields & Macklin Henderson, *Blockchain: Future of Renewable Energy Trading?*, Public Utilities Fortnightly, Sept. 2018, at 53. This relatively nascent technology is most commonly associated with its ability to facilitate the transaction of cryptocurrencies such as bitcoin.

Blockchain technology offers the potential to change the way we buy and sell electricity on the distribution grid, paving the way not only for greater customer choice and control, but also for less dependence on the monopoly utility. One of the more promising applications is the use of blockchain technology to enhance the capability of distributed microgrids, enabling individuals to trade energy among themselves—a phenomenon known as "transactive energy" or "peer-to-peer energy trading." Individuals will be able not only to trade energy with their neighbors but also will have greater visibility into their own energy usage. Ultimately, this capability can also reduce or avoid entirely the traditional role of a centralized monopoly utility.

This article examines blockchain technology in the context of the distribution grid, beginning with a terminology overview and a detailed discussion of a recent blockchain-enabled microgrid pilot project located in Brooklyn, New York. It then discusses the current lack of federal regulation over this technology and what Arizona and New York are doing to begin to address this regulatory vacuum. It concludes by offering specific recommendations for state regulators as they begin examining how to regulate these peer-to-peer energy transactions.

Terminology Overview

References to "bitcoin" and "blockchain" might, at first glance, appear synonymous. However, these are two very different concepts. By definition, bitcoin is a type of Internet-based currency, or cryptocurrency. Blockchain is a type of distributed chronological ledger that is hosted, updated, and validated by several network participants or "nodes," rather than by a single centralized authority. Anuj Thakkar, *How Blockchain Technology and Peer-to-Peer Energy Markets Could Make Distributed Energy Resources More Attractive* 2 (2017). By eliminating the central authority and having immutable transaction records that are validated by several network participants, the blockchain increases the simplicity, speed, and transparency of transactions. *Id.* A blockchain ledger network can be public, as is the case with recording cryptocurrencies, or private, where only authorized users have access. A blockchain network, however, need not necessarily include cryptocurrencies like bitcoin among its component parts. Rather, a blockchain can be used as a ledger to store data on a variety of transactions, including currency payments, contract execution, and asset registration. Livingston, *supra*, at 4.

One of the potential applications of blockchain is the automatic execution of "smart" contracts. A smart contract is essentially software code that can facilitate, execute, and enforce the performance of an agreement automatically upon the satisfaction of preset conditions. Kinter, *supra* at 11. If the various "nodes" agree that the requested transaction is valid based on the distributed ledger, it is automatically approved, time-stamped, and recorded to the ledger. *Id.* This, in turn, enhances the transparency and authenticity of transactions recorded on the blockchain.

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Transactive energy—more commonly referred to as "peer-to-peer energy trading"—is the ability for consumers and "prosumers" to trade electricity services in real time. Prosumers are those individuals who both consume and produce energy. Olamide Jogunola et al., *State-Of-The-Art and Prospects for Peer-to-Peer Transaction-Based Energy System*, Energies, Dec. 11, 2017, at 1–4. The most common application of peer-to-peer energy trading is within the context of microgrids, i.e., localized grids that can disconnect from the traditional grid to operate autonomously, offering both enhanced grid resiliency and reduced dependence on the traditional monopoly utility. *See* Microgrids at Berkeley Lab, Microgrid Definitions, https://building-microgrid.lbl.gov/microgrid-definitions.

In a peer-to-peer microgrid running on blockchain technology, the use of smart contracts enables immediate and automated energy transactions based on available supply and demand in the system. Thakkar, *supra* at 2. All customers within the microgrid could enter directly into energy exchanges with other customers without restrictions or oversight from a centralized authority, which would typically be the monopoly utility. *Id.*

To visualize how peer-to-peer energy transactions might work in practice, imagine being able to sell the excess electricity produced by your rooftop solar system to your neighbor, who needs it to power his electric vehicle. Your neighbor, who also happens to have battery storage in his basement, might then sell you his excess stored energy when your rooftop solar system is not producing.

