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Study On Partnership Between Energy Companies & Blockchain Start-Ups: Based On Corporate Investment Model

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Abstract

The Aim Of This Study Is To Categorize The Partnership Types Between Legacy Energy Companies And Blockchain Energy Start-Ups In 2017 By Investigating Partnership Deals. For It, The Author Reviews Previous References Dealing With Blockchain Energy Business Models And Discusses The Corporate Investment Model. As Results, Among Twenty Start-Ups, Five Partnership Deals Have Been Found. The Enabling And Passive Partnership Is Related To Fundamental Technology Of Blockchain Application And The Cases Are 'Electrical Vehicle Charging' (Slock.It And Rwe) And 'Customer Switching' (Electron And Tepco). The Driving Partnership Is Related To Viable For Sustaining Business And The Cases Are 'Microgrid' (Sun Exchange And Powerhive) And 'Ipp Settlement' (Btl And Wien Energie). The Emergent Partnership Is Related To Robust & Scalable For Business And The Cases Are 'Local Energy Market & P2P Energy Network' (Lo3 Energy And Siemens, Power Ledger And Vector, Innogy Innovation Hub And Tepco), 'Decentralized Exchange' (Grid Singularity And Rocky Mountain Institute), And 'Retail Trading & Settlement' (Ponton And Energy Companies).

Key Words : Energy Company, Blockchain Start-Up, Corporate Investment, Partnership

Ⅰ. Introduction

After rolling-out of smart meters and continued development of demand side response measures, new digital peer-to-peer solutions have been emerged and seamlessly connect energy producers directly with those wanting it. This change empowers consumers to take control of their energy usage and reduce energy bills. A new ecosystem of energy blockchain start-ups is emerging. The applicability of an energy blockchain is yet theoretical and the ability to support a globally connected network of energy transfer, where smart devices will be able to securely send and receive data while autonomously reacting to market signals, is a reality in 5-10 years. Smart meter rollout programs are in their infancy, huge investment is needed to digitize the grid, and global battery storage totals in the megawatts rather than gigawatts.

Most pilots are in early stages across the energy value chain, in the area of peer-to-peer energy trading where small-scale generation owners sell excess generation direct to other consumers. These range from microgrids and solar systems to electronic vehicle (hereafter EV)-charging. But it is expected that the blockchain could offer a means of conducting, verifying, and permanently recording transactions cheaply and without the need for a trusted third party. For it, platforms can be involved to understand its implications for how they can better serve their customers, their partners, and their own business. Those capabilities are now found in global companies like IBM, SAP and some startups. The platforms can help their clients covering various

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industries and blockchain technology is one of these services.

Blockchain standardization is still unclear and it is imperative for platforms to get involved in blockchain working groups like IBM's "Hyperledger." Telecommunication companies also try to have a leading position. People believe, blockchain can solve problems existing at an intersection of public and private data sets and infrastructure with physical and virtual technology assets. There is a potential for blockchain-based technology when collaborating. Companies like IBM, SAP and Accenture are involved with blockchain already[1].

Energy sector can adopt blockchain technology too. The power sector has been to recognize blockchain's potential. Blockchain can revolutionize a sector that is becoming increasingly decentralized and connected and it has energy industry attention as some start-ups are merged into the legacy energy companies. IBM demonstrated that blockchain helps its customers resolve industry issues and leverages its industry relationships, knowledge, and capabilities in pushing blockchain[2]. The purpose of this study is to categorize partnership types between energy companies and blockchain start-ups by investigating deals in 2017. For it, the author will review previous academic papers dealing with the blockchain business models and discuss the corporate investment model initiated by Chesbrough. With this backdrop, the author will investigate partnership deals between energy companies and start-ups of blockchain applications.

Ⅱ. Theoretical Background

2.1 Previous Reference Review

There are two technological paper dealing with business model development of blockchain energy. Kim et. al developed blockchain-based energy trading system because the decentralized and unmodifiable nature of the blockchain technology is offering the potential to improve the power trading process. The authors modeled the power trading problem as the interaction between admin, producer and consumer nodes and a power trading scenario has been created for this model using a blockchain platform "Multichain." To verify this scenario, they proposed and implemented a power trading method determining price according to the pure market principle and can't be hacked[3].

Cheng et. al developed an application model of blockchain. To solve the current problems that the cost of centralized solution construction, management and maintenance is high, and it is difficult to support the collection, transmission, reception, storage and analysis of massive data, the authors applied blockchain technology to the distributed electricity market to achieve P2P transactions in the power systems. The blockchain technology is used in power system to establish a credible direct transaction between devices. This study suggested the future direction of the power systems, pointed characteristics of decentralized systems, and emphasized issues in the development process. As results, they put a new transaction framework in consideration of problems in energy market. The transaction framework is based on the blockchain technology in the distributed electricity market and includes the pricing method, the power transaction system architecture, various modules of the trading system and the details of the whole transaction system runtime[4].

