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BLOCKCHAIN FOR ENVIRONMENTALLY SUSTAINABLE ECONOMIES: CASE STUDY ON 5IRECHAIN

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ABSTRACT

Blockchain technology, therefore, creates opportunities to make things differently. The field of sustainability is one of the areas where efforts of the international community are scarce and deficient. For this reason, blockchain could be implemented to improve and advance the achievement of UN-SDGs. This paper focuses on the application of blockchain to address pressing environmental challenges such as climate change, biodiversity loss, and water scarcity along with a case study of 5ireChain. It looks at emerging applications including those that might be the biggest game-changers in managing our global environmental commons while assessing the potential challenges and developing recommendations to address them.

Keywords: 5irechain, climate change, the fifth industrial revolution

1.0 INTRODUCTION

Emerging technologies such as artificial intelligence or the Internet of Things are generating changes that affect the economy and the possibilities of future generations. These innovations provide a unique opportunity to help address environmental issues and transform the way we manage our environment(1). Blockchain technology refers to a software protocol that facilitates the secure transfer of money, assets, and information over the Internet without the need for a third-party intermediary such as banks or other financial institutions. Or what is the same, it is a decentralized electronic accounting system that registers any transaction —funds, goods, property, or votes— through a network of peers. Data is immutably stored in a continually expanding list of interconnected registers. Transactions are stored in blocks, which are connected to previously created blocks by including the hash of the previous block in the new one. This structure makes it extremely difficult to make a change without altering subsequent records in the chain, providing security for the records. Also, each participant with access can simultaneously view the information, providing confidence in the system as a whole. Transaction verification is achieved when participants confirm changes with each other replacing the need for a third party to authorize transactions. This decentralized consensus is designed to protect the platforms from the domain of the network by an individual or a group of subjects(2). Two of the best-known applications of this technology

are cryptocurrencies and smart contracts. Although the financial sector is the original application of this technology, blockchain has significant potential in other sectors, offering decentralized and cleaner solutions. For example, it offers the possibility of mitigating the challenges that arise with respect to the environment where the challenges of non-financial value and global commons prevail(3). The potential offered by this technology to redefine current models has generated a great deal of publicity and an excessive expectation within society. In short, as the technology matures, the opportunities to take advantage of the potential it presents can be implemented to address climate change and environmental sustainability. Sustainability and supporting the 17 Sustainable Development Goals (SDGs) of the United Nations are at the heart of everything that 5irechain does. To create the Unicorns of Tomorrow, the 5irechain team is searching for mission-driven founders that are interested in creating a new paradigm in 'social impact'(4). They're in the business of sustainability and on the lookout for the next unicorn who will pave the way(5). That is overall what we will share in this paper.

2.0 METHODOLOGY

This research uses a phenomenological approach and belongs to a type of qualitative descriptive research. Data sources in this study include primary and secondary data sources. Observations and documentation are used as data collection tools. While the data analysis techniques used are data comparing, presenting, and drawing conclusions. A blockchain-based company named 5ireChain has been used as a case study for this paper. 5ireChain is a fifth-generation blockchain that aims to bring a paradigm shift from a for-profit to a for-benefit economy. The aims of 5ireChain are to become a blockchain ecosystem for the 5th industrial revolution where self-sovereign decentralized organizations are empowered & incentivized toward accelerating the implementation of the United Nations 2030 Agenda for Sustainable Development.

3.0 DISCUSSION

3.1. Actions to address environmental challenges

One of the main challenges facing humanity in the coming decades is to feed, provide water and energy for the 3 billion more people that there will be by 2050. In order to meet this challenge, it will be necessary to change the practices of water, use of the land, consumer preferences, and demand or ensure energy supply. Companies are facing increasing pressure from investors and consumers to address the risks that supply chains generate, such as human rights violations, forced labor, new forms of modern slavery, or environmental degradation, among others. In response, many companies are making public commitments —zero deforestation policies, use of recycled materials, etc.(6) However, supply chain processes are often complex and opaque, making it difficult to implement these commitments and display achievements. The data that is generated throughout the supply chain, from the origin of the product to the point of sale, can be registered through the blockchain, storing the information generated in an immutable way. In this way, full transparency would be provided due to the complete traceability of the data of the entire process. Providing such transparency to the consumer would help them to know how their consumption habits and purchasing decisions are affecting the environment or what the working and living conditions are around said