Blockchain Application for Distributed Energy Resources

While the goal of applying blockchain technology to distributed energy resources is to enable peer-to-peer energy trading of those resources, this reality is still a long way off. That is mainly because existing utility regulatory models strictly limit who can buy and sell electricity. For example, in the United States today, a prosumer cannot legally sell the power produced from his rooftop solar system to his neighbor for the sole reason that he does not qualify as a utility. Rather, prosumers generally are limited to participation in a utility's net metering program and receive compensation for their excess power in the form of a reduction on their monthly utility bill. Until changes can be made in the regulatory framework, pilot projects offer a near-term solution. By relaxing traditional regulatory requirements, some existing pilot projects are providing safe havens for blockchain technology to be tested in real-world applications.

The Brooklyn Microgrid Pilot Project (Brooklyn Microgrid) is perhaps the most well-known such project. A partnership between Siemens and LO3 Energy (LO3) initiated in late 2015, the Brooklyn Microgrid provides a framework for rooftop solar energy prosumers and traditional utility customers to buy and sell local, emissions-free electricity directly from one to another. Andrew Burger, *Siemens Ups Its Blockchain Ante with New Investment in LO3 Energy* (Jan. 16, 2018), https://microgridknowledge.com/blockchain-siemens-lo3-energy/.

LO3's platform features peer-to-peer electricity trading on community microgrids in which blockchain technology is used to verify and record the transactions. The Brooklyn Microgrid presently is designed to work with the conventional "macro" or "central" grid in New York, including New York utilities and the New York Independent System Operator (NYISO). The project itself began on a very small scale, with only five energy prosumer participants. Emma Foehringer Merchant, *Can LO3 Energy Cut Through the Hype on Blockchain?* (Nov. 1, 2017), www.greentechmedia.com/articles/read/can-lo3-cut-through-the-hype-on-blockchain#gs.5NZwMiGM. It now has 60 prosumers and another 500 energy buyers participating. *Id.*

Because using a blockchain to verify energy transactions is still a new concept, and the data used to run a blockchain and balance a grid requires near-instantaneous monitoring and reaction, LO3 had little choice but to design and construct its own metering infrastructure for its Brooklyn Microgrid customers. *Id.* The meters, which communicate with each other, will eventually move electricity between the pilot's participants. *Id.* LO3 also constructed a blockchain "application" (similar to an app that you would purchase for your smartphone) that creates smart contracts and enables customers to control their electricity usage. *Id.*

While groundbreaking in its design, the Brooklyn Microgrid of today is a far cry from LO3's ultimate vision. As previously noted, most of the project's participants continue to use the central or "macro" grid, and, when two participants "trade" electricity and one "pays" the other, the physical flow of electricity remains unchanged. Livingston, *supra* at 14. For example, one participant feeds excess solar power back into the distribution grid, and the other participant consumes electricity from the grid. And, while the pilot project offers relaxed regulatory requirements in the interest of establishing the viability of this blockchain application, the project is not entirely exempt from regulatory hurdles. The pilot project's participants currently are not permitted to transact energy because the local utility has a monopoly over electricity sales. Rather, they are limited to trading renewable energy certificates (RECs), i.e., numbered certificates that represent the "green" attributes of a resource, separate from the actual electricity produced by that resource.

To aid LO3 in reaching its ultimate vision, it plans to partner with the local monopoly utility, Consolidated Edison (ConEd). Ideally, participants will receive just one bill—from ConEd (the owner of the "wires")—while the Brooklyn Microgrid will serve as the electricity supplier. Robert Walton, *Grid complexity is increasing exponentially. Is blockchain the answer?* (Feb. 4, 2018), www.utilitydive.com/news/grid-complexity-is-increasing-exponentially-is-blockchain-the-answer/514951/. LO3 also hopes to convince state regulators to allow it to legally broker sales of electricity among the pilot project's participants so that it can move from merely facilitating the trading of RECs to actual electricity trading among the pilot project's participants. Livingston, *supra* at 15.

