P-ISSN: 2655-8807
E-ISSN: 2656-8888

Implications of Distributed Energy Development in Blockchain-Based Institutional Environment

Karno Diantoro[1], Dedeh Supriyanti[2], Ardi[3] , Yulia Putri Ayu Sanjaya[4], Sri Watini

STMIK Mercusuar[1], University of Raharja[2,4], Pelita Harapan University[3], University Panca Sakti Bekasi[5]
Jatiwaringin No.144, RT.001/RW.008, Jatiwaringin, West Java, Indonesia[1]
Jenderal Sudirman, Cikokol, Tangerang, Indonesia[2,4]
M.H. Thamrin Boulevard, Kelapa Dua, Tangerang, Indonesia[3]
Hankam No.54, Jatirahayu, Bekasi, West Java, Indonesia[5]
e-mail: karnodiantoro@gmail.com[1], dedeh@raharja.info[2], ardi.kho@lecturer.uph.edu[3], yulia.putri@raharja.info[4], srie.watini@gmail.com[5]

Author Notification
19 July 2023
Final Revised
31 August 2023
Published
01 September 2023

Diantoro, K., Supriyanti, D., Ardi, Ayu Sanjaya, Y. P, & Watini, S (2023). Implications of Distributed Energy Development in Blockchain-Based Institutional Environment. Aptisi Transactions on Technopreneurship (ATT), 209–220. Retrieved from

DOI: https://doi.org/10.34306/att.v5i2sp.343

Abstract

This research focuses on the high urgency of utilizing Artificial Intelligence (AI) and the Internet of Things (IoT) to enhance Smart Tourism Destinations (STDs). The integration of AI and IoT technologies offers unprecedented opportunities to revolutionize various aspects of tourism, from personalized recommendations to real-time data collection. The research aims to provide a comprehensive analysis of the current state, challenges, and future direction of STDs in the context of AI and IoT integration. It explores various AI techniques and IoT-enabled data collection mechanisms that can enrich the traveler experience and improve destination management. However, challenges such as privacy and data security issues need to be addressed. The research also provides foresight into future technologies like Augmented Reality (AR) and Virtual Reality (VR) that can further enhance STDs. The ultimate goal is to contribute to the development of smarter, visitor-oriented tourism destinations. The research highlights the significance of AI in shaping STDs and emphasizes the importance of addressing ethical considerations, data quality, interpretability, and human-AI collaboration to ensure responsible and effective use of AI in the tourism industry.

Keywords: P2P, Blockchain and Decentralized

1. Introduction

The global economy is becoming competitive; conventional energy systems cannot demand the existing requirements. World energy consumption grew by 2.1% in 2017, with fossil fuel energy providing 81% of total demand [1]. Given that climate change through energy efficiency and renewable energy can reduce emission pressures. The share of renewable

P-ISSN: 2655-8807
E-ISSN: 2656-8888

energy is indeed increasing rapidly; in 2017, the world's power supplied as much as 25%. Some countries have high targets, such as the share of renewable energy as much as 32% by 2030 in the European Union (EU) and 100% by 2040 in Sweden [2]

Can harness the power of the renewable environment to contribute to socio-economic growth and environmental sustainability. Distributed energy systems, including energy storage and local renewable sources, will continue to grow by leveraging technological advances [3]. The future of these systems is complex, smart devices that speak in real-time and involve prosumer (both producer and consumer) interactions. The current future cannot be efficiently governed with today's centralized market, communication (ICT) furthermore on mediating energy, distributed energy, and information technology are the focus [4]

Blockchain quickly has momentum in the context of ICT platforms. A distributed ledger that utilizes cryptographic security and consensus procedures is called the "Internet of Values."The emergence of blockchain applications can be disruptive because of their near indestructibility, their quality for a decentralized marketplace, and their immutable nature. Some of the benefits of decentralization include attack resistance, collusion avoidance, price cartels, and fault tolerance.

