Blockchain for Sustainability

Exploring the application of Amazon Managed Blockchain to improve transparency in supply chains, enable real-time auditability, and reduce carbon footprints

December 22, 2020

Notices

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Abstract

Sustainability challenges span social, economic, and environmental considerations. Organizations increasingly seek to provide more transparency into their sustainability practices for employees, shareholders, regulators, and consumers. Blockchain enables increased visibility into the entire supply chain, allowing organizations to accurately track the provenance and authenticity of goods at the product level, and to gain insight into sustainability practices. This paper discusses three use cases and solutions: transparent supply chains and the circular economy, auditing and certifications at scale, and carbon emissions tracking and marketplaces.

Introduction

Sustainability challenges span social, economic, and environmental considerations. Both public and private organizations increasingly seek to provide a more transparent view into their sustainability practices for employees, shareholders, regulators, and consumers.

To meet sustainability commitments, for example carbon emission targets, organizations must measure the impact of their entire supply chain. However, challenges with transparency and data reconciliation in supply chains make this difficult. In a typical supply chain, individual participants are able to see one level upstream and downstream, but not beyond that.

Efforts to improve product and facility audits and certifications can be vulnerable to tampering, and often increase overhead. In addition, many audits are conducted annually, providing limited, snapshot-in-time insight into suppliers' practices.

Although premium commodities, such as organic materials, can be tracked through the supply chain, tracking is typically done at a mass balance level, and not at an individual product level. This type of tracking leaves room for double spending of premium materials, as well as an inability to make certain product claims about the materials it contains.

Blockchain enables visibility into the entire supply chain, allowing organizations to:

- accurately track the provenance and authenticity of materials and goods at the product level.
- gain insight into the sustainability practices of participants.

In this document, we'll share some benefits of blockchain and explore how it can contribute to sustainability goals in the context of three use cases:

- Transparent supply chains and the circular economy.
- Auditing and certifications at scale.
- Carbon emission tracking and marketplaces.

Benefits of blockchain

A blockchain is a decentralized network where governance and operation are maintained by a loosely connected network of members. Blockchains enable parties to transact without the need of an intermediary providing safeguarding services such as maintaining escrow. This approach is enabled by cryptographic algorithms that ensure data can never be tampered with or deleted once committed to the blockchain. Data can be verified at any time for accuracy and authenticity, and with applications designed to run on a blockchain, process integrity can be verified.

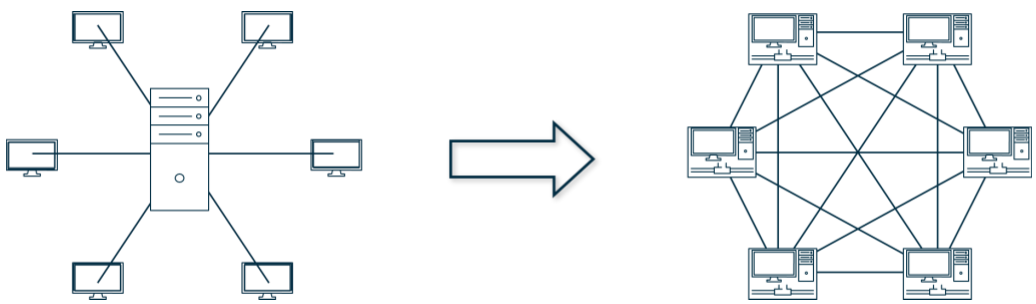

Figure 1 – Blockchain enables transactions without a centralized intermediary

Data is stored in a ledger in an append-only manner, ensuring it can't be modified or deleted. All blockchain activity is recorded to the ledger within blocks of data, enabling anyone to replay the transactions and verify that the contents of the ledger have not been manipulated. This feature is a tremendous benefit during audits, as the full ledger history can be provided to an auditor to verify the transactional integrity.