2.2 Corporate Investment Model[5]

Large companies have long sensed the potential value of investing in external start-ups. There was a mad dash to invest in new ventures in the late 1990s, and then the hasty retreat as the economy turned. However, many companies still have continued to make investments in new ventures. Some big companies including Intel, Microsoft, and Qualcomm have committed themselves to continued high levels of investment. Then, it is questioned why some companies' forays into venture capital have been successful, generating significant growth for their own businesses. To answer these questions, an organized way to think is needed and a framework can help a company decide whether it should invest in a start-up by first understanding what kind of

benefit might be realized from the investment. Chesbrough's paper offers such a framework, one that also suggests in what kind of economic climates different types of investment are likely to make sense. He firstly defines 'corporate venture capital' as the investment of corporate funds directly in external start-up companies excluding investments made through an external fund managed by a third party, even if the investment vehicle is funded by and specifically designed to meet the objectives of a single investing company and also excluding investments that fall under the "corporate venturing", the funding of new internal ventures that, while distinct from a company's core business and granted some organizational autonomy, remain legally part of the company. His definition does include, however, investments made in start-ups that a company has already spun off as independent businesses.

Chesbrough makes dual dimensions of investment. It is defined by two characteristics: its objective and the degree to which the operations of investing company and start-up are linked. Even if company has a range of objectives for its investments, this type advances one of two goals: strategic or financial. Strategic investments are made to increase profits of the company's own businesses. A company making a strategic investment seeks to exploit synergies between itself and a new venture. For example, Lucent Venture Partners invests the telecommunications equipment maker's funds in external start-ups focusing on services for data networks. Many of these start-ups have strategic alliances with Lucent to help sell Lucent's equipment alongside their own offerings. While Lucent would like to make money on its investments in these start-ups, it accepts low returns if its own businesses perform better as result of the investments. In financial investment, a company looks for attractive returns and seeks to do due to what it sees as its superior knowledge of markets and technologies, its strong balance sheet, and its ability to be a patient investor. In addition, a company's brand may signal the quality of the start-up to other investors and potential customers, ultimately returning rewards to the original investor. For example, Dell Ventures, Dell Computer's in-house operation, has made numerous Internet investments that it has expected to earn attractive returns. While the company hopes that the investments will help its own business grow, the main rationale for the investments has been the possibility of high financial returns.

The second characteristic of corporate investments is the degree to which companies in the investment portfolio are linked to the investing company's operational capabilities. A start-up with strong links to the investing company makes use of that company's manufacturing plants, distribution channels, technology, or brand. It adopts the company's business practices to build, sell, or service its products. A company's own resources and processes could be liabilities, when it faces disruptive technologies. A start-up can offer the company an opportunity to build new capabilities that could threaten the viability of current capabilities of the company. Housing these capabilities in a separate legal entity can insulate them from internal efforts to undermine them. If venture's processes fare well, the company can evaluate how to adapt its own processes to be like those of the start-up. The company could decide to acquire the venture.

Neither of these two dimensions of investing, strategic versus financial and tightly linked versus loosely linked is an either-or proposition. Most investments fall somewhere along a spectrum between the two poles of each pair of attributes. Figure 1 shows corporate investment map combining an assessment of investing company's corporate

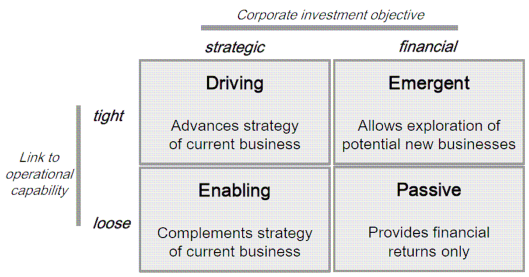

Fig. 1. Corporate venture capital investment map

objective (strategic or financial) with an analysis of the degree of linkage (tight or loose) between company's operation and a start-up receiving funding reveals the four types and purposes of corporate investments.

In the mode of enabling investments, a company makes investments primarily for strategic reasons but not tightly with its own operations. The theory is that a successful investment enables a company's own businesses to benefit but that a strong operational link between the start-up and the company isn't necessary to realize that benefit. If its operations are not tightly linked to the venture, the purpose lies in the complementarity. A company can take advantage of this by using its investments to stimulate the development of the ecosystem in which it operates. It means, the suppliers, customers, and third-party developers make products and services to stimulate demand for the company's own offerings. Intel Capital, the investment arm of the semiconductor giant, is a paradigmatic example of a company making enabling investments. In the early 1990s, Intel realized it could benefit from nurturing start-ups making complementary products. Demand for them could spur increased demand for Intel's own microprocessor products. Thus, Intel invested in hundreds of companies whose products such as video, audio, and graphics hardware and software required powerful microprocessors inside the computers they ran on, thereby stimulating sales of Intel Pentium chips. Intel's case shows, the investments have been aimed at increasing its revenue by boosting sales within the current Wintel operating system (OS) standard. The strategic value to Intel lies not in its ability to coordinate its operations with the companies in its investment portfolio, but in the increased demand for Intel's own products generated by its portfolio companies.

