



BLOCKCHAIN FOR SUSTAINABILITY



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INTRODUCTION

Overview

The need for huge corporations to be sustainable has never been greater in human existence. People demand greater accountability from all industries as the world undergoes severe upheaval. Although this is generally inaccurate, the blockchain community is frequently described as contributing to the issue. This technology may aid the global transformation required for a sustainable future. Sustainable blockchains have enormous potential, and the environmental benefits are too significant to ignore. Like with any industry, issues are still to be resolved, but they are acknowledged and actively being addressed. What other sector has had its second-largest operator cut back on energy use and emissions by more than 99% in less than ten years from the company's inception?

There has never been a greater urgent demand for sustainability in the business sector. The need for accountability is expanding across all businesses due to the tremendous changes our world is witnessing. Despite frequent criticism for its environmental effects, the blockchain industry has the potential to be a key player in building a sustainable future.

Sustainable blockchain technology has a significant positive impact on the environment and must be considered. Even if there are still challenges to be faced, progress is being made. Within the first ten years of operation, one of the leading players in the industry was able to drastically cut its energy use and emissions by more than 99%.

SUSTAINABILITY IN 2023

The significance of ecologically responsible corporate operations has recently risen to the forefront of the public discourse. Major businesses hastily announce the beginning of different sustainability-related initiatives and frequently follow through on their promises. However, some companies frequently conceal themselves behind ambiguous measures and goals open to different interpretations. This is made worse by a lack of transparent oversight or clear norms. Some businesses have been detected as "greenwashing," or fabricating the truth about their attempts to be more environmentally friendly to boost their reputation. This only benefits business executives and sows distrust among the general populace.

Sustainable business strategies have attracted a lot of attention in recent years. Numerous businesses have promised to start programs to lessen their influence on the environment. While some of these initiatives are sincere, others are opaque and have hazy measures and objectives. Due to the absence of clear standards and control, there have been cases of "greenwashing," in which businesses embellish the truth about their sustainability initiatives to boost their reputation. Such actions undermine both public trust and the environment.

BLOCKCHAIN AND SUSTAINABILITY

Blockchains are frequently vilified due to their negative environmental impact. While it is true that proof-of-work (PoW) chains like Bitcoin and others have a significant ecological impact, proof-of-stake (PoS) chains are significantly more energy efficient. As an illustration, when the Ethereum network switched to PoS recently, its energy consumption decreased by 99.9%.

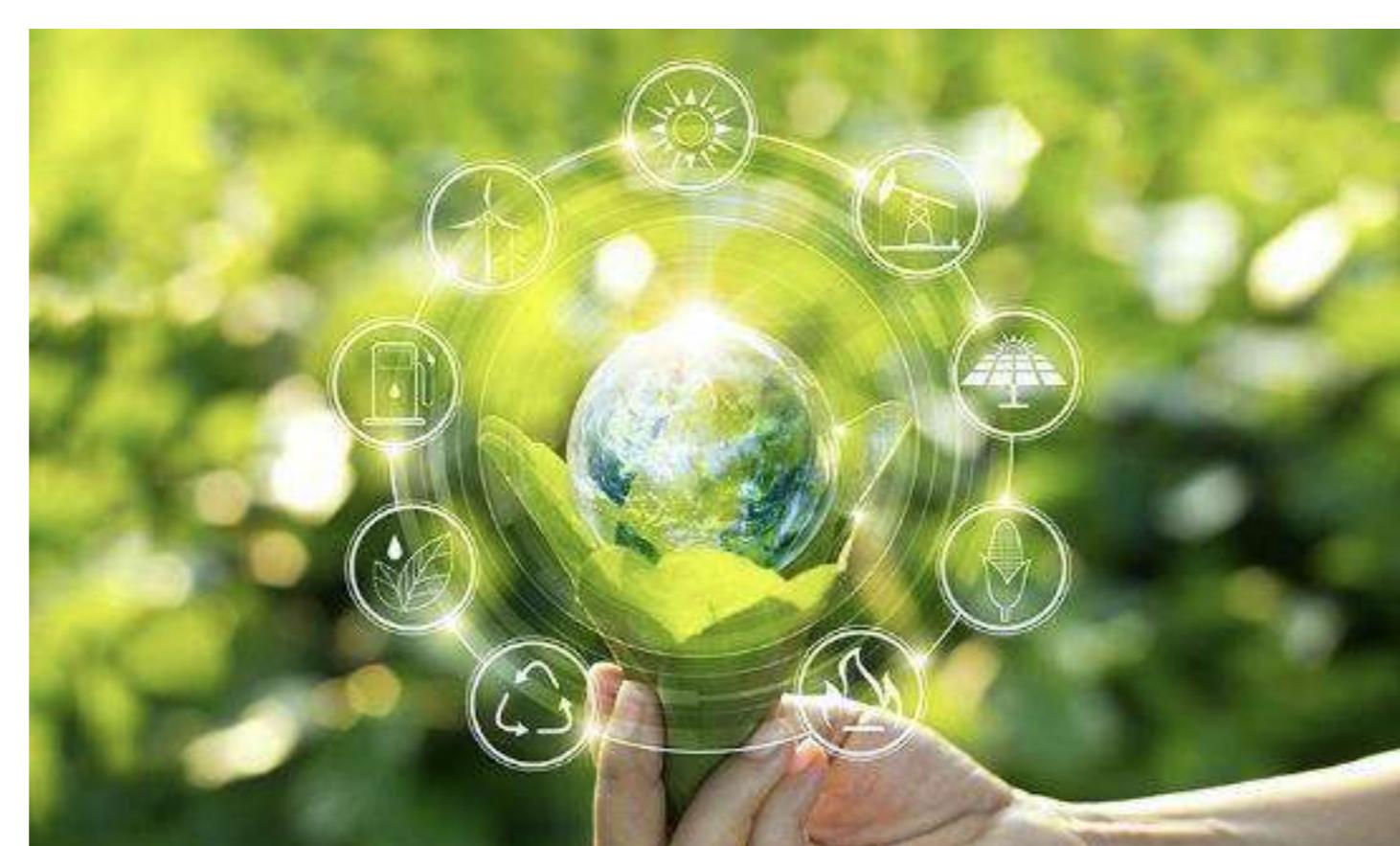
The newly formed Ethereum Climate Platform (ECP), introduced at COP27's U.N. Climate Change Global Innovation Hub, is also working to address and reduce Ethereum's historical carbon consumption. Members of the ECP include Ethereum Enterprise Alliance, ConsenSys, Microsoft, Aave, and Polygon.

What about sustainability and Blockchain? Are they connected? A blockchain is resistant to data alteration by design. In the Blockchain, data is impossible to alter or erase once it has been recorded. A blockchain is thus a desirable option for sustainability initiatives requiring trustworthy data tracking over time.

Blockchain networks can be used by enhancing tracking and verifiably demonstrating emissions of a specific firm or supply chain with new green credentials. Blockchain can track carbon balances and other environmental parameters due to its intrinsic immutability, accountability, and transparency, holding to account businesses that claim to be sustainable.

Using smart contracts, for instance, can automate calculating the amount of carbon produced at each stage of a company's operations. The public would then be informed of this information, and it may be submitted to various monitoring programs. This data cannot be manipulated or obscured in any manner because it is verifiable and cryptographically enforced.

Moreover, smart contracts built on the Blockchain might offer financial incentives for ethical behavior. Also, Blockchain has a wide range of potential uses in sustainability, and the technology has the potential to contribute to the world's transition to a more sustainable future.



Using Blockchain For Sustainability

By facilitating better tracking and verification of emissions, blockchain technology presents new chances to advance sustainability efforts. Its immutability, accountability, and transparency make tracking carbon balances and other environmental metrics possible, enabling firms to be held responsible for their sustainability claims.

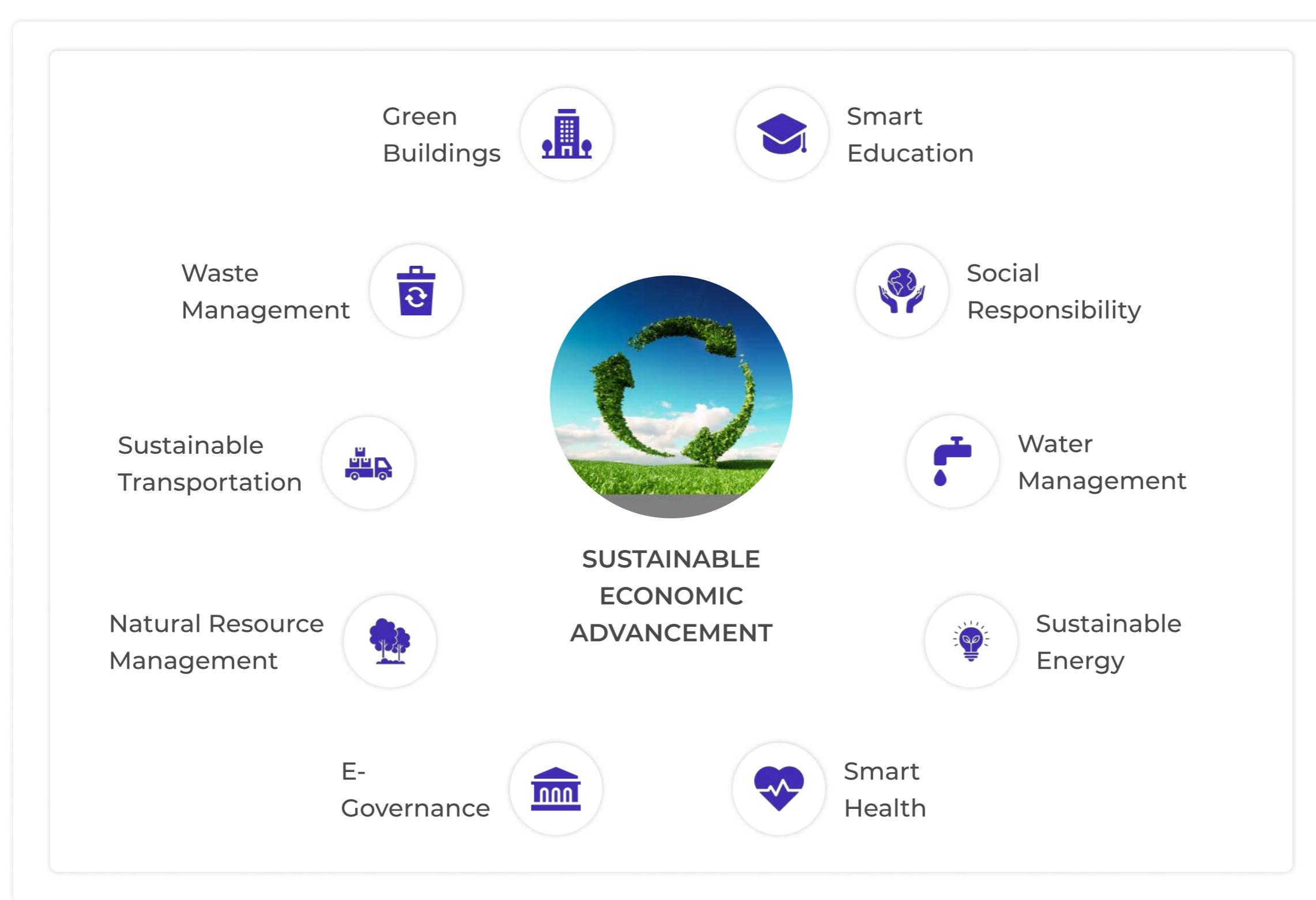
Companies can automate the tracking of carbon emissions across their operations by using smart contracts. The data can be made public and reported to monitoring services with the assurance that it cannot be modified or fabricated thanks to its cryptographic nature.

Additionally, the same cryptography can safeguard a business's anonymity when disclosing emissions. Unfalsifiable proofs can be produced using zero-knowledge (Z.K.) technology to validate the information without disclosing it. This enables a business to demonstrate compliance with energy usage or carbon emission guidelines without divulging the underlying information. Blockchain may support sustainability through tokenization and digital distribution of environmental assets. A notable example is the expansion of the carbon credit market, which has caught the attention of eminent institutions like the World Economic Forum and accrediting registries like Verra and Gold Standard.



Advancements In Sustainability Solutions

Beyond only energy use and carbon credits, Blockchain has the potential to support sustainable development on a significant scale. A growing number of blockchain-based sustainability-related systems, like those that monitor water use and plastic manufacture, are expected to appear in 2023. Governments and regulatory organizations might use these blockchain systems to set clear benchmarks for what amounts of environmental damage are acceptable across various industries. Clearly defining the expectations for emissions not only improves the environment but also streamlines corporate operations. The ability of blockchain technology and its related applications, such as DeFi (decentralized finance), to empower communities that have suffered significant harm due to industrial activities resulting in environmental degradation is a noteworthy characteristic of this technology. These communities, especially those in developing countries, can gain from the transparency and accountability provided by blockchain-based solutions in fields like supply chain management. We would be closer to fair trading practices in the future due to improved treatment and a more equitable revenue allocation.



It is clear that because blockchain technology is still in its infancy, it cannot by itself address the problem of climate change. But different industries must take the possibilities of Blockchain into account. One of its most important characteristics is its ability to address the accountability of businesses that make environmental claims. The options are unlimited; this is just the tip of the iceberg. It's time for the world to change its perspective and let go of the false notion that Blockchain is a part of the issue. In actuality, it can contribute to the answer.

BLOCKCHAIN AND SUSTAINABLE DEVELOPMENT GOALS (SDGs)

The Sustainable Development Goals (SDGs) are a group of 17 global goals with a 2030 target date that address issues such as poverty, equity, education, climate change, infrastructure, land use, and production/consumption. Many global asset owners are turning to Sustainable Development Goals (SDGs) as an organizational framework, especially those looking for a themed investment strategy.

In a poll of asset owners by Morgan Stanley Investment Banking, 78% of the institutions also contemplate integrating or considering sustainable investments as part of their investment strategy. The SDGs provide a conceptual and practical framework for thematic investment.



The U.N. identified several strategic goals as a result of its 2015 General Assembly that were carefully chosen for their global significance and immediate bearing on the future of humanity. Ending poverty in all its forms around the world, achieving food security and improved nutrition, promoting sustainable agriculture, and fostering sustained, inclusive, and sustainable economic growth, as well as full and productive employment and decent work for all, are just a few of these goals, also known as the Sustainable Development Goals (SDGs).

These goals were included in the so-called 2030 Agenda, which aims to carry out the work required to accomplish these goals before 2030. The International Telecommunications Union (ITU), the U.N. agency in charge of information and communications technology issues, has been researching how Blockchain can help achieve the SDGs as evidence of this.

Following this analysis, it was found that achieving the SDGs requires proper management of the financing and oversight of the actions to be taken. As a result, using Blockchain technology as a tool in addition to current systems can help reduce the occurrence of bottlenecks and blockages and increase financial liquidity by reducing frictions in the transfer of value.

How Blockchain Helps To Achieve Sustainable Development Goals (SDGs)

Blockchain has applications regarding the SDGs in different ways:

- Offering a layer of traceability and global transparency to all actors, roles, and participants naturally encourages behaviour and responsible use of all resources.
- Providing security and resilience features prevents unilateral manipulation that can harm third parties.
- Utilizing smart contracts, which authenticate the actions within Blockchain, ensures accuracy in supervising actions.

■ **SDG 1: End of Poverty**

The 2 billion unbanked people worldwide can trade and transact thanks to cryptocurrencies and other blockchain-based tokens. Blockchain solutions are upending the enormous global remittances sector and reducing the cost of migration as projects like BitPesa and CariCoin start to gain pace. Giving the less fortunate a digital identity makes fundamental services more accessible without increasing out-of-pocket expenses.

■ **SDG 2: Zero Hunger**

The ability to "tokenize" assets, or to represent any physical object within a constant and completely traceable registration system, is another intriguing use case with numerous possibilities. So that they can track the use of allotted funds and ensure they are being used for this goal, Sweden launched a program to prevent poor eating habits in the child population.

■ **SDG 3: Health and Wellness**

There are regional initiatives to share patient healthcare records more securely and effectively, which is good for everyone's health and wellness. Moreover, startup Gem is placing information on disease outbreaks on a blockchain to help disaster relief and response efforts.

■ **SDG 7: Affordable and Non-Pollutant Energy**

Applications that enable tracking the source and purchase of energy and managing CO₂ footprints produced by businesses are being developed. These applications enable the implementation of incentive schemes utilizing tokens.

■ SDG 8: Decent Work and Economic Growth

As we've already mentioned, Blockchain offers transparent and secure traceability, ensuring that the things we consume are not created under conditions involving human exploitation, such as minors or slave labor. Due to the constant assurance of moral behavior across the whole supply chain, this also always impacts an increase in the flow of capital for underserved industries.

■ SDG 12, 14, 15: Responsible Production and Consumption

Blockchain has the huge potential to support the Circular Economy by ensuring good provenance throughout supply chains, enabling responsible production and consumption, life below the ocean and life on land. For instance, blockchain startup Provenance already tracks yellowfin and skipjack tuna from catch to customer while digitally strengthening the value of Soil Association Organic certification.

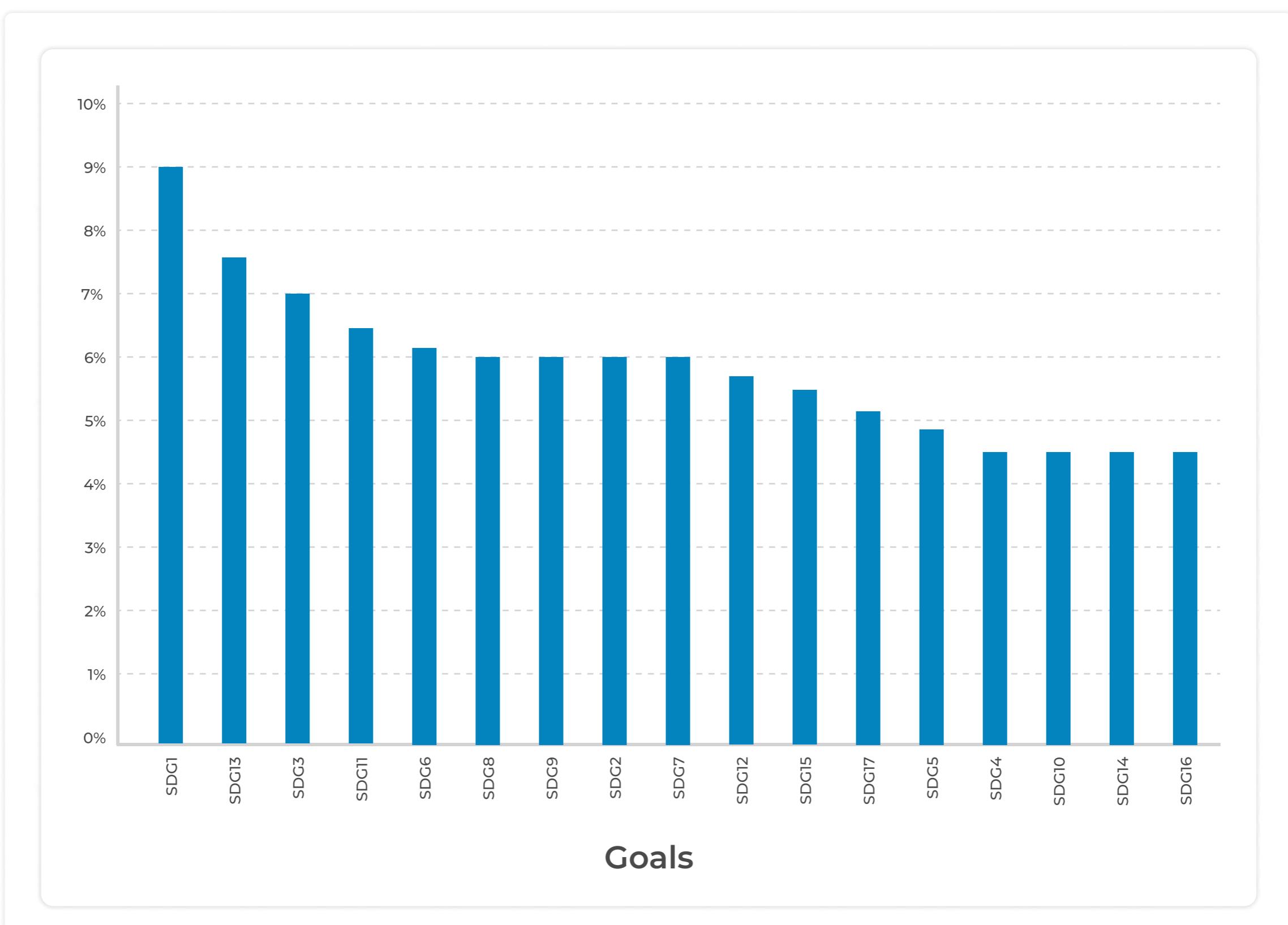
■ SDG 13: Climate Action

The main goal of this program for creating Blockchain-based technologies is climate change. The U.N. thinks that by using Blockchain in this way, among other things, the following advantages can be realized:

- Strengthening of monitoring and verification of the impacts of the actions undertaken.
- Improvement of transparency, traceability and cost-effectiveness.
- Building trust among environmental actors.
- Creation of mechanisms that encourage climate action, especially in an accessible way to the poorest.
- Mobilization of green finance.