These same foundational benefits underpin the motivation to use blockchain across a variety of industries and use cases. For example, using blockchain to trace a raw commodity in a supply chain provides a complete, transparent, and trusted history of its journey as it moves through the supply chain. As the commodity is transferred between counterparties, additional data can be captured on the blockchain, such as who owned the commodity at various times. Additional data can also include environmental data captured from sensors, cameras, and Internet of Things (IoT) devices.

Bitcoin was the first blockchain network, launched in 2008 as a way to exchange monetary value in a decentralized environment with no intermediary required. The Ethereum blockchain launched in 2015 and included support for smart contracts, something that wasn't available on Bitcoin. Smart contracts are applications containing business rules (for example, terms and agreements) that are deployed and executed on the blockchain. From its inception, Ethereum has had a vibrant and active developer ecosystem contributing improvements and new concepts, including tokenization, also discussed in this document.

Public blockchain network basics

A *public blockchain network*, also referred to as a *permissionless network*, can be used by anyone. Although there are many public blockchain networks available, the Bitcoin and Ethereum blockchain networks are widely considered as the leading public blockchains, based on percentage of global blockchain transactions. Blockchain members running the network collect fees for processing transactions and minting new blocks on the blockchain.

Public blockchain networks enable low barriers to onboarding because no central authority is required to grant network access. This allows counterparties to quickly begin using the network to share data and deploy smart contracts. Users pay for their transactions as they create them, with members operating the network collecting the transaction fees. The cost of transacting on public Ethereum fluctuates greatly, as it strongly correlates with other activity occurring on the network. For example, the cost of executing a simple transaction on Ethereum fluctuated by a factor of 10x between July and September 2020.

Given the low barrier to onboarding, along with the low transaction throughput, public blockchains are ideally suited for storing data that is updated infrequently, and read many times. An annual facility audit report is a good example. An auditor would publish an audit report and put the report on the public blockchain. Once there, anyone can access this report. Public key infrastructure (PKI) can provide even stronger verification, allowing a reader to verify the authenticity of the publisher.

Challenges with public blockchain

Public networks have significant limitations making them unsuitable for many enterprise uses:

- They are unable to process transactions at high speed, limiting concurrent usage on the network.
- Fluctuation and risk in the cost of issuing transactions make it difficult to project costs.

- Public availability of all data on a public blockchain cause data privacy challenges. It's possible to privatize the data via encryption, but that skews toward a centralized model where requests for decrypting data must pass through a trusted party that owns the decryption key.

The Bitcoin and Ethereum networks are powered by miners who are rewarded for ensuring the integrity of the network, and solving an extremely difficult math problem. The math problem requires significant computing power, leading to greatly increased energy consumption.

There are alternatives to the math problem approach, including incentivizing good behavior to maintain the integrity of the network. Ethereum has been working on such a transition away from high energy consumption with an algorithm called Proof of Stake, which it began beta testing in 2020. Once fully transitioned, Ethereum's eco-footprint will be reduced by 99%[1].

Understanding private blockchain networks

Private blockchain networks were developed to provide the benefits of blockchain while meeting enterprise requirements. Private blockchains typically have native constructs for data privacy, and they support significantly higher transaction throughput compared to public blockchain networks.

Data privacy enables a subset of members of a blockchain network to transact with one another without revealing details of their transaction to other network members. All members, including those not involved in the private transaction, are still involved in endorsing the transactions and enforcing the business rules within the smart contracts, providing a high level of trust in the network, independent of the privacy level of individual transactions.

Private blockchains enable transaction throughputs on the scale of hundreds to thousands per second, compared to dozens per second on a public blockchain on the high end. This increase in throughput can be attributed to the difference in number of blockchain members needed to achieve consensus. Public blockchain networks can have thousands of members who need consensus on their shared state, while private blockchain membership numbers typically range on a scale from a handful to dozens, leading to significantly shortened times for all members achieving consensus.