In the mode of passive investment, the start-ups are not connected to the company's own strategy and are only loosely linked to the corporation's operational capabilities. The company lacks the means to actively advance its own business through these investments. Despite the perception of some companies enjoying technology or market knowledge to give them advantages over other investors, in passive venturing, a company is another investor subject to the financial returns in the private equity market. For example, Dell Ventures poured money into startups that had only tangential connections with Dell's own strategy and these ventures would have increased demand for personal computers and servers if they had succeeded, but Dell's market share was not high enough to allow it to capture much of the gain from that increased demand. However, this investment has a limitation. When the value of its investment collapses, no potential strategic benefit remains to compensate for the financial losses.

The type of driving investment is characterized by a strategic rationale and tight links between a start-up and the operations of the investing company. If the investment is successful, a company's future business will benefit and if it fails, the company will get a valuable early warning about pitfalls to avoid in that business. For instance, Microsoft (MS) has earmarked more than $1 billion to invest in start-ups that could help advance its new Internet services architecture, ".Net" and this technology to be expected to enable its Windows platform to provide a variety of Internet services is a contender to set the standards for the next generation of products and services over the Web. Microsoft is funding startups exploiting its architecture and promoting the adoption of the MS standard over rival approaches from Sun Microsystems and IBM. The startups are tightly linked to MS's operations through the Windows software and tools that the company provides to them for the development of their own products. The strategic value of MS's .Net investments is highlighted by the company's decision to make them in the shadow of earlier VC investment losses. The company has written off staggering sums $980 million in the third quarter of 2000 alone in its corporate VC portfolio. But rather than backing off, MS is charging ahead with new .Net investments. Because they could help the company win the battle over the next Internet services standard, it is willing to risk substantial financial losses. However, the

tight coupling of the investments with a company's current processes means that it sustains the current strategy and that it is unlikely to help a company cope with disruptive strategies when the company must go beyond its current capabilities to respond to a change in the environment. If a company wants to transcend current strategy and processes, it should not rely on driving investments, which are ill suited for these tasks.

In emergent investments, start-ups have tight links to its operating capabilities of company, but that offer little to enhance the company's current strategy. Nevertheless, if the business environment shifts, such a new venture might suddenly become strategically valuable. This gives it an optionlike strategic upside beyond whatever financial returns it generates. A company may sense an opportunity in a strategic "whitespace," a new market with a new set of customers. Exploring the potential of such a market is often difficult for a company focused on serving its current market. Investing in a start-up able to enter this uncharted territory provides information that could never be gleaned from the hypothetical questions of a market research survey. If the market seems to hold potential, the investing company may choose to shift its course. Thus, while the immediate benefits of such investments are financial, the ultimate return may result from exercising the strategic option. In that sense, emergent investments complement the benefits of driving investments designed only to the company's current strategy.

According to Chesbrough, the emergent investments are more appropriate when the economy is booming and the likelihood of solid financial returns offsets the uncertainty of any strategic benefit. By contrast, enabling and driving investments have more staying power. The enabling investments may retreat somewhat in difficult times. When financial returns are down, enabling investments can be more expensive and less attractive when compared with other, more conventional, business development mechanisms such as advertising or promotional expenses that a company can use to further its strategy. But as the decision by Intel indicate, enabling investments can hold long-term benefits. The driving investments are not justified by their financial returns but rather by their strong potential to positively affect the company's own business. As the decision by MS suggest, a decrease in the rate of return on investments shouldn't undermine that rationale. A company's investments in external start-ups can advance its own growth on number of strategic fronts. Regardless of whether growth is desired in present or future businesses, a company needs a view of its strategy and its operational capabilities. It needs the discipline to build its investment portfolio with these parameters in mind. And it needs to manage its investments to capture the latent strategic benefits in its portfolio.

Ⅲ. Research Design

3.1 Research question

Blockchain is a potential component of the operating system (hereafter OS) required to make a decentralized electricity system work and the increase in decentralized power production creates new needs for information exchanges in the electricity system. The growth of renewable energy is likely to challenge the current electricity system, where most of the production is injected at the transmission grid level. With an increasing share of production happening closer to the consumer, both physical flows of electricity and exchanges of information required to support these flows are likely to be redesigned. They will also need to occur closer to the consumer and be more decentralized.

Optimizing a decentralized electricity system requires sharing data of the market. Consumers producing their own electricity (hereafter prosumer) need to resell a part of the electricity they produce. For this purpose, they must exchange data with a potential supplier or sell directly to other consumers. It departs from the hierarchical model where electricity flows, together with the associated exchanges of information. Managing renewable energy sources is also an area requiring more extensive data exchange for electrical supply and

demand to match efficiently including by optimizing the use of energy storage. Another area is the charging of EV after global warming. Whereas electricity consumption for customers used to happen at home, charging of EV benefits from mobile electricity contracts allowing the customer to be billed for the associated consumption wherever it takes place. It also calls for new data flows allowing the customer to be identified and billed appropriately. It calls for new tools leveraging all the flexibilities offered by local power production, potential demand response instruments or power storage.

Defining the OS and associated applications materializing the benefits of a decentralized electricity system is a key challenge for energy market participants like suppliers, grid operators, software vendors, equipment suppliers, etc. There is an evidence of activity areas from energy suppliers and grid operators to IT specialists in energy management and automation and Internet firms. For instance, GE is experimenting with a decentralized smart grid project in Carros of France in partnership with Enedis and it aims to identify key technologies enabling integration of local renewable sources within the grid. Blockchain can support the increased data exchanges for managing a decentralized electricity system[6].