The Current Regulatory Vacuum

At present, the only regulation remotely touching on blockchain technology is narrowly focused on cryptocurrencies, the popularity of which has increased significantly in recent years. The U.S. Department of the Treasury, the Securities Exchange Commission, and the Commodity Futures Trading Commission all have published guidance on the appropriate treatment of crytpocurrencies. *See* U.S. Dep't of the Treasury, OFAC FAQs: Questions on Virtual Currency, www.treasury.gov/resource-center/faqs/Sanctions/Pages/faq_compliance.aspx#vc_faqs; Press Release, Securities and Exchange Commission, SEC Announces Enforcement Initiatives to Combat Cyber-Based Threats and Protect Retail Investors (Sept. 25, 2017); Press Release, Securities and Exchange Commission, Statement on Potentially Unlawful Online Platforms for Trading Digital Assets (Mar. 7, 2018); U.S. Commodity Futures Trading Comm'n, CFTC Backgrounder on Oversight of and Approach to Virtual Currency Futures Markets (Jan. 4, 2018). Additionally, the IRS recently released guidance designating cryptocurrency as property rather than currency for U.S. federal income tax purposes. I.R.S. Notice 2014-21, 2014-16 I.R.B. 938.

Noticeably lacking is any regulation whatsoever over blockchain technology itself—particularly the use of blockchain technology for facilitating peer-to-peer electricity trading. Given that states have jurisdiction over retail sales of electricity, state regulatory commissions offer an obvious venue in which to examine not only the potential viability of blockchain technology, but also to consider regulatory changes necessary to enable this technology in distributed grid applications. Two states—Arizona and New York—provide instructive examples on how to do so.

The Arizona Corporation Commission's transactive energy investigatory docket. In July 2018, the Arizona Corporation Commission opened the nation's first state regulatory docket specifically focused on transactive energy. *See* Memorandum from Commissioner Andy Tobin's Office to Docket Control (July 16, 2018); Ariz. Corp. Comm'n, Docket No. AU-00000A-18-0261, *In the Matter of the Arizona Corporation Commission's Inquiry into the Role of Blockchain Technology in Arizona, Procedural Order Regarding Consent to Email Service* (July 20, 2018). The docket was opened at the request of Commissioner Andy Tobin, who also expects the docket to address: "the internet of things," cybersecurity, utility accounting, tracking renewable energy credits, and applications for distributed ledger technologies on the grid. Gavin Bade, *Arizona Regulators Open First US Transactive Energy Docket* (July 17, 2018), www.utilitydive.com/news/arizona-regulators-open-first-us-transactive-energy-docket/527900/. Despite its ambitious goals, no formal activity has occurred in the docket, with most of the work taking place behind the scenes among regulatory staff who have begun researching the docket's diverse and complex issues.

The New York Public Service Commission's "Reforming the Energy Vision" proceeding. New York has moved beyond the investigatory docket phase and is actively pursuing new utility business models and a bevy of pilot projects—including the Brooklyn Microgrid—as part of an ambitious effort to increase customer choice, make electricity more affordable, and enhance the resiliency of the state's electric grid. In its April 2014 order instituting the Reforming the Energy Vision (REV) proceeding, the New York Public Service Commission (NY PSC) sought the comprehensive reform of not only its regulatory structure, but also the regulatory treatment of the state's utilities. New York Pub. Serv. Comm'n, Case 14-M-0101, *Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision, Order Instituting Proceeding* (Apr. 25, 2014) (REV Order); *see generally* James M. Van Nostrand, *Getting to Utility 2.0: Rebooting the Retail Electric Utility in the U.S.*, 6 San Diego J. Climate & Energy L. 149, 159–61 (2015). Ultimately, the REV proceeding targets the transformation of the state's utilities into Distribution System Platform Providers (DSPPs) to facilitate greater integration of distributed energy resources (DERs) and to provide customers with greater customer choice through enhanced energy management options. Van Nostrand, *supra* at 160. Thus, REV envisions the role of utilities transforming from sellers of electricity to system operators and distributed platform providers.

