

EXERGY™

BUSINESS WHITEPAPER

April 13, 2018

INTRODUCTION TO EXERGY™

- From Brooklyn to Bangladesh, the new energy consumer wants comfort, security, a more engaging relationship, and a promising future for energy production. A democratized energy marketplace is the only way to achieve this promise, and the Exergy project team, part of LO3 Energy, has developed a key piece of this paradigm shift. With Exergy, we are reimagining the customer's role in, and access to, increasingly open and competitive electricity markets.

In the Electric Power Technical Whitepaper, we define transactive energy and why it is linked to the physical concept of “exergy,” or the portion of energy available for useful work in our economies. That paper defines and describes the value domains and technical attributes required for transactive energy in the multi-party electric power system emerging today. It introduces the idea that we should not consider kWh as the sole attribute of energy service, when equally crucial is where, how and when that kWh was generated for use. As grid edge energy solutions are adopted, the paper describes how a transactive energy marketplace optimizes for lowest cost, lowest carbon, and more resilient networks supported by consumers, new energy service providers and system operators alike.

In this paper (the Exergy Business Whitepaper), we link the technical value domains to the services that consumers and third parties can provide to one another and to the electric power system. We propose what Exergy will accomplish and how it can be utilized by energy system participants including third party developers.

Further publications are planned by the Exergy project team to go deeper into country- and local-level regulatory and policy drivers and barriers to delivering transactive energy and Exergy. Likewise, the deeper academic work that builds on the current work of economists to measure and account for exergy rather than energy will happen in parallel to the technical development of the Exergy token system.

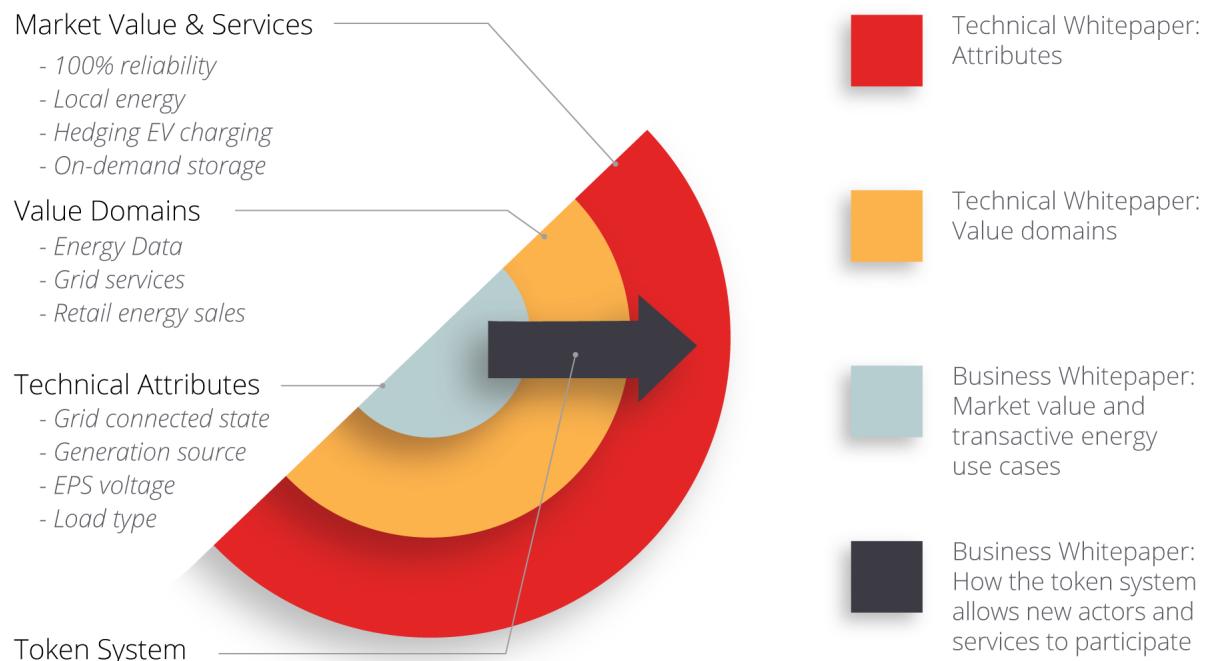


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The Problem

Our economies run on energy, but the current energy system is costly and inefficient.

Creating useful energy is one of the dirtiest and most wasteful things we do, from mining, refining and burning fuel, to transporting electricity across long transmission and distribution lines. In the US, some estimates show an 86 percent inefficiency in converting and transporting energy into the useful product (described by physicists as “exergy”) that powers modern lifestyles and economic productivity.¹ This creates unintended and costly health and environmental challenges, from asthma to climate change, and a significant loss of economic value.

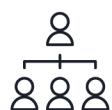
This problem has emerged because in the current power sector business models, utilities use outdated constructs of its consumers as rate payers; missing the opportunity and value only a customer can provide.

Companies earn revenue based on producing energy at the center of the utility grid, in large power plants, and pushing it to the grid edge where it “serves the load” as it is consumed. Companies generating and distributing power are accustomed to roughly 10 percent returns on their capital investment.² This model locks in profitability for regulated electricity companies, but discourages innovation and saddles consumers with decades of legacy costs.

Today, traditional utility businesses can no longer simply rely on demand for the kWh commodity. Policy, regulation, technology and customer expectations are all contributing to a shifting paradigm. Our global commitments to halting climate change, as well as a slew of energy efficiency policies and subsidies for renewable power are bringing in a new wave of technological innovation such as smart energy services, battery storage, and rooftop solar PV, making it possible for us to not only save energy, but to produce our own power in factories and homes alike. In newly-electrifying countries, a centralized grid is too costly and sluggish for the needs of the one billion people without energy access today. As demand grows, it also becomes more distributed.

It is harder and more costly to predict and balance demand and supply while lacking visibility into millions of new consumer devices and distributed energy resources popping up at the grid edge.³ These trends are tearing apart existing utility business models and spooking shareholders and analysts alike.⁴

PROBLEMS IN THE MARKET TODAY



Centralized model



Locks in models of energy waste



Lack of consumer choice



Electricity networks in need of expensive upgrades



Financial models are locked in

¹ Laitner, Skip. Linking energy efficiency to economic productivity: recommendations for improving the robustness of the U.S. economy, *WIREs Energy Environ* 2015, 4:235–252. doi:10.1002/wene.135

² See for instance California Public Utilities Commission: [http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/PPD_Work/PPD_Work_Products_\(2014_forward\)/PPD-An-Introduction-to-Utility-Cost-of-Capital.pdf](http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/PPD_Work/PPD_Work_Products_(2014_forward)/PPD-An-Introduction-to-Utility-Cost-of-Capital.pdf)

³ Though examples abound in countries facing higher penetration of renewables, see for instance how PJM market operators push back with even further subsidies that drive up costs for consumers. <https://www.utilitydive.com/news/pjm-price-formation-proposal-would-dramatically-change-how-prices-are-set-i/511053/>

⁴These trends are outlined in greater detail in our Electric Power Whitepaper.

The Opportunity

In the model of the future, ratepayers become the customers.

Utilities will have to serve many, many more customers, from consumers and prosumers to third parties who want to access and sell services to these new customers. Demand for the kWh commodity may be falling,⁵ but demand for new energy services is on the rise.