A research company, Cognizant's white paper categorized three levels of blockchain capabilities meeting utility industry requirements and illustrated some company examples including start-ups[7]. In level one, blockchain is a 'foundational technology' for the legacy utilities industry and its core capability is transactional security and reliability. There are four kinds of blockchain apps relevant for utilities: Bill pay, solar renewable energy certificates, electrical vehicle charge, and customer switching. In case of bill pay, start-ups could solve bill settlement and prepaid recharge of smart meters using cryptocurrencies. An example is Bitconnect-enabled utility bills using Bitcoins[8]. In solar renewable energy certificates, blockchain can be used for authenticating and trading renewable energy credit certificates. SolarCoin, a start-up is an example of a cryptocurrency earned by generating solar electricity[9]. In electric vehicle charging, for example, BlockCharge is working on blockchain-based charging, authentication and billing for electric vehicles[10] and Innogy similarly enables digital payments for charging electric vehicles over Ethereum blockchains[11]. Lastly, in customer switching, UK start-up, Electron has built a blockchain-based platform to facilitate faster switching of suppliers[12].

These four apps rely on blockchain's superior security and transaction traceability (i.e., validation that parties are who they say they are, without the need for an intermediary). For the existing utility business, blockchain at a level one capability can't transform the existing business other than impacting transactions and customer contract benefits and this situation is equally applicable in regulated and deregulated markets[7].

In level two, blockchain is 'viable for sustaining utilities' to overcome the system integration challenges inherent in implementing the technology and the traditional utility technologies must coexist with blockchain and drive internal business units to sustain the technology investments. If the technology delivers services to a critical mass of users in markets, associated regulatory oversight will be a challenge. In this, a very loose regulatory framework should exist for blockchain. Examples of experimental and regulatory permissioned blockchain apps for utility sector include tree kinds: Microgrids, independent power producer (IPP) settlements and grid settlement & wholesale market trading. In microgrids, distributed energy systems named as 'microgrids' can function independently from a centralized grid and network-based telecom and IT companies can run those in 'behind the meter' market. Because the scale of operations is limited for microgrids, blockchain networks are more relevant for managing transactions. Utility companies can cooperate in IPP settlements. For example, Austrian utility company, Wien Energie is taking part in a blockchain trial focused on energy trading with two other utilities[13]. The last one, grid settlements & wholesale market trading are the next

steps after IPP settlements. Thus, IPP and microgrid link a small number of players and this trading consists of many nodes and the processes must comply with industry regulations.

In the long term, blockchain can add value to emerging utility markets like local energy markets, virtual power plants (VPP) and energy communities. This vision is 'robust and scalable for business' in level three and needs additional data points before a definitive bet can be placed on how blockchain is a mainstream technology, coexisting and eventually replacing existing systems. There are three kinds: Local energy market & P2P energy networks, decentralized exchange, and retail trading and settlement. For local energy market & P2P energy networks, "Brooklyn Microgrid" project demonstrates blockchain's applicability in the P2P energy market[14]. For decentralized exchange, Austrian start-up Grid Singularity experiments with a decentralized energy exchange platform using blockchain technology[15]. For retail trading and settlement, New York-based start-up, Drift experiments with a distributed ledger for retail energy trading[16]. Similarly, Wepower is building a blockchain-based green energy trading platform[17].

Within those three levels, energy companies and start-ups start to have partnerships in the blockchain based energy projects. Large companies such as MS and IBM also offer blockchain technology as a service to other companies. Thus, various types of cooperation can be realized. The author formulates an analysis framework for analyzing four partnership types along with the three levels of energy company's operational capability and ten blockchain apps as the following figure 2.

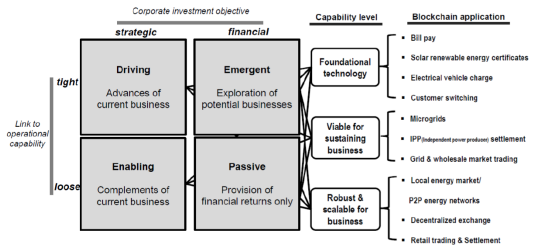

Fig. 2. Analysis framework for analyzing four partnership types

As figure 2 shows, the vertical axis shows the link to operational capabilities of energy company. The link closer to the bottom side of the matrix are more likely to involve complements of the energy company's current business. On the other hand, the horizontal axis shows the partnership types. The partnership activities that are closer to the left part of the matrix are more likely to represent driving alliance focusing on advances of energy company's current business and the partnership activities that are closer to the right side of the matrix are more likely to have emergent relationship for exploration of company's potential businesses. The research questions are as follows based on the analysis framework:

1) What kinds of blockchain energy business deal are in the type of enabling partnership?
2) What kinds of blockchain energy business deal are in the type of passive partnership?
3) What kinds of blockchain energy business deal are in the type of driving partnership?
4) What kinds of blockchain energy business deal are in the type of emergent partnership?