Given the higher throughput than public blockchain networks, and their native support for data privacy, private blockchain networks are ideally suited for powering transparent supply chains. Some of the relevant use cases include:

- Tracking premium materials (for example, organic cotton) from their source and throughout the supply chain, ensuring quality in finished products.
- Product safety and recall by tracking goods as they move through a supply chain, providing the ability to trace a faulty product upstream to proactively identify other potentially faulty products.

Transparent supply chains and the circular economy

In a linear economy, a product is produced, used, and disposed. In a linear supply chain, individual participants generally have a limited view of the entire supply chain. Participants know their contributions and the contributions of the parties with whom they are in direct contact—one step upstream and one step downstream—but lack visibility into the full supply chain. This lack of visibility contributes to unpredictable lead times, product delays, and in the case of recalls, time wasted tracing the source of the problem.

A blockchain-enabled supply chain allows a shared, single view of the data, enabling a transparent supply chain into which all parties have visibility, and ensuring the authenticity and provenance of products used within that supply chain.

Amazon Managed Blockchain is a fully managed service that makes it easy to create and manage scalable blockchain networks using the popular open-source frameworks Hyperledger Fabric and Ethereum. Amazon Managed Blockchain reduces the overhead required to create a network, and allows for simple member management and maintenance of the network, enabling customers to quickly start building their decentralized applications. With Amazon Managed Blockchain, network setup takes minutes rather than days.

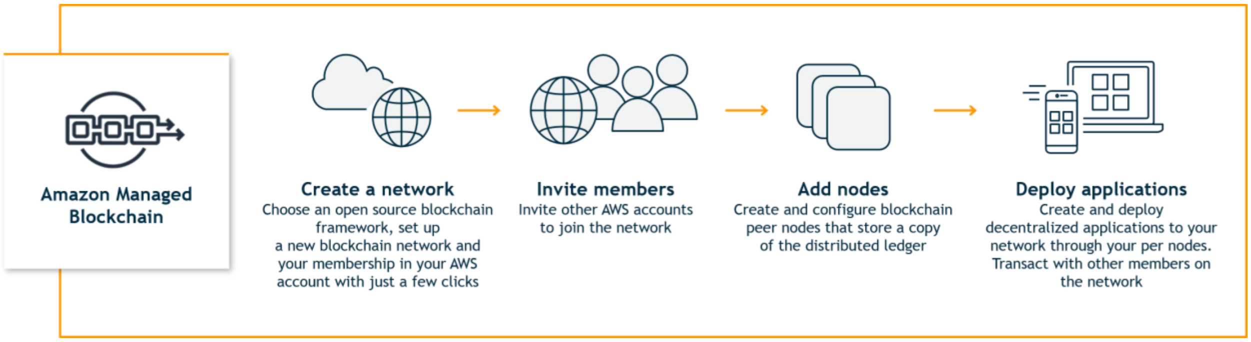

Figure 2 – Deploying an application on Amazon Managed Blockchain

Nestle uses Amazon Managed Blockchain to power its “Chain of Origin” coffee product, allowing consumers to scan a QR code on each bag of single origin coffee to learn more about the coffee and the packaging material used. Using Amazon Managed Blockchain, data entered at the source of harvesting is digitized to provide a full history of location, time harvested, shipping, and quality information. As the coffee continues its journey through the supply chain, to the bean driers, roasters, and grinders, each entity records information about their processing and handling of the beans to the blockchain. Not only do consumers gain a fully transparent view of their coffee’s origins, but farmers and other vendors who are part of the supply chain are now also able to see the full supply chain.

Figure 3 – Nestle’s “Chain of Origin” coffee from chainoforigin.com

How circular supply chains support a sustainable business model

Linear economies require easily accessible and ample resources. As the population grows and resources are depleted, it becomes more important to take a circular, ecosystem-based approach that focuses on resource replenishment and renewability.

In a circular economy, products are repurposed with a few goals in mind:

- Ensuring the product loses as little value as possible.
- Recycling the product back into the supply chain.