The REV Order established two parallel tracks for the proceeding—one to examine the utility business model, and another to examine the regulatory framework and ratemaking issues. REV Order, Att. 1, at 6. The first track focuses on DERs, integrated system planning, distribution-level markets, and the DSPP concept more generally. *Id.* The second track focuses on reforming utility ratemaking practices to reflect the new DSPP model, including the development of new utility financial incentives, designed to aid utilities in transitioning away from traditional cost-of-service regulation. *Id.*

An example of how these new financial incentives might work in practice is provided by ConEd. In 2014, the NY PSC rejected the utility's proposal to construct a new $1 billion substation to address demand increases in Brooklyn, and instead required the utility to propose a more cost-effective alternative. New York Pub. Serv. Comm'n, Case 13-E-0030, et al., *Con Edison—Electric Rates, Order Approving Electric, Gas and Steam Rate Plans in Accord with Joint Proposal* (Feb. 21, 2014); *see generally* Gavin Bade, *Little less talk: With new revenue models, New York starts to put REV into action* (June 9, 2016), www.utilitydive.com/news/little-less-talk-with-new-revenue-models-new-york-starts-to-put-rev-into/420657/. ConEd returned to the Commission with a request for 52 megawatts of DERs and demand-side management solutions to meet the same need for significantly less cost. New York Pub. Serv. Comm'n, Case 13-E-0302, *Petition of Consolidated Edison Company of New York, Inc. for Approval of Brooklyn Queens Demand Management Program* (July 15, 2014). Under the old regulatory model, the NY PSC would have been unable to permit ConEd to earn a rate of return on these types of investments, but it was able to do so under the new REV Order. New York Pub. Serv. Comm'n, Case 13-E-0302, *Petition of Consolidated Edison Company of New York, Inc. for Approval of Brooklyn Queens Demand Management Program, Order Establishing Brooklyn/Queens Demand Management Program* (Dec. 12, 2014).

Recommendations for State Regulators

Because the electric power sector is already highly regulated and the application of blockchain envisioned by this article is on the distribution grid, state utility regulators ultimately will play a crucial role in determining how much of blockchain's potential can be realized. Given the relative infancy of blockchain technology, recommendations for state regulators can be divided into both short- and long-term objectives.

In the short term, regulators should invest first in understanding the technology. Livingston, *supra*, at 17. Next, to the degree possible, they should actively support the development of technical standards. *Id.* Then, regulators should make it possible for blockchain ventures to establish pilot projects, such as the Brooklyn Microgrid, by relaxing electric power sector regulations to permit experimentation and demonstration. *Id.* at 18. In the longer term, regulators also should consider changes to the utility business model necessary to support blockchain and related distributed grid technologies.

Invest in understanding the technology. Electricity regulators in Great Britain already have proactively organized gatherings of representatives from academia and industry to understand the basics of blockchain and its potential applications in the energy sector. *Id.* at 17. The National Association of Regulatory Utility Commissioners (NARUC)—the association representing state public service commissioners—can and should play a similar role for regulators in the United States. At future meetings addressing blockchain technology, possible topics for discussion include consumer adoption and trust, data security and privacy, dispute resolution, interaction with existing wholesale markets, and future regulatory changes. At a local level, state commissions can follow the example set by the Arizona Corporation Commission and open investigatory dockets to understand blockchain technology and its potential applications within their individual states.

Actively support the development of technical standards. When properly developed, technical standards can result in increased productivity and efficiency in both government and industry, greater innovation and competition, increased benefits and choices for consumers, and improved health and safety. *Joint Hearing: Beyond Bitcoin: Emerging Applications for Blockchain Technology Before the H. Comm. on Science, Space, and Tech. Subcomm. on Oversight and Subcomm. on Research and Tech.*, 115th Cong. 6 (2018) (statement of Charles H. Romine, Director, Information Technology Laboratory, National Institute of Standards and Technology). To the degree practicable, regulators should support the development of standards for blockchain technology that enable open-source platforms that foster competition, but that ultimately pave the way for interoperability. Livingston, *supra* at 18.