3.2 Methodology

This study is based on blockchain energy landscape data found in 2017 by searching Google. In February 2017, Besnainou found start-ups such as Electron, LO3Energy, Power Ledger, M-Payg, Sun Exchage, Grid Singularity, Chonicled, Xpansiv (Authentication of renewable energy data)[18]. In April 2017, Johnston found Bankymoon, Gem (Cryptocurrency), Solarcoin, Smappee, Energy Blockchain Lab., VoltMarkets (Renewable energy credit issuance), Slock.it, Chronicled (Smart supply chain solutions of power energy), Power Ledger, LO3 Energy, M-Payg (Pay-as-you-go solar energy system for families in the developing world), innogy Innovation Hub, and Ponton[19]. In October 2017, Bonenfant and et al categorized blockchain based energy market by business models and players.

The selected start-ups are Solarcoin for renewable energy cryptocurrency, Bankymoon, Slock.it, Sunchain, Evolution Energie for certifying renewable energy, an enabler for incentive certificates,

PowerLedger, LO3 Energy, Grid Singularity, and BTL[6]. Those start-ups searched via three references will be analyzed to categorize partnership types.

Ⅳ. Results and Discussion

4.1 Type 1: Enabling Partnership

Microstructure The enabling partnership is complements of current business and a company's investment enables its own businesses to benefit. In that cases, blockchain can enable more value creation for current energy market players and is a new option to manage the bill payment of electricity offers, charging of electric vehicles or renewable energy certificates.

The charging service start-up of electric vehicles, Slock.it initiates a R&D partnership with RWE and "Share & Charge" enables testing the usage of smart contracts in the charging process. The prototype consists in an EV charging station and an application. The "Share & Charge" built on Ethereum links EV drivers to private-owned charging stations and it enables the client to pay for the used electricity. The goal is to launch the first charging station in 2017 and RWE's goal is to build a network of private charging station to supplement their more than 5,000 public charging stations[6].

4.2 Type 2: Passive partnership

The passive partnership' purpose is only financial returns and start-ups are loosely linked to an investing company's operational capabilities. Despite the perception of advantages of new technology or market knowledge, in passive venturing, the investing company is subject firstly to the financial returns. Among the energy apps, the customer switching is a flexible electricity offering on the side of current energy companies. Electron, a British blockchain company to transform the UK's energy infrastructure and it approach is not bottom-up, but top-down. It means, it works in collaboration with key stakeholders like utility company. It developed several platforms, which include meter registration platform, flexibility trading program and smart meter data privacy.

It recently focuses on handling the multiplying options for flexible demand in electricity systems and signed a memorandum of understanding with TEPCO to experiment with P2P electricity trading on June 2017. Currently, the Japanese group is a part of the Energy Web Foundation (EWF) which has more than 70 energy companies including utilities Duke Energy and Centrica, and oil firms Royal Dutch Shell and Equinor. Among many initiatives, the EWF is pioneering a blockchain application that tracks renewable-energy certificates used to offset carbon emissions to make them more transparent and granular. Even if everyone can use the blockchain and cryptocurrencies to trade locally-generated energy with each other, the customer switching service requires a centralized utility platform in the middle.

Tokyo Electric Power Company Holdings, Inc. (TEPCO) closed an early-stage bridging round investment in Electron at the end of 2017. Electron is harnessing blockchain to establish more efficient, flexible, and reliable systems for the energy sector and TEPCO needs to work with Electron to obtain additional know-how on blockchain that has the potential to significantly impact the energy market. TEPCO needs to partner with Electron to explore expanding its utility service offerings in other energy markets[20].

4.3 Type 3: Driving partnership

The driving partnership focuses on advances of current business for sustainable growth and is characterized by tight links between a start-up and the operations of the investing company. If the strategic investment is successful, a company's future business will benefit and if it fails, the company will get a valuable early warning about pitfalls to avoid in that business. Thus, blockchain is used for exploration tools and provides a cost-effective way to build projects requiring the management of large amounts of data, using a standardized language to build an interoperable infrastructure. It is easier to use the blockchain platform to collaborate with other innovative start-ups rather than investing in a centralized and

proprietary solution. Blockchain contributes to lowering decreasing energy sector entry barriers and allow start-ups to venture into large energy companies' playground, with innovative business models and new ways to sell electricity. It is an opportunity for potential new entrants on the current smart grid market by entering microgrids.

South African start-up, Sun Exchange owns solar panels installed in the sunniest locations on earth and lease them to businesses and communities in developing nations. The owners of the solar panels receive rental income through bitcoin and/or national currency. By breaking down ownership to a single solar cell, it could reduce the cost of going solar by two orders of magnitude. Sun Exchange won several awards for its work such as Best Blockchain and Bitcoin Business in Africa 2016 & 2017, the 2017 SDO Global Blockchain Challenge in Dubai and won the 2017 Mondato Award for Social Impact in Sub-Saharan Africa. Thus, Sun Exchange raised 1.6M USD in seed funding in Oct. 2017.