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supply chain. In other words, the use of blockchain tools would allow products to be tracked from their origin to the point of sale, contributing to the decision-making of the final consumer or retailer(6, 7). Consequently, confidence in production processes would be built by verifying supply chains and exposing dishonest or illegal practices. For example, the application of blockchain could be used to address the global challenge of increasing illegal, unreported, and unregulated fishing as a result of growing demand. As a result, two-thirds of fish stocks are overexploited, with forecasts for the trend to rise. Blockchain technology could track these species by providing transparent information about their origin. Likewise, smart contracts could support new agreements that grant specific resource rights to communities or fishermen. As a consequence, by sustainably managing marine and coastal ecosystems and the fish market, and limiting illegal, unreported, and unregulated fishing, the oceans, seas, and marine resources would be conserved and used more sustainably. In this line, a large amount of data could be collected, monitored, and managed to contribute to biodiversity management —including the cataloging of species and habitats— to facilitate species conservation processes through an immutable geospatial digital record. The processing of such information would also make it possible to implement market mechanisms that protect global systems, which are currently subjected to unprecedented levels of stress and whose limits have been exceeded. Environmental degradation represents a risk for many supply chains since according to the CDP report, 941 billion dollars of global sales come from products related to deforestation and around 32% of those companies are experiencing business impacts due to these risks(8). The use of blockchain technology (e.g. 5irechain) could help stop deforestation processes resulting from the production of these goods by providing transparency in supply chain processes and by addressing conflicts arising from land use(9). Addressing deforestation is a key to curbing climate change, as up to 33% of climate mitigation efforts depend on forest conservation and up to 15% of all greenhouse gas emissions are caused directly by this practice.

3.2. Optimize carbon markets

In the field of greenhouse gas emissions, various initiatives have also emerged to apply blockchain technology. The Kyoto Protocol established greenhouse gas emission reduction targets for member states, in addition to an international carbon trading system. The goal of carbon markets is to reduce CO2 emissions(10). To do this, the regulator issues the limits that apply to each company in a particular way in certain industries through a certificate. Issuers must monitor emissions and submit them to the competent authority, which commissions an independent broker to review the reports. Companies can legally exceed the limits established in their certificates by acquiring more rights from other entities that have not reached their limits, creating a carbon market where emission rights are traded. This complex system results in a lack of transparency that reduces its effectiveness. The information that is generated and recorded in a governance structure may not be available to other actors working in another structure or to regulators. On the other hand, the operation of the carbon markets implies that it is the emitters themselves who provide the information, instead of deriving it directly from the primary production records, which often leads to errors or fraud, as a result of the information asymmetry. This system, therefore, generates problems of trust both in the producer and in the regulator. This reliance on accurate information flows reflects the important role of transparency and accuracy of data reporting in carbon markets. As an alternative to the current model, the blockchain (e.g. 5irechain) can improve the scheme of

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carbon markets(11). A properly designed blockchain system would collect all relevant information, including transaction history, store it immutably and make it easily accessible to all stakeholders. In this way, the falsification of certificates and the fraudulent sales of credits that give rise to double-counting would also be avoided. By registering a certificate or credit in the blockchain, it becomes unique since encryption only allows it to be created or transferred through the unique digital signature of an authorized person(12). That transaction would be recorded and only the holder's signature could carry out a transaction which means that if the system is designed correctly, it would be impossible to carry out double counting or duplicate a credit thus guaranteeing security(13). This data is made available to inform and influence market decision-making. Blockchain platforms (e.g. 5ireChain) could provide cryptographic tokens with a tradable value to optimize existing market platforms for carbon (or other substances) and create new opportunities for carbon credit transactions. An early pilot example is China's "Carbon Credit Management Platform", developed by Energy Blockchain Labs and IBM(14). The aspiration is that with the introduction of smart contracts, the transparency, auditability, and credibility of the Chinese carbon market can be increased. Further, into the future, it is conceivable that blockchain could underpin a global carbon trading market for individuals, households, or organizations.