■ SDG 16: Peace, Justice and Solid Institutions

Blockchain's transparency and trust features enable real-time monitoring of the creation and development of public budgets, with alarms that go off when they notice any deviations. As a result, it serves as a reliable instrument in the struggle against deceit and corruption.

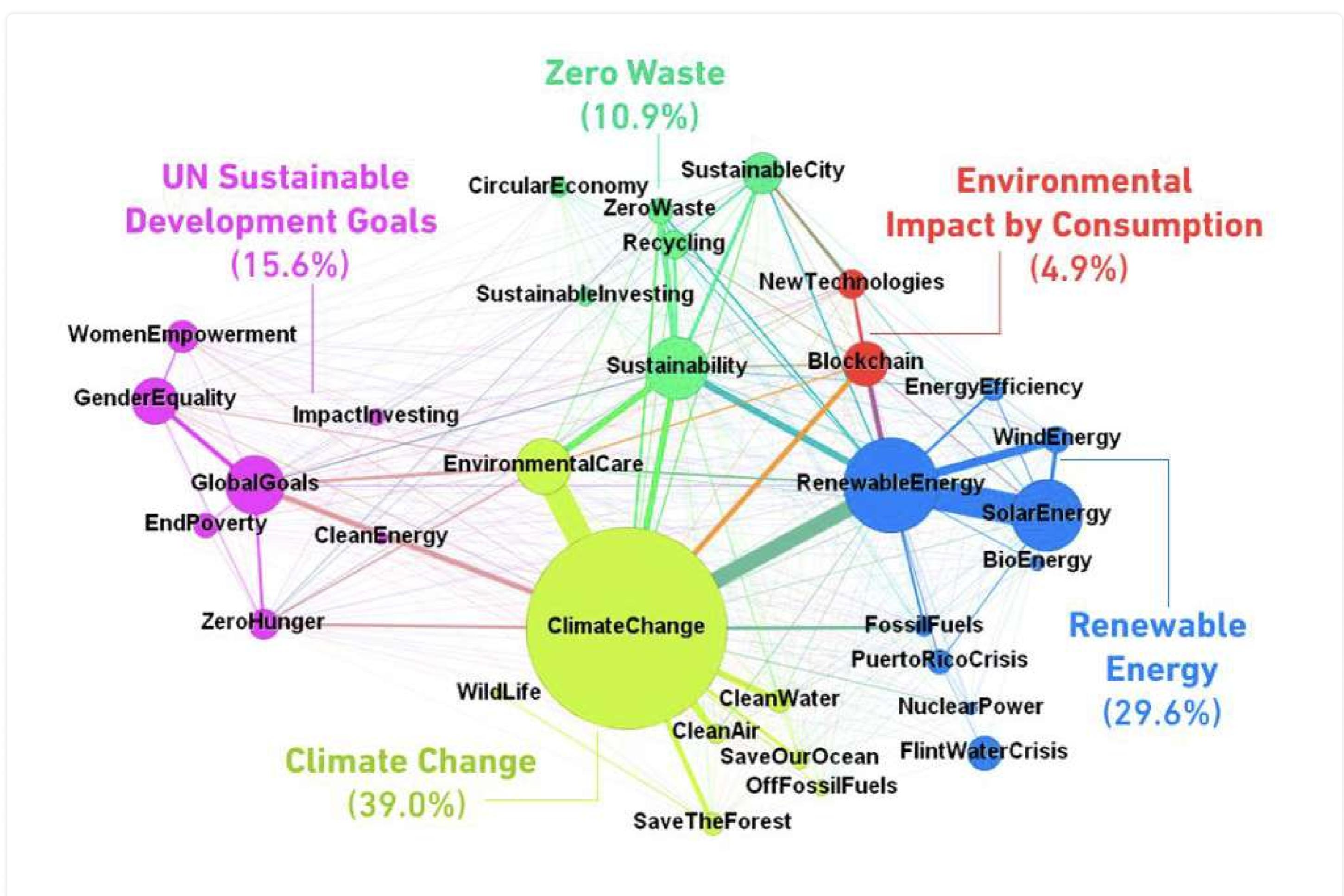


WAYS BLOCKCHAIN SUPPORTS SUSTAINABILITY

The most significant technological advancement in the last ten years has been Blockchain. Although it was created as an information exchange method, it is utilized today for cryptocurrency trading. Yet, Blockchain has a wide range of applications, such as promoting environmental protection. Its strength and effectiveness have the potential to lower overall energy use.

Blockchain has many features that can significantly aid in environmental protection. By providing businesses with access to data stored within the Blockchain, technology features can aid in promoting sustainability. Businesses can utilize this Blockchain-powered data to pinpoint problems in many areas of corporate operations and then create a workable fix.

Blockchain technology can increase an organization's energy efficiency and lower computing costs. Due to Blockchain's special features of security, immutability, and decentralization, our current and future sustainability efforts are secure.



Blockchain Can Be Useful In The Following Ways:

■ Reducing Poverty:

The development of blockchain technology has accelerated in recent years. Blockchain powers most digital currencies and is much more than a standard payment system. A blockchain is an encrypted database where transactions are permanently recorded in a public ledger instead of a traditional bank. The poorest people can use blockchain technology to buy their first real assets. Blockchain technology will safeguard property owners' rights against fraud and guarantee accurate ownership transfer through a decentralized register following a sale. The poorest people can establish their existence thanks to blockchain land registries' ability to increase access to banking services. Some nations, including Bermuda, Brazil, Georgia, and Ghana, have already started testing this technology. A blockchain was developed for this purpose by a startup in the U.K. Users can authenticate themselves using voice and facial recognition on this Blockchain. This authentication procedure can be finished using a basic Smartphone in under 30 seconds. The Blockchain will assist these farmers in making business investments and achieving financial stability. Technology will improve the traceability of land titles, boosting their income. Blockchain will allow for a worldwide record of ownership in addition to lowering poverty.

■ Ending Hunger with Blockchain:

Blockchain technology has many real-world uses, from lowering business costs and risks to boosting accountability and efficiency. Similarly, the use of decentralized blockchain technologies may significantly contribute to the reduction of hunger. To combat food waste and unjust economic distribution, the Blockchain may be able to help eradicate world hunger. Blockchain can potentially be applied to the food supply chain to prevent hoarding. Blockchain tracks how many raw materials are sold to agricultural firms in a food processing system and then routed to distributors. The production or wastage of surplus food and the expense and time associated with buying food for the hungry can be stopped. Governments and agricultural businesses may increase the transparency and efficiency of the entire process by using blockchain technology.

■ Promoting Health and Wellbeing through Blockchain:

Can Blockchain promote health, happiness, and wellbeing worldwide? Clinicoin is an illustration of a blockchain-based health and wellness platform. This platform encourages more cooperation between medical institutions and their users than previous "get paid to exercise" schemes. It connects users to a community of users interested in maintaining their health while offering a safe HIPAA-compliant route for exchanging health information. It serves as a venue for healthcare professionals to honor their patients for adopting healthier lifestyles. By enhancing

data management, real-time integration, and real-time analysis, creating a blockchain-based health app will empower patients and healthcare professionals. Smart contracts built on blockchain technology will concentrate on patient outcomes and compensate users for encouraging healthy behavior. Healthcare professionals will likewise be compensated for the caliber of care they deliver by enabling blockchain-based health apps. This will result in fresh possibilities for A.I. applications. The OSF innovation is one such initiative that will use Blockchain to boost health and welfare. While Blockchain has many potential benefits for the modern healthcare industry, it is not yet ready for widespread implementation. Blockchain technology enables safe, unchangeable information and cooperation without the need for third parties. The HHS is trying to keep up with this field and find opportunities to aid in health-related initiatives. Additionally, it is mapping the blockchain ecosystem and aiding a consortium for communication and cooperation. Also, it will assist blockchain research in locating chances for bettering health and wellbeing.

■ Quality Education through Blockchain:

Many ways exist for using blockchain technology to enhance the delivery of high-quality education. All parties involved can benefit from the security, integrity, anonymity, and encryption that this technology can offer. It may also encourage higher transaction rates for both students and educational institutions. It can be used to reward teachers and students by developing a secure, decentralized record-keeping system. Nevertheless, educators must first build the necessary educational infrastructure to implement blockchain technology in a high-quality education system. This can include MOOCs, which let people with different levels of education interact with one another to learn from one another. The immutability of blockchain technology is just one of many benefits it offers educational institutions. Blockchain ensures that no one can alter or change a student's prior academic accomplishments and certifications. A blockchain cannot be changed, unlike paper documents, which are easily changed. Moreover, data is encrypted on the Blockchain before being stored. Blockchain cannot be changed. Thus, great education delivered through it can improve the sustainability and transparency of educational institutions. It might also lessen the anxiety associated with plagiarism.

■ Gender Equality through Blockchain:

The development of blockchain technology has generated great interest in the emergence and demise of virtual currencies. But, Blockchain has applications beyond the financial sector. Development professionals use blockchain technology to establish and sustain gender equality in all spheres of our personal and professional lives. Blockchain technologies can make it easier for women to acquire credit, develop new types of identification, and manage their money more effectively overall. Professional fields like computer science and I.T. have historically favoured men, making them predominately male areas. Many women and underrepresented minorities

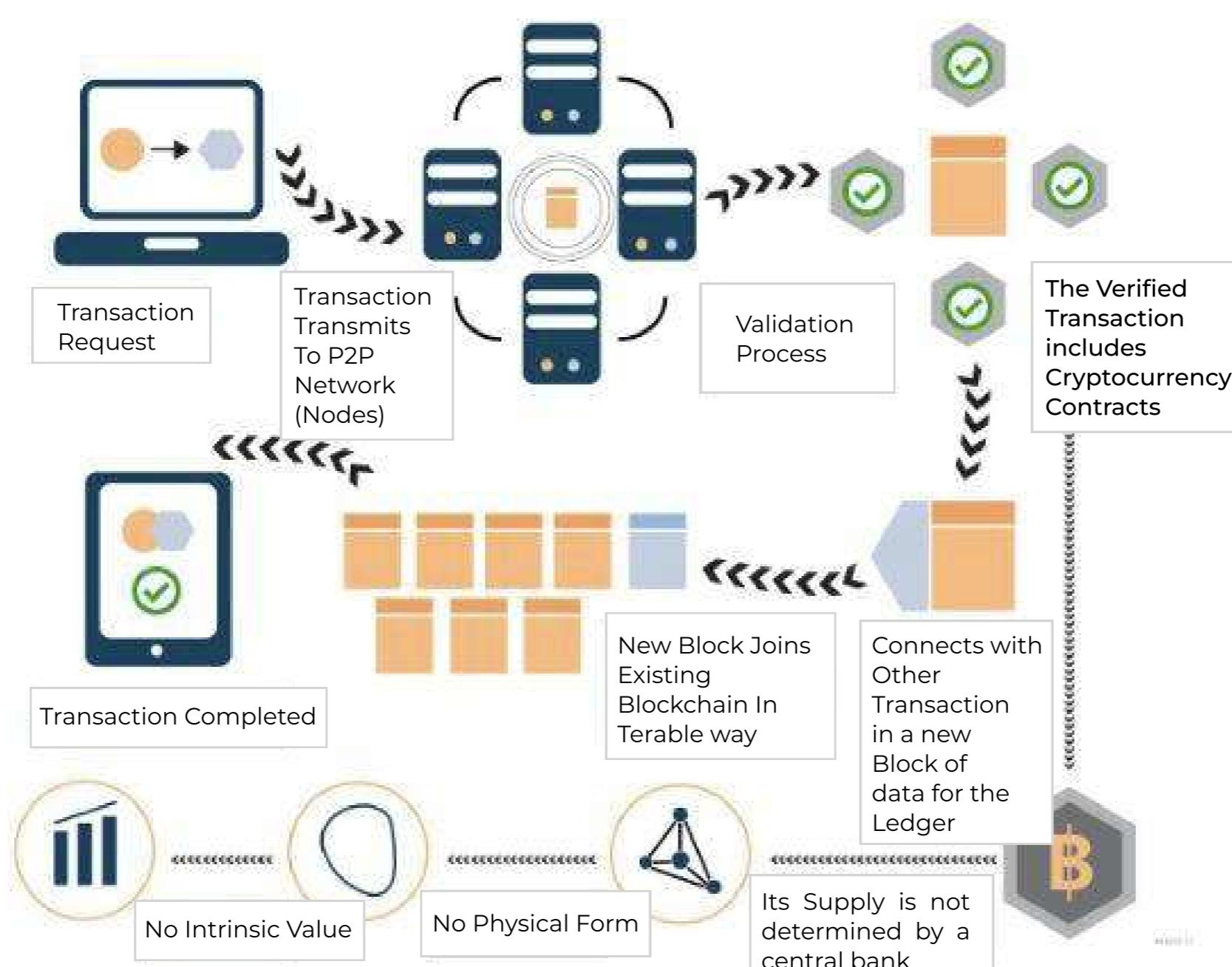
are getting involved in blockchain initiatives, though some activist groups are actively trying to change that. Blockchain Israel's originator, Yael Rozencwajg, advocates for environmental protection and sustainable development. She is actively trying to change the underrepresentation of women in the blockchain business, which she has seen firsthand.

■ Blockchain promotes clean water and sanitation:

Blockchain technology can potentially enhance global water and sanitation management. Physically, water is a limited resource. Current approaches to water management confront major hurdles due to the complexity of water management legislation and the increasing water demand. The use of blockchain applications can be used to integrate automated work processes and consolidate the current water management system. Water and sanitation systems' confidence, openness, and accountability will be further improved by Blockchain. Blockchain may incentivize more communities to embrace clean water and sanitation by providing access to improved financial services. Communities may be more inclined to embrace sustainable water management methods by rewarding conservation initiatives based on performance. Also, by reducing water contamination, these activities may increase access to clean water.

■ Economic growth with Blockchain:

Three of the most important issues relating to sustainable development can be addressed using Blockchain to log transactions between nations and individuals. The importance of inclusion, trust, and multilateralism will be addressed for many years. Governments, civil society, academia, and non-governmental organizations must come up with fresh solutions to these problems and harness the potential of Blockchain to encourage inclusive growth to do this. Blockchain can aid in the SDGs and sustainable development in this way.



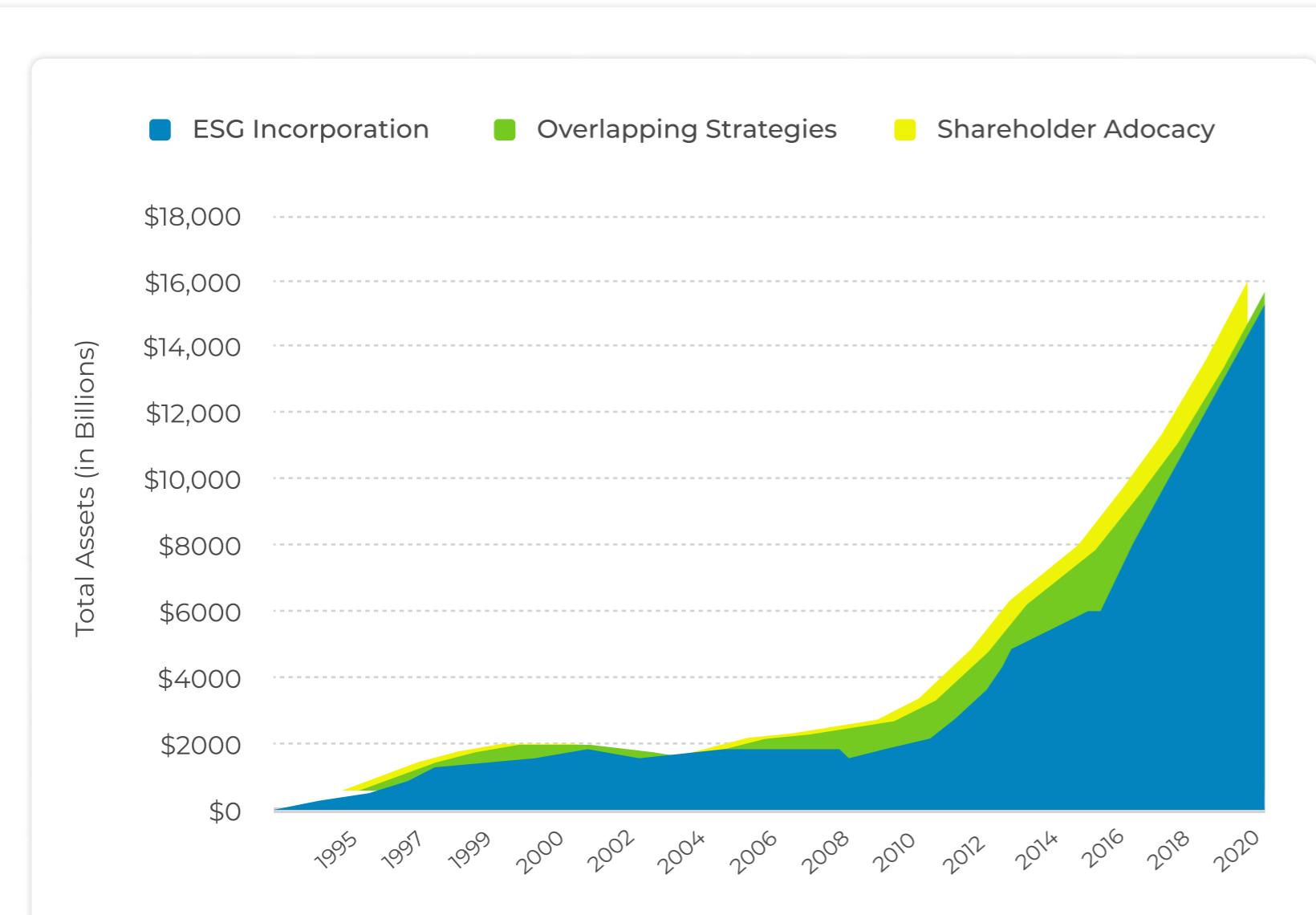
BLOCKCHAIN AND ESG

Blockchain has advanced the markets for environmental, social, and governance (ESG) policies in a distinctive way by expanding the pool of reliable assets. This statement may surprise you. The environmental issues connected to mining are the main discussion topics for blockchain technology. But, it's important to remember that the initial blockchain use case was to democratize monetary and social governance. Examining the significance of Blockchain in ESG in greater detail. A review of a company's social and environmental responsibility is the goal of ESG, which stands for Environmental, Social, and Governance. In doing so, it is particularly helpful in assisting "socially responsible investors" in selecting an investment venue. A company's value is also increasingly influenced by environmental and social considerations, with estimations estimating that by 2025, worldwide ESG assets will be worth more than \$53 trillion. ESG reporting is frequently used to assess the degree of sustainability, particularly for publicly traded organizations. Yet, the ESG-based sustainability rating is still insufficient because data verification, consistency, and transparency are lacking. As ESG measures become more significant, there is a growing need for accurate data. Yet, they can be challenging to find without an industry-wide set of standards, and the absence of validated and standardized ESG data can be a major issue. In general, distributed ledger technology, including blockchain technology, has the ability to provide a safe and open solution to this problem.