If technology were the only driver, its adoption could be stopped. But this opportunity is not only about technology, it's about the way the technology is adopted—by consumers, not by regulated companies. Consumers will continue to buy and use smart phones, smart appliances, and distributed renewable energy, because they think it improves their lives.⁶

Our vision is that people, citizens, communities and energy consumers everywhere can show their demand for exergy—not wasted energy—in our global system by resetting the rules of the marketplace.

Today's Market Assumptions	The New Reality
Consumers have no frame of reference for a kWh—it is a metric with no intrinsic value, only relative value.	New expectations for local or green products, convenience or resiliency.
Our entire focus is on managing from the center, and the supply side.	Grid problems almost always come from the edge, not the center, making them very hard and expensive to resolve.
Infrastructure capital costs are repaid by consumers through broad, not specific, pricing mechanisms.	Traditional energy generation struggles to compete and recover costs due to ever-cheaper renewables.
Building more generation and grid infrastructure is the only way to manage distributed energy resources.	Better smart utilization of the grid reduces costs for customers and increases security.
Time and location of production and consumption are not fully valued.	Time and location—along with other attributes—matter a lot and will have significant value.
Few centralized nodes and limited data.	Big data and millions of new devices exist at the grid edge.

Table 1 Why the market is changing



By virtue of a technological tsunami we are returning to a more decentralized system, and at the same time turning more and more of the industry over to competitive forces, trading economies of scale and predictability for economies of scope and consumer choice.⁷

— Anne Pramaggiore, President and CEO of Commonwealth Edison

⁵ <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/the-math-series-solving-for-disruption-in-US-electric-power-industry.html>

⁶ https://www.accenture.com/_acnmedia/Accenture/next-gen/insight-unlocking-value-of-digital-consumer/PDF/Accenture-New-Energy-Consumer-Final.pdf

⁷ <https://microgridknowledge.com/microgrid-2017-com-ed/>

The Time is Now

Today, 69 percent of consumers are interested in having more options to buy local or differentiated energy products.⁸

The new reality for the energy industry is one in which consumers, commercial and industrial operators all think differently about participating in electric power services, just as they now take other new services for granted, from Amazon's on-demand shopping to Uber's rideshare service. It is a new reality in which electric vehicles displace gasoline demand, combined heat and power (CHP), solar PV, and wind displace coal and nuclear generation, and heat pumps, thermal storage, and batteries begin to reduce the consumption demand for natural gas.

The displaced fossil fuel in this new energy reality will be the data that allows this new value to be unlocked. The data is not simply kWh, but accounts for the state of the grid, the time and location of production, and consumption requirements of a multi-party electricity system (see our Electric Power Technical White Paper). Having this data removes friction in buying and selling real value-added energy services. Our energy industry is digitizing, but it's one of the last industries to do so. Data is difficult to gain access to, because those who have it know it's valuable, even if they're not sure how to capitalize on it. This is a global opportunity as relevant in advanced economies as it is in fast-emerging markets like India, Southeast Asia and Africa.

Societies cannot go back; the new distributed energy technologies, including renewables, offer transformative opportunities for cheaper energy access, resiliency and autonomy. The way out of the broken utility business model is to value these new assets and services by the flexibility they offer existing grid operators in an increasingly complex energy landscape.

The only way forward is to reimagine how we value, transact and consume energy. This is 'transactive energy,' liberating the data that will transform energy markets, and rewarding consumers with better energy services that come from utilizing the existing grid and adding new infrastructure where it's needed most.

In order for this model to function, a transactive energy platform is urgently needed.



Global investment in digital electricity infrastructure and software has grown by over 20% annually since 2014 (USD 47 billion) in 2016, 40% higher than investment in gas-fired power generation worldwide (USD 34 billion) and almost equal to total investment in India's electricity sector (USD 55 billion).

— *Digitalization and Energy, International Energy Agency, 2017*

⁸ https://www.accenture.com/_acnmedia/Accenture/next-gen/insight-unlocking-value-of-digital-consumer/PDF/Accenture-New-Energy-Consumer-Final.pdf

The Solution

We propose that the answer to these mounting concerns is Exergy™, a distributed ledger system that functions across grid-connected hardware, a token system for transactive energy, and a foundation that advances market design and technology in tandem. Exergy generates, controls and secures the data required to enable price as a proxy for control and optimal operation of electric power systems.

Fuel in our current commodity system is worth less and less as the marginal cost of electricity falls toward zero. Fuel in the emerging system of today and tomorrow is data. The data and attributes that need to be collected to release this value are discussed in depth in our Electric Power Technical Whitepaper.

Exergy can manage the flow of electricity and the exchange of energy within electric power systems through the formation and delivery of pricing signals, use of predictive analytics and automation of activities, which reflect true cost of local service. This can all happen behind the scenes, at the machine-to-machine level.

The system unlocks value to be assembled in new ways and priced appropriately. The Electric Power Technical White Paper provides an in depth discussion of the ‘stackable’ value domains associated with energy and grid services based on time, location and current state of the grid. As discussed above, many of these domains are not yet fully valued in the market—Exergy allows the true value of these domains to be fully compensated.

Transactive energy, properly implemented, represents the fairest allocation of risk and reward enabling new business models that provide services to participants. By rewarding efficiency and flexibility, the system has the potential to activate value for customers and create new ways to manage and invest in the responsive grid of the future, which is beneficial in developed economies, and it can be transformative in newly electrifying ones.

Exergy can provide a wide range of benefits throughout the electricity market and ecosystem. In addition to clear value for market participants (described in detail further below), other stakeholders stand to benefit as well. Key outcomes include:

1. Efficient and adaptive market pricing
2. Improved system reliability and flexibility
3. Pathway for technological innovation
4. Data needed to develop additional direct and derivative markets
5. Improved balance of risk and reward for asset owners
6. A rich, interactive future for an energy industry serving informed communities

An Exergy-based transactive energy system could allow market participants around the world to buy and sell electricity and offer grid services based on what the new decentralized system needs to operate at maximum efficiency, reliability and flexibility. It is a distributed solution for an

Market Size

Global electricity markets are enormous. In 2016 alone, \$718 billion was invested in the electricity sector worldwide,⁹ and investor-owned utilities in the US collectively generated \$350 billion in revenue.¹⁰ According to the International Energy Agency, the world will need to invest \$44 trillion in global energy supply and another \$23 trillion in energy efficiency to meet current climate policy goals and forecasted growth in energy demand through 2040. We have calculated that a mere 1 percent savings in energy investment will be worth \$670 billion by 2040.

As industry trends accelerate, we believe that the value of decentralized assets and services can be more fully captured in a transactive energy system.

The market is much larger than simply extrapolating energy generation and consumption metrics, it includes the wealth of value associated with new data availability and flexible grid services. And value accrues to a wide range of market participants: consumers, utilities, generators, and other technology vendors.

In the short term, conservatively estimating market value based on near-term use cases with today's compensation mechanisms, there exists a \$90 billion total addressable market for Exergy. By 2025, reasonable forecasts show this growing to \$200 billion, with an estimated annual value of \$25 billion passing through the Exergy system.



Around 90% of the data in the world today were created over the past two years.

— IBM, 2017

Digital technologies like big data, analytics and machine learning, blockchain, distributed energy resource management, and cloud computing, can help overcome some of the key challenges in the energy sector—most notably intermittency, aging grids, balancing distribution-connected generation, managing consumer self-generation, and coping with increasing system complexity.