3.3. Decarbonization of the electricity sector

The electricity sector is one of the areas where the objective of reducing greenhouse gases is maintained despite the unstable global political conditions(15). Decarbonization involves the reduction of the amount of carbon in primary energy over time thanks to the exploitation of new clean energy sources. However, increasing the percentage of energy generated by renewable sources can present challenges for stability and predictability(16). To facilitate the generation and distribution of this type of energy, a series of technologies are necessary that allow electricity storage, energy trading, and demand forecasting and management. This is where the fusion of blockchain (5ireChain) and microgrids comes into play. It should be noted that a microgrid is a group of interconnected loads and energy resources distributed within defined electrical boundaries that act as a single entity with respect to the grid(17). The uniqueness of this technology is that it can be disconnected from the main network to operate autonomously since they are able to act while the main network is inactive. In the blockchain, each block contains one or more transactions. Regarding the energy sector, the blocks can be organized in tables with details (e.g. the source, the destination, the amount of energy transferred, the presumed associated losses, or the ancillary services used)(18). If any of these blocks are tampered with, the hash changes, and that block is considered invalid, providing security. The figure shows the layout of the energy market based on the union of microgrids and blockchain.

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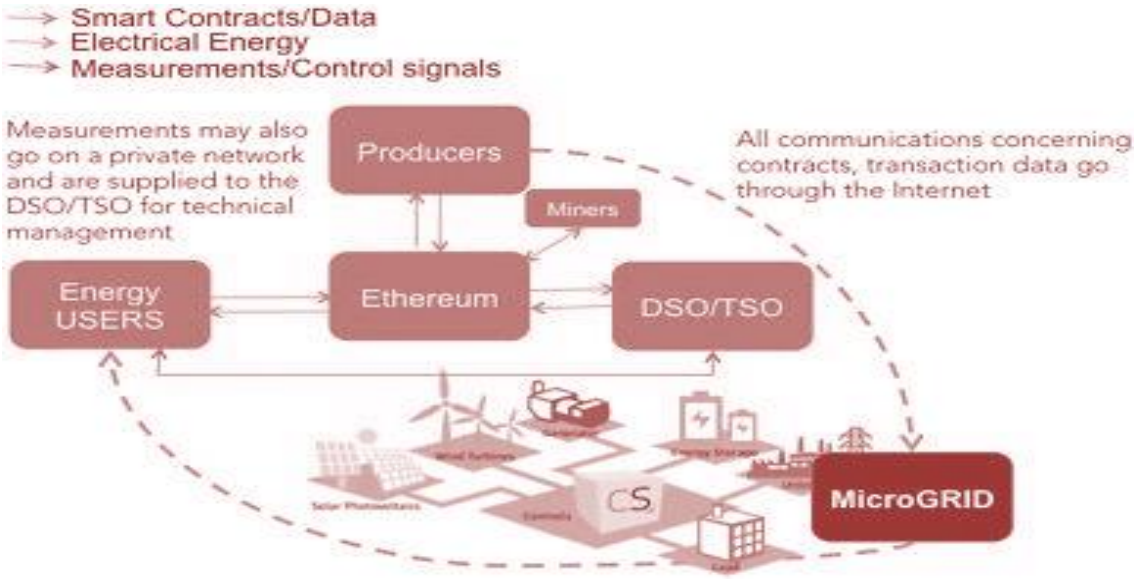

Figure: Blockchain (5ireChain) based energy market model

The system would go from operating on infrastructure to running over the Internet. Therefore, new actors would appear which would bear the computational load of executing the blockchain technology(19). Producers or prosumers (consumers involved in the design, manufacture, and development of a product or service) generate their own energy through the microgrid, which is marketed almost in real-time with consumers. The generated data is stored in the blockchain and is available to all parties involved, including the DSO, which will be in charge of controlling the entire process that has been generated through the internet(20). As it is a network that can operate autonomously, in the event of an attack on the main network or disconnection due to a natural disaster, the affected infrastructure would be the only one inactive, while the rest of the microgrids would function normally. In addition, there is the possibility of redirecting energy to hospitals or community centers in the event of a catastrophe, or to areas of the world where energy scarcity prevails, reducing the need to store said energy. Therefore, this model has the capacity to create energy resilience in cities or urban areas. This is why decentralized energy networks have the potential to reduce costs while increasing energy efficiency, supporting the integration of renewable energy, and providing resilience(21).