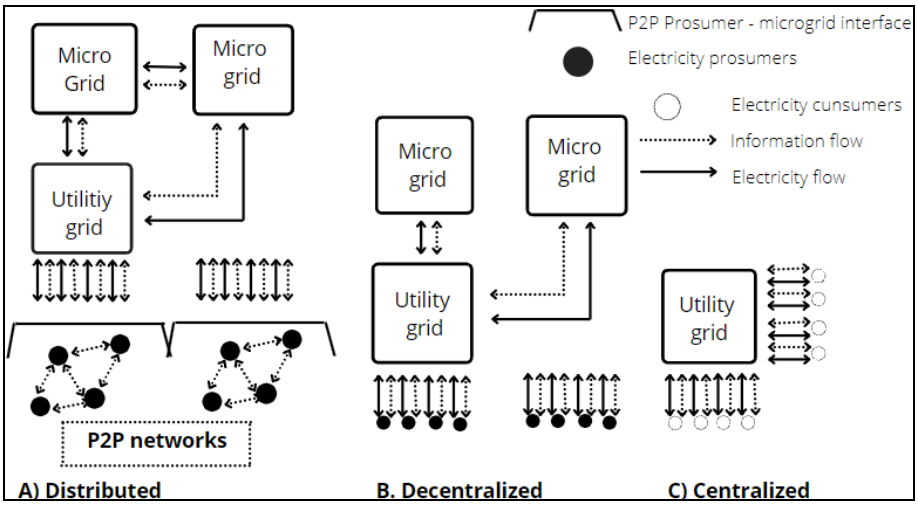

Figure 1. A simple overview of the potential transition from A) Centralized, to B) Decentralized, to C) Distributed energy systems with micro-grids and P2P networks.

In the context of the energy sector, blockchain technology has emerged as a potential catalyst for overcoming challenges and optimizing opportunities therein. In this regard, the term “Blockchain” is often associated with its potential benefits, although further explanation of the key role it can play in addressing various energy sector challenges is still needed. The main focus of this content is the “Internet of Energy” powered by blockchain technology, leading to the emergence of distributed prosumer markets that bring transparency to the energy economy. However, for a more complete understanding, it is essential to discuss not only the positive aspects, but also the potential drawbacks, challenges or limitations that may be associated with the application of blockchain in the energy sector. Based on this comprehensive assessment, we can embrace the innovative potential offered by blockchain while remaining realistic about the obstacles that may be faced in implementing it. In doing so, this article seeks to provide a more balanced and comprehensive picture of the role and potential impact of blockchain technology in revolutionizing the energy sector [5].

2. Monitoring on Prospects within the Energy Sector and Blockchain

Blockchain emerged by changing the potential demonstrations of value being created in various sectors and the overall functioning of society. Distributed ledger to record information in an open and decentralized manner, applies in tangible and intangible assets [6] In transactions stored as blocks at the convention of all parties, relating to the league produces a chain with prior accountability and transparency. With multiple agencies running trials for public services, this technology raised USD 1.4 billion in commercial investment 2014–2017 [7] For example, in 2018, the first block chain was released in Australian dollars based on bonds, created by the Commonwealth Bank of Australia and World Bank Innovation Lab.

2.1 Overview of prospects in the energy sector and blockchain

Some authors discuss the systems in the future of distributed energy, driven by intelligent sensors and ICT in 2-way communication between all entities in the intelligent network [8]. Smart grids can be worked on in real-time, managing loads with system requirements, pricing, builds and contracts. Smart grids and microgrids are expected to become a new energy paradigm, using micro-grids that enable higher sharing of cal renewable energy, increased resilience, and prosumer trade in the community [9]

annual market value capability of 200 billion USD. In the local energy market supported by micro-networks, at special prices, boundaries between interconnected actors [10]. With the introduction of blockchain technology, P2P trading on micro-networks can be carried out, in addition to the exchange of electricity through physical and virtual utility network connections [11]

2.2 future energy development on blockchain

This system was first developed for the supply of electricity from low-voltage fossil fuel-based generators [12]. In decentralized energy systems, smart grids and microgrids continue to contribute to the development of small and medium-scale renewable energy generation in residential areas.

On the blockchain platform, eventually, transactions can be reduced in real-time to a scattered micro-scale [13]. With a distributed system, all members of the network have transparent access to information, with direct value exchange provided without a third party. From a security point of view, blockchain has a distributed structure, so that blockchain is not easy to be directed to a central server. Such characteristics in the P2P model can contribute to distributed energy becoming a reality [14].

Demand taking into account the supply of prosumers and with the conditions set on smart contracts with excess energy can be sold transparently. On the blockchain are coded smart contracts and directly carried out on states that have been previously scheduled, such as the example of the preferred energy source and the highest price and floor. With this method, citizens shift power and control to a more decentralized form of government [15].