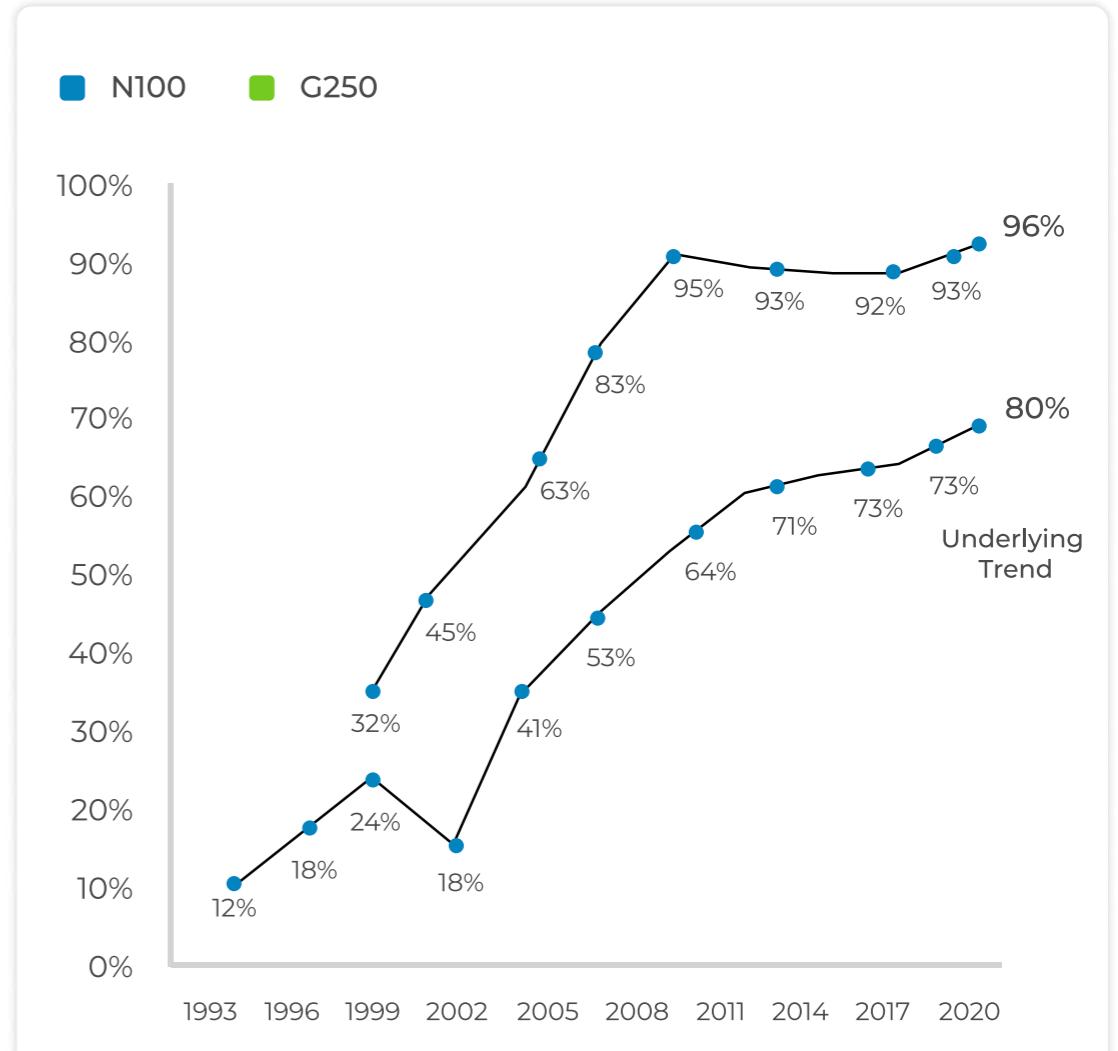
Other digital technologies, such as the Internet of Things (IoT), which enables diverse devices to speak with one another and share data and information without requiring human intervention, can support the automation of data collecting. Using Blockchain as the communication infrastructure, all data exchanged between devices is guaranteed to be accurate and, more importantly, fully encrypted so that it cannot be changed without permission.

By reporting their emissions through a single blockchain platform, businesses may provide a standardized environment for data to be gathered and tracked consistently, allowing for significant metrics in reducing the carbon footprint internationally.



Source : [US SIF Foundation](#)

ESG investment funds experienced a record inflow in 2020, with the global total; now equal to \$40 trillion - this is larger than the entire U.S economy.



ESG Supply Chain Transparency

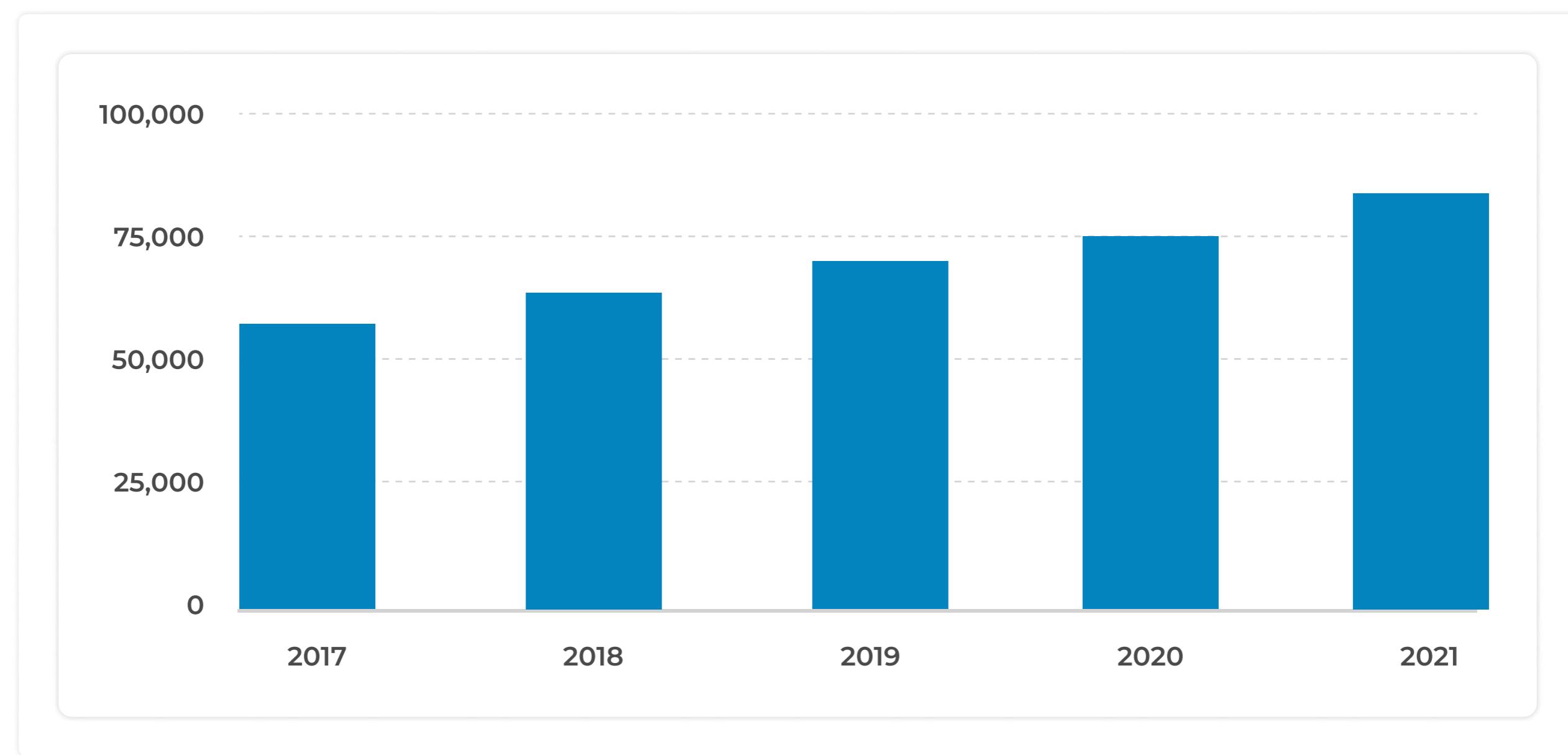
A key component of accomplishing the sustainable goals of the E.U. is strengthening supply chain sustainability. Supply chain management may change as a result of blockchain technology. The blockchain platform offers a digital system and database to record transactions along the supply chain using distributed ledger technology. Supply chain management is made more transparent, dependable, traceable, and effective because of this decentralized database of transactions. Blockchain can therefore automate data collecting at various stages of a company's supply chain utilizing IoT. Companies can have a better overview of and control over their environmental effect because the pertinent data do not have to come from possibly error-prone providers. The automation and availability of information in real-time can also assist businesses in identifying problems earlier and accurately tracing them to their origin. Blockchain is also important for ethical and responsible sourcing. By enabling all parties to access the transactional data at any time, its transparency can be vital in tracing the materials and items from their origin to their final destination and contributes to ensuring everyone's security.



Blockchain Benefits For ESG Market

Blockchain can potentially elevate ESG business relationships and considerably help businesses uphold social responsibility standards. Distributed ledger technology (DLT) has the potential to significantly improve sustainability.

Non-financial reporting and ESG compliance are already a component of the way that business operations are now conducted. There are over 600 ESG ratings and 2,000 unique ESG reporting indicators. Some stock markets mandate ESG reporting for listing, and several stock exchanges show ESG criteria. Yet, to be reliable and helpful for making decisions, ESG accountability has difficulties and needs to be automated, standardized, and provable. Data gathering should be automated, and sustainability indicators should be quantitative and verified. Blockchain and some other emerging technologies may be the answer and the main component of a strong ESG architecture. Thankfully, the flow of digitalized, authenticated, and tokenized data that the private sector so sorely needs can be produced by combining Big Data, the Internet of Things, and DLT.



Accessible Investment:

The United Nations Environment Programme (UNEP) and investor initiative The Principles of Responsible Investing study the advantages of Blockchain for ESG investments. The primary application of blockchain technology is microfinance, which enables access to financial instruments for businesses and individual investors in underdeveloped nations. Examples of solutions include payments and transfers, money exchange, loans and investments, and decentralized decision-making tools.

Sustainable Supply Chains:

Businesses look into blockchain technology's potential outside the financial industry. Several organizations are testing blockchain-based innovations to increase sustainability and address various unmet needs. Increasing supply chain transparency is one of these needs. Stakeholders can access the full transaction history in any company's supply chain and assess whether the resources are from moral, ecologically friendly sources. Documents on the Blockchain cannot be hacked or faked. The blockchain network's accessibility to this data makes it possible to lower losses and counterfeiting, improve relationships with third-party contract producers, and boost brand reputation. Companies will better know their progress and strong points with deeper and more comprehensive ESG data.

■ Responsible Governance:

Blockchain has uses in ethical business management as well. The Blockchain can record shareholder meetings, votes, and decisions, lowering the possibility of disagreement and safeguarding the information needed to make corporate decisions. Through more effective hiring procedures, more secure transfer of sensitive data, and more thorough learning and development environments, blockchain technology can enable more efficient human resources administration and an engaging employee experience. These blockchain applications can also enhance employee wellbeing, a growingly crucial sign of an organization's health and effectiveness.

■ Standardized ESG Reporting:

ESG reporting and ratings come in a wide range. One of the main problems with ESG reporting is that there are no international standards. Blockchain technology can potentially improve ESG reporting standards' openness and consistency while increasing the significance of non-financial accounting for global decision-making. Some businesses are already developing Blockchain use cases for the ESG data exchange platform. Companies need to perform much more research into how DLT-enabled platforms and Blockchain might help close their present ESG data gaps in light of the ongoing social disturbances. Technology already exists that can increase stability and confidence in the expanding ESG sector. The next stage is to identify appropriate localizations and use cases, an energy-efficient blockchain architecture, and an appropriate set of tools for data processing and sharing. Companies today are being shortsighted by ignoring the positive effects of Blockchain on ESG in light of the little discussion surrounding Bitcoin's energy usage.

■ Improving Market Efficiencies:

Even in markets where ESG products are standardized, the market structure remains a persistent issue. Carbon markets provide a particularly good illustration. Walid Al Saqqaf of Rebalance Earth notes that while an African forest elephant is alive, it still contributes \$1.75 million in carbon sequestration services, worth \$40,000 for its ivory. These inefficiencies have made consumers skeptical of what should be a potent tool for sustainable finance. Overwhelming demand is one factor contributing to market friction. The demand for voluntary carbon offsets is expected to increase from U.S. \$1 billion in 2021 to \$50 billion by 2030 due to corporate net zero commitments. But, even today's throughput cannot be properly handled by markets. Due to market structure, offsets are frequently misapplied, incorrectly reported and devalued. This is made worse because carbon credits vary depending on the market. Three operational advancements have been made due to the adoption of Blockchain in carbon markets. Decentralization simplifies registering, trading, and managing carbon credits, which is the first

improvement. The ESG1 platform is one instance where energy-measuring software produces public chain offsets. GuildOne Inc. developed it and uses the Corda network and smart contracts to establish an automated environment for credit validation. But, even today's throughput cannot be properly handled by markets. Due to market structure, offsets are frequently misapplied, incorrectly reported and devalued. This is made worse because carbon credits vary depending on the market. Three operational advancements have been made due to the adoption of Blockchain in carbon markets. This kind of market simplification has been demonstrated to boost quota use. As an illustration, consider AirCarbon in Abu Dhabi, which is constructing the world's first completely regulated carbon trading and clearing house. This is a significant advancement in a previously unmoving global industry. A shared ledger's openness makes existing markets more dependable and open, another improvement. This deals with market opacity, a major factor in "usual" issues like missed deadlines, unethical trading, fraud, and repetitive transactions.

■ Safer Analytics for Social Policies:

The social aspect of company policies is covered by the "S" in ESG. Issues with data measurement frequently hamper work on social policy. Particularly, gathering data may endanger the people it is intended to assist. The organization Hope for Justice, which compiles information on human trafficking, is a prime example of both the issue and the solution. Businesses like R3 embrace initiatives like this to bring transparency to a major issue. But, they rely on their data collection in extremely private, specific circumstances. Because of the risk to the tenuous position of those who contribute the original data, any leaks in that data have historically made analysis impossible. The use of Blockchain and secure computing has been one solution. This enables the nonprofit organization to produce aggregated statistics about patterns in human trafficking without disclosing the underlying data. This has already demonstrated success in one nation by identifying a 35-mile radius as the source of 95% of all reports of human trafficking. This information gives authorities the intelligence they require to find and apprehend the traffickers. This ESG component has historically received less attention than it deserves in corporate policies because it is difficult to share information about sensitive subjects, including exposure to geopolitical risk, the use of forced labor, and safety issues.

Blockchain highlights how governments and socially conscious companies already possess an unrivaled capacity to utilize their data, with potentially game-changing implications for global inequality.

■ Creating new investable asset types:

Blockchain has streamlined ESG programs in a fourth way by developing new types of investable assets. International businesses as varied as Ikea, Keurig, and H&M have had difficulty commercializing products with advantageous ESG attributes. Consumers prefer "green" cosmetics and shoes manufactured from plastic bottles. Yet, a lack of standards encourages shortcuts and occasionally exposes exaggerated claims. What if an asset could independently confirm its own ESG claims? Tradable assets have been diversified in three ways due to this in finance already. First, previously illiquid assets can now be traded by confirming provenance claims. As a result, it can facilitate the issuance of green bonds or new instrument classes in which ESG provenance is a crucial quality. Banyan and the RABC group use the Corda network to offer sustainable finance to larger markets and customers. The second benefit is opening a wider market for previously syndicated assets like infrastructure. Thanks to improved liquidity discovery and tokenization, legacy asset types are now more easily available. All market players are more likely to believe in digital assets because their provenance is straightforward. Consumers and investors prefer sustainable fuels, such as hydrogen and natural gas, with verified low emissions, as a third example. Blockchain traceability and emissions accounting aided the transition to cleaner fuels and investable products, such as ESG1's low-carbon natural gas certification initiative on Corda, which will begin in Q3 2022 with two Canadian energy partners.

All three of these actions broaden the range of assets available on the market by including those whose value is influenced by ESG factors. This can refer to the network's business types or the sustainability of the materials used. But, by putting these assets on a ledger, they can grow thanks to their issuance, asset servicing, and market discoverability.

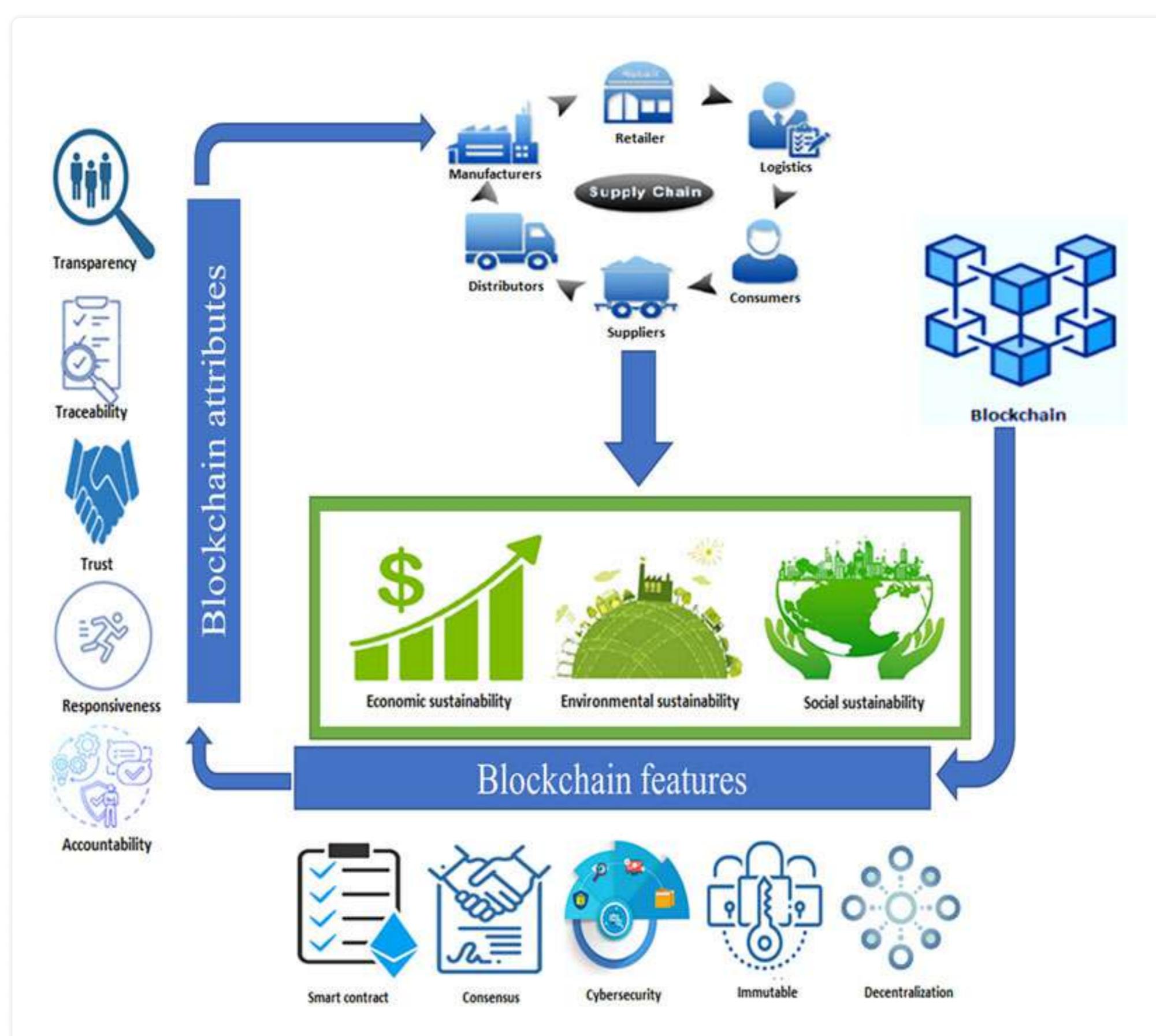
BLOCKCHAIN AND ESG: ACHIEVING SUSTAINABILITY THROUGH BLOCKCHAIN

BLOCKCHAIN AND ENVIRONMENTAL SUSTAINABILITY

One of the numerous cutting-edge technologies that could aid in resolving some of the current environmental issues is blockchain technology. Blockchain applications can provide decentralized energy systems, common-pool resources, innovative financial instruments, supply chain monitoring and tracking, and peer-to-peer trade of tokenized goods.

