KLEROS

COULD KLEROS BE USED TO SOLVE DISPUTES IN A PEER-TO-PEER ENERGY MARKET?

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Introduction

Blockchain has been suggested as the next big technological advance - impacting everything from online transactions to energy trading. Blockchain can be described as a distributed and immutable ledger that stores information (or data) in blocks. These blocks are structured in the form of a "chain" sequence stored on various nodes ("computers"), which ensure that no single person or entity can manipulate the ledger without everyone else knowing.

The potential effect of blockchain extends far beyond its potential use in payments, finance, and smart contracts. Blockchains blend several existing concepts including peer-to-peer networks, public-private key, cryptography, and consensus mechanism, to create a highly resilient and tamper-resistant technological advancement. This new technology has enabled the transfer of digital currencies, the management of valuable assets, and-perhaps most profoundly, facilitating the trade of surplus electricity.

According to the Energy Market Barometers conducted by Grenoble Ecole de Management (GEM)[1] in December 2018 "*[p]eer-to-peer energy trading and electric vehicle charging and sharing[2] are the most promising applications of blockchain technology*." Thus, it is expected for Blockchain in the energy industry to gain momentum, since it is a technology that has the potential to optimize energy efficiency and cope with a decentralized energy market.

The concept of what blockchain technology can do for distributed energy makes sense and the technology will likely be implemented at a larger scale in the upcoming years. However, for a full implementation of this technology, the users must rely on adequate mechanisms to solve disputes effectively.

Differences of needs, values and interests provide fertile ground for conflicts. Therefore, if the energy market is moving towards a decentralized market, the mechanisms to solve disputes should trend in the same direction. Rather than using centralized governmental mechanisms, alternative dispute mechanisms, such as Kleros, could be used to solve disputes between buyers and sellers in a decentralized market powered by blockchain and smart contracts.

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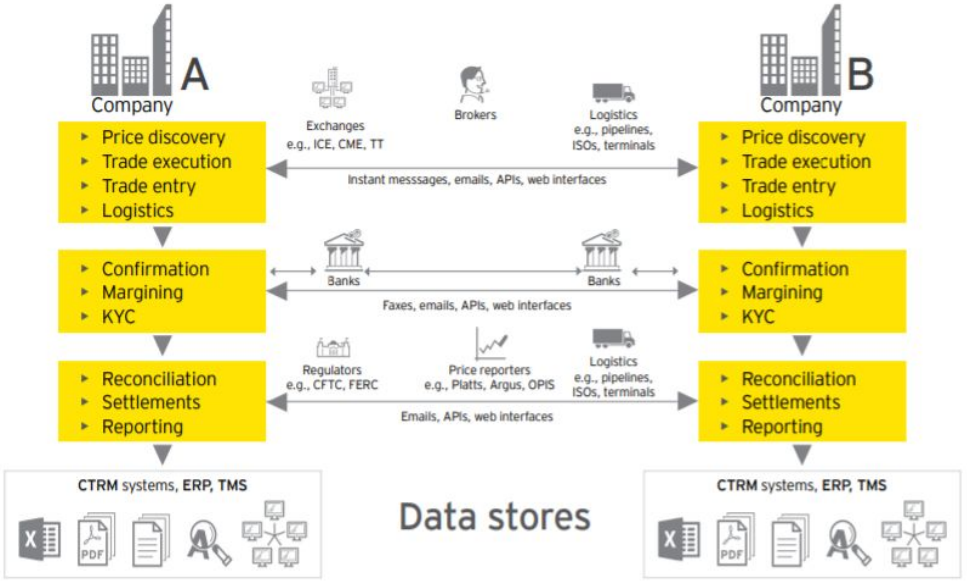
[1] Grenoble Ecole de Management, The Winter 2018 Edition of the Grenoble Ecole de Management (GEM) Energy Market Barometer, 2018: Available at: https://en.grenoble-em.com/sites/default/files/public/kcfinder/files/Barometer-2018-Winter-EN.PDF [accessed August 25, 2019]

[2] For example, BlockCharge by RWE and Slock.it are developing a mobile phone app, which links to a blockchain-based network that allows electric vehicle (EV) owners to charge their car via any charging station network and to be billed for the energy consumed.

1. Blockchain in a Decentralized Renewable Energy Market

Historically, centralized energy generation has been used to satisfy the electricity demand. The energy and power that is generated is translated into data that gets logged in a spreadsheet. The spreadsheets are then sent to a central authority, where the data gets entered into the system (grid) and certified. A second set of intermediaries' such as wholesale entities, promote deals between buyers and sellers for the power and electricity generated. Hence, this system relies on the trust granted by a central authority (normally a governmental entity). Furthermore, the current electricity market comprises brokers, trading agents, exchanges, price reporters, logistic providers, banks and regulators.