3. Method

To address the research challenges on the relatively uncharted topic of blockchain applications in the energy sector, a methodological exploration approach was used. This approach is used to build new insights and formulate a comprehensive initial understanding in the context of the problem [16]. In terms of constraints that may influence problems and opportunities, this exploratory approach helps identify relevant factors that provide a basis for further research.

However, it is important to explain in more detail why the exploratory approach was chosen as the main methodology. This methodology was chosen because it is able to provide a deep understanding of blockchain-based P2P power systems and is able to reveal new elements that may not be detected by conventional approaches. By approaching this topic through an exploratory method, we are able to respond to the complexity and dynamics of new and developing problems in the energy sector.

In collecting data, a semi-structured approach and open opinion were used. Participants in this research will be asked a series of clarifying questions designed to elicit deep insights into various aspects of blockchain-based P2P power systems. This approach allows each participant to provide a comprehensive view in their unique context [17]. This process will ensure that the data collected is directly related to the research questions and supports the exploratory aims of this research.

By adopting this methodology, we hope to collect relevant and in-depth information that fosters a better understanding of the potential and challenges of applying blockchain technology in the energy context. Ultimately, we hope that this understanding can make a valuable contribution in revolutionizing the energy sector.

4. Analytical framework development

While several studies have explored and explained the framework for making energy system decisions, social criteria are generally more than economic, environmental, and technological [18] but often omit explicit institutions. Some of these combine, as an example, the collated framework for the evaluation of renewable energy in Katre and Tozzi, using institutional dimensions centered on community participation and governance.

4.1 Technology dimension

At the start of a new energy project, a technological decision is required. Tanaka et al. conducted experiments in a P2P power trading on the private Ethereum blockchain, in multiple generations, load state, and solar PV storage. Pop et al. To respond to the demand (DR) blockchain, explored Experimenting on Ethereum using smart contracts, found that the demand and supply of energy can be balanced. Hwang et al. [19] On Prosumer's business model in a scaled-down test laboratory, facilitating the model to process transactions for virtual commerce using blockchain and the Internet of Things (IoT).

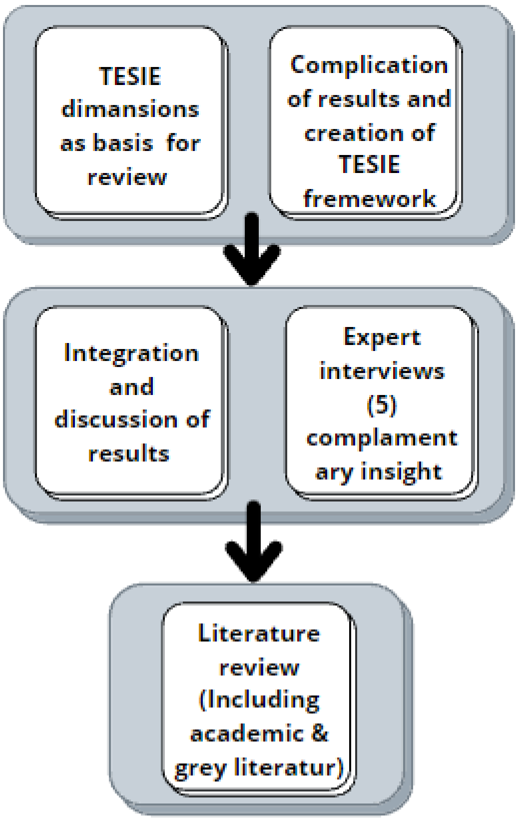

Figure 2. Schematic Simple overview of the methodological approach of this research (TESEI: Technological, Economic, Social, Environmental, Institutional).

4.1.1 Blockchain: technical issues and prospects

Before going any further, it's also worth talking about the technical challenges of blockchain capabilities and their impact on P2P microgrids. Some an author proves the cost of consensus computing on blockchain mechanism and the difficulties that accompany scalability. Proof of Work (PoW) is a consensus method required for solving complex mathematical problems before a new block is inserted, for example, avoiding double-spending. Computation, which in turn lies behind the relatively high PoW energy intensity.