Blockchain applications are being created using peer-to-peer logic, which enables organizations to exchange goods, services, and information without the need for centralized authorities to validate transactions, verify identities, or uphold agreements, or at the very least by doing away with the need for numerous intermediaries as is the case right now.

Blockchain



Blockchain is a revolutionary technology transforming information technology and signifies a shift in how information is exchanged on a cultural level. Businesses are scrambling to figure out how to use distributed ledger technology on the Blockchain to innovate processes, products, and transactions. What function does the Blockchain serve in a globalized world where environmental sustainability is a crucial success factor? This study uses a systematic review methodology and the preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) protocol to examine whether and how blockchain technology might increase environmental sustainability.

Following the search protocol results from 195 studies from 2015 to 2023 were analyzed. The findings suggest blockchain technology may help various ecologically sustainable development goals (SDGs), including establishing safe and dependable smart cities, a sustainable supply chain, and increased energy efficiency. The report also identifies the fields where research funding should be concentrated, offering a means of encouraging sustainable behavior while boosting environmental sustainability.

Ways Blockchain Can Be An Environmental Game -Changer

Despite the excitement, many obstacles must be addressed before it can be as widely used and adopted as the Internet or mobile phones. They include addressing issues with user acceptance and trust, performance obstacles (such as interoperability, scalability, and energy utilization), security threats (such as identity and cyber theft), and legal and regulatory issues.

If these obstacles can be addressed, Blockchain could resolve environmental problems, from illegal fishing and deforestation to better water and energy management, as the technology develops and its applications across sectors and systems expand. We highlight more than 65 developing use cases where Blockchain might assist in resolving environmental issues in new research from the World Economic Forum and PwC, released at the Global Climate Action Conference in San Francisco. In conjunction with other cutting-edge technologies of the Fourth Industrial Revolution, we also identified areas where Blockchain could prove to be a wild card that upends current business structures and how we address climate change and other environmental issues.

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We Called These Game-Changers, And There Are Eight Of Them.

■ See-through Supply Chains:

A blockchain can track transactions across the supply chain and produce an immutable (unchangeable) record of provenance, such as the place of origin for a product. This offers the possibility of radical and complete product transparency and traceability from source to retail. Furthermore, this may soon make such transparency inevitable, changing how suppliers, buyers, and regulators view supply chains. This might spark a fresh wave of consumer demand for clean supply chains. Going ahead, Blockchain can create a platform that unites all parties involved in a global supply chain, including factory employees, logistics providers, retailers, customers, investors, NGOs, and regulators. For customers and workers in the informal sector, a platform offering the data, traceability, transparency, control, or compliance mechanism that the specific user needs would be a genuinely transformative idea.

■ Decentralized and Sustainable Resource Management:

Decentralized, eco-friendly, and more resource-efficient energy and water systems can be scaled up using Blockchain. Platforms might gather dispersed data from various resources (e.g., household-level water and energy data collected with smart sensors). This is a game-changer since system decision-makers, including centralized authorities and retail-level consumers, frequently act on incomplete information. Platforms powered by Blockchain could get around this and allow for better informed and even decentralized decision-making regarding managing those resources or the overall system. This could include peer-to-peer trading, dynamic pricing, traceability and certification of renewable energy sources, and improved demand-side balance.

■ Raising the Trillions – New Sources of Sustainable Finance:

A whole new class of potential investors for projects to address environmental challenges could be attracted by blockchain-enabled finance platforms. These projects could range from investments in green infrastructure projects to facilitating blended finance or charitable donations for developing nations. To put it more broadly, a system change from shareholder to stakeholder value and from traditional financial capital to accounting for social, environmental, and financial capital is possible with Blockchain.

■ Incentivizing Circular Economies:

By motivating people and organizations to see the financial value in items that are now wasted, discarded, or viewed as economically invaluable, Blockchain has the potential to profoundly alter how materials and natural resources are valued, used, and exchanged. This could lead to a general change in behavior and aid in realizing a completely circular economy. For instance,

Plastic Bank has developed a social enterprise that rewards contributors of collected ocean recyclable plastics with money as a cryptographic token.

■ **Transforming Carbon (and other Environmental) Markets:**

Blockchain platforms might offer cryptographic tokens with trading values to enhance the carbon (or other substance) markets currently in place and open new avenues for exchanging carbon credits. China's "Carbon Credit Management Platform," created by Energy Blockchain Labs and IBM, is a recent example of a pilot project. The goal is to strengthen the Chinese carbon market's transparency, auditability, and credibility through smart contracts. In the future, Blockchain may support a global carbon trading market for people, homes, and businesses.

■ **Next-Gen Sustainability Monitoring, Reporting and Verification:**

Blockchain technology can revolutionize sustainability reporting and assurance, assisting businesses in better managing, demonstrating, and improving their performance, as well as empowering investors and consumers to make more informed decisions. To access real-time, reliable data and reduce fraud, smart contracts could automate data collection and management (for example, greenhouse gas emissions). As the efficiency of such mechanisms depends on transparent and reliable GHG emissions data, improved GHG accounting via the Blockchain could increase the effectiveness of carbon taxes.

■ **Automatic Disaster Preparedness and Humanitarian Relief:**

For various parties involved in disaster preparedness and relief, blockchain technology might serve as the foundation for a new shared system to increase resource efficiency, efficacy, coordination, and confidence. Using smart contracts, a well-designed system might allow various players to automatically communicate vital information in the case of a catastrophe. For instance, this might improve the efficiency and speed with which emerging resources are mobilized, automatically reroute supply lines, and allow relief organizations to better coordinate their activities in reaction to calamities.

Earth management platforms could enable new market mechanisms to protect the global environmental commons, from life on land to ocean health. These applications are further out regarding technical and logistical feasibility but remain exciting. For example, blockchain technology could incorporate a global ocean data platform to monitor ocean resources. Blockchain has the potential to facilitate a move to cleaner and more resource-conserving decentralized solutions, to release natural capital, and to empower communities if the technology lives up to its hype and is applied to the correct problems. This is crucial for the

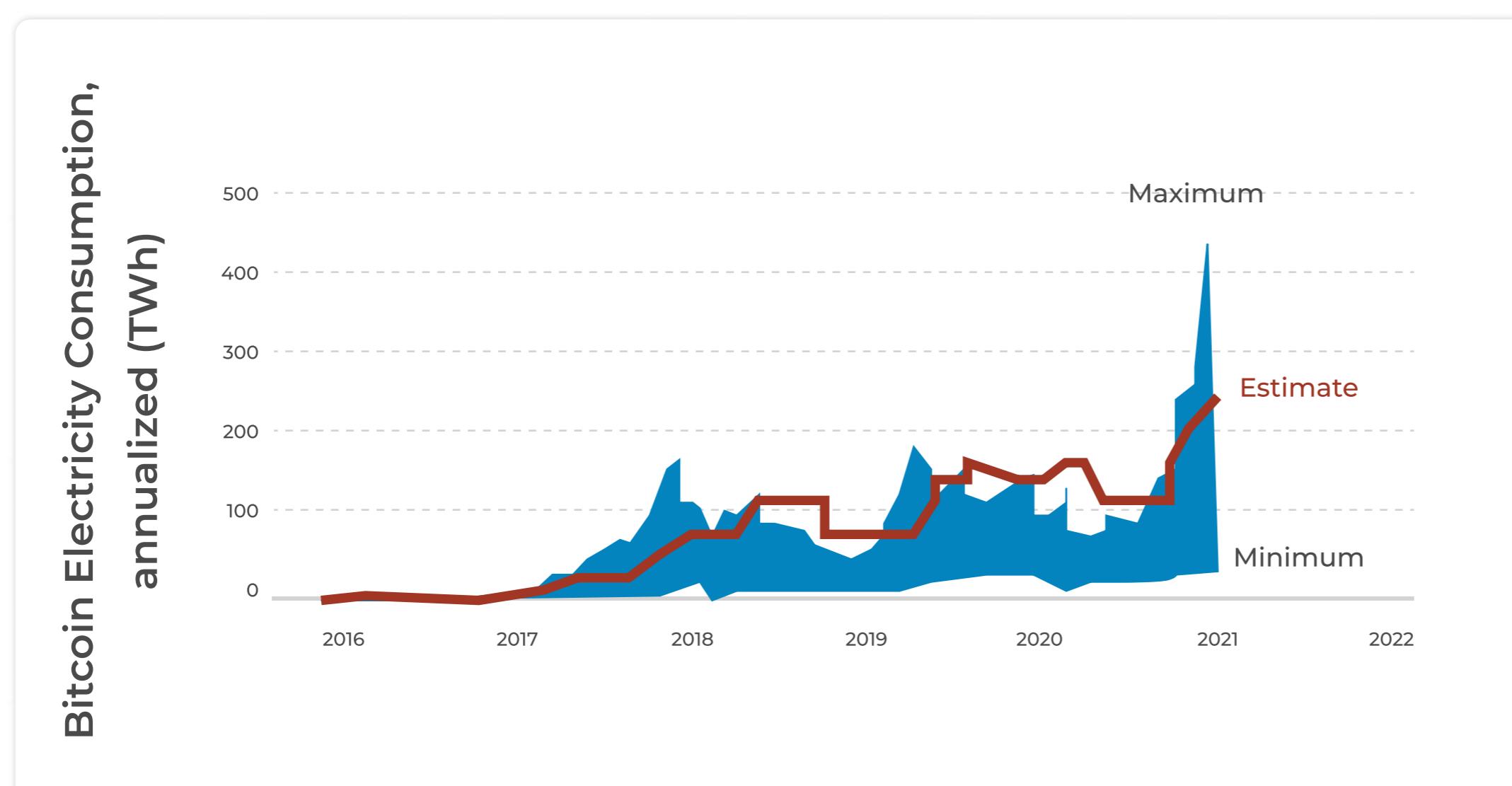
environment because it is now so difficult to capture the non-financial value and suffer from the tragedy of the commons.

The Environmental Challenges Of Blockchain

The new distributed concept behind it has led some experts to refer to it as the Internet of Value. A process for validating transactions by resolving mathematical puzzles is known as "mining," and it is responsible for creating the majority of cryptocurrencies. Public scrutiny of the "miners," who give their processing power, is growing due to their skyrocketing electricity use and carbon imprint. Yet, technological advancements imply that this issue might be remedied in future years.

Electricity consumption and carbon footprint: devastating and demonized at the moment, Blockchain's environmental impact is its primary obstacle. An analysis of the Luxembourg market undertaken in the fourth quarter of 2021 by LHoFT and PWC with the involvement of ALFI brought this difficulty to light. ESG is ranked as the top problem by 31% of the respondents, according to the survey. One of the protocols employed, POW (Proof Of Work), is harshly criticized since it is an energy hog in a world where addressing climate change is a major issue. This criticism follows several (often conflicting) research and analyses of the amount of electricity used by blockchain-related activities. Bitcoin would be the 26th largest electricity consumer if it were a nation.

POW, which supports the capitalization of 65% of cryptocurrencies, is a significant energy consumer. According to the Cambridge Bitcoin Energy Consumption Index³, which offers quantitative information on the cryptocurrency network, the annual energy consumption of Bitcoin is projected to be 133 terawatt hours. Due to the short lifespans (less than 1.5 years) and low recycling rates of mining equipment, its carbon emissions are also criticized, in addition to the energy used.



Country equivalent :

UK: 300 TWh

Spain: 242 TWh

Sweden: 131 TWh

Argentina: 131 TWh

Israel: 56 TWh

■ Putting the Information in Context

Blockchain still uses less electricity than, say, the banking sector compared to other economic sectors⁴. Among the energy-intensive operations are data centers. Non-POW systems for coins, including POS (Proof Of Stake), use up to 99% less energy. The transition to the POS protocol has started for Ether, the second-largest cryptocurrency in capitalization. We should also note that about 70%⁵ of the energy used to power the Bitcoin sector is renewable. Lastly, various initiatives have been developed to heat hospitals, schools, and swimming pools with heat produced by mining equipment⁶.

■ Regulatory Debates

The primary regulatory agencies and market infrastructures are also interested in blockchain electricity use. The European regulatory framework for cryptocurrency assets, MiCA (Markets in Crypto Assets), has long debated limiting these energy-intensive systems. On March 15, the Parliament eventually decided against outlawing the POW protocol. Since they were planning forward, some market infrastructures wanted to integrate environmental factors simultaneously. For instance, Societe Generale added these components to their documents before applying to add three security tokens to the Securities Official List (SOL) of the Luxembourg Stock Exchange. Along with regulators and existing infrastructure, there are other considerations.

The crypto sphere has released a charter intending to make the industry carbon-neutral by 2040 since it knows the difficulties it must overcome.

■ Crypto and Blockchain: A Positive Social Impact

Although Blockchain has received harsh criticism for its impact on the environment, its social implications are an entirely different story. Cryptocurrencies may be a way to get more than a billion individuals worldwide without bank accounts to use payment systems. The automated and inexpensive nature of the transactions means that they support microfinance. A smartphone with an internet connection is the sole requirement. The underlying Blockchain technology also supports cryptocurrencies, including traceability and transparency capabilities that enable the creation of unique use cases.

Another notable example is land registries. 70%⁷ of people worldwide, according to the World Bank, do not own officially registered land. As a result, numerous programs have been launched, especially those led by the United Nations Development Programme, to remedy this weakness.

Not to Mention Governance

Another important subject in emerging technology is governance. Corporate governance has historically been centralized with clear roles and duties. Given cryptocurrencies' "distributed" nature, the term is entirely different in this context. Communities make decisions in this place, and depending on the approach, decisions are made transparently and through Voting. The votes are kept in "smart contracts," which render them transparent and impenetrable. As more DLT/crypto initiatives are introduced, these decentralized organizations will likely expand in the coming years. Undoubtedly, Regulation will come up at some point, particularly about accountability. Blockchain technology, which underpins cryptocurrencies, is a brilliant invention that has spurred the creation of numerous ground-breaking projects. In a world where global warming is an issue that affects everyone, the energy required to keep it running presents a significant hurdle. So, creating new protocols may help technology realize its full potential in the years to come and allow for the benefit of all people.

BLOCKCHAIN AND SOCIAL SUSTAINABILITY

Blockchain-related technologies create a wealth of possibilities for making a beneficial social impact. Our partnerships with businesses, governments, and NGOs that work to create a more inclusive, just, and sustainable world inspire us every day. Because how you develop matters when the entire globe is a shareholder.

By enhancing data quality (Choi & Luo, 2019), monitoring potential social situations that could pose health and safety hazards, and promoting collaboration among supply chain participants, Blockchain can contribute to social welfare and supply chain profit (Rejeb et al., 2021; Saberi et al., 2019).

The decrease of unethical corporate practices, such as child labor, brutal working conditions, extortion, preservation of human rights, and the battle against social inequality and poverty, can be one of the positive social benefits of Blockchain (Kononets et al., 2022; Varriale et al., 2020).

Peculiarities Of Blockchain For Social Good

We define the following four peculiarities of Blockchain that can be linked to social objectives:

■ Reliability

Reliability because every active node keeps a complete copy of the blockchain ledger. Due to the near immutability of the Blockchain, all chain additions are controlled by security algorithms.

■ Transparency

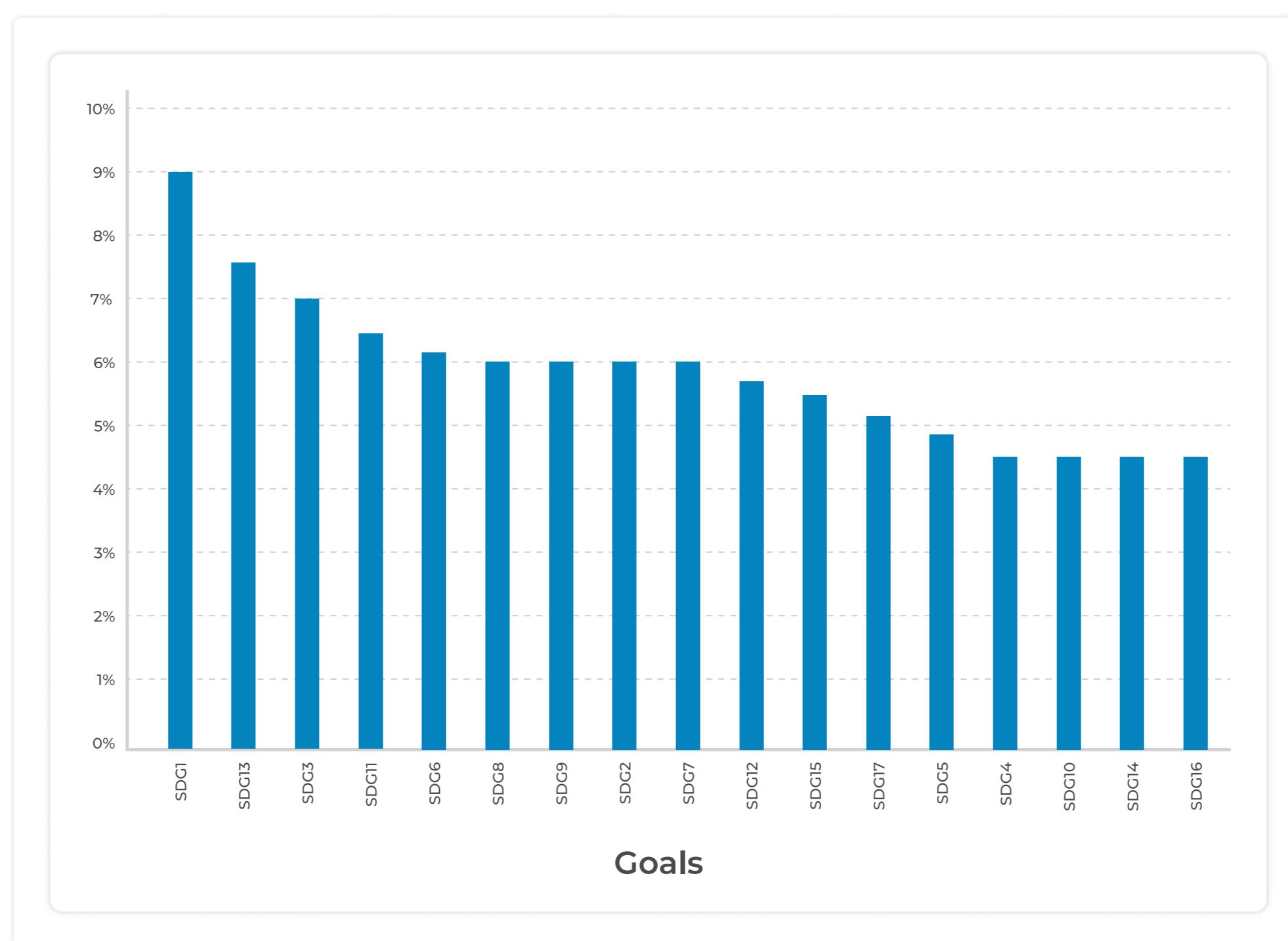
Transparency because all transaction histories are visible to anyone with network access. In actuality, Blockchain is a safe, open-access technology.