3.4 Sustainable water management

Global demand for water has grown by around 1% annually due to population growth and economic development among other factors and will continue to grow significantly(22). It is estimated that almost half of the world's population lives in areas at risk of water scarcity(23). This number is expected to rise to 3 billion by 2050(24). Simultaneously, due to climate change, the water cycle is undergoing variations that lead to the wettest regions becoming even wetter and drought intensifying in the most affected areas. On the other hand, the state

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of the water has only gotten worse. According to the ORB report, micro-plastics have been found in 83% of tap water samples and 90% of bottled water(25). The quality is expected to deteriorate further, posing threats to human health, sustainable development, and the environment. By 2050, close to 70% of the world's population will reside in cities and more than 90% of that urban growth will occur in emerging regions where water infrastructure may not be viable, due to financial constraints, governance challenges, or climate variability. Decentralized systems can expand access to drinking water and sanitation services in these areas. By providing transparency in transaction records between parties, blockchain-based technology could transform and optimize the way water resources are managed and traded(26). Smart water meters involve the integration and remote communication of information through enabling technologies such as sensors, meters, and automated controls, which continuously monitor the water distribution system. Some of the parameters that are accounted for are pressure, quality, flow rates, temperature, and leaks. These meters would be available in each home or entity and would allow resources to be managed sustainably, based on the needs of each family, each company, or each farmer. Blockchain would therefore allow all stakeholders (including consumers) to access the same data on water quality and quantity to make more informed decisions(27). Similarly, it could prevent corrupt behavior in situations where local authorities encourage the manipulation or withholding of water quality data.

3.5 The energy consumption challenge

One of the barriers concerning the implementation of the blockchain is the energy consumption that comes from its use. The design of many of these technologies entails high energy consumption that represents a threat to the global commitment of the Paris Agreement to mitigate greenhouse gas emissions. Currently, the application of the most used blockchain is cryptocurrencies, specifically; the most popular is bitcoin, whose mining and the trading system requires such large electricity consumption that it is equivalent to that of many states.

The bitcoin protocol is intentionally designed to be energy-intensive. The number of bitcoin blocks is finite and the block acceptance procedure occurs approximately every ten minutes. The more miners operate on the network, the more difficult it is for individuals to solve mathematical problems, thus needing to spend more time and energy. Therefore, the nature of the mining process entails high rates of energy consumption that can cause environmental damage. The "polluter pays" principle is included in article 191.2 of the TFEU. This is not motivated by economic incentives, but environmental; with the purpose of making those who pollute financially responsible for the damage caused and, consequently, encourage the development of more sustainable practices. One possibility is the regulation of this technology is to incorporate environmental externalities in its design(28, 29). The purpose would not be to stop this growing sector but to force the industry to take into account the negative environmental impacts and motivate the change to models that use less energy. However, in order to regulate cryptocurrencies and introduce charges on transactions based

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on their energy consumption, they would have to be legally considered money. This is a hurdle faced by legislators and regulators around the world. The decentralized nature and lack of government control of cryptocurrencies mean that, as yet, no Central Bank or other authority has legally certified that they are considered currencies.