The goals can be met by:

- Extending the use-cycle length of the product, keeping it in use for longer.
- Increasing use of the product, for example, by sharing it among users.
- Refurbishing, recycling, or reusing the product, often connecting it back to the initial producer or tying it to a financial incentive.[2]

Not only does this involve changing the flow of supply chains, but it also requires new business models.

One such business model is a *circular supply chain*. A sample application of this business model was developed by Accenture in collaboration with Mastercard, Everledger, and Mercy Corps, and is built on Amazon Managed Blockchain.[3] It combines supply chain, blockchain, identity, biometrics, and payment capabilities to connect base-of-the-pyramid producers to consumers. This business model allows customers to directly recognize and reward sustainable producers. Once a producer's growing practices are verified, the producer receives a badge, and this data is stored on the blockchain. Consumers can view the information and tip producers through an app. This business model also benefits processors, who gain transparency around proof of provenance, and wholesalers, who benefit from improved food security and faster recall times.

Solutions for implementing circular supply chains

Blockchain with digital tokens

Pioneered on the Ethereum blockchain, tokens are assets that can be created and exist on a blockchain, and can be used for a variety of use cases. The simplest use case is for payment. Bitcoin's and Ethereum's native tokens (bitcoin, ether) have a combined market value of in the hundreds of billions of dollars (Q4 2020).

Besides payment, tokens can be created and used within applications running on the network. Tokens are commonly used to represent real world assets, such as shares of real estate which can be easily transferred over the network and between users, with payment if needed, making the transaction's occurrence immutable.

Two types of tokens

Using tokens as payment is an example of fungible tokens, which are tokens that can be equally replaced by another token of equal value. Using tokens for shared real estate is an example of non-fungible tokens, which have attributes that uniquely identify them.

These tokens belong to a single owner at any given time and can be transferred between parties throughout their lifetime. Due to the blockchain's inherent immutability, a token's complete history since its creation is available. In textiles, a token represented by the *digital twin* of a bail of cotton moves through the supply chain. At each point of transfer, the bail's ownership updates on the blockchain. At any point, a reader can query the blockchain to obtain a complete history of the provenance of the cotton, tracing back to the community or farm where it was grown.

Although blockchain enables more accurate and transparent tracking across a supply chain, manual intervention will likely remain a part of many supply chains, especially with regard to dispute resolution. In the event of a dispute, such as around damaged or lost goods, a third-party agent may still be required to intervene and determine what caused the issue and how to resolve it.

A circular economy example

This example works through the context of a theoretical consortium comprised of manufacturers, retailers, and brands. The consortium members are interested in repurposing rubber from end-of-life products, for example, tires, into new products, such as shoe soles and bicycle tires.

The process begins with a product that has reached end-of-life (EOL), arriving at a facility where the rubber is extracted from the product. A non-fungible token (NFT) is created to represent the rubber that was extracted, and includes attributes about the rubber such as weight, quality, and place of origin. As the rubber moves from the extraction facility to a manufacturing facility where it is repurposed into a new product, the NFT also changes ownership.