■ Decentralization

A blockchain network's decentralization results from participants agreeing directly on exchanging assets inside it. The ability to immediately communicate with another user without going through a middleman or intermediary is provided by blockchain technology. Blockchain is one such example. Because it is decentralized in design, it has no single point of failure, which increases its resilience, efficiency, and democratic nature. Blockchain's decentralization could provide the answer. We must trust the blockchain "code," though, without an institutional guarantor.

■ Accessibility

Accessibility because, theoretically, anyone with an internet connection can use Blockchain in the same way wherever. Given that it allows for the participation of all stakeholders, this characteristic may make it possible to establish community-based initiatives. Also, it has access to a global market (including talented people).



This process uses one or more blockchain peculiarities for stakeholders' demands and social good. Nonetheless, several Blockchain for good social features may help a project achieve various social goals. Also, under the stakeholder theory, we take stakeholders' requirements into account because they may have an impact on how a venture approaches the achievement of one or more social objectives.

Here are some instances of how a business could use a blockchain quirk for social benefit. Blockchain's dependability may support an effort to increase a company's cybersecurity to achieve the social goal of privacy protection. The Blockchain, a secure database, might aid in protecting privacy. Reduced bribery and fraud are two more crucial societal goals impacted by stakeholders in addition to privacy protection. Blockchain's transparency might also support a project to fix this. A company can use Blockchain to show all of its transactions.

How To Use Blockchain For Social Impact

The following 5 applications of Blockchain can aid society, advance social change, and protect the environment:

■ Saving Lives: With Blockchain as an Anti-Counterfeiting Technology

What type of technology saves lives? You would likely think of various medical gadgets without the headline, "Blockchain as an anti-counterfeiting tool." Another straightforward response to the question above is that security technology can save lives.

Seldom has Blockchain or Distributed Ledger Technology (DLT) been touted as a life-saving invention. Nonetheless, it is one of our best available security technologies.

Also, we can use it in various ways to improve medical technology or properly retain health records. For instance, in our situation, to stop theft and combat fake goods that kill millions of people every year worldwide. Particularly in the pharmaceutical sector.

Blockchain technology as an anti-counterfeiting solution can minimize the number of deaths caused by counterfeit medications and, thus, save many lives by making it much easier to detect and prevent stolen and counterfeit goods in the supply chain.

■ Increasing Consumer Safety: By Increasing Supply Chain Transparency and Protecting Products.

Successful businesses seek to preserve their brands. It is a sizable industry since outdated data and logistics management systems are ineffective at preventing the sale of fake and pirated goods. It is considerably simpler to identify and stop fraudulent and stolen goods from entering the supply chain when there is greater transparency and security.

DLT solutions for organizations like Vault do more than only safeguard supply chains and brand equity. Blockchain can improve the security of any type of consumer product.

How? From third-party suppliers' parts through the final customer, including those who purchase a product second-hand, product authenticity can be tracked and validated throughout the production process (or even third-hand). Supply chain managers can verify the validity of components and ingredients like that outlined above for the end user. By implication, higher consumer safety results from increased product safety, which benefits society.

■ Tracking Assets to Prevent theft: B2B, Logistics and Supply Chain, and Consumers.

We've talked a lot about how to strengthen supply chain security generally to combat the black market. The volume of stolen goods may be a far bigger issue for some businesses.

We have long developed use cases for asset tracking, theft prevention, and law enforcement. Blockchain is being used, for instance, to prevent cargo theft and track containers. Certain anti-theft systems that use integrated chips, sensors, and small-scale technology, like the vault Blockchain, are already available on the market.

■ Building a Social Engagement Platform: To Find Help When You Need It

People used to be more compassionate toward one another in the past, long before the internet revolution. They would assist in the search for misplaced items. It would be obvious to assist if someone needed to borrow something. Regrettably, while being more linked than ever because of digitization and globalization, those habits have been lost in our fast-paced society. We are developing a social engagement platform for individual residents to more easily access local assistance using the Vault mobile app for local communities. Helping one another enables everyone to harness blockchain technology for social good. In addition to our extensive database of lost and recovered objects, anyone can lend or borrow items or merely ask inquiries of their local community. This digital social engagement platform makes it much simpler to assist others and swiftly seek assistance when you do.

BLOCKCHAIN AND GOVERNANCE SUSTAINABILITY

As technology has the potential to alter how we make decisions and manage resources fairly and transparently, Blockchain and governance sustainability are inextricably linked.

The potential of blockchain technology to establish transparent and auditable voting systems is one of its major advantages for governance. Voting may be made more secure by utilizing blockchain technology, and anyone with access to the ledger can simply audit and verify the election results. This can aid in lowering the possibility of fraud and ensuring the fairness and transparency of the democratic process.

Blockchain technology can also be used to build supply chains that are more effective, improving product and service tracking and tracing while lowering the risk of fraud and corruption. Blockchain technology can improve supply chains' sustainability by establishing a safe and open system for tracking products and resources. It can also encourage ethical labor and sourcing practices, cut waste, and support waste reduction.

Financial systems can be made more responsible and transparent with the use of blockchain technology. Building a decentralized ledger available to all participants can easily inspect and confirm financial transactions. This lowers the risk of fraud and ensures that money is handled responsibly and sustainably.

By enabling more transparency and material traceability, blockchain technology can potentially be used to advance sustainability. Blockchain technology can lessen waste, encourage ethical sourcing and labor standards, and lessen the environmental effect of manufacturing and consumption by establishing a safe and open system for tracking items and resources.

Blockchain technology has the potential to transform governance sustainably by fostering better accountability, transparency, and trust across a range of industries. Blockchain technology can encourage ethical behavior, cut waste, and enhance system sustainability by establishing more transparent and auditable mechanisms. As a result, it is likely to become more crucial in determining the direction of governance and sustainability.

In ways that make sustainability governance more enigmatic and distant from the people and communities that the operations of global supply chains directly affect, blockchain projects reinforce existing power dynamics. This paradoxical failure is ongoing: Blockchains and their proponents purport to make visible immutable recordings of data that designers choose to include "on the chain," but they do the opposite. But, despite their invocations of visibility and traceability, abuses are covered by what we call a "veil of transparency."

We contend that by drawing attention to this veil, blockchain initiatives can be exposed for the ways they hide both the political decisions underlying the design of blockchain systems for traceability and the larger configuration of power relations through which global production networks operate. This themed issue maps out the modalities of governance and power relations activated by blockchain projects to depoliticize the larger shift toward technology in sustainability governance.

By enhancing the quality and accessibility of sustainability-related information, Blockchain can increase transparency. Nevertheless, the current legal and regulatory structures that control market-based instruments might make it impossible for these advantages to be fully realized. To determine how laws, rules, and regulations might restrict the transparency of sustainability information, we examine the governance frameworks of market-based instruments in many international jurisdictions, including Brazil, India, Kazakhstan, Mexico, South Africa, and Ukraine, as well as the European Union, with particular reference to the Netherlands and the United Kingdom (which was a member of the E.U. at the time this writing).

We also consider jurisdictional disparities to pinpoint challenges in developing a global framework for handling sustainability information from market-based instruments. Due to these differences, finding a solution that works for all jurisdictions may not be possible. We suggest a blockchain governance paradigm that uses combined blockchains and peering agreements to get around this. The layering of permissions allows for flexibility in information disclosure. Therefore, building a transparency system that meets domestic legal and regulatory standards should be feasible without requiring significant legal and regulatory reform.

Important Of Blockchain In Governance Sustainable

Blockchain technology can substantially impact government sustainability by encouraging accountability, openness, and efficiency. These are some ways that Blockchain can support sustainable governance:

■ Transparency:

Thanks to Blockchain's decentralized and transparent system, citizens can track government actions, contracts, and financial transactions in real time. By lowering corruption, fraud, and other wrongdoings, this transparency can improve governance.

■ Accountability:

Blockchain offers an unchangeable record of transactions that cannot be added to, erased from, or otherwise tampered with. By doing so, citizens will be able to hold government employees and agencies accountable for their deeds and hold them accountable for any misconduct.

■ Efficiency:

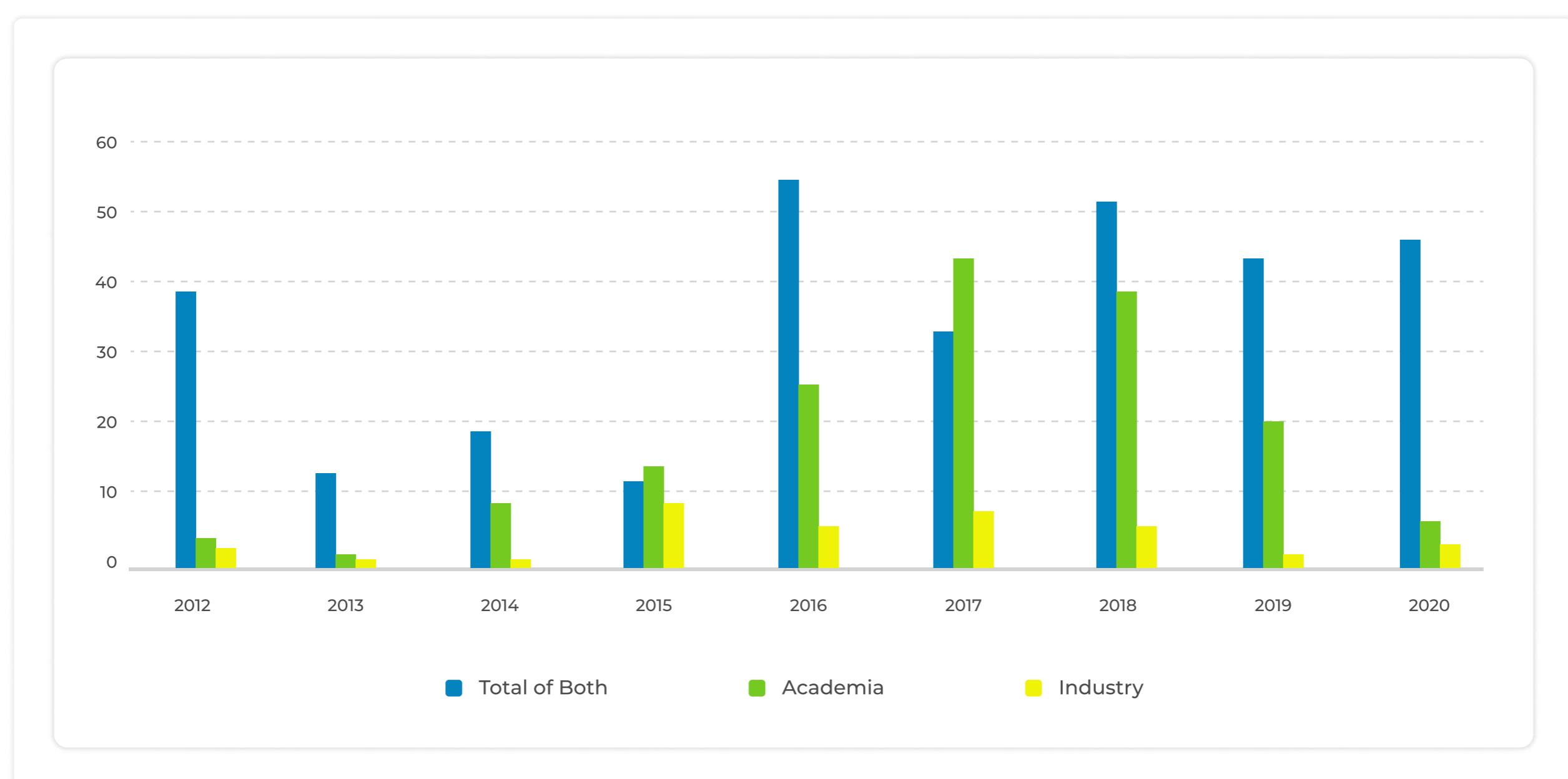
By eliminating the need for middlemen like lawyers, auditors, and other third parties, Blockchain can streamline government operations, which can help save money and time. This may enable governments to offer their constituents better services.

■ Voting:

Blockchain can offer a trustworthy and transparent voting process to reduce voter fraud and boost turnout. This may contribute to elections' free, transparent, and fair conduct.

■ Supply Chain Management:

Blockchain may be used to trace the flow of products and services, lowering waste, boosting productivity, and enhance sustainability.



Challenges Of Blockchain In Governance Sustainability

Blockchain technology can change governance and sustainability by providing a safe and transparent means to record and verify transactions. To ensure its success in these areas, it also presents several issues that must be resolved.

■ Scalability:

Scalability is one of the main obstacles facing blockchain technology regarding sustainable governance. Blockchain networks can only currently support a finite number of users and transactions, making it challenging to scale them up. This problem might prevent blockchain technology from being widely used in governance and sustainability, which depends on its ability to handle massive amounts of data.

■ Interoperability:

Sharing data between blockchain networks may be challenging since they may employ protocols and consensus procedures. Interoperability is essential to establish integrated systems and foster cooperation across many organizations to achieve sustainability goals.

■ Security:

Although being thought of as being extremely safe, Blockchain is nevertheless susceptible to hacking, data leaks, and other types of cyberattacks. The consensus algorithm utilized and the caliber of the underlying code both affect how secure a blockchain is. Any weakness in the consensus mechanism or the code can compromise the entire system's security, resulting in catastrophic data breaches.

■ Energy Consumption:

Blockchain technology, which is essential to it, depends on the mining of cryptocurrencies, which uses a lot of energy. This energy use may not be environmentally feasible and may interfere with sustainability objectives. To solve this problem, efforts are being made to create more energy-efficient blockchain solutions.

■ Legal and Regulatory Challenges:

Because blockchain transactions are decentralized and anonymous, monitoring and controlling activity might be difficult. Also, how blockchain technology fits inside the current legal systems is unknown. Thus, setting precise rules and laws to control its use is important.

BLOCKCHAIN AND ESG REPORTING

THE USE CASES AND APPLICATION OF BLOCKCHAIN FOR ESG

THE USE CASES AND APPLICATION OF BLOCKCHAIN IN ENVIRONMENTAL SUSTAINABILITY

Blockchain technology is often criticized because it is considered unsustainable and environmentally harmful. Yet Blockchain can also help with issues like climate change, the degradation of the biosphere, water scarcity, and others that are related to the environment. The key use cases are listed here.



■ Certification of Environmental Credits

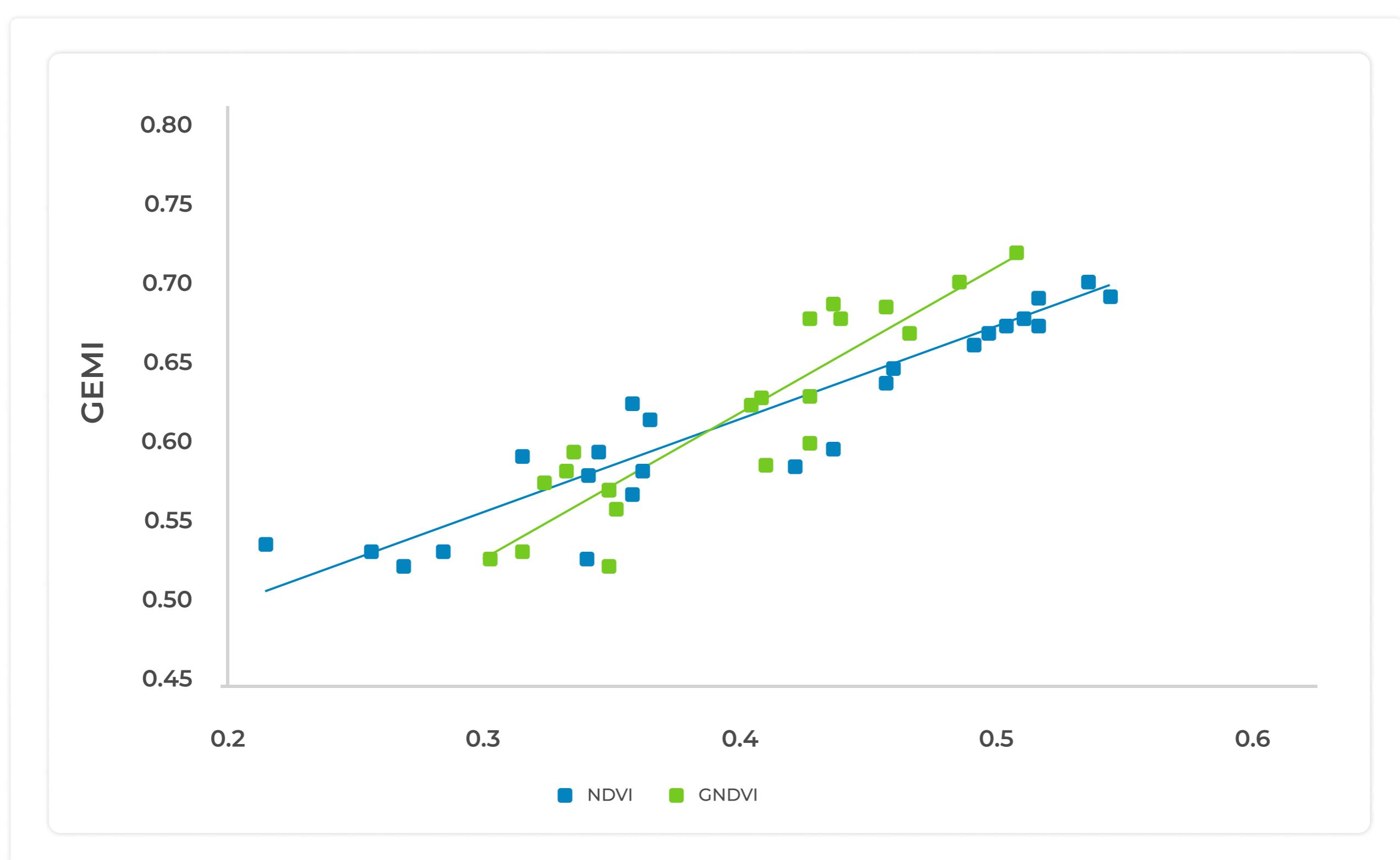
The number of carbon credits traded globally last year exceeded 144 billion, and the quantity of offsets sold keeps increasing exponentially.

Global Carbon Holding, a business active in this space, tokenizes carbon credit assets and supports a global, open market for verified carbon offset purchases using blockchain technology. The corporation owns certified carbon credits safeguarded by unique tokens created by the Blockchain and registered with internationally renowned organizations. In the same industry is a Spanish company called ClimateTrade. The company's major mission is to assist businesses in

achieving their environmental objectives. It helps businesses finance climate change projects and offset CO₂ emissions. ClimateTrade has improved productivity for businesses to reach carbon neutrality. It presently collaborates on more than 150 projects with over 20 foreign organizations. Large corporations like Iberia, Melià Hotels, Cabify, and Telefónica are among them.