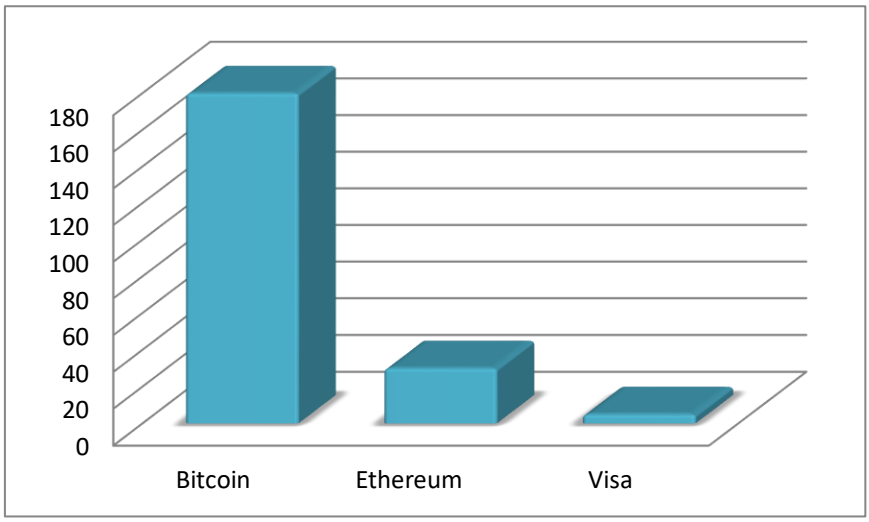

Figure 3: Comparative energy consumption (Estimated kWh for each transaction)(28)

The first generation of blockchain platforms employs a protocol called a Proof of Work (PoW) system to operate which implies that they require higher power consumption(30). However, the second generation includes Ethereum which consumes much less power. Protocols called Proof of Importance (PoI) are also being developed which are expected to consume even less power thanks to their simplified and more accessible validation process. Consequently, there are many ways to build and operate on blockchain networks. Also, the mining process is not always necessary in all applications on the blockchain. However, understanding the impact of blockchain technology on the energy system is complex(31). It is important to take a big picture perspective and consider the energy impact relative to blockchain solutions, compared to existing models. For example, energy management is an area where, as discussed previously, the blockchain can incentivize the use of renewable energy and more sustainable use of it. Implementing these solutions could support and accelerate the decarbonization of the system by assisting global efforts to reduce greenhouse gas emissions. It is therefore expected that as blockchain evolves its energy consumption will decrease and that the opportunities that the blockchain offers to mitigate climate change will exceed its energy use limitations(32).

3.6. Why could 5ireChain matter for environmental sustainability?

The potential of blockchain to support environmental sustainability comes down to one key feature: its ability to provide a verifiable record of who exchanges what with whom – and therefore who has what at a given time. Many of the challenges for how we manage natural resources and maintain ecosystem services arise because of a lack of trust and confidence in the rules governing exchange and possession: will governments and other users respect entitlements to use a natural resource? Can companies' claims of reduced environmental

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impact be verified and trusted? Can environmentally sustainable actions be effectively incentivized? Blockchain's ability to provide a verifiable and transparent record may make it well-placed to help answer such questions. By decentralizing and digitizing the adjudication of what is trustworthy, blockchain (e.g. 5ireChain) also has the potential to empower broader communities of stakeholders and improve the slow, costly intermediation associated with our current models of environmental governance.

Figure: blockchain's potential for environmental sustainability

5ireChain use-case solutions that are particularly relevant across environmental applications tend to cluster around the following cross-cutting themes: enabling the transition to cleaner and more efficient decentralized systems; peer-to-peer trading of resources or permits; supply-chain transparency and management; new financing models for environmental outcomes; and the realization of non-financial value and natural capital. Several key highlights are outlined below:

⇒ Next-gen sustainability monitoring, reporting, and verification: 5ireChain has the potential to transform both sustainability reporting and assurance, helping companies manage, demonstrate, and improve their performance while enabling consumers and investors to make better-informed decisions.

⇒ Transforming carbon markets: 5ireChain platform could be harnessed to use cryptographic tokens with a tradable value to optimize existing market platforms for carbon and create new opportunities for carbon credit transactions. 5irechain's blockchain technology can support the creation of a sustainable environmental supply chain, monitoring and reduce CO2 emissions along the supply chain, monitoring the exchange of dangerous waste and creating a system of incentives favoring recycling, improving circular economy practices, and monitoring the use of natural resources, especially in the agro-food industry.