However, the intervention of middlemen in the supply chain of electricity affects the consumer, racking up transaction costs. Additionally, the use of obsolete spreadsheets includes accounting errors that can range from honest mistakes to outright fraud. Although it is not common for participants to execute false transactions due to the highly regulated nature of the industry, there have been incidents that have affected the consumers and the credibility of the industry.[3]



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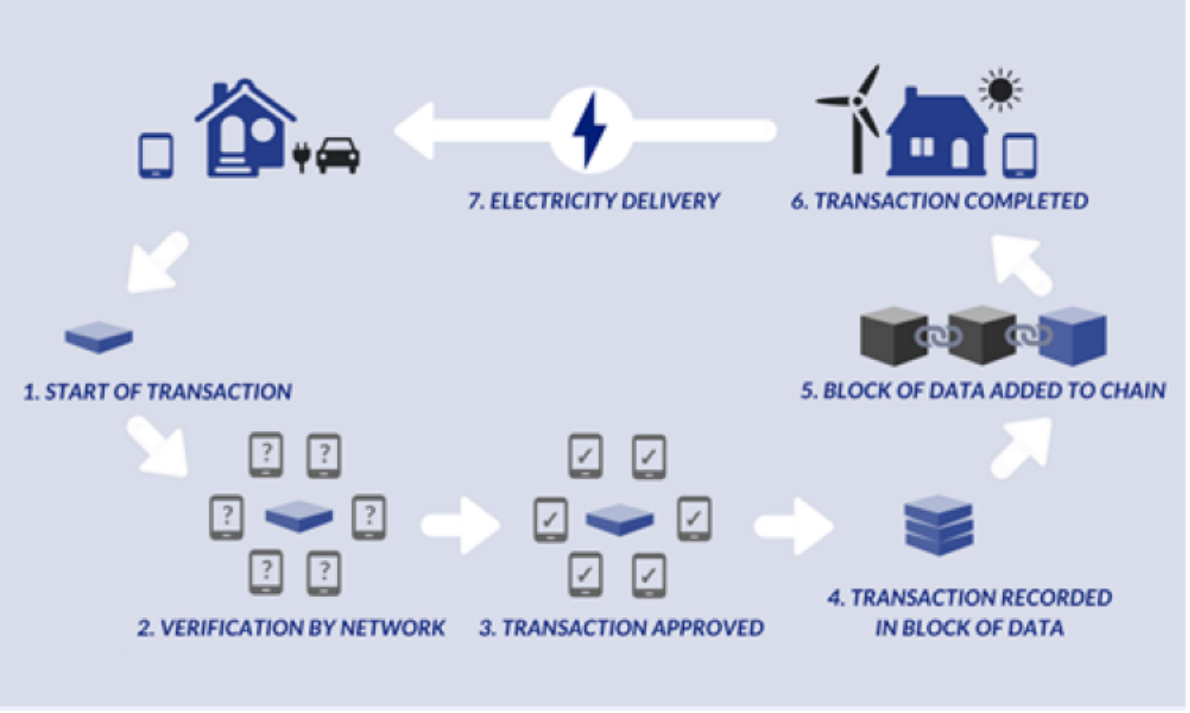
[3] For instance, Panda Power sued the Electric Reliability Council of Texas for intentionally manipulating projections to encourage new power plant construction to increase generation in the state. This resulted in pricing errors, mistake-ridden forecast and transaction fees paid by consumers. See. Panda Power Generation Infrastructure Fund, LLC, D/B/A/ Panda Power Funds v. Electric Reliability Council of Texas, Inc., 05-18-00611-CV.

[4] Image from Ernst & Young. Overview of blockchain for energy and commodity trading, Available at: http://www.ey.com/Publication/vwLUAssets/ey-overview-of-blockchain-for-energy-and-commodity-trading/FI

Energy markets are evolving and shifting into decentralized markets. Energy systems are undergoing a transformational change triggered by the advancement of blockchain. Blockchain technology is providing decentralized energy systems a new way to organize themselves and is steadily becoming a central part in electricity markets of the future.[5] Furthermore, decentralized energy generation and blockchain technology are enabling more democratic and decentralized markets.

The 4th Industrial Revolution is providing us with the ability to create decentralized energy grids, linked to the emergence of smart contracts, blockchain, and the internet of things (IoT). A peer-to-peer energy market comprises a distributed network of individuals who trade and buy excess energy from other participants.

In a decentralized market, transactions are executed on smart contracts, while smart meters provide the data necessary to execute those transactions. In these smart contracts, the parties agree when they will trade electricity at what price and how the energy will be paid. This new trend is providing an automated secure way to buy and sell electricity.