Sun Exchange partners with Powerhive focusing on microgrid development and the partnership accelerates progress towards global energy access. The US company, Powerhive partners with utilities and independent power producers (IPPs) to provide access to productive, affordable and reliable microgrid electricity for millions of rural homes and businesses around the globe. Powerhive now provides tools and services for implementing rural electrification projects in energy access markets worldwide and its portfolio include Honeycomb, a cloud-based software platform automating account management tasks, remotely monitors and controls microgrid operations, and runs real-time data analytics. its smart meter, 'Asali' handles complex operations for off-grid microgrid app and there are 'Site Wizard for Analysis' and 'Mapping', a solution that streamlines project development by enabling microgrid site selection and customer identification. The company also provides services for microgrid operations management and project development.

Over one billion people and 625 million in Africa live without electricity. Thus, they combine decentralized solar power with innovative technologies and financial instruments such as blockchain and digital currencies. Powerhive is the exclusive recipient of proceeds designated for solar project pre-financing from sales of Sun Exchange's SUNEX rewards token, a cryptocurrency designed to catalyze solar development and make using Sun Exchange platform more rewarding. Powerhive uses the funds for building solar-powered rural electrification mini-grid projects. The solar panels are offered to Sun Exchange members, who can own cells and earn decades of "solar-powered money" from the electricity. When fully subscribed, it catalyzes USD 23 million of capital for Powerhive's solar powered microgrid roll out. Through Sun Exchange online solar panel micro-leasing platform, anyone, anywhere across the globe can earn income while helping to bring clean, sustainable, affordable solar power to organizations such as schools, small businesses, hospitals and NGOs in emerging markets. Sun Exchange runs a token sale event for its new rewards token, SUNEX, which aims to make the Sun Exchange user experience more lucrative and rewarding[21].

In regards with IPP settlement, BTL (now Interbit in 2019) develops a multi blockchain platform, 'Interbit' targeting enterprises (B2B) and run an energy trading pilot with and Wien Energie. This was successful in all 8 test scenarios and are looking to broaden the scope of the pilot and progress to the next phase. BTL has interest from a larger consortium for the next phase of the trading project and it files patent applications for 'Interbit' platform. Currently, BTL is a publicly traded company on the Toronto Stock Exchange[22].

4.4 Type 4: Emergent partnership

The emergent partnership allows an exploration of potential business and start-ups have tight links to its operating capabilities of company. Exploring the potential market is difficult for the company. Thus, investing in a start-up to enter this uncharted territory provides information that could never be gleaned from the hypothetical questions of a market research survey. Blockchain's added value lies in its decentralized nature than in its mere performance as

an information management solution. Thus, blockchain's benefits appear stronger in areas where this technology enables novel sets of transactions or facilitates new information flows, that is, where it affects the way markets work. In the energy sector, this could be the case for local energy (microgrid) market and P2P electricity exchanges and B2B processes between energy companies including decentralized exchange and its retail trading.

In local energy market & P2P energy network, blockchain is disruptive. Small-sized energy transactions between two parties are cost-efficient and energy consumers have an increased incentive to act as suppliers (Prosumer) of the excess energy e.g. their solar panels and take a role in energy supply sourcing such as local production sources. One of these projects is run by US start-ups, LO3 Energy for energy and Consensus Systems. They develop a "virtual" microgrid platform in Brooklyn, allowing participants to trade locally the energy they produce and buy from their neighbors, while relying on the local distribution infrastructure. The project is enabled by both a blockchain-based trading platform developed by LO3 Energy and a microgrid management solution provided by Siemens. After that cooperation, Siemens finally invested in LO3 Energy early 2018. With the partnership between LO3 Energy and Siemens, LO3 Energy established Brooklyn Microgrid (blockchain-enabled community power), which is enabled by blockchain technology to manage internal energy transactions[23]. The Brooklyn Microgrid platform developed by this partnership is meant to be a local P2P retailer of electricity, an energy exchange platform for prosumers. The first experiment in 2016 located in Gowanus neighborhood in Brooklyn, and as of 2017, this project is in talks with the state regulator to be an official retailer.

In P2P energy exchange, Power Ledger leverages the large share of homes equipped with solar panels (25% of houses in Western Australia), which produce excess electricity at certain times of day, with no possibility to monetize this energy. Through blockchain, connected users can sell this excess electricity to their neighbors, or purchase from them when relevant. Power Ledger platform has two objectives: Incentivizing usage of the grid for prosumers by simplifying sale of power and acting as an energy exchange platform for prosumers. First trial in Western Australia with 15 residential homes, one retailer and one Distribution system operator (hereafter DSO). After small-scale trials, Power Ledger started a new microgrid pilot in Auckland and New Zealand with 500 homes, one retailer and one DSO, Vector.

Further P2P energy exchange project has been planned by Fremantle city which has partnership with Power Ledger. In November 2017, the Australian government provides $2.57 million in funding for a project in the City of Fremantle. $5.68 million is funded through project partners including Curtin University, Murdoch University, Curtin Institute of Computation, LandCorp, CSIRO/Data61, CISCO and Power Ledger. The project uses blockchain-powered distributed energy and water systems. Power Ledger provides the transactional layer for the renewable assets, the energy and water systems, as well as the ownership model for the community owned battery and maintains all blockchain apps which demonstrate how blockchain works with co-located assets as well as assets at other locations, such as an off-site solar farm which is planned for South Fremantle. The data interfaces with water assets. Power Ledger's first step is to procure the battery and work with various stakeholders to find the best location for it within the City of Fremantle. The project is just getting started and will conclude on June 30, 2019[24].