— *Digitalization and Energy, International Energy Agency, 2017*¹¹

⁹ World Energy Investment 2017, International Energy Agency. Published July 11, 2017.

¹⁰ EEI, Annual Financial Review, 2016. Accessed at: http://www.eei.org/resourcesandmedia/industrydataanalysis/industryfinancialanalysis/firereview/Documents/FinancialReview_2016_02_IndustryFinPerf.pdf

¹¹ <https://about.bnef.com/blog/market-digitalization-energy-sector-grow-64bn-2025/>

Product

Exergy creates the ability to buy and sell value by ensuring data—the market's new fuel—is made available for transactions at all levels of electricity markets. The Exergy blockchain is the private distributed ledger securing and managing the data needed to create marketplace transactions, and settling those transactions cost-effectively. The XRG token provides the incentive for energy prosumers, consumers, and commercial market players to participate in an energy marketplace where consumers are front and center.

Exergy is based on a market model called transactive energy, which refers to economic and control techniques that enable broad participation in the new multi-party energy system, and designed to provide all market participants more opportunities to connect customers to energy system value.

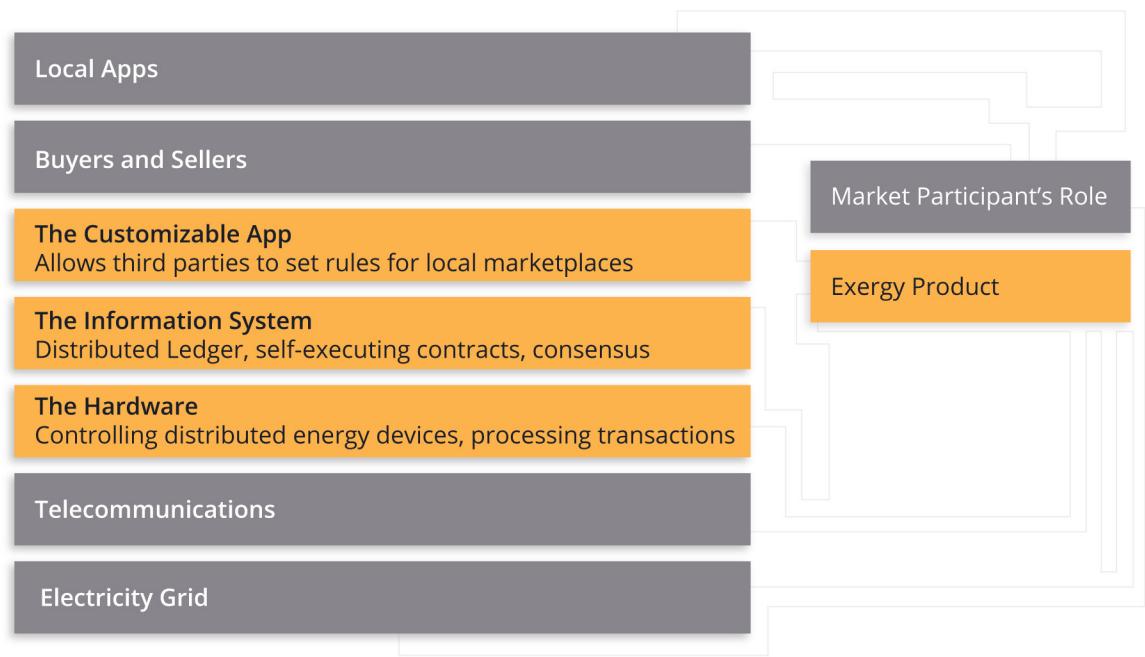


Figure 1. Transactive Energy Stack

Customizable App

Exergy offers participants the ability to engage in the transactive energy marketplace on their own behalf, or to bring new functionality to their customers. Third parties will be able to use the system to set the rules of a microgrid or other application, utilizing the token to incentivize the recruitment of new customers. We have described the token interactions within the use cases below.

As discussed, network participants need only the use of a smartphone app and staked XRG account to be engaged in the Exergy marketplace; they do not require an Exergy-compliant device. Accordingly, many network nodes will look quite simple—requiring only light computation yet transacting securely and efficiently. Over time, by adding compliant devices, the consumer can easily upgrade their participation role to that of a prosumer who can then provide energy and balancing services at the edge of the grid.

Until others begin developing on Exergy, LO3 Energy has developed a ‘white label’ mobile app soon to be available globally to third parties who can use it to set up microgrids and access the services of the Exergy platform, including establishing market participants and marketplace rules.

Information System—Distributed Ledger

Exergy’s distributed ledger accounts for the data within the energy system that makes it possible for marketplace behaviors to be securely transacted, such as buying or selling, and setting and reacting to prices. The XRG token is staked to access the marketplace, where available data and transaction behavior can be verified into blocks and, where necessary, linked to actual control of assets and settlement of energy transactions.

Exergy runs on a private, permissioned blockchain through a network of distributed computing nodes globally. Some of these Exergy-enabled devices—developed by LO3 Energy as well as other 3rd party providers—control, manage and validate actual electricity flows on the power grid. Others simply verify and monitor marketplace rules and activity. More detail about the mechanisms for achieving network consensus will be released in 2018.

Scalability is enabled by the underlying system architecture, which relies on “clustering” of nodes. These nodes are efficiently arranged—and rearranged, as 3rd parties like consumers, prosumers, and developers become part of the system and drive network growth—to match real-world utility service territories, fundamentals of real-world grid infrastructure, and the evolving needs of our partners and market participants. Such clustering allows multiple marketplaces to be established and grow in parallel while the overall system collectively benefits from the analytics and shared data on consumer behavior, device performance and system needs.

Hardware

It is critical for energy system control that the distributed ledger operates in conjunction with real-world hardware, rather than purely as a financial layer. LO3 Energy has developed, manufactured and deployed an Exergy-enabled IoT hardware device that functions as a distributed computing node and an asset control switch. This device provides the control layer to translate economic signals from Exergy's TE layer into physical device control algorithms to enable functionalities in local generation, storage, and smart device operation desired by the market. The Exergy distributed ledger system has been operational since early 2016 on this hardware network in Brooklyn and in cloud-based testing environments.

Rather than tie the Exergy system exclusively to LO3 Energy's devices, other 3rd party Exergy-compliant hardware can be brought into the network through a light client-and-partnership approach (described further below). Incentivizing and enabling interoperability of a wide range of devices will allow other technology vendors to accrue value from Exergy while accelerating network growth through their own contributions. In being device-agnostic, device control algorithms have been developed to be compatible with the vast majority of commercial communications protocols.

Exergy Foundation

As a not-for-profit, 501(c)3, the Exergy Foundation exists as a governance body for the network of Exergy users, and an agency interested in advancing policy and technology of the Transactive Energy system. The Foundation is chartered to advance market participation inline with token distribution, monitoring adoption and ensuring that the benefits of the Exergy system are being realized fully in the real world. The Foundation is set to invest in installation and integration of distributed energy resources including IoT hardware, electricity storage, generation assets, and smart appliances. In most markets, while there may be pilot financing for new solutions and customer trials, there are very real market barriers to turning these into ongoing commercial operations. In other markets, off-grid for instance, the ability for participants to access credit, and therefore basic debt financing, may stand in the way of initial deployments. By directing funding toward third party developers that can build on the Exergy marketplace where participants hold the XRG token, the Foundation has the capacity to provide an early market structure within which to grow and integrate—along with the combined efforts of 3rd party developers and network partners—toward utility scale impact.

