

# A Review on Blockchain Based Reward System for Sustainability (Greenstride)

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more sustainable future.

**Abstract**—Innovation by smart cities is supposed to adopt novel technologies and strategies in order to accelerate already existing sustainability solutions targeted for the fight against greenhouse gas emissions and climate change. We therefore overview the existing work concerning blockchain technologies and other digital technologies, including IoT with the purpose of incentivizing individuals and organizations towards more sustainable behaviors. Our attention is directed towards three principal domains in which digital technologies could catalyze initiatives aimed at reducing environmental repercussions: specifically, low-carbon transportation, energy efficiency, and waste diversion. Notable instances of such initiatives comprise The Plastic Bank, ECO-Coin, and SolarCoin. An examination of these case studies, wherein both financial and non-financial incentives have effectively facilitated changes in behavior, enables us to identify essential components necessary for the execution of blockchain-based solutions. We further outline critical pathways for further investigation in this area.

## I. INTRODUCTION

Sustainability becomes an important global goal; corporations, governmental bodies, and citizens undertake any effort to minimize their impact on the environment as they seek economic and social development. The use of mechanisms of incentives to encourage sustainable behavior has often proven unhelpful due to providing scarce transparency and limited engagement. Consequently, more and more interest is being gained in new incentives that may be included within sustainable results. The most striking technology within this framework is blockchain- an open-source, decentralized, and transparent system for the administration of rewards and monitoring activities.

Blockchain-based systems will revolutionize the game of sustainability efforts by allowing trustless transactions and making verifiable records of digitals. Through blockchain, one can potentially trace the individual and organizational contribution towards goals such as reduction of carbon footprint, recycling, or adaptation of renewable energy. Stakeholders could be prompted using blockchain in handing out rewards through tokens or cryptocurrencies. The integrity of data and subsequent reduction in fraud make it a quite strong contender for increasing the credentials of sustainability-related initiatives.

This survey article researches the wide spectrum of incentive mechanisms with blockchain-based mechanisms to introduce sustainability. This article reviews the current research and applied state in this field, focusing on the extent of recent contributions, challenges of the current state, and future applications of incentive mechanisms. Additionally, it discusses benefits and limitations of applying incentives using blockchain as mechanisms to introduce sustainability, along with personal opinions on how such incentives may contribute to advancing the world toward a

## II.

## RELATED WORK

Blockchain technology has been experimented in many industries, and various sectors have been pointed out for improving their sustainability through tokenization and digital incentive mechanisms. Possibly the most critical focus of the research was the utilization of blockchain as a reward mechanism for people and organizations participating in green activities. Examples like Power Ledger and the Energy Web Foundation are on top of using blockchain for peer-to-peer energy trading. These systems incentivise users who generate or consume renewable energy sources such as solar power using blockchain technology to record transactions and distribute rewards through smart contracts. Such platforms have clearly shown their ability to reduce transaction costs, promote transparency, and embrace the adoption of renewable energy- all of which has proven to suffice the potential of blockchain to promote decentralised, sustainable ecosystems.

Apart from energy markets, blockchain is applied to a context of sustainable supply chains. A blockchain can provide a visible and unalterable history that is best for tracking the origin of products and verifying claims about the sustainability of those products. For example, IBM's Food Trust programme applies blockchain to track food items from their production to when they are consumed in order to ensure standards of sustainability as well as ethical sourcing. Similarly, Everledger employs blockchain to track the lifecycle of diamonds and other valuable commodities so that there is greater transparency and much less fraud. Altogether, these applications reveal blockchain's potential to reward firms for sustainable practice, thus providing consumers with verified, ethical options for purchase.

Carbon credit and environmental reward systems through the use of blockchain is another exciting domain of research. Carbon trading platforms among them Verra, and CarbonX are researching blockchain technology for innovations that will make verification and trading easier in carbon credits. Blockchain ensures the issuing of carbon credits is transparent

in the form of automated processes by smart contracts which moreover cannot be replicated or tampered with. This program has the ability to provide more precision in following carbon emission reductions while being able to supply firms with confirmed evidence of reductions in their negative environmental impacts.