The information clashes with the environment and the economy that distributed energy systems seek to generate. Nonetheless, new resolutions continue to be implemented to improve scalability, security, and performance, as well as reduce latency. For example, the blockchain platform and EOS were developed by the company Block one in plans to scale up to 10,000 tps and above [20].

4.1.2 Energy management system

In hardware and software interdependence in micro-network quality, market profitability, and market support, in carrying out 2-way real-time flow of information fiber energy with intelligent estimation to balance supply and load [21]. Market efficiency will be an essential basis, introducing new market players, integration of renewable energy, and optimal bottlenecks. In this case, automated management based on supply, supply, and load strategies in equalizing energy in microgrids, as well as performing peak power to bypass technical burdens and network upgrades that can be considered expensive.

Some authors focus on is also essential in energy management systems that save frequency and voltage currents in the range obtained by enabling utility grid connections. As shown by Tanaka et al. [22], the back-to-back (B2B) framework can be changed to network interconnection challenges through 2-way frequency and voltage conversion. At low voltage current (AC), the alternative in a distributed system can be managed into direct current (DC) and the opportunity to become high voltage AC in the main utility network (and vice versa). In a B2B structure, as in the example in Fig. 3, is able to relieve obstacles associated with the difference between the micro-network and the utility network because the frequency and voltage of the micro-network are isolated [23].

4.1.3 Blockchain: technical issues and prospects

The interconnection of micro-networks with utilities requires essential considerations to improve the system. In addition, microgrids are a vital material to include in planning, for example offering local power supplies to be more remote and ensuring special policies [24]. Energy storage can further help upgrade, enable additional services, prevent errors, and reduce overload and Undervoltage.

In the energy archive by discuss the technology needed to protect and the power strengths to be pursued in the advancement of P2P microgrids.

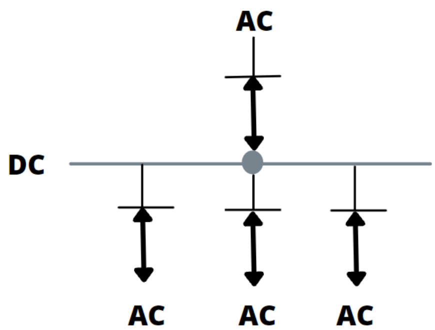

Figure 3. Back-to-back (B2B) power conversion. It is adapted from Tanaka et al.

 P-ISSN: 2655-8807
E-ISSN: 2656-8888

On system maintenance and timeframes, operation and maintenance (O&M) performed on micro-networks and equipment required for long-term planning [25] highlighted by Zhou et al. More and more P2P energy sharing processes are running. In the power exchange channel such as P2P networks and microgrids, power loss is important in the evaluation and determination of the correct energy price.

4.1.4 P2P network

On a P2P energy network, each node can be responsive to price, network, and local supply and demand conditions. Blockchain is a market-driven technique due to its simplified measurement and retrieval. Strategy offerings can be likened to smart contracts, and payments can be made of digital currency with smart meter value. Information systems are networks for microgrids that are critical of market access and monitoring, bringing together various prosumers and consumers with the software layers that need to be included in the P2P power trading network.

On smart contracts, it is necessary to inform the negotiation strategy system to be carried out, plus the procedures to be effective, such as PoI. Thus, when setting up a P2P blockchain network, it is important to pay attention to cryptography, component conventions, data storage, and decentralized applications, for example, virtual wallets, to ensure individual balances In components and concerns, such as platform scalability, pose an important place for further research. These needs depend on the technical system as well as economic, social, and environmental conditions. In advancing the P2P microgrid, the TESEI dimension is useful in its place of technological change.

4.2 Economic dimension

4.2.1 Energy market mechanisms

The development of micro-networks that effectively supports generation and multiple loads and networking and is able to lay the groundwork for new dynamic markets. Newmarket mechanisms require strengths from P2P, such as internal micro-network pricing. In much more effective market competition, a clear and variable price and cost framework is needed, but fixed costs on infrastructure and volumetric costs with price conditions when used or in real-time. Around the world, most energy markets are being liberalized by a process of liberalization, which is aimed at new opportunities, for example, the retail market has a lot of energy balance, and additional. One potential way is that P2P microgrids, capable of accumulating a supply of prosumer services, provide add-ons, such as balancing support.