In a decade, we anticipate that Exergy will be a new normal; a standard protocol stack advanced by a commercial network of market participants that benefit from predictability in a functioning marketplace that allows them to invest in the capital costs required to deliver value added services. LO3 Energy is poised to be one of many commercial actors developing services on the platform. Regulators will be able to incentivize/disincentivise market actions directly across the platform. Support for projects can be distributed in ways similar to how they flow today but with much more transparency and assurance that they reach the right market participants for the right reason and result.

Competition

Paradoxically, it takes deep sectoral knowledge to truly disrupt an industry. Exergy was developed by LO3 Energy, a business with novel IP and energy expertise, bringing together a team with experience in electricity market design, utility sales, regulatory knowledge, policy advocacy, and trading and financial markets. No other crypto project has a deployed distributed ledger architecture that scales to the full range of energy market applications.

Exergy's key advantages include:

Hardware: Exergy is the only system to have developed, manufactured and deployed a grid-edge hardware element that not only functions as a meter and distributed computing node, but also an asset control switch. While other entities have designed (and, in some cases, prototyped) components of a solution, all have yet to undertake the multi-year product development and design-for-manufacturing effort inherent to producing these components at scale. The complexity of such product design and development processes—optimizing for cost and interoperability with a wide range of existing products and communication protocols—requires expertise and talent beyond the scope of many early crypto project teams. The scalability of competing networks will therefore be limited by their ability to deploy comparable grid-edge computing capabilities.

Customer Acquisition: No other project can show the organic acquisition of customers in the absence of a utility pilot or a utility channel partner. To date, LO3 Energy's Brooklyn Microgrid represents the only proven example of network effects in a commercial environment. Acquiring and retaining retail consumers in competitive deregulated markets has been well-documented to be challenging and costly: \$75-150 average customer acquisition cost (CAC) across major markets.¹²

Exergy Is	Exergy Is Not
An operating commercial microgrid transactive energy marketplace	Strictly a settlement platform (settlement is just one of the functions it can provide)
Global in scope and highly scalable in design	Limited geographically or to specific market designs
Creating new value-added services (such as local energy) and valuing grid services	Focused only on electricity sales of today
A ledger system operating commercially since 2016 on LO3 Energy hardware	A prototype
Designed to operate with underlying grid infrastructure	Focused narrowly on financial transaction settlement

Table 2 What is Exergy

A number of solutions for managing distributed energy resources exist without operating on blockchain. At least in the near term, a number of technical approaches will coexist, and in some cases may be complementary. We envision the advent of transactive energy operating on distributed ledger technology unleashing the power of consumers to achieve some of the same optimization benefits, but with greater potential to scale at lowest cost in the future. Distributed ledgers improve our system by allowing us to give untrusted third parties control over smart contract marketplaces and data value-added processes, and allowing them to settle transactions within our network. This could be done today without blockchain, but that would not enable the next-level ecosystem that we've described.

¹² <https://woodlawnassociates.com/electrical-potential-solar-and-competitive-electricity/>

Traction

Use cases are outlined in detail in our Electric Power Technical Whitepaper, but here we detail how the XRG token interacts with them. We will be releasing further use cases over the coming months as we validate them with market participants.

Use Case 1: Peer-to-Peer Energy

LO3 Energy has already implemented a peer-to-peer use case, the Brooklyn Microgrid, but the full market value of peer-to-peer energy is just beginning to be explored. Our calculations show that, for residential customers in Germany alone, this market is worth \$5 billion a year.

Electricity retailers and distribution utilities generate revenue by selling electricity to customers and ensuring a reliable power supply. Last year, Europe's 260 million electricity customers paid more than €115 billion for their electricity. Across the US, EU and Australia, customers paid \$185 billion. As DERs continue to proliferate, so too will the ability to transact locally with other network participants. As the Exergy network grows, we envision that an increasing amount of this power will be sold not between utilities and customers, but between customers themselves, peer-to-peer, on the Exergy platform.

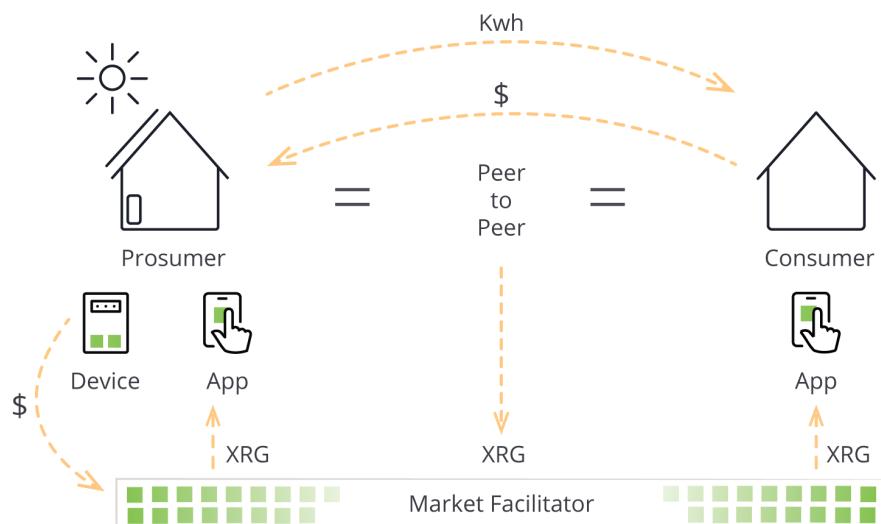


Figure 2 Peer-to-peer (P2P) energy use case

Step 1: John is a 'prosumer' with solar panels on his roof. He buys an Exergy compliant metering device.

Step 2: John downloads the mobile app that lets him join his local microgrid community. The app is enabled by his own XRG token, or by one provided for that purpose by an interested third party.

Step 3: John stakes XRG to his meter corresponding to his revenue capacity in order to join the local marketplace.

Step 4: John earns fiat currency for selling his power to his neighbors on the local market.

Step 5: His neighbor also downloads the app because she wants to buy power from John. She sets her budget for local renewable energy in the app and pays in fiat currency.

Participant	XRG usage	Fiat Usage	Incentive
Prosumer <i>(selling services)</i>	Stake XRG to a compliant hardware device in order to claim the profits from an asset in the marketplace.	Pay for a meter Pay for electricity Withdraw revenue	Prosumers are able to sell services—including local energy—into the marketplace
Consumer	Stake XRG to an account in the app to participate in the marketplace. No compatible hardware device is required.	Pay for electricity.	Consumers are able to buy a new product, local energy, and reduce network charges.

Use Case 2: Microgrid

Microgrids today encompass a range of integrated grid-edge hardware and software technologies to operationalize closed, efficient, clean-energy systems ranging in size from a hospital or campus to a military installation or entire island nation. These resilient systems can be tied to existing grid infrastructure or deployed as standalone grids—vital to the effort to bring electricity to the 1.2 billion people still without power around the world. The market is set to nearly double in value to \$23 billion by 2021. Microgrids represent the grid infrastructure model of the future, and Exergy can be the enabling functionality to accelerate deployment around the world.