■ Environmental Monitoring

The world's greatest laboratory for fundamental physics, CERN, aims to enhance global air quality monitoring and assist in resolving the air pollution problem that threatens millions of people's health. CERN spin-off business PlanetWatch has created and deployed a global network of inexpensive air quality monitors to validate, filter, and display data over the Internet and through a real-time mobile application. The monitoring network is the first immutable global ledger for historical air quality data and provides real-time data.



■ Nonprofit Environmental Protection

Nonprofit organizations are undertaking projects for environmental conservation at an increasing rate. Here, money is raised from donors to finance projects. Blockchain can give donors transparency because it is a safe and unchangeable ledger, which is a feature of the

technology. This lowers the likelihood of fraudulent charities, giving you greater confidence in the amount raised and how it will be used. Thanks to this technology, donors may then precisely verify where their money will go. Other businesses in this field, such as GiveTrack, provide open, real-time reporting on fundraising totals and objectives. In a broader sense, the company's goal is to use blockchain technology to transform charity giving.

■ Tracking and Waste Reduction

Real-time tracking of waste management and collection is made possible via Blockchain. It makes it easier to track how much waste is gathered, who collects it, and where it is transported for recycling or disposal. Moreover, it is successful in encouraging better habits by issuing cryptocurrency, which has been shown to result in more responsible actions. Blockchain can be useful for monitoring how people and corporations dispose of their waste. It can also be used to pinpoint areas that still require work. Food waste is one particular area of application. The need to reduce waste is becoming increasingly urgent, given that over one-third of all food produced is wasted. The food supply chain can be completely transparent thanks to a blockchain-based system. Also, it enables partner network optimization, which lowers waste.

■ Rewards for Recycling

Plastic garbage is one of the main contributors to environmental deterioration among the numerous waste categories. By 2100, the amount of waste produced worldwide is predicted to rise by 4 million tons. The water on Earth has already been seriously polluted. There are numerous initiatives to give participants real value using bitcoins. Recycling results in the receipt of bitcoins, improving pricing and lowering taxes. A special mechanism that concurrently provides the prize after recycling registration is incredibly efficient. Such initiatives are advantageous because they offer a worthwhile incentive to recycle waste through a dependable and accessible revenue-generating medium, which is especially helpful in underdeveloped nations.

■ Enforcement of Environmental Treaties

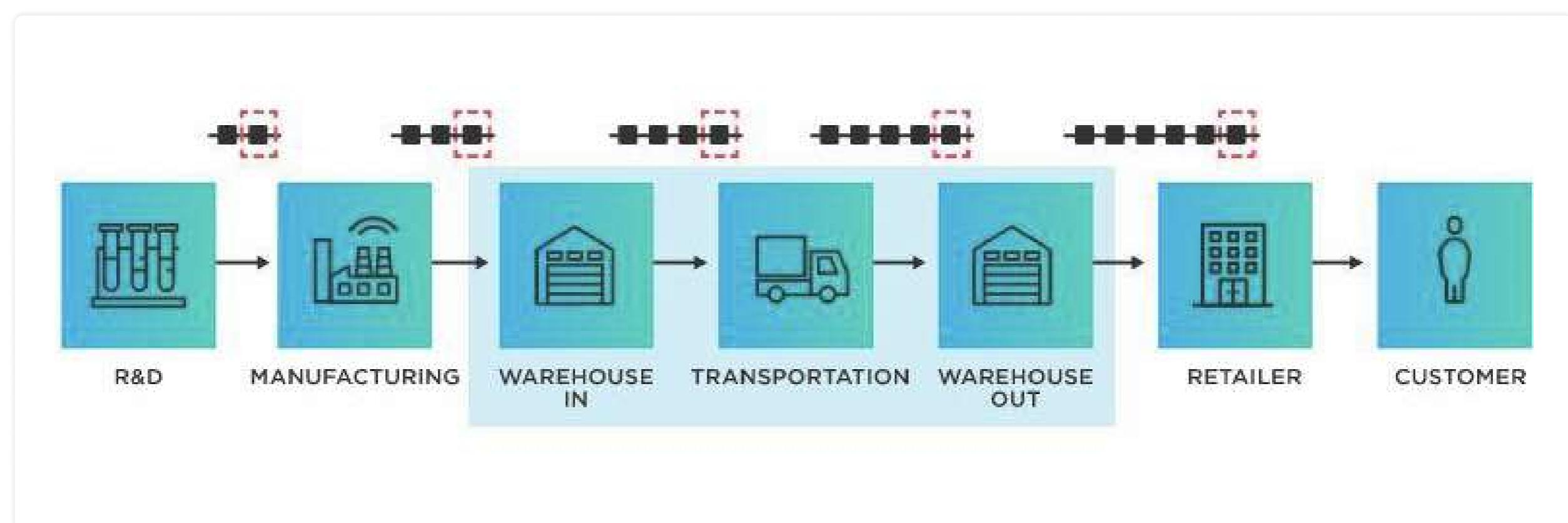
There are 2,294 bilateral environmental agreements, 1,311 multilateral environmental agreements, and 250 additional forms of environmental agreements, according to data from the International Environmental Agreements (IEA). There are a lot of worries that these agreements will be on paper and have no real consequence. Blockchain can be used to track member countries' progress toward a treaty. An immutable and interoperable blockchain provides data certainty and plenty of opportunities for supervision. To increase adherence to accords whose implementation depends on smart contracts, the United Nations is conducting many blockchain experiments.

THE USE CASES AND APPLICATION OF BLOCKCHAIN IN SOCIAL SUSTAINABILITY

There are several applications and use cases for blockchain technology in social sustainability. The following are a few of the more important ones:

■ Supply Chain Transparency:

Blockchain may be used to track the supply chains of different products and make sure they are created ethically and sustainably. You might be able to minimize exploitation and promote fair trade by doing this.



■ Decentralized Energy:

A decentralized energy system built using blockchain technology can help communities produce and distribute energy sustainably. This could improve access to renewable energy while lowering carbon emissions.

■ Identity Management:

Blockchain can be used to develop a safe and decentralized identity management system, which can allow those who lack formal identification documents to gain access to basic services like Healthcare, education, and financial services.

■ Charitable Giving:

Blockchain technology can be used to build open and safe platforms for charity giving, helping to ensure that donations are made to the right people and are put to good use.

■ Voting:

Blockchain can provide a safe and transparent voting system, minimizing fraud and ensuring that elections are run fairly and openly.

■ Land Ownership:

A decentralized system of land ownership can be established using Blockchain, which can aid in minimizing property conflicts and advancing the rights of marginalized communities to their land.

■ Microfinance:

Blockchain can be used to build a decentralized microfinance system that allows those who don't have access to traditional banking services to access credit and financial services.

THE USE CASES AND APPLICATION OF BLOCKCHAIN IN GOVERNANCE SUSTAINABILITY

Like any large company, governments have difficulty coordinating processes among diverse stakeholders. Nonetheless, the public expects more from governments than from most other institutions regarding transparency, fairness, and accountability. Data management is the main obstacle to success in these undertakings, especially in the digital age. Regrettably, the problems governments face cannot be adequately addressed by outdated centralized data management solutions. The typical client-server model's single point of failure compromises data security, and centralized government databases make it challenging to provide transparency. As a result, most governments do everything from Voting to registering land titles slowly, ineffectively, and opaquely.

Governments may provide consumers with the streamlined, on-demand services they have grown accustomed to in the digital era by utilizing a new data management framework that leverages distributed ledgers enabled by Blockchain and cryptography. Governments may also surpass the digital titans by providing greater data protection and previously unheard-of transparency and accountability.

Here are just a few examples of Blockchain's use cases and applications in governance and sustainability:

■ Digital Identity

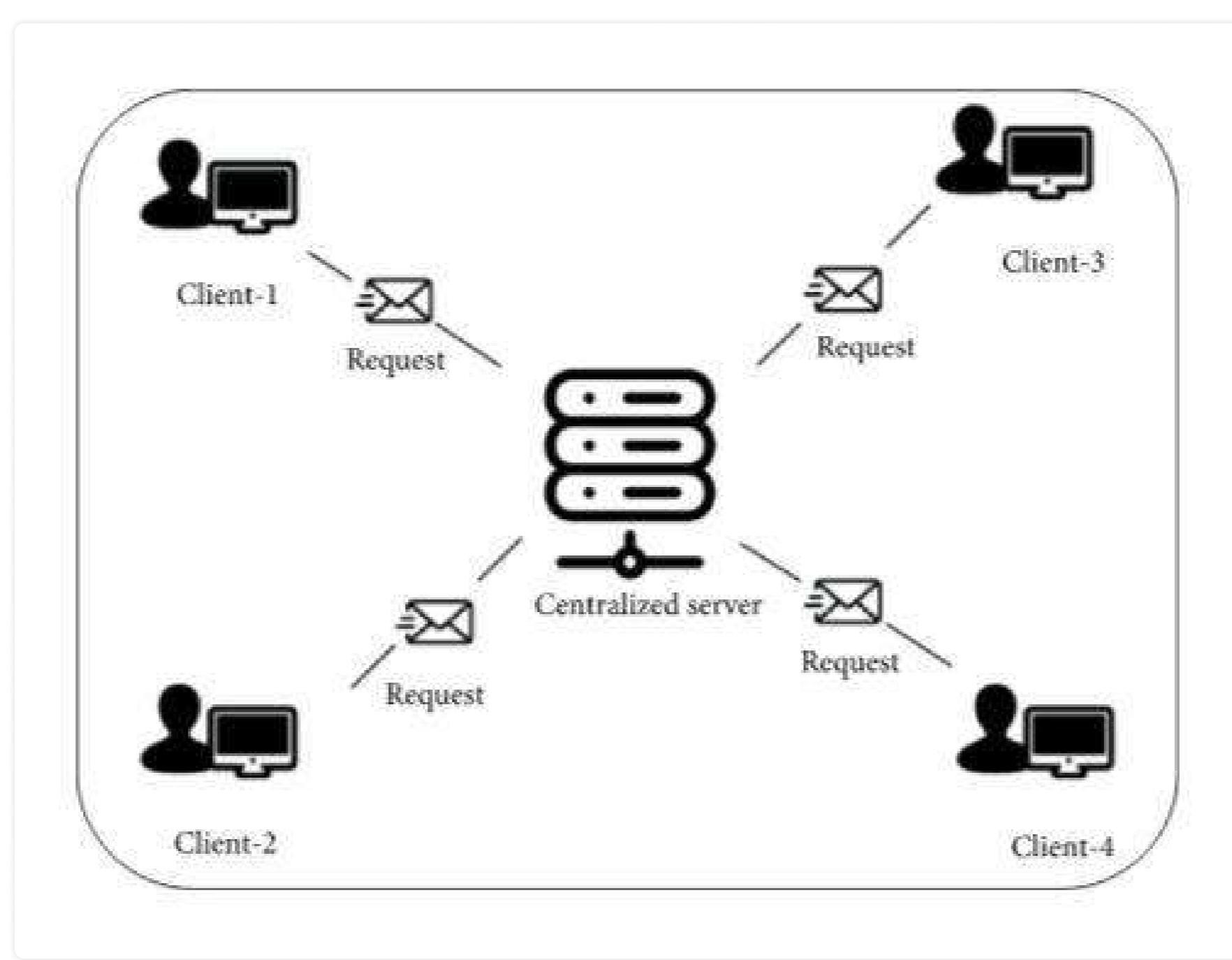
Governmental services are built around identity management, yet outdated data management tools cannot deliver safe yet quickly accessible and updateable identities. Blockchain-based identity management gives users the option of self-sovereign identification, which gives them fine-grained control over who may see their I.D. but instantaneously verifies the information inside. A municipal officer might, for instance, authenticate a citizen's identity and city of residence by scanning her I.D. without disclosing any other critical information. Access to services offered by the government is greatly expedited with a safe and verifiable digital identity in place. So, self-sovereign digital I.D. built on the Blockchain can be the foundation for numerous additional projects. Here are only a few instances:

- Verifying academic credentials
- Interacting with the tax system
- Electronic health records
- Pensions
- Grants

■ Registries

The government and its legal institutions are the principal sources of information on everything from land titles to the registration of corporate entities, marriage and divorce records, criminal records, and more. When done with obsolete tools, managing these registers leads to corruption, fraud, high expenses, and sluggish processing.

Distributed ledgers powered by blockchains can be used to manage registries and offer the opportunity for real-time changes while also providing the transparency necessary to combat fraud and corruption. The latter aspect is crucial for accelerating operations known for being tediously slow, such as land title transfers. For instance, the 1.5 million registered land titles on the distributed ledger enabled by the Blockchain in the Republic of Georgia, the first country to implement blockchain-based land registries, can be legally transferred in minutes with the right multiparty digital signatures. Real estate transactions could be completed in days rather than months using this technology, reducing the time and cost of completing secured home loans.



■ Healthcare

Electronic health records (EHRs), which can provide the groundwork for efficiency gains in government-managed Healthcare, are currently not widely adopted and used due to security, privacy, and interoperability problems inherent to outdated data management platforms.

EHRs built on a distributed ledger with support for blockchain technology can facilitate some or all of the following use cases:

- Mobility within the healthcare system
- Removal of extraneous onboarding processes and exams
- Easily examined digital prescriptions for any negative responses
- More individualized medical care
- Individuals taking control of their health data and using it for study or selling it
- Incentives for people to make specific, healthy decisions
- Automated payments to vendors and healthcare professionals.

■ Regulation

It is just as difficult for the government to enforce regulations as for businesses to follow them. When managing the data required to enforce and adhere to Regulation, legacy tools'

inadequacies significantly contribute to the issue. Take aviation components as an illustration; they are subject to stringent rules throughout their lifecycle to ensure safety. The use of parts that have received approval (a rigorously regulated process in and of themselves) must be documented and follow a strict overhaul schedule. The secondary aviation parts business, a \$4.2 billion per year industry, requires that all collected data remain consistent. Therefore, it is crucial to prevent fraud and maintain safety to precisely track the provenance of aviation parts in a transparent and unchanging manner. It is also crucial for authorities to track and trace products in great detail and in real-time, enabling them to locate the origin of contaminated or inferior parts and issue targeted recalls at the appropriate moment. All the capabilities mentioned above are made possible by distributed ledgers supported by blockchains, which can simplify Regulation and improve emergency response time. The following are a few instances of industries that could profit from legislation enabled by Blockchain:

- Aviation Parts
- Pharmaceuticals
- Medical Equipment
- Securities
- Food Supply

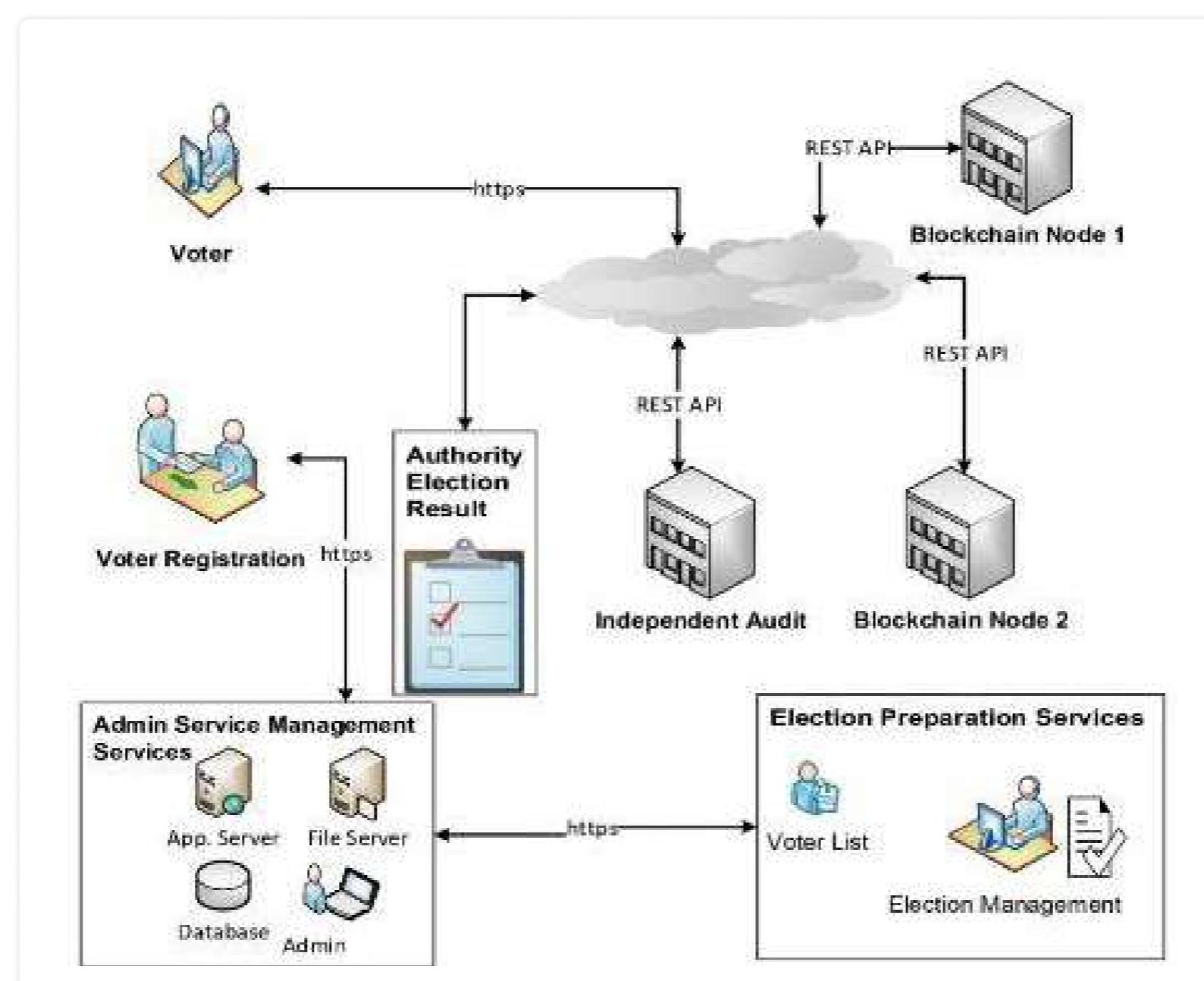
Administration

Coordination between many parties is frequently necessary for the Administration of government-run programs, including pension systems, Healthcare, education, and defense. It virtually always involves sensitive data that needs to be protected. Blockchain-supported administration solutions allow transparency while enabling real-time cooperation amongst numerous players. Use cases include, for instance:

- Management of government contracts: The required balance between openness and confidentiality can be achieved by posting and managing government contracts on a distributed ledger with granular read/write access management.
- Sovereign wealth-fund Administration: The transparent management of sovereign wealth funds made possible by Blockchain can increase public trust and ensure compliance with objectives like sustainability.
- Pension administration: The entire pension lifecycle, from joining the workforce to expiration, can be streamlined by integrating blockchain-supported digital identification with partners in the pension ecosystem.

Voting

Every democratic government faces the difficulty of quick, secure, and transparent vote counting. Voting has been demonstrated to be supported by Blockchain by increasing immutability and transparency during the collation process (when, after votes have been counted at individual polling stations, they must be aggregated with other polling stations to form a consensus for a given region).