[6]

LE/ey-overview-of-blockchain-for-energy-and-commodity-trading.pdf, [accessed September 2, 2019]

[5] Burger, C., Kuhlmann, A., Richard, P., Weinmann, J. Blockchain in the energy transition a survey among decision-makers in the German energy industry, 2016. Available at: https://shop.dena.de/fileadmin/denashop/media/ Downloads_Dateien/esd/9165_Blockchain_in_der_ Energiewende_englisch.pdf, [accessed August 6, 2019].

[6] Image from Shelton, Sadie., Blockchain Technology Can Boost Climate Action, Available at: https://samples.ccafs.cgiar.org/blockchain-technology-can-boost-climate-action/ [accessed September 6, 2019].

Furthermore, this new business model can reduce control from central authorities, thus saving the relative costs of an intermediary. Blockchain could eliminate the middleman, reduce transmission and distribution costs and enable consumers to participate, directly, in the electricity market. In a peer-to-peer market in the energy industry, consumers will increasingly move into the focus as market participants. Blockchain technology will allow consumers to become "prosumers"[7], as they will become involved in generation of energy and trade that energy actively in the market via small-scale interactions.[8]

For instance, prosumers are starting to generate their own solar energy from rooftop panels, trading in near-real time with neighbors. That is why the Blockchain In Energy report by Wood Makenzie[9] shows that 59% of blockchain energy projects are building peer-to-peer energy markets.

However, for energy trading on blockchain, regulatory speedbumps often appear. In the renewable energy industry, there are participants such as consumers, state-owned companies, and central authorities. Also, other factors play a role, such as the political decisions regarding whether electricity should be traded for profit or it is a public service that must be provided at the lowest price conceivable with the sponsorship by the state. This is not technological discussion, but clearly a regulatory decision. Therefore, the implementation of blockchain in the energy sector will be affected by the regulatory conditions of each respective country.

Although the current structure of energy markets is highly regulated and controlled by a few players, early blockchain developers are implementing decentralized energy marketplaces using Blockchain and smart contracts.

2. Use of Smart Contracts in the Renewable Energy Industry

Smart contracts are one of the most interesting promises from the blockchain. Agreements that could automatically execute, written in code, after the conditions (functions) have been met. Obviously, a smart contract could be complex depending

[7] Alvin Toffler in his book The Third Wave (1980), proposed the notion that consumers are a phenomenon of the Industrial Age. As society moves toward the Post-Industrial Age, so will the number of pure consumers decline. Consumers will be replaced by "prosumers," that is, people who produce many of their own goods and services.
[8] Mylrea M. Gourisetti SNG. Blockchain for smart grid resilience: Exchanging distributed energy at speed, scale and security. In: Proceedings of the Resilience Week (RWS) 2017, IEEE, 2017, pp. 18–23.
[9] Wood Makenzie, Blockchain for Energy 2018: Companies & Applications for Distributed Ledger Technologies on the Grid. Available at: https://www.woodmac.com/reports/power-markets-blockchain-for-energy-2018-companies-and-applications-for-distributed-ledger-technologies-on-the-grid-58115325, [accessed September 15, 2019].

on the magnitude. A smart contract could rely on oracles or other decentralized applications. However, the use of smart contracts translates to the reduction of transaction costs. Furthermore, smart contracts reside in a decentralized system that is not controlled by an intermediary party.[10]

Many of the new blockchain electricity projects use smart contracts to communicate with smart meters (powered by IoT) that are connected to electrical systems. While smart meters track the electricity produced and consumed, a Blockchain-based decentralized application records the smart contracts and enables automatic peer-to-peer transactions. These technologies coupled together allow to directly trade with a consumer or an energy retail supplier via autonomous trading agents cutting out the middleman.

For instance, you could program a smart meter to sell solar electricity from your home at a given price when a surplus is available. If those two situations are met, the device executes the contract. No need for written contracts drawn up by lawyers and signed by all the parties. A smart contract is executed between the two devices. Furthermore, the consumer knows that he is purchasing clean energy for the price you requested.
In a decentralized market powered by smart contracts, the consumer will search for the best deal in the marketplace that satisfies a forecast demand for electricity. The agreement would be safely recorded in the blockchain and automatically executed. Furthermore, that data would be available to all parties and the system in general, by the use of distributed ledger technology.