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⇒ Supply chain transparency and management: Along with economic sustainability, 5irechain can enhance the green supply chain. 5irechain can indeed facilitate new means of green production. 5ireChain's blockchain-based technology can also create potentially unavoidable transparency in supply chains. Recording transactional data throughout the supply chain on a blockchain and establishing an immutable record of provenance offers the potential for full traceability of products from source to store. Providing such transparency creates an opportunity to optimize supply-and-demand management and ultimately enable more sustainable production.

⇒ Decentralized and sustainable resource management: 5ireChain can underpin a transition to decentralized utility systems at scale. Platforms could collate distributed data on resources to end the current asymmetry of information that exists between stakeholders, enabling more informed – and even decentralized – decision-making regarding system design and management of resources.

⇒ New sources of sustainable finance: 5ireChain's-enabled finance platforms could potentially revolutionize access to capital and unlock potential for new investors in projects that address environmental challenges. On a broader level, there is the potential for blockchain to facilitate a system shift from shareholder to stakeholder value, and to expand traditional financial capital accounting to also capture social and environmental capital. Collectively, these changes could help raise the trillions of dollars needed to finance a shift to low-carbon and environmentally sustainable economies.

⇒ Incentivizing circular economies: 5ireChain could fundamentally change the way in which materials and natural resources are valued and traded, incentivizing individuals, companies and governments to unlock financial value from things that are currently wasted, discarded, or treated as economically invaluable. This could drive widespread behavior change and help to realize a truly circular economy.

⇒ Automatic disaster preparedness and humanitarian relief: 5ireChain could underpin a new shared system for multiple parties involved in disaster preparedness and relief to improve the efficiency, effectiveness, coordination, and trust of resources. An interoperable decentralized system could enable the sharing of information and rapid automated transactions via smart contracts. This could improve efficiencies in the immediate aftermath of disasters, which is the most critical time for limiting the loss of life and other human impacts.

4.0 CONCLUSION

Blockchain technology, therefore, creates opportunities to do things differently. The field of sustainability is one of the areas where the efforts of the international community are scarce and deficient. Therefore, blockchain could be implemented to improve and advance the achievement of global objectives. The route explored in the document contemplates how to use this technology to manage supply chains, marine ecosystems, global energy value chains,

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etc. more sustainably thanks to increased transparency. The objective is to use this transparency to encourage more sustainable behavior by all the actors involved (producers, suppliers, consumers, etc.). However, the purpose of this discussion is not to imply that blockchain is the panacea that will solve all the problems outlined above. Blockchain can be implemented in various ways; that is why the technical design of the system must be adequate to optimize sustainability. First of all, it is necessary to choose whether the blockchain will be open or closed since the visibility of the record in an open blockchain would allow anyone to see the transactions. However, this level of transparency also presents threats to confidentiality in certain sectors. On the other hand, it is necessary to consider what is the consensus mechanism that is going to be used. In the section concerning the energy consumption of this technology, the various protocols and the cost that each one entails are exposed. In the case of bitcoin, for example, PoW is too resource-intensive for dishonesty to be profitable, however, it is expensive and inefficient, so that system cannot be scaled up to handle large volumes of transactions. Therefore, the choice of the consensus mechanism is key to considering the costs, but also the level of trust that will be granted to the process. Also, you have to take into account the roles and responsibilities of system administration, determine permissions or who can make changes to the code or correct possible errors in the system. Despite this, blockchain is not a complete solution in itself, but greater benefits would be obtained if it is combined with other technologies of the Fourth Industrial Revolution such as Artificial Intelligence or the Internet of Things (IoT, for its acronym in English). Therefore, there is a need to integrate blockchain with other solutions to address global environmental challenges. The opportunity generated by blockchain to benefit our environment is substantial, but the technology itself is at a relatively early stage. Far from being an obstacle, this represents an opportunity for the parties to ensure that the development of blockchain technology will be carried out in a sustainable manner. If this challenge is achieved, it would mean that blockchain will play an important role in enabling new technological solutions to address pressing environmental challenges such as ocean health, water management, or climate change. And so far, 5ireChain is representing this with its blockchain ecosystem that brings forward socio-economic-environmental sustainability to build the 5th industrial revolution.

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