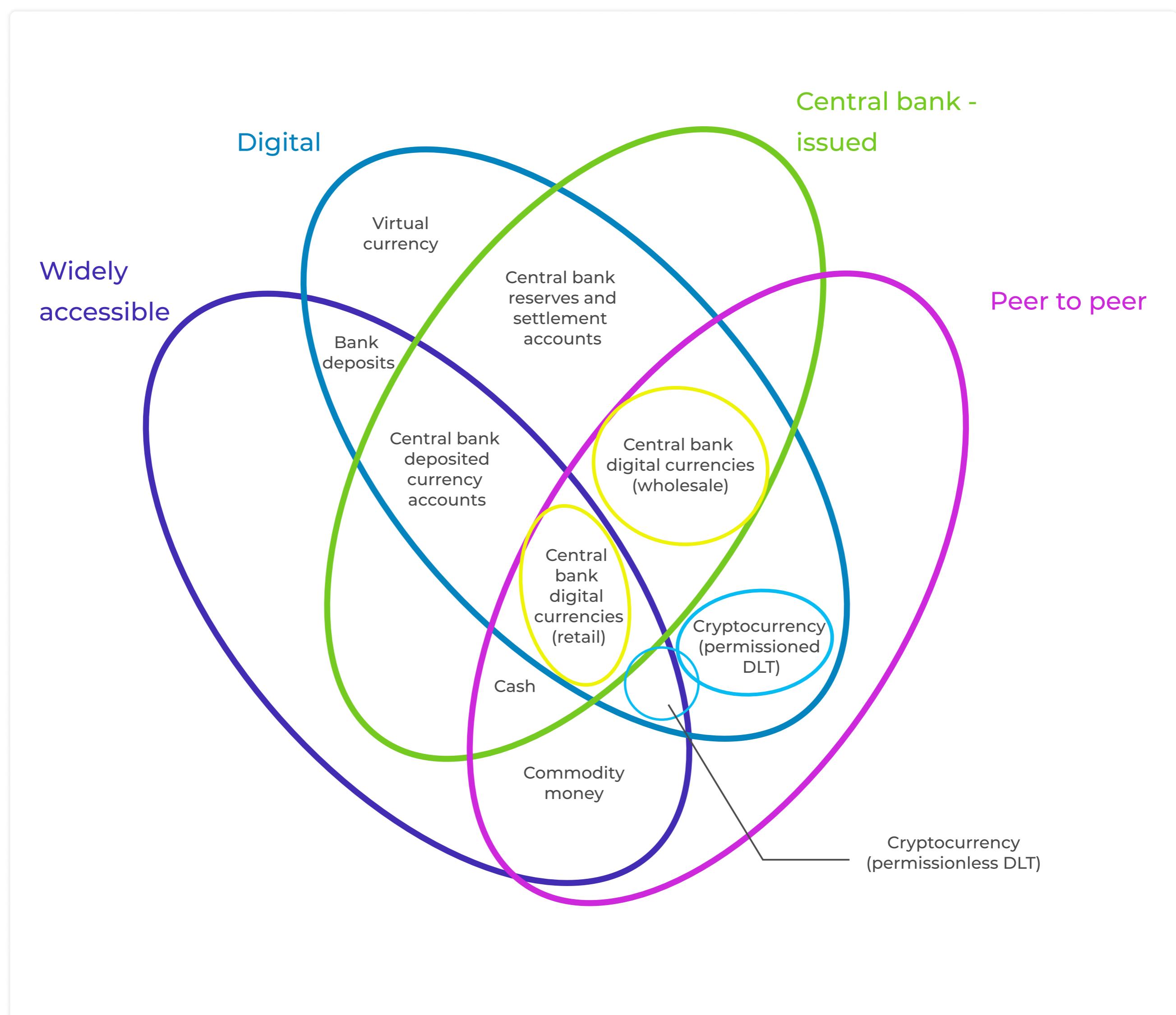
■ Data Storage

Publicly available records can be digitally stored using blockchain technology. Data integrity and resilience can both be guaranteed by distributing storage over several nodes.

■ Central Banking

Digital currencies used by central banks (CBDCs)

CBDCs give central banks a mechanism to better control the money supply by, for instance, promptly and effectively distributing cash to individuals and companies in the case of a liquidity crisis. Governments can now provide more transparency into the money supply thanks to CBDCs, and they may even be able to set strict spending and money-issuing caps.



CARBON CREDIT FOR SUSTAINABILITY

Carbon credits are crucial for promoting sustainability and reducing climate change's effects. In its simplest form, a carbon credit is a legal authorization to release a certain quantity of carbon dioxide or other greenhouse gases into the environment. Organizations or nations with decreased carbon emissions below their allotted quota can profit by selling carbon credits. Those who have increased their emissions beyond their quota can buy credits to compensate for the extra emissions.

Carbon credits can be bought and sold on carbon markets, which function like other commodity markets. Supply and demand have a role in determining the price of carbon credits, with the price rising as the supply of credits declines or the demand for them rises. In recent years, the market for carbon credits has expanded dramatically.

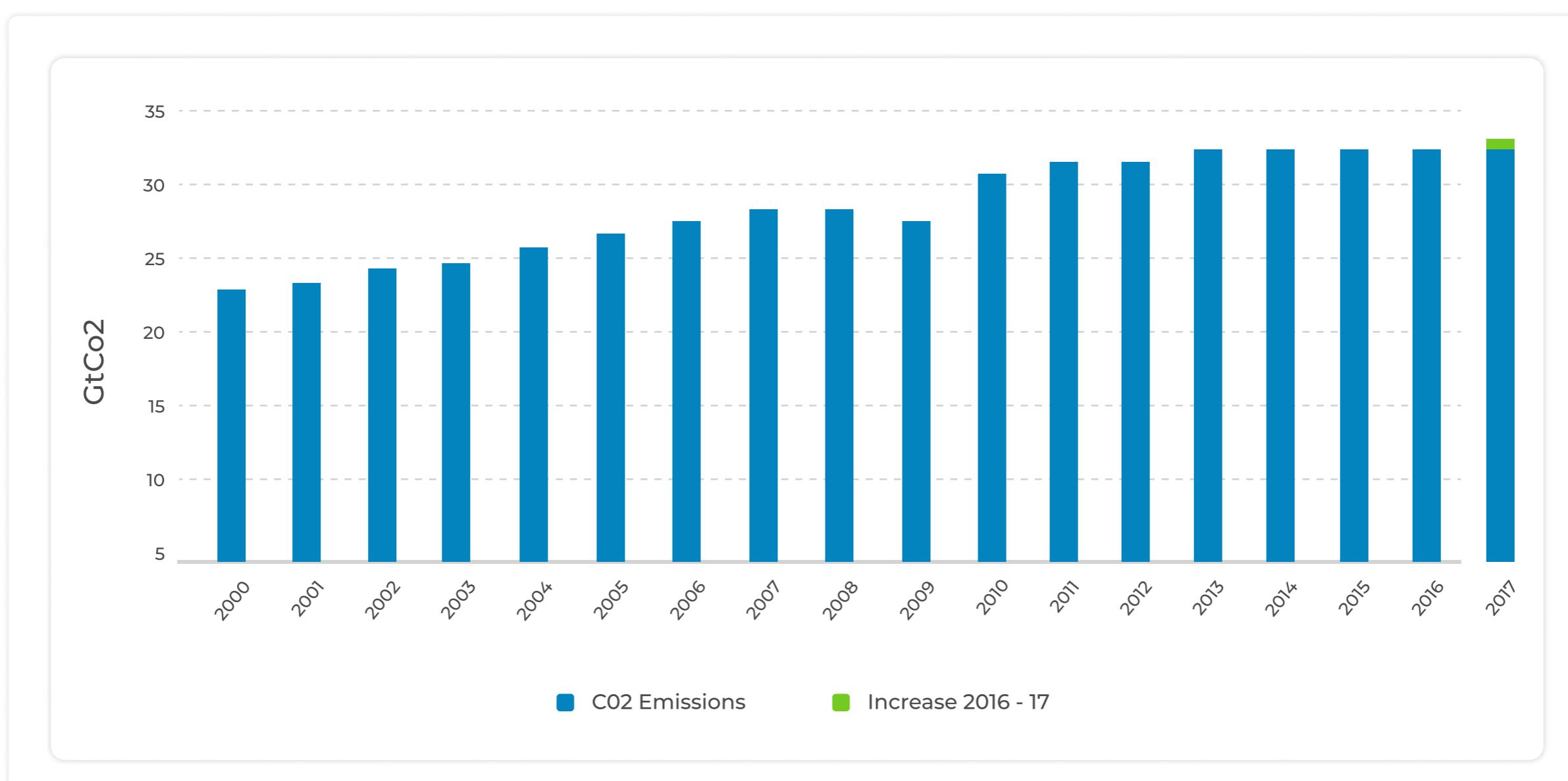
According to some estimates, the global carbon market might be worth \$1 trillion by 2030. Carbon credits offer enterprises and nations a financial incentive to minimize carbon emissions, one of their main advantages. This can be particularly important for developing nations, which would not have the resources to invest in sustainable technologies without outside assistance. Developing nations can make money to fund sustainable development programs by selling carbon credits on the international market.

Carbon credits can aid in promoting sustainable practices in other ways and offer a financial incentive for carbon reduction. Businesses could acquire carbon credits to offset their carbon emissions even though it is not required by law.

A company can demonstrate its dedication to sustainability and lessen its carbon impact by taking this action. As a tool for sustainability, carbon credits have drawn considerable criticism. Some contend that because the carbon market is so complicated and challenging to control, there is a risk of fraud or market manipulation.

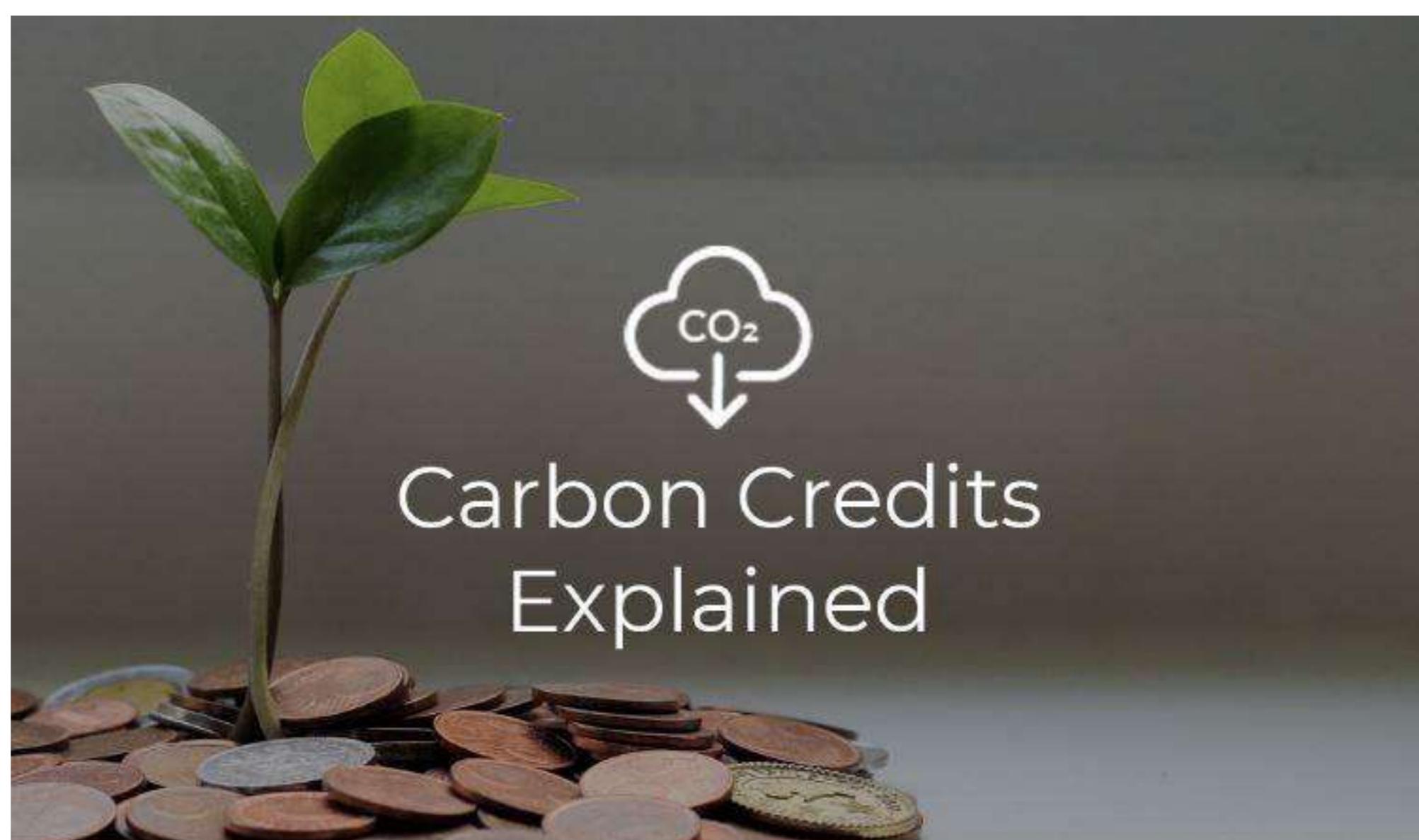
Others contend that carbon credits could be utilized in place of or in addition to genuine emissions reductions.

Carbon credits are nevertheless a valuable instrument for encouraging sustainability and lessening the effects of climate change, notwithstanding these objections. Carbon credits can contribute to a more sustainable future for all of us by offering a financial incentive for carbon reduction and supporting sustainable development projects.



WHAT ARE CARBON CREDITS?

Owners of carbon credits, usually referred to as carbon offsets, are allowed to emit a certain amount of carbon dioxide or other greenhouse gases. One credit allows for releasing one ton of greenhouse gases, such as carbon dioxide.



A "cap-and-trade" program's carbon credit is its component. Polluting businesses receive credits that let them continue to pollute up to a periodically reduced cap. Any credits that the company doesn't need can be sold to a different company that does. So, lowering greenhouse gas emissions is doubly motivated by private firms. If their emissions exceed the cap, they must first pay for additional credits. Second, they can generate revenue by reducing emissions and repurchasing unused allowances.

The carbon credit system's proponents assert that approved climate action programs that use it cut eliminate or completely prevent greenhouse gas (GHG) emissions in a quantitative and verifiable manner.

One ton of carbon dioxide that has been removed from the atmosphere is represented by one carbon credit, a type of permit. A person or, more frequently, a business can buy them to offset carbon dioxide emissions from industrial operations, delivery vehicles, or travel. Although almost any project that cuts, eliminates, destroys, or collects emissions is eligible to earn carbon credits, these credits are most frequently produced through agricultural or forestry techniques.

People or businesses looking to offset their greenhouse gas emissions can purchase the credits through an intermediary or those directly capturing the carbon. If a farmer plants trees, the landowner receives money, the company pays to reduce its emissions, and the middleman, if there

is one, may profit from the transaction. The governing body generates carbon credits distributed to certain businesses within its purview. The amount of CO₂e (or carbon dioxide equivalent) that a corporation is permitted to emit is represented by one credit.

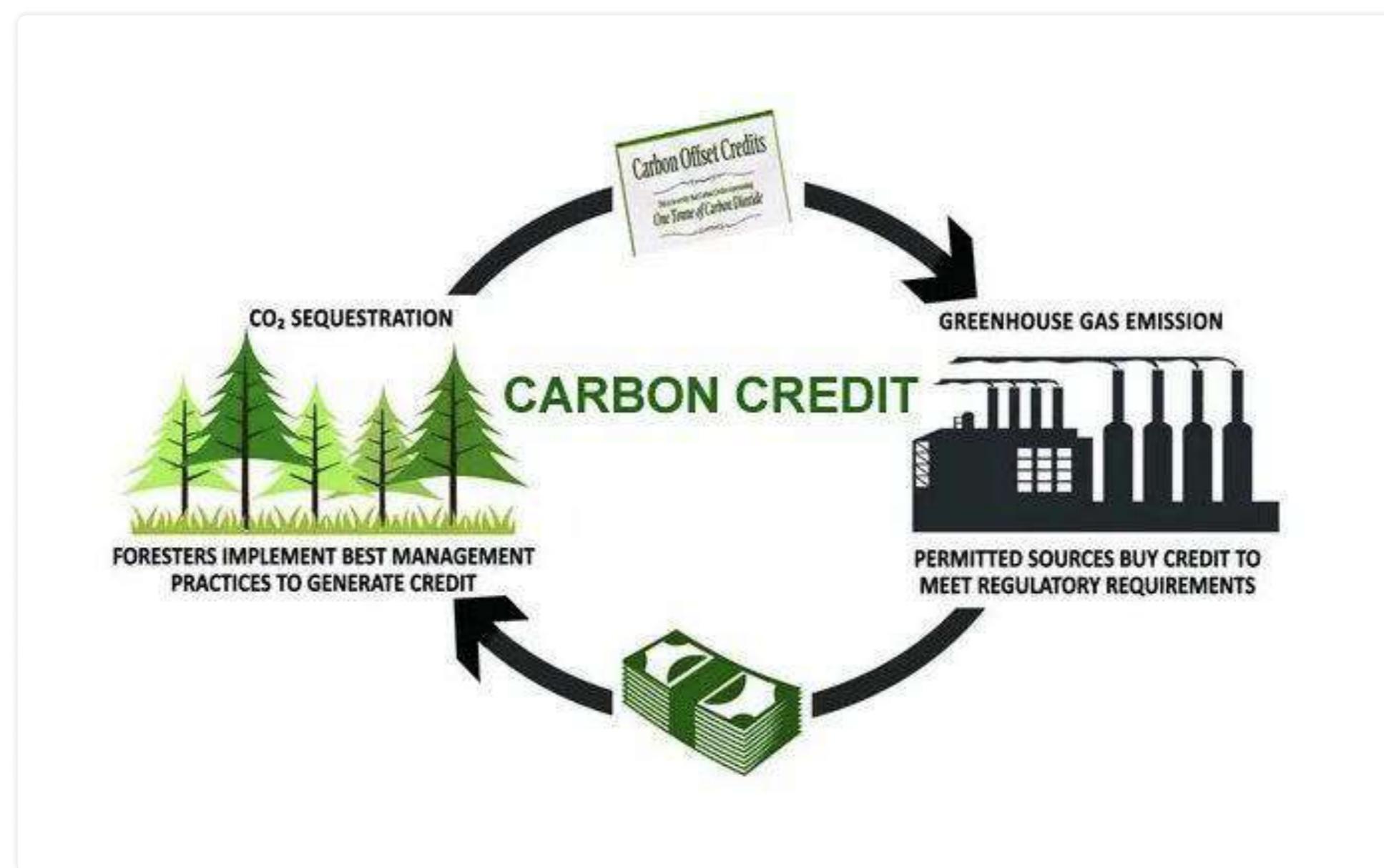
HOW DO CARBON CREDITS WORK?

Reducing greenhouse gas emissions into the atmosphere is the ultimate purpose of carbon credits. As stated, the right to emit greenhouse gases equal to one ton of carbon dioxide is represented by a carbon credit. In terms of carbon dioxide emissions, that is equivalent to driving 2,400 miles, according to the Environmental Defense Fund.

Businesses or countries are given certain credits to exchange to help balance overall global emissions. The United Nations states that as carbon dioxide is the main greenhouse gas, "people speak simply of carbon trade. A company or organization's emissions cap (or "cap" in the case of cap and trade) is represented by the number of credits granted to that entity.