A smart contract can ensure that energy is delivered automatically, eliminating third parties or retailers. Hence, the value underlying smart contracts is the trust in transactions between strangers. The use of blockchain to decentralize energy supply and transaction systems ensures the elimination of third parties in the energy sector resulting in a reduction of cost for the end consumers. There will no longer be any need for such intermediaries like energy companies, banks or traders. Instead, blockchain-based smart contract applications would enable direct relationships between producers and consumers. In other words, the consumer of energy will be one of the greatest beneficiaries of the upcoming blockchain transformation.

3. Blockchain-Based Energy Projects

The current energy sector is based on centralized authorities and plants that generate power and electricity. Just in recent years, a growing number of smaller "distributed"

[10] Grewal-Carr V, Marshall S. Blockchain Enigma. Paradox. Opportunity, Available at: https://www2.deloitte.com/content/dam/Deloitte/uk/Documents/Innovation/deloitte-uk-blockchain-full-report.pdf, [accessed October, 1 2019].

power generators, like rooftop solar panels and electric-vehicle batteries have been connecting to centralized grids.

However, blockchain technology allows decentralized contractual transactions, satisfying the cyber security concerns for data. These features that can be implemented in the energy field, as proven by the following projects:

A. LO3 Energy:[11]

A company with a focus in energy, finance and technology. Their projects use smart meter technology to measure a building's energy production. Furthermore, using Blockchain technology, the energy that is generated is stored and traded, which is verified, and added to a distributed ledger. Consequently, prosumers that are generating energy through their own renewable resources can transact energy autonomously in near-real time with consumers in their local marketplace .LO3 Energy has partnered with Transactive Grid[12] to develop the Brooklyn Microgrid, an early example of an open-source and scalable blockchain platform for the energy sector in which solar energy from rooftop panels are traded in near-real time with customers in the local Brooklyn market in New York. Additionally, in partnership with EnergieSüdwest[13] and Karlsruhe Institute of Technology (KIT)[14], the company wants to change the energy market in the Lazarettgarten microgrid in Landau, Germany. Similar approaches are being taken in Texas in partnership with Direct Energy[15] and the United Kingdom in partnership with Centrica[16].

B. Power Ledger:[17]

An Australian tech startup involved in a variety of blockchain applications for energy systems. The most mature application is the development of a residential peer-to-peer electricity trading marketplace between prosumers. As Power Ledger describes it:

> "If you have solar panels on your rooftop you can use our platform to sell excess energy to your neighbor. If you have battery storage you can store your energy and sell it at the peak to maximize your profit from the solar power you generate. Similar to trading shares on a stock exchange you can set buy and sell prices so that you can trade energy at the right price for you. We give you security and peace of mind, by recording all transactions on the blockchain."

[11] https:// lo3energy.com
[12] https://www.sciencedirect.com/science/article/pii/B9780081022078000102
[13] https://energie-suedwest.de/
[14] https://www.kit.edu/kit/english/pi_2017_155_practical-test-for-the-future-energy-market.php
[15] https://lo3energy.com/direct-energy-business-lo3-energy-houston/
[16] https://www.centrica.com/news/centrica-and-lo3-energy-deploy-blockchain-technology-part-local-energy-market-trial-cornwall
[17] https://www.powerledger.io

Currently, Power Ledger is involved in more projects in several countries including Tasmania, Japan, United States, Austria, Thailand and Lichtenstein.

C. Alliander:[18]

A project developing a peer-to-peer energy sharing platform. Initially called Jouliette at De Ceuvel, the project was re-named Spectral Energy Xchange (SPEX). The project harnesses the capabilities of blockchain technology to provide a transparent and robust transaction system for automated negotiation and settlement of energy and flexibility trading. Moreover, with this project, energy will be exchanged within the smart grid in a peer-to-peer fashion. Furthermore, the SPEX platform can display real- time power flows of the community and uses AI algorithms to predict energy production and consumption.

D. Stratum:[19]

Stratum is a company incorporated under Paris, looking to solve complex inter-business problems with systems powered by blockchain networks. Stratum partnered with Bouygues Immobilier, Microsoft and Energisme to build a Smart Grid blockchain solution for the local energy production and delivery in Lyon, France. With this platform, prosumers are allowed to produce their own solar energy and sell it directly to nearby consumers. With a similar approach as other projects, clean energy can be provided at a lower cost to consumers.