Microgrid project developers, operators and other hardware vendors all see additional value by staking XRG. Exergy can improve system-wide operational efficiency by responsive load management, thus improving return on investment (ROI) and economics for developers and operators. It will allow monitoring of excess capacity and potential to sell to other microgrids as long as they are connected, or otherwise find value for the storage and other services available from the microgrid. Data transparency and uniformity across project portfolios will further support the commercial investment ecosystem.

Consumers and prosumers' roles in the microgrid use case look similar to Use Case 1. The difference is that in Use Case 2 there are two distinct microgrids that are connected to one another over the existing distribution network, and the distribution system operator can open up their network to allow electricity flow between them.

Participant	XRG usage	Fiat Usage	Incentive
Prosumer (selling services)	Stake XRG to a compliant hardware device to claim the profits from their asset into the marketplace.	Pay for electricity. Withdraw revenue.	Prosumers are able to sell services—including local energy—into the marketplace.
Consumer	Stake XRG to an account in the app to participate in the marketplace. Compatible hardware is not required.	Pay for electricity.	Consumers are able to buy a new product, local energy, and reduce network charges.
Distribution System Operator (DSO)	Stake XRG to sell the service of electricity transport into the marketplace.	Pay for the micro controller hardware.	DSO receives payment for physical transfer of electricity across the network between microgrids.
Microgrid Service Provider	Stakes XRG to create the rules of the marketplace (between microgrids).	Paid to run settlements between prosumers and consumers.	Allows local value-added services.

Table 4 Market Participants in Microgrid use case

Use Case 3: Distribution System Operator Use Case

The distribution network operator role is evolving as more activity is required of them to ensure real and reactive power requirements are met in a world of distributed energy resources. In New York state, the United Kingdom and other regions, the role of the distribution network operator is changing to one of distributed “system” operator (DSO), able to provide more of the ancillary services or demand side response currently managed centrally by market operators. The system operator ultimately needs flexibility on the demand side to be available as a resource.

This use case assumes, based on our experience in discussions around the world, that the DSO is willing to pay for access to grid-and-customer data in combinations described in more depth in the Electric Power Technical White Paper to enable the valuable grid services they will require. According to the International Energy Agency, smart demand response alone could save \$270 billion globally in investment in new energy infrastructure that would otherwise have been required by 2040. Already the Demand Response Auction Mechanism in California is showing that up to \$27 million may be spent annually to deliver demand shaving.¹³

The data is worth more or less depending on the location and timing.

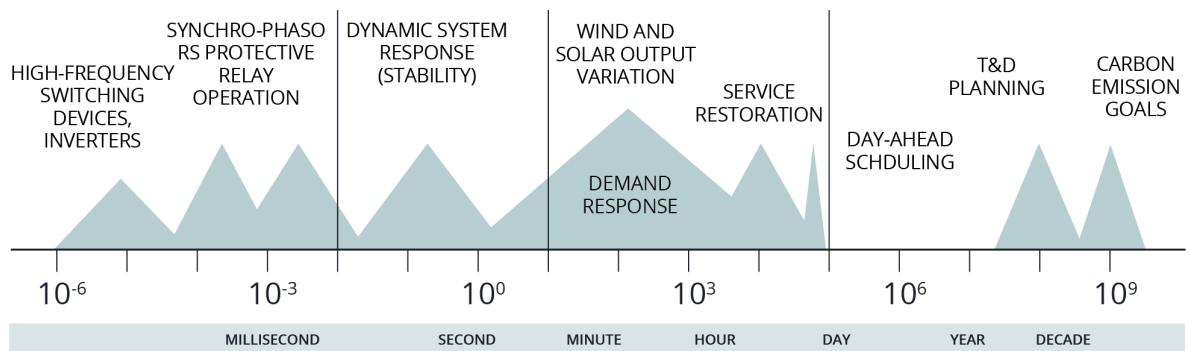


Figure 3 Demand Response by Source

¹³ <https://www.greentechmedia.com/articles/read/californias-dram-tops-200mw-as-utilities-pick-winners-for-distributed-energy>

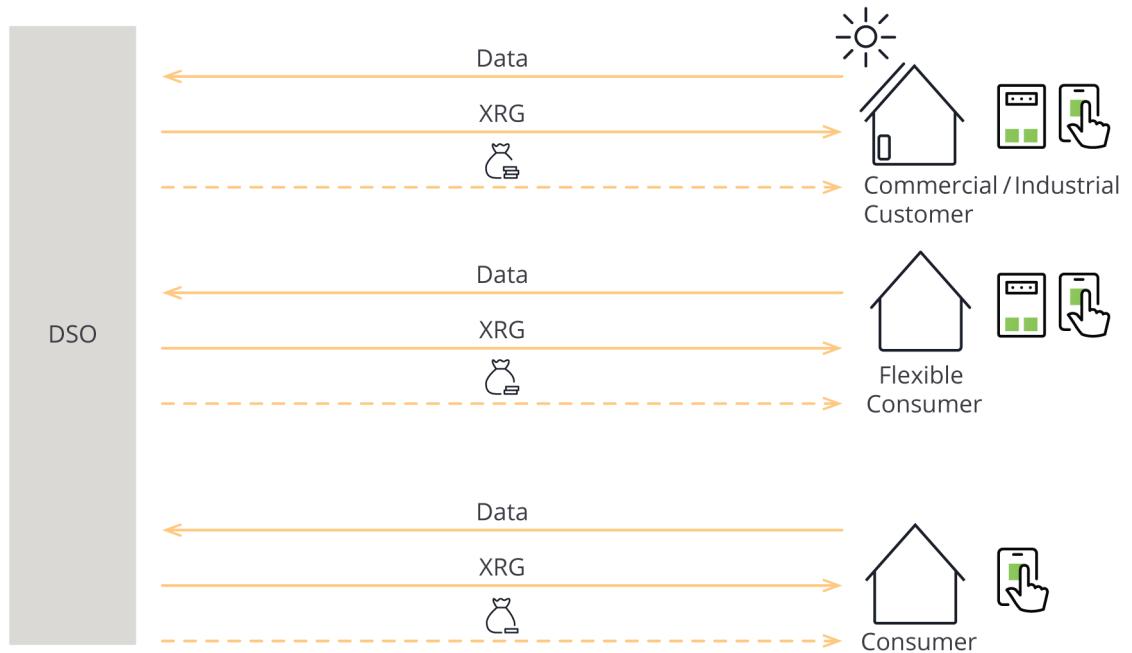


Figure 4 DSO use case

Step 1: DSO acquires XRG and stakes it to devices in a marketplace. This effectively pays the customers XRG in proportion to the value they will provide at three levels:

- Analog or 'dumb' data such as that from an electricity bill
- Connected or 'smart' data that is enabled by a smart meter or other device
- Responsive ability, that can control the energy use of on site assets (such as a building management and control system)

STEP 2: Customers are able to access and 'opt in' to the services offered via a mobile app

STEP 3: DSO gets the data

STEP 4: DSO either signals the service event via the app for behavioural responses, or self-executing contracts transact on behalf of the devices to trigger IoT control events.

STEP 5: Customer is paid in fiat currency per the service offered

STEP 6: DSO gets the value of the service, e.g. capacity, balancing, frequency response.