4.2.2 Smart contracts and market interoperability

P2P energy sharing requires new technologies and business models to be varied but the entities that contribute, profit structure, and value proposition. Using blockchain, variable load settings are based on frequent fluctuations in internal and wholesale market prices. Considering the reduced turnaround times, being able to make micropayments, the complexity of P2P networks, and real-time spending settlements are preferable to blockchain-based microgrids. Real-time on-demand and inventory (including storage) transactions are estimated using smart contracts, which model indirectly for sales and purchases can be written.

4.2.3 Prosumer business models

Prosumers can tailor power consumption, storage, and purchasing strategies for themselves at wholesale and local P2P market prices. This option is reliable with other factors, such as the level of renewable energy provision and increased service sales options, all of with are contract-encrypted reachable. Wiretapping is the achievement of community costs derived from the following P2P network, with multiplied benefit levels that can be achieved.

Locality refers to the ability of microgrid participants to buy electricity at wholesale prices, which are cheaper at retail prices due to network, service, and market costs. Selectivity in the sequence can refer to the prosumer's ability to take advantage of fluctuations in wholesale prices, selling power when prices are rising, and buying when prices are falling. The potential to turn electricity sales on a temporal basis will also affect the energy availability factor, which has so far been identified in both the economic and technological dimensions.

While trends and risks will be significant in discussions of cryptocurrencies, this paper aims for blockchain as its P2P infrastructure. Blockchain can be supported with economics at the individual level, with economic independence and entrepreneurship, with ease on prosumer. However, distributed networks will also include new markets and behaviors that have their current understanding. Knowledge and skills regarding blockchain in applications require developers to build and maintain prosumer business models more efficiently.

4.3 Social dimension

On blockchain social values lies the company's business model, critical infrastructure, and critical influence. Taking into account the influence, behavior change is essential to determine when setting and new policies. As stated by Caputo et al. Related to environmental protection, it is located at the intersection of economic and social actors. Where electricity users were previously in the role of producers, or producers, they may fall into and invest in energy engineering.

4.3.1 Socioeconomic incentives

In the local context, income distribution is the primary consideration because an unequal income distribution can make P2P and withhold acceptance trade between prosumers and consumers. Stimulation of the local economy, which comes from the use of local resources and the creation of profits, is also intended as a major award in carrying out public disclosure.

Effective mechanisms to promote sustainable behavior are a significant area of research to find out more broadly except for the energy sector. In this condition, it functions to control the maker, the user, and their relationship.

4.3.2 Interest management

author's location, how vital stakeholder interest is to micro-network marketing, and incentives. Stakeholders include the regional network industry, governments, lord micro-network, energy distributors, equipment distributors, and consumers. On P2P network conditions, prosumers are a new consumer model subject to various bidding strategies. The importance of exploring the perception and social acceptance of distributed networks.

Compared to some countries historically, In large industries and fossil fuels, many policies are shifting to circular electricity, ensuring an uncertain future for conventional use. Industry concerns are also significant for further research, for effective handling of stakeholders in the metamorphosis of the system. Digitization affects the utility of actor models, new businesses, and roles on the grid. Hirsch et al. describe a "utility death spiral" in which the user and the lever themselves in the microgrid can reduce consumer demand, advancing the market price of electrical energy, thereby reducing demand. Therefore, utilities are currently a significant organizer of interests and roles that needs to be monitored in any upgrade of the P2P micro-sharing network.

4.3.3 Editing Community

With energy digitization, stakeholders can also pay more attention to energy. User engagement is a crucial opportunity with digitization when through relationships and representations on digital platforms.

The mode of communication for user interaction is key to being provided a place for further exploration and in the assistance of new digital energies. The views and behavior of consumption of new energy ways appear from the central knowledge needed for the platform improvement.

4.4 Socio Economic Incentives

Emission restriction is one of the advantages of microgrids and the development in its development. This can be relevant given that reducing global warming to 1.5 ranks above the pre-industrial phase will require "widespread, rapid and unprecedented change in all aspects of society". Blockchain will involve itself in these contexts, such as developing roaming greenhouse gas (GHG) radiation, cleanliness in trade, and control through data.

4.4.1 Independent and Energy management

The leading indicator is the independence of the subsequent environmental utility of micro-grids because of the utility's higher renewable energy potential and missing the bottom line. Over the prolonged, affiliation micro-grids can run renewable delivery energy, thus reducing emission reductions. Enhancing these uses, regulations for radiation attenuation could provide an improved P2P micro-network. The importance of pouring environmental regulations into microgrid energy handling, especially touching the object of radiation reduction and with renewable energy.