E. Electrify Asia:[20]

Electrify Asia is an energy technology company that is building sustainable energy ecosystems through the development of transactive energy for the Asia Pacific. With their project Synergy, prosumers who own rooftop solar panels can sell energy to friends, neighbors, and strangers across a city-wide grid. On the other hand, consumers can purchase power directly from small-scale solar power producers, eliminating intermediaries and reducing energy costs for everyone.
Instead of listing more and more innovative projects using blockchain, the industry is prone to be disrupted with over 50 similar[21] projects around the world. These projects rely on a simple, yet true, idea: blockchain can simplify the current energy system structure by enabling a direct market between producers and consumers. The only requirement for realizing this simpler way of operation would be to adjust the way the

[18] https://www.alliander.com
[19] https://stratumn.com
[20] https://www.electrify.asia
[21] Ogushi, Albert., Energy Blockchain Cases January 2019, Available at: https://medium.com/energy2030/energy-blockchain-cases-january-2019-23ea4e5e539d, [accessed October, 6 2019].

grids and networks are controlled. Instead of relying on central authorities and heavy regulations, the industry can rely on market dynamics, trust of the participants, and technology.

4. Disputes in the Energy Sector

Disputes relating to the energy sector may occur with a great diversity of producers, stakeholders and off takers who will all opt for different solutions. However, across the supply chain, consumers are being hit the hardest as a result of energy disputes. Most of the time, consumers are the ones that suffer the most and do not have any recourse to solve their disputes. For instance, according to a 2017 study for Ombudsman Services, it was reported that consumers experienced more that 173 million issues with products and services, yet only 27% of the claims were raised with the provider.[22]

For consumers, disputes may be caused by: i) problems related to the price or charges to the bill; ii) an excessive price due to a hardware problem in the meter; or, iii) an irregular supply of electricity. In many jurisdictions, such as Guatemala, a dispute will not be solved directly with electricity retailers and suppliers. In Guatemala, a consumer must file a complaint with the National Commission of Energy if a dispute or problem arises with the electricity retailer and hope for the best. There are no other procedures, resources or alternatives for a consumer. Furthermore, a consumer will not file a claim or even try to solve a dispute, especially if the fees for a lawyer are equal to, or bigger than, the sum of the claim.

For example, most European jurisdictions[23] provide mechanisms to solve disputes between a consumer and an electricity supplier[24]. However, not all mechanisms are created equal.

[22] Oxford Economics, Consumer detriment. Counting the cost of consumers problems, Available at: https://www.oxfordeconomics.com/recent-releases/consumer-detriment-counting-the-cost-of-consumer-problems, , [accessed November, 1 2019].
[23] See Table I
[24] According to the *DIRECTIVE 2009/72/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL* of 13 July 2009 concerning common rules for the internal market in electricity, greater consumer protection is guaranteed by the availability of effective means of dispute settlement for all consumers. Member States should introduce speedy and effective complaint handling procedures.

Austria	E-control - http://www.e-control.at
Belgium	Service de médiation de l'energie - Ombudstienst voor energie - https://www.mediateurenergie.be
Bulgaria	Държавна комисия за енергийно и водно регулиране (State Energy and Water Regulation Commission) - http://www.dker.bg
Croatia	https://www.hok.hr/sud_casti
Cyprus	Ρυθμιστική Αρχή Ενέργειας Κύπρου (Cyprus Energy Regulatory Authority) - https://www.cera.org.cy/
Czechia	Mimosoudní řešení sporů - Out-of-court Dispute resolution - https://www.eru.cz/mimosoudni-reseni-sporu
Denmark	Ankenævnet på Energiområdet - Energy Supplies Complaint Board - www.energianke.dk/
Estonia	Konkurentsiamet - Estonian Competition Authority - http://www.konkurentsiamet.ee
Finland	Kuluttajaneuvonta - Consumer Advisory Service - https://www.kkv.fi/kuluttajaneuvonta/
France	Le médiateur national de l'énergie - The energy ombudsman - http://www.energie-mediateur.fr/
Germany	Schlichtungsstelle Energie - https://www.schlichtungsstelle-energie.de/
Greece	Συνήγορος του Καταναλωτή - Hellenic Consumer's Ombudsman - http://www.synigoroskatanaloti.gr/index.html
Hungary	Magyar Energetikai és Közmű-szabályozási Hivatal - Hungarian Energy and Utilities Regulatory Office - http://www.mekh.hu/
Ireland	Commission for Regulation of Utilities - https://www.cru.ie/
Italy	Il Servizio Conciliazione dell'Autorità per l'energia - https://www.arera.it/it/consumatori/conciliazione.htm
Latvia	Sabiedrisko pakalpojumu regulēšanas komisija - The Public Utilities Commission - https://www.sprk.gov.lv/
Lithuania	Valstybinė kainų ir energetikos kontrolės komisija (National Control Commission for Prices and Energy) - http://www.regula.lt
Luxembourg	Institut Luxembourgeois de Régulation - http://www.ilr.lu
Malta	Regulator for Energy and Water Services (REWS) - https://www.rews.org.mt/#/en/home
The Netherlands	De Geschillencommissie - https://www.degeschillencommissie.nl/consumenten/
Northern Ireland	Utility regulator - http://www.uregni.gov.uk
Poland	Postępowania ADR - http://www.ure.gov.pl/pl/koordynator-ds-negocjac/postepowania-adr
Portugal	Entidade Reguladora dos Serviços Energéticos (Energy Services Regulatory Authority) - http://www.erse.pt
Romania	Autoritatea Națională de Reglementare în Domeniul Energiei - http://www.anre.ro/ro/contact/depunerea-unei-petitii
Slovakia	Alternatívne riešenie spotrebiteľských sporov - http://www.urso.gov.sk/?q=node/394
Slovenia	Javna agencija Republike Slovenije za energijo (Energy Agency of the Republic of Slovenia) - http://www.agen-rs.si
Spain	Agencia española de consumo, seguridad alimentaria y nutrición - Spanish Agency for Consumer Affairs, Food Safety and Nutrition - http://www.aecosan.msssi.gob.es/AECOSAN/web/consumo/seccion/resolucion_d...