Standards for blockchain technology currently are being considered in several forums. At the federal level, the National Institute of Standards and Technology (NIST) is actively participating in consensus-based, documentary standard development efforts for blockchain technology. *Id.* at 17. The Energy Web Foundation—a global nonprofit founded by the Rocky Mountain Institute and Grid Singularity—is focused on accelerating blockchain technology development across the energy sector. Walton, *supra*. This foundation also is working to develop a market standard that "ensures interoperability, reduces costs and complexity, aligns currently dispersed blockchain initiatives, and facilitates technology deployment through easy-to-implement applications." Energy Web Foundation, What We Do, www.energyweb.org. State regulators can support the development of a standard through future collaboration between NARUC and organizations such as NIST and the Energy Web Foundation.

Support the development of pilot projects. Other countries are experimenting with blockchain technology in the electric power sector by relaxing electricity regulations to foster innovation through pilot projects. This approach is sometimes referred to as "creating a regulatory sandbox," in which new ventures can test their ideas without facing regulatory risk. Livingston, *supra* at 18.

Some U.S. states are beginning to follow suit, but more should do so. While the Arizona investigatory docket envisions pilot projects down the line, it is not yet there. New York is perhaps the best example. The state's REV proceeding has encouraged several firms to pursue small-scale demonstration projects applying a range of technologies—not just blockchain—under less restrictive regulations. The Brooklyn Microgrid is one of many demonstration projects enabled by the REV Order.

Consider changes to the utility business model. Making significant changes to the utility business model will prove challenging, as this model has existed in much the same form for more than a century. One reason for the progress made in New York under the REV proceeding is that all involved groups were essentially in agreement that the old system was not working. Richard Kauffman & John O'Leary, *How State-Level Regulatory Reform Can Enable the Digital Grid of the Future* 111 (2018). In short, despite energy supply costs being historically low, customer bills were still higher (and continuing to grow) because of increasing transmission and distribution costs, environmentalists and renewable energy developers wanted more renewable energy more quickly, and fossil fuel plant operators were dissatisfied with short-term capacity payments supporting much of the generation fleet. *Id.* Even with this relatively widespread agreement on necessary changes to the traditional utility business model, the REV Order envisions a gradual transition away from the traditional cost-of-service model rather than an immediate overhaul.

The political climate in New York that paved the way for REV's success is undeniably unique. The likelihood that other states will launch their own copycat REV proceedings is not great—at least in the near-term. The changes to the utility regulatory model envisioned by the REV Order are instructive, however, and, within the context of investigatory dockets, state commissions should consider examining these changes, as well as other potential utility business models.

Distributed energy resources offer many opportunities, including more affordable energy access, grid resiliency, and autonomy. The application of blockchain technology to the distributed grid enables us to envision a future in which seamless electricity trading among peers is possible and more cost-effective than purchasing power directly from a monopoly utility. Through these blockchain-enabled trading platforms, customers also will have more say in who provides their electricity (neighbors versus a centralized monopoly utility), what resources are used to generate their electricity (whether renewables or fossil fuels), and how much they are willing to pay for that electricity.

Despite these potential benefits, blockchain technology's ultimate success in the electricity industry remains highly dependent on changes to a regulatory model that have been in use for more than a century. State regulators have important roles to play in helping utilities understand this technology and its potential impacts on their ratepayers, as well as in testing its true value in the context of pilot projects. Investigatory dockets like the one initiated by the Arizona Corporation Commission offer a good starting point for such endeavors. Longer term, assuming blockchain's value proposition eventually proves out, state regulators should follow the example set by the New York Public Service Commission's REV proceeding and consider changes to the utility business model necessary to support blockchain and other distributed grid technologies.