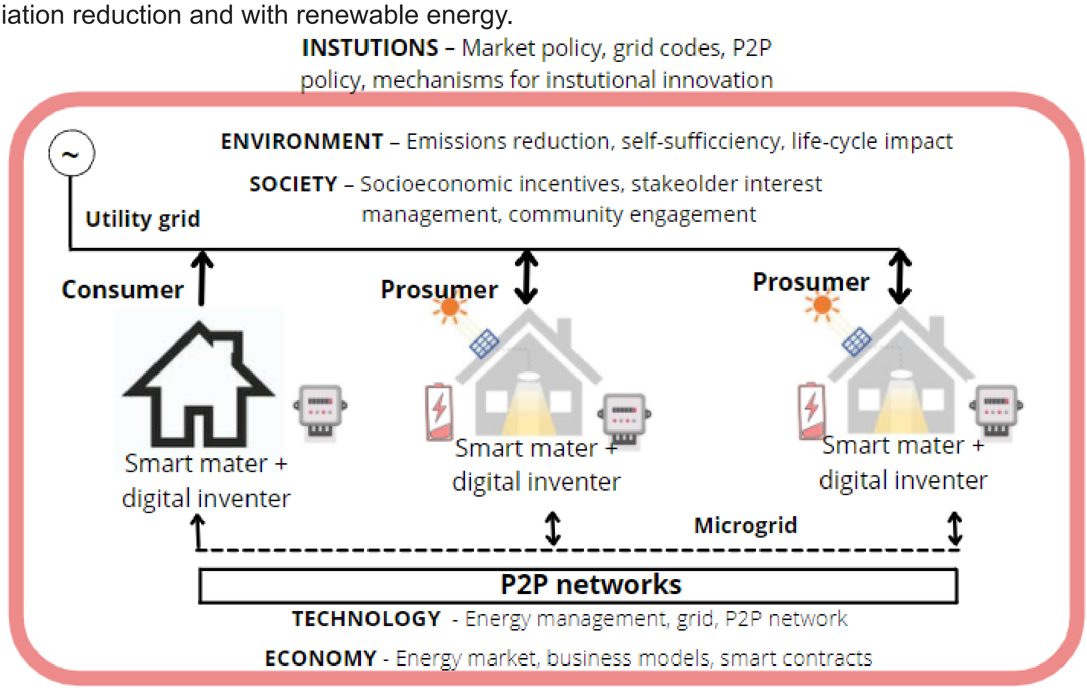

Figure 3. TESEI framework in the context of an illustrative, simplified example of a blockchain P2P power microgrid. Adapted from Tanaka et al

4.4.2 Blockchain for environmentalism

Self-sufficiency is a crucial hint of the subsequent area utility of micro-grids because of the utility low line losses with a higher share of a renewable energy capability. For a long time, interconnected micro-networks can enable renewable energy to be distributed, thereby reducing emission reductions. Increasing these uses, regulations to reduce emissions can facilitate the development of P2P micro-networks.

4.5 Institutional dimension

Blockchain is in its infancy and proliferating among beginners, but without clear rules and standards, It has been seen in consulting and academic reports. Institutions are one of the blockchain-based P2P energy dimensions that are very difficult to influence, and it also has its most significant research gap.

Institutions have a formal nature, such as standards, policies, regulations, and free, for example, norms and customs. In academia, the institutional basis of blockchain is lacking, so the authors have provided valuable discussion to advance this. Pots et al. [2) blockchain has the ability to shift the smart city schedule to a "crypto city". The director may make bids.

on municipal services, excluding energy, which can be obtained by new economic organizations such as civic associations. Green and Newman are exploring whether the rapid expansion of solar PV and storage is already boosting "citizen utility" in Australia.

4.5.1 Market policies and grid codes

A formal microgrid design has the prerequisites for success to conform to the regulatory landscape, with clear policies and standards. With interconnection and with the usual costs and market policies, microgrid participation and market competition may increase. At the level of the energy market, competition can affect the realization of microgrids. Policies that apply to the generation, transmission, distribution, and retail are not good are an essential procedure in the transformation of energy systems. Changes to microgrid regulation are needed for further innovation, as this system crosses the boundaries of generation, transmission, and distribution. As well as having several places in institutions that provide micro-network development, such as New York State Reforming the Energy Vision.