Most of the mechanisms rely on a state-sponsored entity to solve disputes in the electricity market. This "ordinary" mechanism is based on the presumption that the state has a centralized knowledge of any and all types of disputes. Most state-sponsored mechanisms rely on the notion that only the state is qualified to solve disputes. This notion might be because only the state has the power to coerce the execution of a resolution; or, erroneously, because many believe that only the state has prepared individuals (judges) to solve all types of disputes. This has led to

However, in other jurisdictions, there are some Alternative Dispute Mechanisms (ADR) to solve disputes between consumers and suppliers in the electricity business. For

example, Ombudsman Services[25] is a service in England in which they work to help retailers understand their customers, so they can serve them better and resolve problems faster. The energy ombudsman enters as a third party that provides a mechanism for consumers, they hear the dispute and search for a solution, sometimes resulting in the reimbursement and/or compensation to a consumer from the electricity supplier. You can find similar uses of Ombudsman in Arizona[26], France[27], and Australia[28].

Hence, alternatives for the consumer and their disputes must be provided. A state-sponsored dispute mechanism or a few ADR mechanisms are not enough to protect the consumer. If the world is trending towards a distributed and collaborative economy, a decentralized system to solve the disputes could be useful. Furthermore, in a digital era were the states have been found wanting in handling and solving disputes, new distributed mechanisms could be key to promote an accessible, just and equitable market.

5. Kleros in the Peer-To-Peer Electricity Sector

Aside from technology, regulatory concerns will be key to promote a decentralized electricity market. However, the energy industry, especially with peer-to-peer (P2P) energy trading applications, is a perfect implementation field for Kleros.

In its most basic concept, Kleros is a decentralized court system to adjudicate smart contracts. Moreover, Kleros is a decentralized autonomous organization (DAO) that uses economic principles to incentivize users to become jurors and solve disputes on a basis of what is fair, equitable and according to the evidence submitted by the parties.

Kleros uses blockchain technology to promote a decentralized justice system, compatible with a collaborative and digital world. Furthermore, Kleros is expanding to new industries, creating efficient legal recourse and automating the enforcement of rulings through smart contracts.
To understand how Kleros works, I summarize how this decentralized arbitration works in seven simple steps. However, for more information, please refer to the *Kleros Handbook of Decentralized Justice*[29].

[25] https://www.ombudsman-services.org/about-us
[26] https://www.srpnet.com/about/dispute/default.aspx
[27] https://www.energie-mediateur.fr/en/the-energy-ombudsman/presentation/the-institution-statutes-and-organisation/
[28] https://www.ewov.com.au/
[29] https://ipfs.kleros.io/ipfs/QmZeV32S2VoyUnqJsRRCh75F1fP2AeomVq2Ury2fTt9V4z/Dispute-Resolution-Kleros.pdf