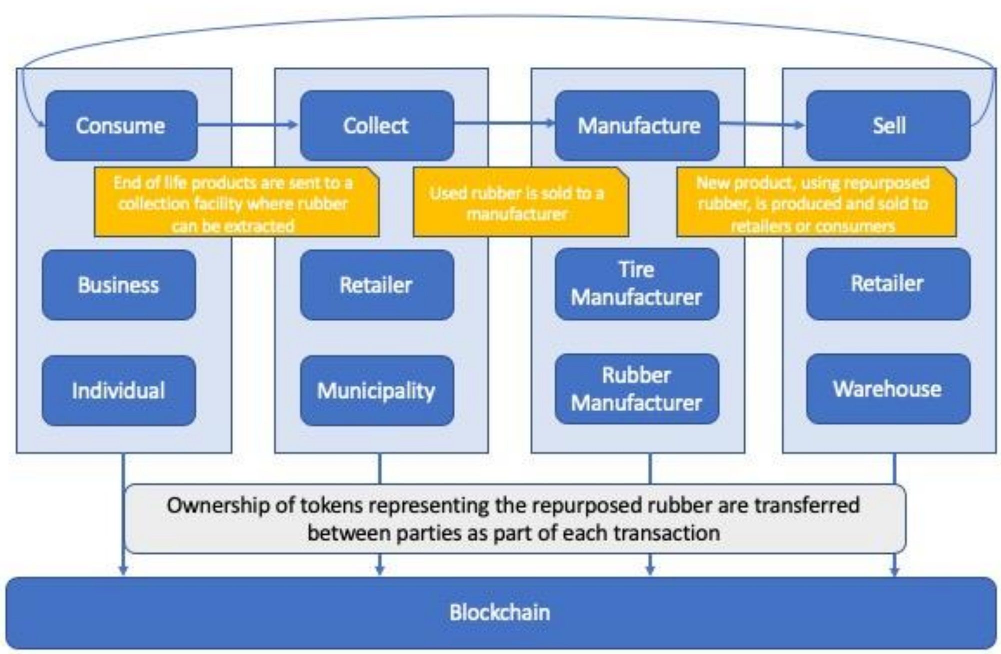

Figure 4 – Tracing the lifecycle of rubber using NFTs

This example has been simplified to help illustrate the process. Typically, several entities are involved in the entire manufacturing supply chain of a product. However, the same mechanism of transferring NFTs between counterparties, and adding data to it as it progresses through the supply chain, can be used in more complex supply chains.

Although blockchain provides the technology to track the products through the supply chain, manufacturers may need to track the NFT rubber within their facilities to accurately record where and in what products it is being consumed. A finished product comprising several different materials can be associated with several NFTs, each containing a complete history of an individual material's journey from where it entered the circular economy.

By leveraging blockchain to trace the NFTs, access to the data becomes decentralized, allowing any of the participants in the supply chain to own and access this data. If the network members agree to make certain data publicly available, eco-conscious consumers can also access the blockchain and trace the repurposed rubber that was used in a product they have purchased, and follow its journey through the supply chain, starting from the facility where it was extracted from its previous product.

Using governance to provide guardrails

A consortium of members is needed to operate the network, and to define the business processes and data standards. For example, business processes are required for properly onboarding and offboarding members. Although the network may be operated by a handful of consortium members, it needs to support thousands of users participating in the circular economy. Extensible data standards, defined by the consortium, enable integrating the blockchain with virtually any other AWS service, or with an on-premises enterprise resource planning application.

The example outlined in the preceding section is well suited for a private network due to its presumed requirement for higher transaction throughput as well as native support for data privacy between parties. Data privacy enables multiple parties to exchange sensitive data that is visible only to the parties involved.

Another approach is designing a circular economy to take advantage of both types of blockchain networks—having a private network to track and trace the materials as they move through the supply chain to enable counterparty privacy, and leveraging the public network to transfer monetary value between parties.

Auditing and certifications at scale

Within nearly every supply chain, auditors are trusted to audit entities within the supply chain, and to make the audit reports available to supply chains participants who request them. These audits typically fall into one of two categories: site audits and transaction audits. This section discusses what each of these audits are, why they are needed, and where Amazon Managed Blockchain can help with sharing this audit data easily and in a trusted manner.

How site audits work

Site audits are typically conducted against a set of industry standards, and are used to evaluate a supplier across a number of areas including:

- Sustainability practices in areas such as water conservation and land preservation.
- Environmental impact of their production process.
- Social responsibility and ensuring humane working conditions, and no forced or child labor.

The output of a site audit is a certification in the form of a PDF or Excel document. Downstream suppliers, retailers, and brands use these reports to ensure their entire supply chain is in compliance with their own social and sustainability objectives.