Conjoule, a joint start-up developing P2P energy markets enabled by blockchain technology collected €4.5 million from two strategic investors, TEPCO and the innogy Innovation Hub in July 2017. With this investment, Conjoule launches the platform and initial product that have been in pilot in selected markets in Europe, as well as starts the development and testing of the next products. Conjoule was founded by innogy Innovation Hub and spun-out to the external market to build the distruptive energy marketplace enabled by blockchain technology. Conjoule develops a P2P marketplace for producers

and consumers of renewable energy, as well as owners of batteries and other sources of flexibility, to transact with each other without the need for traditional intermediaries. The platform allows residential prosumers with solar photovoltaic installed on their homes to sell excess electricity to local consumers, have been piloted in two German cities[25].

Blockchain can accelerate the redefinition of current smart grid operators and energy suppliers' role with the increase of renewable production sources. If applied at a large-scale, implementation of P2P energy exchanges would have disruptive effects on retailers and current DSOs like Vector place in the new energy ecosystem. Assuming a long-term scenario where energy prosumer would manage a large share of their energy needs through their own production and the direct purchase of energy from local production sources, the retailer ultimately would be an insurance firms supplying the mere difference between consumption and what is directly sourced by the consumer. It can also support local platforms connecting prosumers and local production assets within so-called "energy communities".

Producers and consumers can manage the supply of electricity and incentives can be introduced, as it would be progressively challenging for grid operators to recoup their costs over such a shrinking usage base. It is opportunity for DSOs who are well-placed, close to local production sources, to play a role in the introduction of blockchain in local energy markets. It raises issues for Transmission System Operators (hereafter TSOs) and DSOs to manage the coexistence of different systems, to deal with local imbalance and ensure that energy is supplied. Some of the issues can be linked to the transformation of energy systems towards a more decentralized exchange model. A case of a joint venture started by the Rocky Mountain Institute and Austria(Vienna)-based start-up, Grid Singularity explores the potential of blockchain on energy transactions attracting a new joint venture of partnerships, "Energy Web Foundation" started in May 2017 by a partnership between Rocky Mountain Institute and Grid Singularity. Major energy companies including Engie, Elia, Shell, and Statoil partnered with Rocky Mountain Institute and Grid Singularity to support this Foundation which is a non-profit organization seeking to accelerate the introduction of blockchain-based technologies in energy markets[26].

Potential use cases in the energy sector include the optimization of retail energy trading system, the management of industrial assets' maintenance, and new disruptive services. As an example, in May 2017, some European utilities including Engie, RWE, Total, Uniper, Vattenfall teamed up with Ponton, a German venture of blockchain supported energy trading, to test blockchain-based trading of energy as part of a project named 'Enerchain'. Ponton is part of the "NEW4.0" ("Norddeutsche Energiewende" – northern German energy revolution) project, which has started in December 2016. The project is financed by the German Ministry of Economics and Energy with 44 Mio. Euro and aims at developing standards and technologies to support an efficient way to cope with volatility of renewables. "NEW 4.0" aims at balancing production and consumption locally in the Schleswig-Holstein and Hamburg, the first being one of the largest net exporting regions, the latter being a huge consumer right nearby.

Ponton's contribution to "NEW 4.0" is the development of a market for flexibility. This marketplace is a logical venue that executes orders from the demand and supply side. Traded products are short-term regional consumption or generation, both provided at market prices. Ponton's vision is to use the blockchain as a joint data layer to coordinate market activities such as the submission of buy or sell orders and the execution of trades. Users of this system are DSO, TSO, industrial and private prosumers[27].

Ⅴ. Conclusions

The summary and the related use cases in 2017 are as table 1.

In enabling partnership, Slock.it develops an open

source infrastructure where manufacturers and users can monetize their unused energy assets including apartments, industrial machinery, sports equipment, etc. It is "Share & Charge," allowing EV drivers to share their charging stations and benefit from the transactions and is successful by a productive R&D partnership with RWE. RWE's goal is to build a network of private charging station to supplement their charging stations. After this partnership, innogy SE, Germany's leading charging network operator, wins largest funding allocation to install 1,245 new charging stations (equal to 2,490 charging points) from the "Federal program for charging infrastructure" from government in 2017. In Germany, Innogy, subsidiary of RWE already has operated 4,600 charging points in 635 cities and districts, around 2,200 of which are publicly accessible as of 2017[28].

In passive partnership, TEPCO's investment with an undisclosed sum in Electron which focuses on blockchain to establish reliable systems for the energy sector. Even if blockchain could democratize the current energy industry, the electricity still needs to travel down poles and wires, for which the transmission and distribution companies like TEPCO want hard cash. The blockchain can be used at either end of the grid. In infant stage, energy companies can employ blockchains in which only trusted participants can join, making the process of maintaining the blockchain faster and less energy-hungry. Ironically, legacy utility company would like to use blockchain to remain central to the decentralization of electricity. Thus, in the passive partnership, blockchain start-ups would achieve commercial traction and work within the existing system and partner with incumbents such as utilities[29].