Notwithstanding all of this to encourage sustainability, there exist many other issues that continue to impede the progress of blockchain technology. Scalability is one such problem, especially in blockchain networks with energy-intensive consensus protocols like proof-of-work. Critics argue that

such systems could exacerbate environmental concerns instead of solving them. In addition, the regulatory environment surrounding blockchain incentive schemes for environmental sustainability is at a very primitive stage. Concerns regarding privacy, data ownership, and adherence to cross-border regulations must be resolved prior to the comprehensive incorporation of blockchain technology into international sustainability frameworks. Researchers such as Tapscott and Tapscott (2017) and Mougayar (2016) have highlighted that, despite the significant prospects presented by blockchain, its complete potential can only be achieved if these technical and regulatory challenges are successfully addressed.

### III. APPLICATION BACKGROUND

The urgent need to meet set sustainability goals combined with the growing concern over environmental degradation has made sustainable lifestyles more interesting. All these things made blockchain technology stand out as one of the advanced innovations in this field because it provides decentralized, transparent, and secure systems for managing and recording transactions or digital documentation in a peer-to-peer, distributed ledger technology. Most industries are strategizing on how blockchain could aid in reframing financial incentives to encourage such sustainable practices. This included carbon footprint reduction, renewable energy sources, proper waste management, and responsible supply chains.

This context for blockchain providing sustainability can be best seen in the arena of decentralized energy markets. Power Ledger and Energy Web Foundation are among the many that use blockchain to facilitate energy transactions between customers, allowing them to trade energy with one another directly by bypassing company middlemen. These very systems record energy generation and consumption on the blockchain transparently, allowing participants to receive digital tokens or credits for contributing renewable energy back to the grid. Token-based reward systems provided by blockchain create incentives for both consumers and producers to pursue sustainable energy practices, thereby creating an effective and resilient energy economy.

Another remarkable blockchain application for sustainability may address supply chain transparency and ethical sourcing. Given that supply chains globally, for the most part, remain murky, blockchain aids tracking provenance, thus guaranteeing that products originate in an environmentally and socially responsible manner. Applications such as IBM Food Trust have installed a blockchain system that allows a consumer to trace the journey of a food product from the farm to the table, confirming claims about sustainable farming practices, fair labor conditions, and carbon footprint. The verifiable record of these very claims on blockchain are issued to encourage a corporation's compliance with sustainability criteria and give power to consumers to make informed buying decisions.

Growing surety of sustainable business revenues, blockchain introduced a perfect arena for corporate social responsibility gains: the carbon markets and environmental reward systems. Blockchain enables the issuance, verification, and transaction of carbon credits while confirming that those credits are valid and cannot be both counted and altered. Platforms like Verra and CarbonX apply blockchain to actively manage carbon-credit transactions with a transparent and immutable

ledger of emission reduction and offset projects. Smart contracts automate this process with the added benefit that blockchain, as a result, not only ramps up efficiency and provides nurturing for corporations but also gives unmistakable incentives for corporate climate training to describe its engagements in greening corporations.

### IV. TECHNIQUE BACKGROUND

The introduction of blockchain technology can help implement sustainability initiatives through some key experiments and principles through which it can effectively promote a transparent, decentralized, and secure system for rewarding sustainable behavior. The areas include aspects like smart contracts, consensus algorithms, tokenization, and cryptographic security, which are very much integral to the actual development of blockchain-based solutions, which can actually reward for sustainability.

**1. Smart Contracts:** The heart of many blockchain-based reward systems is that of smart contracts, which are essentially self-executing contracts, or a programming contract where the conditions and terms of an agreement are coded in lines of code and enforced by the blockchain itself. In a sustainability application, smart contracts on the blockchain automate transactions based on predefined conditions. A carbon credit trading system, for example, might have smart contracts automatically validate that a company gives up a certain amount of emission in exchange for certain rewards, in turn negating the need for any mediator to distribute rewards in a transparent and efficient manner. Smart contracts can be used to reward various sustainable actions, such as recycling, renewable energy generation, or responsible farming, by triggering rewards (often tokens) whenever such actions are carried out.

**2. Consensus Algorithms:** Central to all blockchain systems are consensus algorithms, which allow all networks participating in a decentralized network to come to an agreement on the validity of certain transactions. While there are numerous other types of consensus coordination algorithms, two of the most famous are the Proof of Work (PoW) and Proof of Stake (PoS). Bitcoin uses PoW and thus relies on participants to solve extremely hard mathematical problems before they can validate transactions, while PoS locks participants' cryptocurrency and uses that as collateral with which to validate blocks depending on their stake. This selection of the consensus algorithm can create a great difference in the implementation of sustainability applications, particularly in their scalability, security, and environmental footprint for a blockchain system.