There are a few problems with how these certifications are managed today. First, because the certifications are maintained as PDFs, there is room for tampering, including removing any violations or low scores. A retailer receiving a report from a malicious supplier does not have a simple way of verifying the authenticity of the report. Some certification standards organizations, such as the Better Cotton Initiative (BCI), provide a centralized repository for their BCI certifications, which reduces the opportunity for tampering, and increases trust in the certifications.

For standards organizations that do not want the responsibility of providing a centralized source of certifications, blockchain provides an opportunity to offer a high level of trust against tampering, while providing easy accessibility to certifications for all supply chain participants.

The annual cadence of many site audits provides a limited snapshot insight into a supplier’s practices. Technology offers opportunities to improve this to conduct ongoing, real-time audits and certifications. For example, Internet of Things (IoT) devices and sensors used with AWS IoT Greengrass can capture environmental conditions such as temperature and humidity in a factory. Onsite cameras used with Amazon Machine Learning services like Amazon SageMaker and Amazon Rekognition can measure the space between workers to ensure humane working environments. Passive or active RFID tags can be added to goods to track batches and lots more accurately. Automated data capture can be stored on the blockchain, supplementing the manually captured site audit results. The outputs of these automated mechanisms can be saved on the blockchain.

Transaction audits: background and challenges

Transaction audits certify the exchange of goods between counterparties, and are issued by third-party auditors. A cotton gin selling one ton of organic cotton to a spinning mill results in the creation of a transaction audit attesting to the quantity of goods being sold, and the attributes of the goods—in this case organic cotton, a premium fiber for which a supplier can demand a higher price. As with site audits, a transaction certificate is typically a PDF.

Challenges with transaction audits include:

- **Delays in accessing certificates.** Retailers requesting certifications for goods they received in a shipment may not be able to obtain the certificates immediately. Therefore, although retailers are sourcing from a certified supplier, they still do not have guarantee of preferred attributes assigned to a particular product or raw material.
- **Non-differentiated operational overhead on all suppliers.** Given the large number of transaction certificates that are created in a supply chain (one per transfer of ownership of goods), maintaining and sharing these certificates becomes a non-differentiating burden put on each supplier. In addition, traceability of products via transaction certificates is cumbersome, as it requires consolidating and reconciling certificates between all participants in the supply chain, each of whom may be working with different certification bodies.
- **Vulnerability to fraud.** Limited guardrails are in place to ensure claims of premium fibers are accurate. For example, a malicious supplier can make multiple identical claims against their inventory of premium fibers. Unless they are working with the same auditing body for those transactions, the opportunity is ripe for double spending of premium fibers.

Solutions to overcome audit challenges

Recording site audits and transaction certificates on a blockchain network enables parties to quickly and easily gain visibility into the sustainability profile of a finished product. Records can be trusted with a high degree of confidence as the immutability of the blockchain ledger inhibits tampering with the certificates. Supply chain actors, as well as retailers and end consumers, can directly access the data for a given product directly from the blockchain, removing the need for suppliers to furnish this data on demand.