4.5.2 P2P micro-network policy and governance

Specific regulations require blockchain-based power exchange with a continuous business model. Requires a new law for P2P buying and selling of electricity. For example, to support the electric power market, a prosumer will need a license that can request a continuous supply to meet partners' needs to customer support. This system does not seem practical for small-scale producers because licensing generally assumes Large-scale producers and companies. With this method, the partnership model is clearly visible, whether for energy infrastructure or microgrids are the main considerations. And the role of the market will require further research.

Blockchain stands alone with a digital identity under one umbrella of governance, auditing, management, and internal transactions. With the blockchain consortium, convention procedures are driven by a designated group of nodes while information can be shared publicly, beneficial in the banking and energy sectors. This makes it possible for the blockchain to be publicly available on a wide scale that requires the furthest level of change. Pots et al. Discuss how the government can move from a data facilitator to a provider platform. In this setting, public institutions can become key players in blockchain energy governance.

4.5.3 Institutional innovation prospects

Part-creators desire to explore the gray zones of institutions concerned with blockchain and its applications. As already discussed, environmental agendas, technological innovation, social dynamics, and market economies can all affect the P2P microgrid. Therefore, Addressing these dimensions helps discuss institutional change.

Digital technology impacts the market with a less restrictive regulatory framework, facilitating multiple roles and developments. Entrepreneurial experimentation is an integral part of the energy and technological innovation. Governments often avoid risk when it comes to the rapid growth of blockchain and the associated security obligations.

Strategic phased development related to communities with relevant stakeholders able to drive change and simultaneously empower communities based on participatory engagement and planning In this way, stakeholder interests and concerns are better able to reach within effective institutions. The current form of progressive change can be likened to a multi-stakeholder rule sandbox approach to advance institutional readiness that leverages insights into the multiple dimensions of TESEI.

4.6 Key takeaways: institutional development pillars

A collection of critical factors found in each TESEI dimension, including sub-factors useful for discussion, is presented in Table 1. Hanna et al. Technology movement, policy and with a market evaluation of the microgrid business model. In this section, it is clear whether the interaction of policy monitoring using digital currencies and the development of blockchain technology around the world. With this, all dimensions of TESEI are concerned. For example, the illustration of a P2P microgrid using the blockchain method on TESEI is shown in Figure 4. It offers a summarized network with 2 (two) prosumers and 1 (one) consumer on a microgrid connected to the utility grid and connected to a digital inverter in a giant circle.

The solution to P2P energy is increasing] to extend far and comply with barriers such as scalability and data retention. “Sustainability by definition is a long-term goal.” With the method of “creative syncretism”, actor systems and behavior get an initial change with the previous institution, which is recognized as a changeable basis for the new institution. Aiming for a syncretic approach can be phased to provide interoperability regarding conventional and future energy systems.

5. Conclusion

Concluding this journey, this paper has carried out a holistic exploration of P2P microgrids with a blockchain approach, while also providing an overview of institutional developments and academic research in the energy context. We have developed a comprehensive analysis framework, TESEI (Terrestrial Energy System Exploration and Integration), which includes 1) Economic, 2) Technological, 3) Environmental, 4) Social, and 5) Institutional Dimensions.

It is important to remember that each dimension in this framework is highly dependent on local conditions and stakeholders, so the factors identified cannot be applied universally. The findings from this study, however, have the potential to contribute on multiple scales to more general follow-up research. We encourage the use of this TESEI framework to provide valuable insights into the concept and multidimensionality of P2P microgrids with blockchain, including the importance of this role in the academic sphere and case analysis, as well as to formulate institutional development goals.

However, to summarize, the successful implementation of this approach depends on serious efforts in bridging the gap between technology and institutions in social, economic and environmental dimensions. Community development and regulatory sandbox approaches are capable of fostering relevant institutional growth in all these dimensions, by leveraging diverse perspectives, sharing knowledge, and overcoming sectoral boundaries in an effort towards syncretizing progress. In conclusion, it is hoped that this paper can become a stepping stone to encourage further exploration and collaboration in the field of blockchain-based energy innovation.

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