Use Case 4: Electric Vehicle smart charging

Electric vehicle adoption is accelerating rapidly. In 2016 the total number of electric vehicles topped 1 million for the first time; today there are already more than 2 million. By 2025, 40 to 70 million are forecasted. At ~3 MWh of power consumption per year per vehicle, these new cars will consume the output of one hundred new 400 MW combined cycle natural gas power plants every year. Where, when, and how drivers charge their EVs will be an increasingly important challenge—and opportunity—for managing the grid. Today, in the US alone, that market is \$250 million. Globally, by 2025, it will reach \$25 billion.

In our Electrical Power Technical Whitepaper, we highlight three models of electric vehicle charging use cases, and will further develop the token interactions within them in updates to follow.

Use Case Pipeline

Other use cases are being explored and will be piloted via forthcoming projects announced soon. These include managing transactions for grid services, wholesale electricity market trading and settlement, and enabling monitoring and verification for demand response programs. These use cases carry clear market values for services necessary to manage changes in power market dynamics already underway.

The advanced energy sector is estimated to be a \$1.4 trillion global market.¹⁴

Looking forward, Exergy will enable an entirely new set of market mechanisms and services.



By 2040, 1 billion households and 11 billion smart appliances could actively participate in interconnected electricity systems.

— *Digitalization and Energy, International Energy Agency, 2017*

¹⁴ <https://info.aee.net/aen-2017-market-report>

Go to Market Strategies

Exergy is designed to bring the power of markets to individuals, communities, and utilities alike. We see overwhelming value potential in the Exergy system, and realizing Exergy's full network effects will require commercial strategies to reflect consumer demand, management of commercial partnerships, optimal token distribution, regulatory awareness and engagement, sound governance and incentives to promote growth and adoption.

Three strategies will be pursued in the interest of increasing our market access:

- 1 Establish partnerships to maintain focus on data access and control and network development.

Cost and timelines for the commercialization of hardware have been central challenges in clean energy markets for the past decade. The Exergy team deeply understands production scale-up challenges, commercial financing gaps and the economics of production—and believes Exergy's value increases the more hardware manufacturing partners we work with.

For the production of Exergy-enabled devices as well as other components, we will lean on our strategic partners to deliver physical assets into markets to meet global demand as the Exergy network expands. Beyond existing partnerships with Siemens and Centrica, we are engaged with leading device manufacturers to enable third party hardware components as clients in the Exergy system. These relationships provide diversified production and accelerated deployment of the hardware necessary to fully animate the Exergy system in commercial power markets.

Exergy's current pipeline includes 45 global projects with partners at varying stages of development. Projects range in size from a minimum of 5 participants to hundreds; it's anticipated that average project size will steadily increase as more technology comes online. The majority of projects are located in North America, Europe and Asia in developed markets. More are emerging in off-grid regions, including India and sub-Saharan Africa. LO3 Energy has officially announced 4 projects in addition to the Brooklyn Microgrid that will adopt Exergy—in Houston, Texas; Landau and Kempton, Germany; and in South Australia.

These 45 projects include market participants who already play key roles in their local energy systems, ranging from utilities, DSOs, grid hardware manufacturers, cities and communities. This range of participation can tell us a lot: it signals that these market players are keen to be part of the ongoing value shift and define new roles for themselves as the marketplace evolves.

Other use cases where data is the new fuel need to be rapidly tested. Unleashing token interactions is part of the way we do this. Our aim is to increase the number of projects in the pipeline from 45 to 200 by 2019.

- 2 Garner network growth by going directly to people, policy, and project developers.

The goal of the Exergy Foundation is to contribute to the advancement of policy and technology for transactive energy, as noted above, in some cases through direct grantmaking to projects.

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Given the central role of policy and regulation in this industry, Exergy's success also requires that the Exergy Foundation engage with research institutions, standards bodies, new market entrants and regulatory bodies on the advancement of energy policy and market redesign.

After the token is minted, the Exergy Foundation assumes responsibility for the technical oversight of Exergy as it develops, with LO3 Energy remaining one of the developers along with others that are brought into the network. The Exergy Foundation will focus on identifying other third parties alongside LO3 Energy that can deploy hardware or customer applications that demonstrate the utility of the Exergy system and the ability to faster commercialize new energy services. In 2018, the Blockchain and Governance white papers will clarify these plans further.

3 Incentivize Token distribution

We see early network growth as a key enabler of scale. The goals of distribution are to ensure the rapid adoption of XRG into real-world projects.

A white label app will be available initially for third parties to develop their own microgrids rapidly in on- and off-grid markets. Through the app, XRG will be available to stake to devices for participation in the marketplaces in a local area.

The XRG value required for participation, the scope of services a participant can access in the marketplace, and the time period for accessing those services will be different depending on individual marketplace dynamics. Broad roles based on market participant type are currently being established and more information will be released in the coming months.

For commercial service providers, benefits include the value of the data itself and optimizing key business processes such as access to new customers and avoiding acquisition and settlement costs, increased retention, operating at smaller market closing or settlement periods, access to services that allow network operators to avoid or defer expensive network upgrades and improve efficiency, and the ability to aggregate and manage customer load and behavior in new ways.

Consumers and prosumers are incentivized to participate to access a new service they may not have been able to obtain before such as verified green energy, local energy, or the ability to engage their electric vehicle as a grid asset. Economic compensation for valuable market behavior is further expected to incent participation.

On and off chain rewards

In the above use cases, XRG is the required payment from any provider of services to energy consumers for access to their data, which in principle belongs to them, but which has been difficult for consumers to access, monetize or control. This is the base value of XRG, and utilizing this data in energy services is very conservatively estimated to become a \$200 billion dollar market in 2025.

But there is more. Once a customer is earning XRG in exchange for their data, as well as accessing the new services they previously couldn't directly participate in (paid in fiat currency), the Exergy platform can also allow for XRG to be rewarded 'on chain' or exchanged for real world discounted products and devices.

A rewards pool of XRG will be held for rewards to the higher compute nodes that bundle and verify transactions into the blockchain for a specific application (such as a microgrid). A percentage (to be defined) of the processing reward will in turn be distributed algorithmically to participants who have been transacting in that marketplace. This means that prosumers and consumers will be rewarded in proportion to the number of transactions that they are part of, above and beyond the XRG they earn in exchange for their data.

One use case for this off chain value would be to exchange XRG for discounted devices or appliances such as the 'smart' lighting or fridges coming into the market. These devices may be offered by service providers such as DSOs above, or the Foundation, to drive adoption and increased efficiency. For instance, the Foundation could select the 5,000th, 10,000th and 50,000th users of Exergy to receive the first off chain rewards.

Token Mechanics

The future grid is optimally organized in geographic clusters. Interconnected at multiple levels, clustering allows for locally structured markets and balancing areas. Such network design enables efficient grid operation and a range of valuable services at the grid edge. Increases in grid efficiency and new service offerings can allow economies to become more productive by reducing waste from the outset. The Exergy System is designed to promote the most efficient, secure, generation and consumption of energy.

Today, expensive cloud-based infrastructure is necessary for top-down management by distribution utilities and ISOs. Current command and control architectures become impractical, insecure and cost-prohibitive as grid edge nodes – smart assets and distributed energy resources (DERs) – continue to proliferate. The grid architecture of today also locks up data more optimally available to support new incentive structures, behavior and markets. The blockchain is necessary to enable and manage the new communication and marketplace layers underpinning the electricity network of the 21st century. LO3 has designed a scalable, multi-layered blockchain system to unlock this valuable data and enable these new markets – The Exergy System.