**3. Tokenization and Digital Assets:** The fundamentally essential concept of tokenization must be noted. The issue of creating energy, waste recycling, or carbon credits in exchange for quantified values as blockchain assets offers exactly the envisaged and tradable rewards for sustainable action that would otherwise not be acknowledged. These traded tokens could actually be easily created on a blockchain network and issued as an incentive for reducing energy use, recycling materials, and ethical sourcing practices. These tokens could later be redeemed for products or services or traded in open markets, thereby benefiting both individuals and organizations for their sustainable behaviors—a technique that imbues sustainability

initiatives with liquidity and flexibility. There is also the exploration of non-fungible tokens (NFTs) in sustainability situations, where each token can represent a unique action or achievement (e.g., a certain amount of carbon offset or a verified recycling contribution), providing new opportunities for rewarding sustainable behaviors.

**4. Cryptographic Security:** For that purpose, the linked and basically unmodifiable record of transactions on the blockchain provides guaranteed integrity, anonymity, and traceability, which are key for putting trust in sustainability reward systems. Each blockchain transaction is going to be recorded in a block which is cryptographically linked to the previous one making it tamper-proof. This way it is possible to verify and audit the claims on sustainability without any fear of the fraud. In addition, public key cryptography provides secure token or reward transfers where identities are protected, yet their dealings remain public. This is most crucial for credits in environment or carbon trading because the probity of such actions relies on a legitimate issuance of those credits.

**5. Decentralized Autonomous Organizations (DAOs):** A more sophisticated organizational structure that is gaining traction in blockchain-based sustainability projects is the Decentralized Autonomous Organization (DAO). DAOs are essentially blockchain-based legal entities governed by smart contracts rather than a hierarchy, where decision making is distributed among many stakeholders (as opposed to a central authority). In a DAO, members vote on initiatives and funding proposals or the rules of a reward distribution system for participation in or contribution to a project. When applied to sustainability, DAOs could collectively decide on reward systems for environmental action, such as the governance of a decentralized carbon credit market or a platform rewarding users for steps they take to reduce their carbon footprint. This approach would ensure that governance is transparent, democratic, and aligned with community values, while also generating buy-in and collaboration among stakeholders.

**6. Interoperability and Cross-Chain Communication:** As blockchain ecosystems become larger and more complex, it is important to enable interoperability, or the ability for different blockchains to communicate and seamlessly transfer data and value. Specifically, interoperability can help connect all other disparate sustainability initiatives, such as carbon credit registries, renewable energy trading platforms, and sustainable supply chain solutions, into one framework. Cross-chain communication has the potential to transfer tokens and rewards across different blockchains without the need for complex, centralized intermediaries. Techniques are being developed to allow for communication between different blockchains, thereby opening up the possibility of scaling blockchain-based sustainability solutions even further. In particular, atomic swaps, a method of exchanging one cryptocurrency for another without the need for a trusted third party, along with token wrapping and unwrapping protocols, are being developed for cross-chain functionality.

**7. Oracles for Real-World Data Integration:** To develop efficient sustainability reward systems, blockchain platforms often have to integrate oracles, which are external connectors to bring off-chain real-world data into on-chain automation processes. As blockchains are isolated and cannot

connect to external systems, oracles serve as connectors and send data to blockchain networks in a secure and trustworthy way. For example, oracles can be set up to send energy consumption data, realtime carbon emissions data, or weather patterns to blockchain systems. In the context of sustainability, an oracle can feed data in realtime about how much renewable energy has been generated, how much waste has been collected for recycling, or even send data on how many trees have been planted. This data can be used to automatically trigger smart contracts and release rewards accordingly. By using oracles, it is possible to make blockchain-based sustainability solutions more precise, since the system will always verify that the information registered on the blockchain aligns with the reality.

The combination of these techniques—smart contracts, consensus algorithms, tokenization, cryptographic security, DAOs, interoperability, and oracles—forms the technological backbone of blockchain-based sustainability reward systems. Each of these techniques addresses key challenges in incentivizing sustainable behavior, from ensuring transparency and security to automating reward issuance and fostering decentralized governance. However, their successful implementation requires careful consideration of the specific needs and goals of sustainability initiatives, as well as overcoming challenges related to scalability, energy consumption, and regulatory compliance. As the technology matures, blockchain's potential to drive meaningful progress toward global sustainability goals will continue to expand, offering new ways to incentivize, track, and reward sustainable practices across industries.