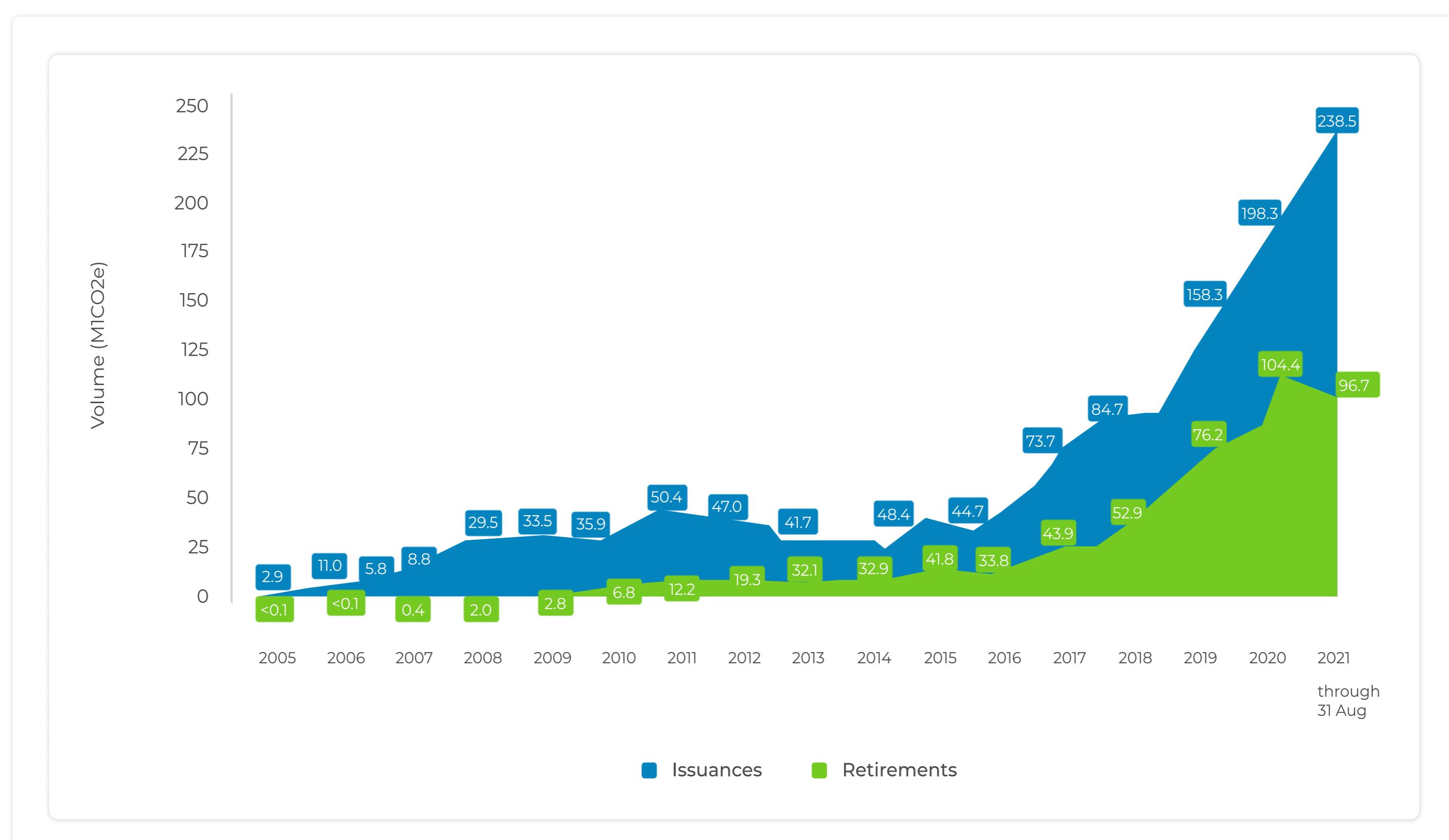
Suppose a management team is successful in keeping corporate emissions below their cap. In that case, the firm will have extra carbon credits, which they can either keep for later use (or sell) or sell immediately into the compliance carbon market regulated by the regulatory body.

A management team is in non-compliance and must make up the difference if it cannot keep the company's emissions within the limit. In order to purchase carbon credits from an "under-emitter" within their cap and trade network, over-emitters turn to the carbon market.



CARBON MARKETPLACES

The voluntary carbon market includes any carbon offset transactions not made to sell them on an active, regulated carbon market. It includes offsets bought to resell or retire them to satisfy carbon neutrality or other environmental claims. Purely voluntary purchasers, or those who offset their emissions, and organizations that buy pre-compliance offsets before emissions reductions are mandated by law, are the main drivers of the voluntary market for carbon offsets.

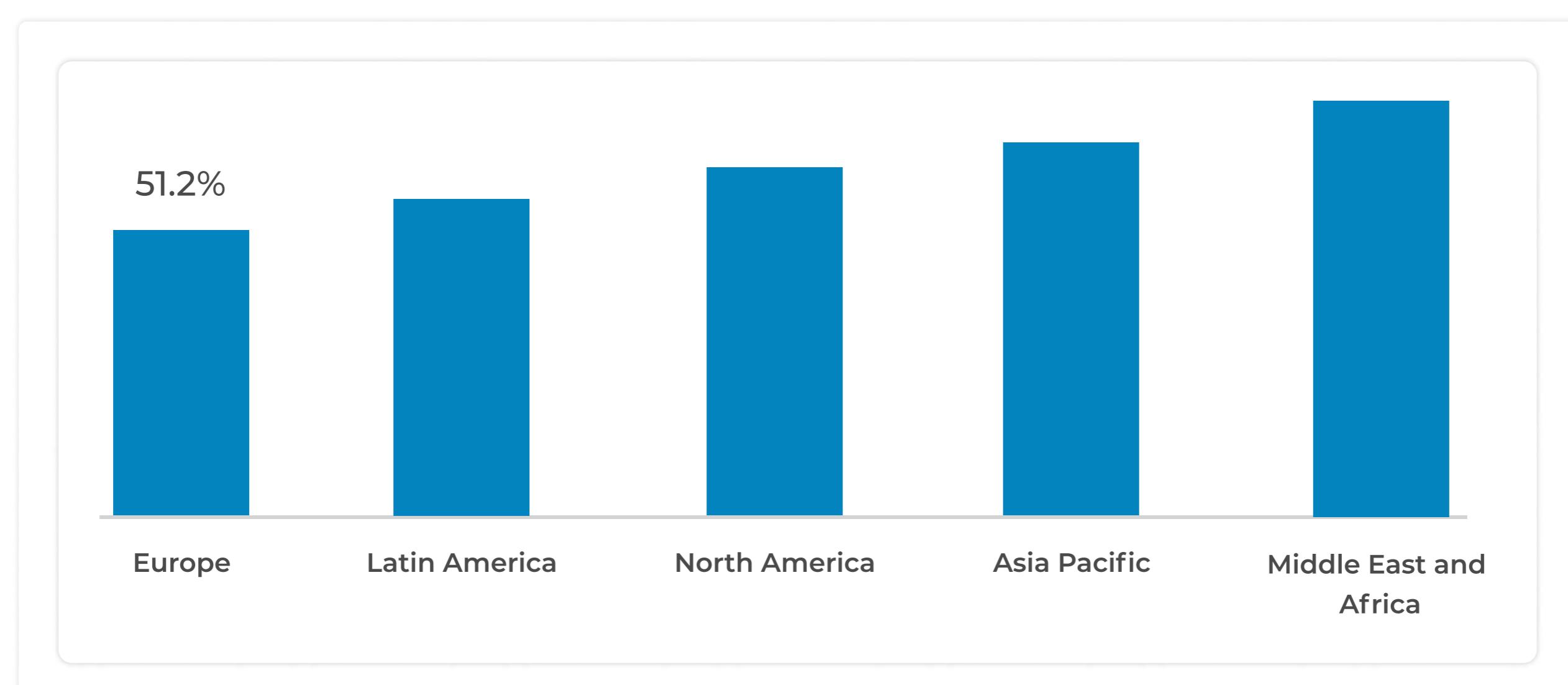


Entirely voluntary offset buyers are motivated by various factors, including supply chain risk, reputational risk, and corporate social responsibility. Pre-compliance buyers speculatively purchase offsets before the compliance carbon market's launch date to pay less than the offset would ultimately sell for under the compliance program. Voluntary markets coexist alongside compliance offset markets, which are substantially more expansive and are fueled by imposed restrictions on greenhouse gas emissions. Compliant carbon markets are exchanges where regulated organizations can buy and sell emissions permits (allowances) or offsets to achieve predefined regulatory goals. Participants in cap-and-trade regimes, which frequently include emitters and financial intermediaries, can exchange allowances to generate revenue from unused allowances or satisfy regulatory obligations.

The United Nations Clean Development Mechanism provides offsets to signatory countries to the Kyoto Protocol and buyers in the European Union Emissions Trading System, the largest active compliance carbon offset program. The flexibility of the voluntary carbon markets more than makes up for their scale, spawning advancements in project financing, monitoring, and methodology that also impact regulated market mechanisms. For instance, the voluntary carbon market has produced standards, registers, and project kinds that go outside the purview of the market mechanisms now in place for compliance. As a result, in recent years, governments worldwide have become more dependent on voluntary carbon market mechanisms, particularly standards and registries, to help create or act as their compliance tools.

How Big Is The Carbon Credit Market?

According to a research estimate from Ecosystem Marketplace, the voluntary market is expected to reach a record of \$6.7 billion by the end of 2021. According to a poll conducted by the International Emissions Trading Association and published in June, traders in the European compliance market expect carbon prices to rise by 88 per cent to roughly \$67 per metric ton by 2030. The recent corporate net-zero targets and interest in achieving the worldwide climate goals outlined in the Paris Agreement to limit global warming to 1.5 degrees Celsius over preindustrial levels are the main drivers behind the voluntary market's rapid acceleration over the year.



BLOCKCHAIN AND CARBON CREDITS: CARBON CREDIT INDUSTRIES ACHIEVING SUSTAINABILITY THROUGH BLOCKCHAIN

Carbon credits are a novel and efficient technique to encourage organizations and people to lessen their carbon footprint. They enable the trade of credits corresponding to a specific decrease in carbon emissions, resulting in a market-driven strategy to combat climate change. Concerns regarding fraud and inefficiency in the carbon credit industry have arisen due to the difficulty in tracking and confirming carbon credits. Blockchain technology is increasingly used to solve these problems and improve sustainability in the carbon credit industry.

The improved transparency and security it offers in the carbon credit industry are one of the main advantages of employing blockchain technology. A decentralized digital ledger known as Blockchain offers a transparent and impenetrable record of transactions. This lowers the danger of fraud and ensures that credits are used effectively to cut emissions because transactions involving carbon credits can be traced and validated without intermediaries.

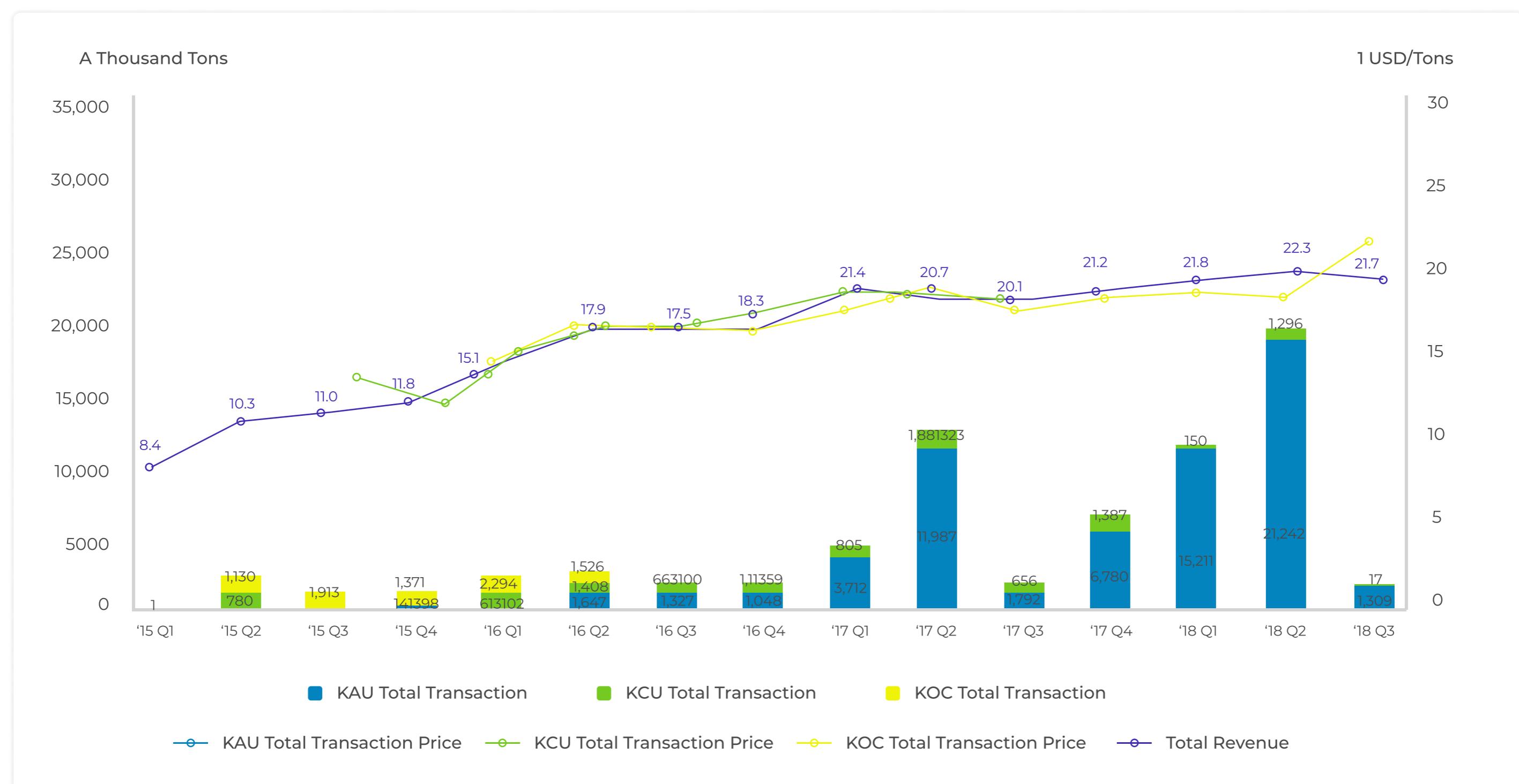
Blockchain technology can boost carbon credit transactions' efficiency, traceability, transparency, and security. Blockchain can lower the cost and complexity of the carbon credit market, making it more accessible to businesses and individuals by expediting the process of tracking and confirming carbon credits. Using Blockchain also enables the traceability of carbon credits, allowing buyers to find out where the credits came from and confirm that they are funding certain projects to reduce emissions.

Another significant benefit of employing blockchain technology in the carbon credit industry is decentralization. Decentralization enables transactions without intermediaries, cutting the price and processing time of conventional carbon credit trading. Small and medium-sized firms and individuals may now have easier access to the carbon credit market, which might hasten the drive to reduce emissions.

Blockchain technology suits the rising demand for carbon credits due to its scalability. As more businesses and individuals work to reduce their carbon footprints, it is anticipated that the market for carbon credits will grow quickly.

While also making it simpler for new participants to enter the market, adopting blockchain technology can help ensure that the market remains effective and transparent. Applying blockchain technology to the carbon credit market has the potential to enhance the sustainability of efforts to reduce emissions greatly. Blockchain technology has the potential to hasten the transition to a more sustainable future by offering increased transparency, efficiency, traceability, decentralization, and scalability.

We realized that blockchain technology has the power to transform the carbon credit market completely. For instance, the Climate Chain Alliance research indicated that Blockchain could increase the integrity and openness of the carbon credit market while reducing transaction costs by up to 90%.



Several initiatives and projects have already been undertaken to investigate the usage of blockchain technology in the carbon credit industry. For instance, the "Climate Accounting Infrastructure" is a blockchain-based platform created by the Climate Chain Coalition, a coalition of over 150 organizations working on Blockchain and climate action (CAI). The CAI seeks to provide a transparent and consistent method for tracking carbon credits, allowing the market to expand and become more efficient.

Blockchain is also being used in other attempts to track carbon offsets and facilitate the peer-to-peer exchange of carbon credits. For instance, a "Carbon " project utilizes blockchain technology to develop a platform for people and companies to invest in sustainable energy projects to offset their carbon footprints. Blockchain technology is also being used by a project called "Poseidon" to allow customers to offset the carbon footprint of their purchases at the point of sale, providing a simple and transparent way to help efforts to reduce emissions.

Overall, the studies and actions in this field show how blockchain technology has the potential to promote sustainability in the carbon credit industry. Blockchain can accelerate the shift to a low-carbon economy and achieve a more sustainable future by offering increased transparency, efficiency, traceability, decentralization, and scalability.

THE USE CASES AND APPLICATION OF BLOCKCHAIN FOR CARBON CREDITS

By offering a transparent and secure platform for tracking and verifying carbon emissions, blockchain technology can play a critical role in addressing the issues with carbon credits. The following are some possible blockchain applications and use cases for carbon credits:

■ Tracking Carbon Emissions:

Blockchain can track a company's carbon emissions in real time. This data can be saved on a decentralized ledger, and any modifications to the data will be permanently recorded there. Regulators will be able to measure carbon emissions more precisely as a result, and businesses can utilize the information to further their sustainability efforts.

■ Carbon Credits Trading:

Blockchain can make selling carbon credits between businesses or organizations easier. Blockchain technology can assure transaction security and transparency, lower transaction fees, and boost liquidity. The verification and transfer of carbon credits can also be automated using smart contracts.

■ Verification and Certification:

Blockchain technology can confirm the integrity of carbon credits and ensure they adhere to the requirements. This can reduce fraud and boost confidence in the carbon credit market. Blockchain technology can be used by certifying bodies to store data relevant to the verification and certification of carbon credits, improving the efficiency and transparency of the process.

■ Carbon Offsetting:

Blockchain can be used to track and verify carbon offset operations like reforestation or renewable energy projects. Businesses can offset their carbon emissions by funding these initiatives and receiving carbon credits in return. Blockchain can guarantee the accuracy and transparency of the offsetting carbon process, which can boost market trust.

■ Supply Chain Traceability:

Using blockchain technology allows tracking of carbon emissions across the supply chain. Companies will be able to pinpoint areas where they can cut back on their carbon footprint, and customers can make better decisions based on the carbon emissions linked to the goods they buy.

CONCLUSION

BLOCKCHAIN DRIVING THE FUTURE OF SUSTAINABILITY

The development of blockchain technology has made it a potent tool for advancing sustainability projects in numerous industries. In fields including energy management, supply chain tracking, waste reduction, and carbon offsetting, its capacity to design tamper-proof and decentralized systems has created new opportunities for openness, accountability, and efficiency. Blockchain fosters trust among stakeholders, motivates sustainable behaviors, and opens up new possibilities for collaboration and innovation by enabling safe and transparent data sharing.

The potential advantages of Blockchain for sustainability are too enormous to be disregarded, even though there are still obstacles to be addressed in terms of scalability, interoperability, and regulatory frameworks. We may anticipate a brighter future for the earth when economic progress and environmental care go hand in hand as more businesses and people adopt this technology.

By developing more efficient and effective systems that cut waste, conserve resources, and support sustainable practices, Blockchain is advancing sustainability. Blockchain-based platforms, for instance, are being used to trace the provenance of commodities, from raw materials to completed goods, and ensure they adhere to particular social and environmental criteria. This can aid in promoting ethical production methods and sustainable sourcing, which can lessen the negative effects of enterprises on the environment and enhance worker well-being.

Additionally, Blockchain is enabling the development of decentralized energy systems that are more reliable and effective, which is transforming the energy industry. Individuals and businesses can sell surplus energy produced by their solar panels or other renewable energy sources to other community members using Blockchain to construct peer-to-peer energy trading platforms. This can encourage using clean energy alternatives and lessen reliance on fossil fuels.

Blockchain is also being used to encourage carbon offsetting and reward sustainable behavior. Individuals can receive prizes that can be used to offset their carbon footprint by using blockchain-based tokens as a reward for acts that reduce carbon emissions, such as cycling or taking public transportation. This can encourage people to adopt more sustainable practices and contribute to developing a sustainable culture.

Blockchain technology has enormous potential to promote sustainability and is crucial for building a more sustainable future. The momentum behind blockchain-based sustainability efforts is building, and it is an exciting time to be involved in this subject, even though there are still obstacles to overcome. We may anticipate a future in which sustainability and economic growth coexist to make the world better for everyone with sustained innovation and cooperation.

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