The Exergy System's top layer, the "Exergy Layer," will use a blockchain to establish and manage a global network of energy market participants. It will also establish location, security and proof of ownership. The Exergy token ("XRG") is an ERC20-compliant medium of exchange and will be used to attract consumers, prosumers and communities to the marketplace by requiring and incentivizing them to acquire and hold tokens.

Consumers and prosumers will be rewarded for participating in local energy markets. Other market participants such as generators, aggregators and service providers can also acquire and hold tokens. Commercial agents can acquire and hold tokens both for themselves and on behalf of (and with the consent of) consumers and prosumers as they see value in the data at the edge of the grid that they would not have access to without significant investment.

A fixed global supply of XRG will be minted, once, upon the Exergy 'network launch' event. XRG will be used to 'stake' mobile accounts and Exergy-compliant hardware devices of market participants to enable them to participate in the network over certain 'participation periods'. 'Staking' in this sense is the act of binding a pre-determined minimum amount of XRG in a 'cryptocurrency wallet' linked to one's hardware device or mobile application for the duration of each period. XRG tokens will not be mined, nor will they carry any half-life.

The Exergy System's local layer is a series of local, fast-acting, resilient blockchains around the world powered by grid-edge smart assets. In this layer, a set of underlying data is captured and managed, including the measured attributes of the grid state at the time of the energy transfer (such as real or reactive power). Market participants with an XRG compliant device can parcel, permission and monetize access to their data. Permissions and access to this data may be bought, sold, enabled, and disabled between market participants.

The Exergy Foundation will incentivize new business models through supply control. In advance of the token launch, the Foundation will engage transparently with market participants and developers to develop supply controls that align with the goal of maximizing "useful work." More information about the consensus mechanisms by which those will be adjusted over time will be released in the upcoming Blockchain paper. Additionally, a rewards engine will encourage distributed generation and consumer choice.

The Utility of Tokenization

Why will commercial participants today be incentivized to join this network? Incentives vary across market stakeholders:

- Utilities and ISOs gain critical transparency to grid edge activity which enables more efficient load balancing and efficient system operation. Such visibility allows for the deferral or elimination of significant capital expenditures otherwise necessary to manage the confluence of increasing grid complexity and aging infrastructure.
- Electricity retailers, DG installers and grid edge hardware developers can drastically reduce customer acquisition costs, which are significant industrywide. A reduction in this cost directly lowers opex and improves companies' bottom lines.
- Technology vendors and asset developers can dramatically improve asset IRRs and reduce return on investment (ROI) timelines for their products. More fully monetizing the range of services grid edge assets can provide has been to date held back by a lack of true market visibility over their performance and capabilities.
- Commercial participants, tomorrow, can leverage access to this data to create and operate new business models. New markets will be established around the incentive structures and participant behaviors enabled by this data. Initially, data access would be expected to be transacted bilaterally among local parties—prosumers and their distribution utility, for example. The pool of grid edge data may be accessible by global participants across the world via the Exergy layer. Applications for- and predictive analytics applied to- such a large dataset would be valuable in their own right. As the number of consumers, prosumers and commercial entities fluctuates so will the number of XRG tokens required to be staked per participant. In a simplified example, if the staking minimum was set at 1 in a network size of 100, it may be expected to be .1 in a network size of 1000. Exergy participants may also be able to use XRG for real-world goods and services. For commercial participants to further incentivize prosumers and consumers to join the network and produce increasing amounts of data, they may be expected to offer ways to spend XRG on physical products and services. As an example, utilities may offer their Exergy-participating customers discounts on LED bulbs or efficiency products for using XRG as the medium of exchange with a participating hardware vendor. Such an exchange would represent another layer of linkage between market participants and important channel for consumers to 'sink' value into other asset classes.

As the network grows in size, traditional network effects are expected to yield significant value creation, in aggregate, within the network. Portions of this total value vary in size and composition for each of the different groups of network participants – these drivers and dynamics are discussed below. Network effects further dictate that as network value increases, network growth continues in tandem. Therefore, we confidently assume that as system speed and efficiency improves, and additional connections are enabled among network participants, the overall value of network participation will be increased.

For distribution utilities and ISOs, the larger the network the size, the greater the visibility each entity may achieve across geographic clusters and to grid edge nodes. Better access and visibility is closely correlated with operational efficiency from the perspective of balancing, and capital efficiency from the perspective of resource allocation.

- As retailers, installers, developers and vendors seek to grow their respective businesses,

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network growth correlates to broader access to customer data, which expands the pool of value to be captured associated with customer acquisition and service.

- For consumers and prosumers, choices for energy purchasing and services will expand as commercial entity participation increases. The scope and size of economic incentives available to them for certain behaviors and network actions will be further expected to increase in accordance with network growth. Why will the network grow in the first place? For commercial entities, the primary incentive to participate is access to the data. For consumers and prosumers, it's economic returns, choice and resiliency.

On Network Layer Design

Information exchange between the two layers is critical to the flow of value within the Exergy ecosystem. Virtual machines at the Exergy layer validate and verify data transmitted up from devices in the local distributed ledgers. Commercial market participants have indicated interest in staking XRG for their customers to access data at the local market level across geographic clusters.

The Exergy System is unique and differentiated from other energy and blockchain tokens because the blockchain architecture is designed from the ground up to align with the physical characteristics of electricity grids at the distribution level, making it possible to secure and transfer the information critical for integration of DERs and operating a truly decentralized grid. The two layer architecture of The Exergy System brings the strength of global network effects together with the virtue of local market design to bear on the power sector transformation. LO3 Energy will use the Exergy system to build its products and applications, and opening the system to other developers with the intention of sparking innovation and rapid adoption of Exergy.

The Revolution

In April 2016, The Brooklyn Microgrid—LO3 Energy's flagship innovation—completed the world's first blockchain energy transaction.

LO3 Energy and the Exergy team have built confidence in transactive energy solutions and proven the essential role they will play in the future world of energy. Today, prosumer and consumer energy interactions are tracked and recorded on the blockchain. Users can set preferences and monitor near-real time energy transactions through a secure microgrid mobile app and web interface.

We've been celebrated as an early market leader by Utility Week, Fast Company, E.On and Nominet Trust, and our innovations have caught the attention of no less than The New York Times, The Guardian, Greentech Media , and MIT Technology Review.

In October 2017, LO3 Energy was awarded a Series A investment from Braemar Energy Ventures and Centrica Innovations to further develop our blockchain platform for new markets and services.

Our team was invited to present and speak on regulatory energy change in front of The US House of Representatives, European Commission, OECD, and many other regulatory bodies and industry conferences.

With a functioning proof-of-concept in Brooklyn, Series A investments from leading energy investors, and groundbreaking conversations happening around the world, LO3 Energy is poised to disrupt the global energy economy and rewrite the rules for how energy can be generated, distributed, and put to use.



"This project..., is the first version of a new kind of energy market, operated by consumers, which will change the way we generate and consume electricity."

-New Scientist

If in the future you find yourself selling your excess solar panel energy to your neighbor via secure blockchain, you'll have one startup's actions on President Street in Brooklyn to thank."