1. Parties agree in a smart contract, for a given transaction, that any and all disputes related to the contract must be submitted to arbitration in Kleros. Since Kleros is a voluntary opt-in system, parties must expressly agree to this mechanism.
2. If a dispute arises from the smart contract, a party proceeds to submit the case to Kleros and send all relevant pieces of evidence, which are secured by public key cryptography.
3. A jury will be selected randomly among all the users that entered into the pool of Kleros to serve as a juror. Parties are not allowed to select their juror, reducing significantly the possibilities of a conflict of interest. However, jurors have to act honestly and serve in the "sub court" (i.e. specialization area) in which they are skilled and qualified. For instance, some sub courts specialize in e-commerce disputes; others in digital marketing, and others in programming. If an unqualified actor decides to act as a juror in a sub court, Kleros economic incentives and structure will disincentivize dishonest behavior. For example, I recognize I am not an expert in programming SQL. Thus, I should not enter into the pool for jurors available to solve disputes relating to SQL freelance programming. If I decide to act as a juror, regardless of my lack of knowledge, I will lose the tokens (pinakions) I paid to serve as a juror. Furthermore, I will not be paid for my work as an unqualified juror.
4. Jurors will have access to the evidence for analysis. However, not all sub courts are equal. Different sub courts will have different costs & fees, depending on the complexity of the issues, evidence and the scarcity of qualified jurors.
5. After assessing the evidence and the dispute, jurors adjudicate the dispute, by voting for an option to solve the dispute. However, jurors need to justify their reasoning. If these conditions are met, the option with the most votes will be the solution to the dispute.
6. The decision made by the jury is enforceable using smart contracts and blockchain technology. Instead of relying on ordinary recourse, the technology provides the necessary tools for the execution of the judgment.
7. Finally, qualified jurors are paid for their honest work with more tokens (pinakions) If a juror arrived at an erroneous solution, Kleros assumes that juror who voted incoherently with the rest was not properly qualified. Thus, in the long term, is not economically feasible to solve disputes in a sub court which a juror is not prepared or skilled.

Kleros' peculiar and disruptive approach to justice can be used in an industry that is shifting to a collaborative and decentralized market. Furthermore, Kleros' method of blockchain-based arbitration has the potential become one the most appropriate mechanisms to settle decentralized market electricity disputes in the following ways:

1. Prosumers will have direct recourse for disputes, rather than relying on a state-sponsored entity. Moreover, Kleros could provide the necessary recourse that prosumers have found wanting.
2. Kleros substantially reduces the expenses involved with initiating ordinary

state-sponsored dispute mechanisms. Prosumers will not have to worry about the notion that access to justice is dependent on the lawyers' fees. On the contrary, a notion of democratic access to justice is conceivable, using a decentralized mechanism such as Kleros.

3. Jurors will have the technical knowledge and understanding to solve disputes in a complex matter. Using Kleros incentive structure, jurors that are skilled and qualified will have a reason to serve as jurors and solve disputes. Furthermore, jurors will find new avenues to profit by serving a noble purpose, solving disputes justly and equitably.
4. The decentralized energy projects that use smart contracts are compatible with the infrastructure of Kleros. Furthermore, Kleros infrastructure is philosophically compatible with a decentralized market in the energy industry.
5. Given the infrastructure of Kleros, automatic execution of the judgment embedded in a smart contract is expected. This could promote efficiency in the decentralized energy markets, creating additional incentives for the expansion of the industry. If the necessary mechanisms to solve disputes are implemented, uncertainty and lack of trust in the market is reduced. Furthermore, users will feel comfortable and "safe" to invest in the industry, if there is an adequate and valid forum to solve disputes.
6. For instance, let's use an example. It is 2022 and Federico is a hardworking man living in Guatemala. After saving up enough money, Federico decides to buy two solar panels. As a part of this new investment, Federico connects a smart meter to his panels, which show how much energy is generated.

Federico is not a miner or a hardcore gamer. Instead, Federico is quite a conservative user of energy. He mostly uses a collection of lightsabers from the 12th movie of Star Wars to light most of his home. After a while, his smart meter has shown he has a surplus of energy.

Clement is Federico's neighbor. He is a hardcore Bitcoin miner and is in need of enormous amount of energy for his computing power. Especially since the price of Bitcoin is at US$ 50,000, Clement is using 35 computers to mine Bitcoin. However, Clement is tired of the costs associated with his electricity bill. Sometimes the bill is absurd and Clement believes he is being "ripped off" by large corporations.[30]

On the matinee of the 13th Star Wars movie, Clement and Federico meet. Federico tells Clement about his brand-new solar panels and the uses of his smart meter. Clement tells Federico that he is in need of "cheaper" sources of energy.

Using the new modern infrastructure in Guatemala, powered by Internet of Things and 6G, Federico decides to sell electricity directly to Clement. Clement requests 5MW

[30] Disclaimer: Investing is risky, do so at your own risk and we advise people to never invest more money than they can afford to lose. Content is for educational and illustrative purposes only and do not imply a recommendation or solicitation to buy or sell a particular asset or to engage in any particular investment strategy.

(megawatts) for a month. The smart meter shows that Federico has a surplus of 5.6

MW. Clement and Federico enter into a smart contract for the transaction of electricity. However, under the advice of their lawyer friend, they incorporated Kleros as the mechanism to solve any and all disputes related to the agreement.