Table 1. Research Summary

Partnerships	Blockchain Applications	Current Energy Companies (nation)	Blockchain Start-ups (nation)	Name of Projects or Joint Ventures
1) Enabling	EV charging	RWE (Germany)	Slock.it (Germany)	
2) Passive	Customer switching	TEPCO (Japan)	Electron (UK)	
3) Driving	Microgrids	Powerhive (USA)	Sun Exchange (South-Africa)	
	IPP Settlement	Wien Energie (Austria)	BTL (UK-Canada) → Interbit Ltd. from 2019	
4) Emergent	Local energy market and P2P energy networks	Siemens (Germany)	LO3 Energy (USA)	Brooklyn Microgrid project
		Vector & retailers (Australia)	Power Ledger (Australia)	Fremantle Smart City project
		TEPCO (Japan)	Innogy Innovation Hub (Germany)	Conjoule (Joint venture after spin-out)
	Decentralized exchange	Rocky Mountain Institute (USA)	Grid Singularity (Austria, Wien)	Energy Web Foundation (EWF)
	Retail trading & settlement	New 4.0Forum(Energy companies of Europe)	Ponton (Germany)	New 4.0 Forum's 'Enerchain' project

Driving partnership promotes the sustainable growth of current business. In case of microgrid of Powerhive focusing on microgrid development, this company partners with South African start-up, Sun Exchange owning solar panels installed in the sunniest locations on earth and lease them. This partnership utilizes the crypto-economy to provide greater access to energy in rural Kenya. Sun Exchange allows users to buy solar panels with cryptocurrencies and lease them to various projects, while Powerhive's role is the development, financing, and management of bankable solar micro-grids[30].

As a deal of IPP settlement, BTL (now Interbit as company name in 2019) develops a B2B platform with a pilot with Wien Energie. Ultimately, they can reduce the costs of energy trading, transaction processing, bookkeeping and administration industry-wide. BTL is among the first blockchain platform developers to widely market what's billed as a commercial-grade, enterprise-scale blockchain-based transaction processing and record-keeping platform. 'Interbit' is an open, multi-chain, asset settlement platform with a suite of APIs and smart contracts that allow businesses from across the world to provide global access to fast, secure, and auditable financial and asset trading services and Wien Energie can expand its distributed solar and wind power services and investments with partnership[31].

For emergent partnership deals, obstacles like technical, regulatory and sovereignty issues should have to be overcome before blockchain proofs-of-concept turn into more robust and scalable large-scale applications. On the technical side, the priority issue is to ascertain the scalability of blockchain-based applications. In the shorter term, current limitations could be remedied more easily in a localized setting, for example to allow just P2P energy exchanges at the local scale. Most current

blockchain protocols don't ensure a clear level of sovereignty for national policy makers to support their usage at the center of energy systems. The concentration of data mining activities is a critical issue and it may call for specific blockchain protocols designed to remedy these concerns. The regulatory frameworks are slow-moving. Thus, global project or joint venture activity is not easy for enabling new disruptive business models to emerge and start-ups to develop.

Nevertheless, in the emergent partnership, first case is a technical cooperation of LO3 Energy and Siemens for "Brooklyn Microgrid (BMG)" project. This allows prosumers with an excess of solar energy to directly sell to their neighbors and contribute to the local economy and similar project can be expanded to other countries. Second case takes place between Power Ledger and Vector for 'Fremantle City' project which can be expanded to other areas. Last case is a joint project 'Conjoule' between innogy Innovation Hub and TEPCO.

For decentralized exchange, a joint project, 'Energy Web Foundation (EWF)' co-created by Rocky Mountain Institute and Grid Singularity, is developed as a common open source network based on blockchain which can be used by a variety of energy stakeholders. It is expected to develop more disruptive business use cases which can be built on this network. Grid singularity works on the creation of a permissioned decentralized energy data exchange platform built on blockchain.

For retail trading and settlement, ponton has partnerships with energy companies in Europe to create New 4.0 Forum's 'Enerchain' project. Ponton is the driving force behind this, a decentralized energy trading platform for the wholesale energy market which is supported by more than thirty of the leading European Energy Trading companies.

In conclusion, it is a great challenge for start-ups that have a battle for sustainable and disruptive growth of energy industry, firstly on technology issues to make it viable and work in tests, secondly on competitiveness and convenience compared to other existing solutions to enabling current market adoption and early financial revenues, and lastly on disruptive business models and regulatory issues as well. With this research, it is expected for blockchain start-ups in energy data management, IT giants, and energy companies to capture a more significant part of the energy as a service and to work together. IT is not considered as a competitive advantage of energy companies due to their own IT capabilities and perceived IT user experience for B2C or B2B clients. However, adopting blockchain-based technologies could enable energy companies to explore new ways to develop stronger relationships with their customers and adapt to propose new disruptive services and business models.

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