## V. APPLICATION AND TECHNOLOGY TOGETHER

Blockchain technology provides powerful solutions for promoting transparency, decentralization, and automation in tracking sustainability efforts across all sectors by running some proof-of-concept pilot projects. Smart contracts automate transactions and incentives for eco-friendly activities like renewable energy generation, waste recycling, etc.. Energy trading on platforms like Power Ledger is decentralized so that renewable energy can be exchanged directly with blockchain to ensure secure and transparent transactions.

In supply chains, blockchain increases due diligence by tracing product provenance, ensuring ethically sourced materials, and verifying sustainability claims. With blockchain's immutable nature, carbon market transactions are automated, without any flexibility for dishonest acts. This overlap divides all systems into tokens that reward green activities with blockchain-based digital currency that can be traded or cashed out.

In the circular economy, blockchain helps waste management by providing incentives for recycling efforts and in smart cities, it rewards sustainable urban practices like public transport use through blockchain-based tokens. Interoperability suggests integration among urban sustainable practices within one system. Finally, blockchain helps corporate sustainability by automating ESG reporting to ensure accountability in environmental concerns.

When these technologies are merged, blockchain guarantees a secure, efficient, and transparent way of integrating sustainability across industries, which nevertheless has to overcome challenges such as scalability and energy consumption.

## VI. SOLUTIONS FOR CHALLENGES

1) **Energy Consumption:** The shift to energy-efficient consensus mechanisms such as Proof of Stake or Proof of Authority reduces energy usage drastically. Generally, these models are far less computationally expensive and better suited to environmentally sustainable ones. Also, the promotion of the use of renewable energy as incentivized mechanisms makes the future clean and further reduces harm to the environment and blockchain technology.

2) **Scalability and Transaction Speed:** Layer-2 solutions, such as state channels and sidechains, can offload transactions from the main blockchain that allows increased speed and reduced congestion. Sharding—explaining where the blockchain is divided into smaller, more easily manageable pieces—scaling becomes more attainable by allowing parallel transaction processes further providing bitcoin networks much more efficient for large-scale sustainability applications.

3) **Regulatory and Legal Challenges:** Governments and blockchain organizations should work together to establish standardized regulations and legal frameworks for blockchain-based sustainability projects. This could involve establishing clearly defined protocols towards such key issues such as the verification of carbon credits, the tokenization of environmental assets, and data privacy. Secondly, permissioned blockchains that are governed by trusted entities would provide more control over access, ensuring compliance and still benefiting from transparency and security through the use of blockchain.

## VII. VARIOUS DOMAINS IN REWARD SYSTEM

**1: Energy and Renewable Energy Trading:** Energy and Renewable Energy Trading: Blockchain creates decentralized energy trading, allowing renewable energy consumers and producers—who might use solar wind—to transact one-on-one without intermediaries. The participants can earn digital tokens as rewards for generating or consuming renewable energy, which can then be traded or used for any purposes.

- Example: Power Ledger allows for peer-to-peer energy trading, whereby users earn tokens for sharing surplus solar energy with others.
- Reward Mechanism: Energy producers receive tokens for the volume of renewable energy they generate to shift towards greener energy sources.

**2. Carbon Offset and Carbon Credit Markets:** Blockchain ensures transparency and traceability in carbon credit systems. Individuals or organizations can earn carbon credits for such activities as planting trees or reducing carbon emissions. These credits are thereby recorded on the blockchain and cannot be edited afterward.

- Example: Platforms like Verra use blockchain to track and manage carbon credits.
- Reward Mechanism: Participants that reduce or offset carbon emissions are rewarded with verified carbon credits via the blockchain in global emission-reduction efforts.

**3. Supply Chain Transparency and Ethical Sourcing:** Blockchain is deployed for enhancing transparency in the supply chain, enabling consumers to verify sustainability and

general ethical sourcing for products. In this case, the company or producer who follows sustainable practices, such as avoiding waste or assuring the application of ethical labor standards, gets rewards that are delivered via blockchain.

- Example: IBM Food Trust employs blockchain to track the journey of food products, ensuring sustainable and ethical sourcing.
- Reward Mechanism: Suppliers and producers receive tokens from the blockchain for meeting sustainability standards, which builds towards ethical sourcing while reducing environmental impact.

## VIII. CONCLUSION

The project demonstrates the effect of deep learning, specifically U-Net architecture, for satellite image segmentations. This complements with perfect pixel-wise classification of land cover types for any kind of applications such as urban planning, environmental monitoring, and disaster management. The future work can explore other deep learning architectures to better improve accuracy and to manage large-scale satellite data even more efficiently.

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