-Fast Company

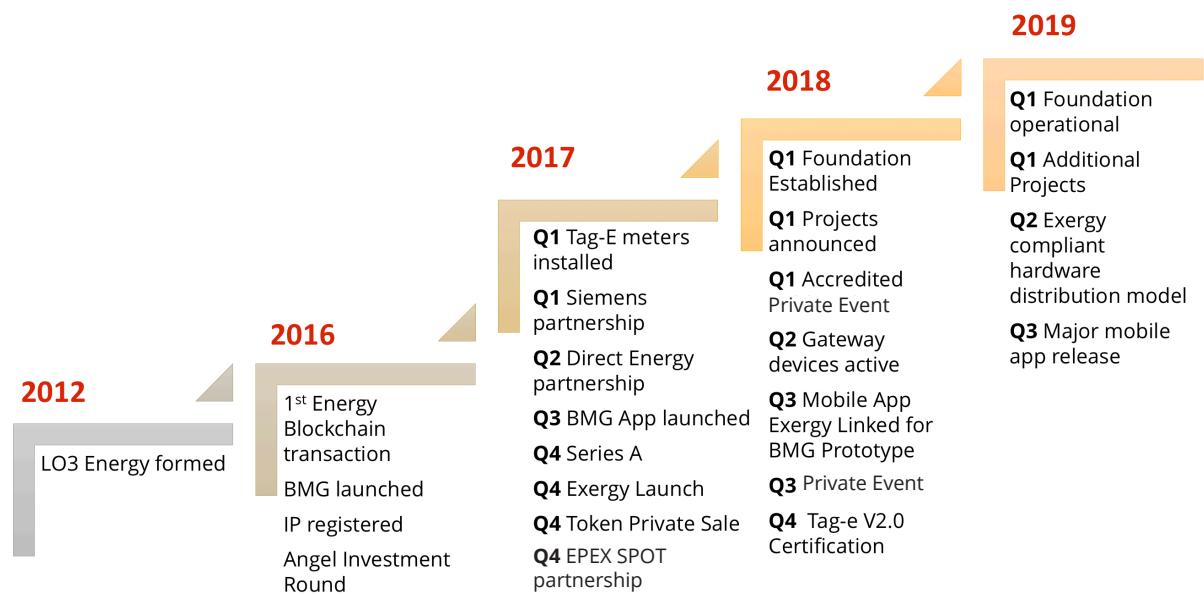
"This opportunity represents the convergence of two macro trends that underpin Braemar's investment thesis – the transition of global energy markets to more decentralized, distributed systems and the development of platforms that will provide new forms of consumer participation," said Dr. Jiong Ma, Partner at Braemar Energy Ventures.

"We look forward to working with LO3 on blockchain-based projects more broadly across Centrica, and the opportunity to provide our customers with more flexibility and control over how they buy and use their energy." Christophe Defert, Ventures Director at Centrica Innovations.

Scaling to Meet Future Demands

With Exergy, a dedicated team is committing to rapidly scaling and opening up the information and marketplace app and ledger platform to create global impact. The Exergy Foundation takes LO3 Energy's work and opens up the broader network of global participants that we know are actively developing and influencing markets today. With the XRG token, everyone can own, participate in, and profit from this new system to access better energy services that prioritize exergy, creating the most productive economies possible with the mechanisms to scale ongoing investment and improvement over time.

Roadmap



Team

Exergy's core team brings a diversity of skillsets, ranging from hardware development to utility design, technical standards setting, marketing strategy and policy advocacy, financial product design, and complex trading in derivatives markets. It builds from the LO3 Energy core team that has deep expertise in distributed energy computing, peer-to-peer consensus networks, cryptography, and cybersecurity, among other disciplines. The team has a unique knowledge base of integrating blockchain and transactive energy elements with physical energy generation and control assets in a regulated environment.



Lawrence Orsini

Lawrence has more than ten years of experience in all aspects of commercial energy programs—design, management, implementation and marketing—and a strong understanding of the energy policy and regulatory environment. Lawrence's broad industry experience runs the gamut from field auditing to managing relationships with Fortune 100 utility and corporate clients, giving him a unique ability to draw connections between policy-driven utility energy efficiency program requirements and bottom line-driven business spending.



Bill Collins

Bill is a finance professional with decades of experience in investment banking, structured finance, and environmental markets. Working as a derivatives specialist in Asia, Bill used his creativity and knowledge of financial markets to spot unique and innovative ways to help his customers (large government, state and private counterparties) to identify and manage complex financial risks. He further developed the same skillset in the international carbon market, leading a team tasked with sales, trading, and risk management of the largest private sector carbon project portfolio with EcoSecurities for seven years. Bill serves on OneEnergy Renewables' Advisory Board and as an advisor to the Microgrid Investment Accelerator.



Molly Webb

Molly has more than ten years of experience in market acceleration and advocacy for global innovations in technology, climate change, smart cities and energy, in partnership with leading companies and cities at The Climate Group and UK think tank Demos. She has over five years of experience in software and IT product development in New York, Tokyo and London. She was green innovation strategy advisor for Skype-founder's Zennström Philanthropies, and founded Energy Unlocked in 2015 to accelerate energy transitions working with new market entrants to the energy sector.

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Cian Montgomery

Cian is a blockchain architecture and software development expert. Previously he was Intel's lead architects on the Hyperledger Sawtooth project, leading the project to its 1.0 release. Cian has more than 25 years of professional technology leadership and software engineering experience leading teams to develop products across diverse fields, including finance and accounting systems, 3D graphics, computer vision, embedded systems and web applications.



Ben Conte

Ben is an executive-level business developer and strategist and a strong leader and motivator. He has an extensive background in domestic and international markets, supply chain management, and logistics, as well as expertise in crypto currencies and energy-related blockchain applications. He also holds board positions as Independent Non-Executive Director (INED) with multiple foreign regulated financial services companies. A proven risk manager and operator focused on execution, Ben brings to the team twenty-three years of profit and loss responsibility in renewable energy, physical commodity, crypto currency, forest product, and equity derivative markets.



Melanie Adamson

Mel is a recognized marketing expert among business and consumer industries in energy, technology and finance. She is an innovator in evolving brands through insightful and deliberate marketing communication strategies who has spent the last 18 years researching audiences, building multi-channel plans, developing strategic brand stories and successfully leading teams to create strong, effective marketing deliverables for her clients.



Paul Heitmann

Paul is the founder and President of Businovation, LLC, a grid modernization and clean energy innovation consulting firm. He currently supports a number of client initiatives in the area of EVSE, Renewable DER, and Microgrid infrastructure development. He also provides thought leadership for the advanced standards frameworks that will leverage IEEE 1547 certified interconnections to support transactive energy services through grid-edge interoperation, and serves as the Working Group chair for the IEEE Power and Energy Society P825 Transactive Energy initiative.

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Scott Kessler

Scott is the Director of Business Development for LO3 Energy in Brooklyn, where he is responsible for managing partnerships and developing new projects. He previously worked for TRC Energy Services in San Francisco as a consultant, primarily focused on working with PG&E, SMUD, and other West Coast utilities to implement energy efficiency programs, integrate renewables, and assess their impact across the grid. Prior to his time in the Bay Area, Scott spent time in NYC working at NYSERDA and Connecticut Light and Power.



Matt Brown

Matt is an energy technology and market consultant focused on early- and growth-stage investment advisory. He has worked with venture capital, private equity, and family office investors focused on cleantech and innovative energy technology solutions since 2009. Matt currently leads clean energy investment research and analysis at the CREO Syndicate and serves as a consultant to Braemar Energy Ventures.