Everything was running smoothly. Clement was mining and Federico was selling the surplus of energy he produced. However, one day, Clement stopped receiving the energy. Clement's home was out of electricity for 12 hours and he confronted Federico about it. Clements wants compensation for the 12 hours he was unable to mine Bitcoin and the new cryptocurrency called Sagittarius. Federico tells Clement that this happened because he exceeded the 5MW he requested. However, Clement believes Federico is "ripping" him off, just like large corporations.

Clement and Federico decide to submit their dispute to Kleros in the sub court "peer-to-peer energy". Moreover, each party sends their evidence to Kleros. The jurors are selected randomly, and they come from different parts of the world. Jacob from Australia, Daniel from Brooklyn and Danielle from France. They all have experience in decentralized energy transactions.

After analyzing the evidence, all of the three jurors agree that Clement exceeded his request for 5MW. Furthermore, they learn that the electricity needed to mine Sagittarius is far more than anticipated. The jurors embed their judgment in a smart contract which is automatically executed. Clement receives a notice explaining the motives. On the other hand, Federico is granted monetary damages and restitution of fees for winning the dispute. Instead of feeling ashamed, Clement accepts the outcome and decides he is better off mining Libra (not the cryptocurrency from Facebook which never took off due to regulatory restrictions) instead of Sagittarius. However, Clement was satisfied with the resolution by Kleros. Thus, he keeps transacting with Federico. Rather than losing more than a year in the dispute, it took less than a week to solve the dispute.

This short example could become a real-life situation in the next few years. However, we need to trust our peers and the alternate dispute mechanisms that are provided to solve any potential disputes. Rather than becoming dependent on the state, prosumers can become active participants in democratizing justice. Furthermore, prosumers can become an integral part of a decentralized market, solving disputes efficiently and cordially. If all of this sounds impossible, I simply believe you are underestimating creativity, humanity and innovation.

Kleros has the potential to revolutionize access to justice and dispute resolution. However, Kleros will be implemented as long as blockchain technology continues to improve. This change will not happen overnight. However, there are futurists, innovators and dreamers that are implementing disruptive technologies that will create fertile ground for Kleros to succeed.

6. Conclusion

The energy industry is rapidly transforming, and the "millennial" generation will demand technologies that enable the integration of distributed energy resources. Blockchain, smart contracts and smart meters are drastically changing the way electricity is produced. These new technologies are enabling the increase in energy prosumers as participants of a distributed and decentralized energy market. Blockchain adoption in the energy sector will benefit markets and consumers. This new technology offers disintermediation, transparency and tamper-proof transactions, but most importantly, it empowers prosumers as active participants of a distributed economy.

To achieve this next step in a decentralized economy, key improvement to the blockchain will have to happen for the desired scalability and decentralization. However, different startups, projects and enterprises are experimenting and showing that if Blockchain technology can reach its full potential, it will have a large impact in the way we transact in the energy market.

For the mainstream adoption of Blockchain in the energy market, significant policies and regulations will have to be implemented. Regulatory entities and states will need to endorse the active participation of prosumers in electricity markets. Moreover, there will be a need for integral policies and regulations that create incentives for a decentralized energy infrastructure which can be used and accessed by prosumers. Most regulatory frameworks do not allow peer-to-peer electricity trading. However, as we shift into a digital, decentralized and distributed economy, regulations will need to adopt new ways to promote participation of prosumers. Most importantly, a new regulatory framework will be required to allow flexible electricity prices, which are currently heavily regulated.

Finally, for the mainstream adoption of Blockchain in the energy sector, adequate dispute mechanisms will have to be implemented. Instead of relying exclusively on state-sponsored mechanisms, the market will have to adapt new and innovative alternate dispute mechanisms. The excessive dependence and monopoly from the state to solve energy disputes has led to congestion and inadequate mechanisms. Furthermore, consumers have been affected deeply, sometimes not even attempting to pursue a claim due to the costs, time and frustrations associated with state-sponsored mechanisms.

Ombudsman Services have helped to decentralize the congestion in the state courts and have shown the importance of ADR. However, Kleros is possibly the best ADR tool available for a peer-to-peer market. The infrastructure of Kleros and its economic incentives infrastructure is compatible with a peer-to-peer market. Moreover, Kleros is a decentralized application powered by blockchain that can be perfectly integrated to other decentralized applications.

Although there are sceptics about the potential of Blockchain, there are futurists, innovators, programmers ready to move forward a new culture of innovation. To enter a new era, the first step is the acceptance of the premise that we can do better as humans using technology. Rather than fantasizing about the future, this is an open invitation to become part of creative and innovative projects. Regardless of the industry, anyone can become an integral part of the future. However, to move further and faster in the context of the energy transition, blockchain should be understood as an enabling technology that can support future market dynamics.

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