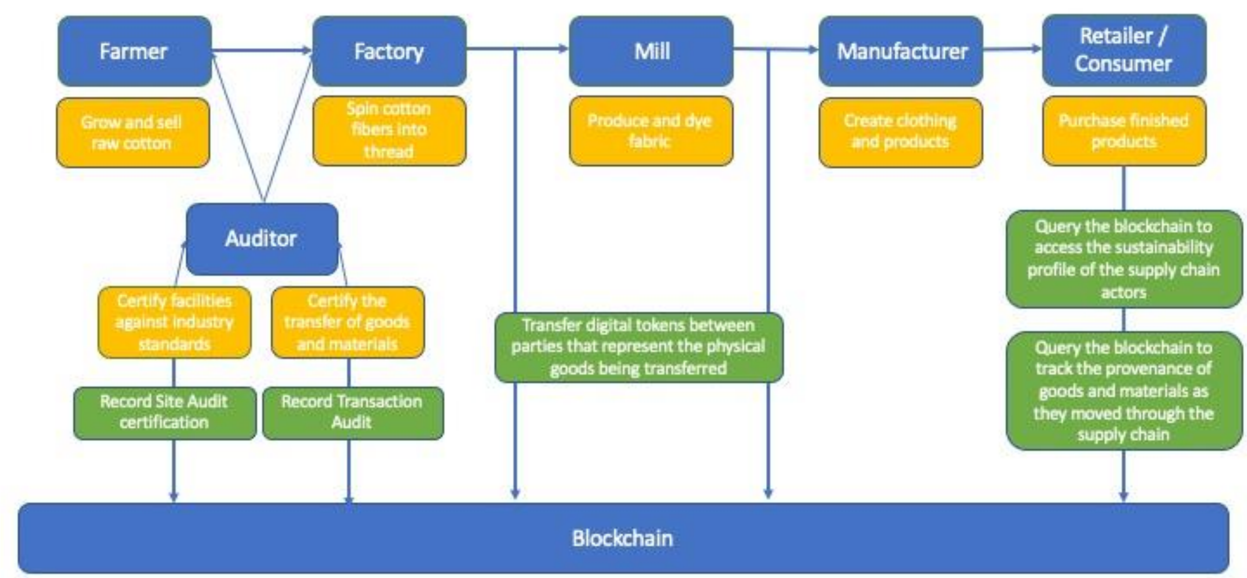

Figure 5 – Real-time audit of a cotton supply chain

Combining blockchain with Public Key Infrastructure (PKI) enables a verifiable and trusted solution for managing audit reports and certifications. Amazon Managed Blockchain would provide a self-service membership registry where users register and provide a public key that attests to their digital signatures. An auditor certifies the document with a digital signature. The reader can then verify they are reading the original, unedited document by verifying the auditor's signing key. Any supplier requesting this certification would have immediate access to it, as it would be available on the blockchain.

Rich media, such as photographs or videos, can be supported with the same level of verifiability and authenticity. Unique, digital fingerprints of media can be saved on the blockchain, allowing the consumer watching the video to verify the authenticity of the media, and with PKI, ensure the identity of the video creator.

Another solution relies on non-fungible tokens (NFTs). Using a blockchain network to store transaction certificates provides a trusted, transparent, and reconcilable source of truth that ensures claims of any goods or materials correctly balance. Because all transaction audits are maintained in a single ledger, checks and balances occur immediately, eliminating the potential of double spending or fraudulent claims. NFTs can be used to track materials as they move through the supply chain. When material tracked with an NFT is exchanged between counterparties, the NFT will also transfer to the new owner. The inherent immutability of blockchain allows the NFT to include a trusted, complete history of the various transfers of ownership of the material, providing an unbroken chain of visibility of where material moved through the supply chain.

Supplemental data can be added to the NFT, such as using forensic testing to add attestation of a material's properties, or sensors and IoT devices to capture geolocation or environmental data. Unique identifiers such as RFID tags, NFC chips, or DNA marking of the product itself[4], can be connected with the NFT and attached to the product, enabling consumers to follow the journey of all materials that went into that final product.

As previously mentioned in the circular economy example, although NFTs provide a means to digitally track materials as they move through the supply chain, suppliers need to be able to accurately track these materials within their facilities as they are processed and blended with other materials.

Carbon emissions tracking and marketplaces

Another growing area for blockchain is its use in carbon emissions management.

Organizations can balance their carbon budgets, an emissions accounting measure ensuring that emissions output is at least equal to their avoided emissions, by purchasing carbon offsets. Carbon offsets are produced by projects that carry out on-the-ground emissions reduction activities. Emission reduction activities include installing renewable energy infrastructure, planting trees, and increasing access to public and/or alternative transportation. Offsets can either be traded as part of a compliance market, where government regulations require emitters to either reduce their emissions or purchase offsets, or on the voluntary markets, where buyers and sellers trade of their own volition.

Compliance markets are created and regulated by mandatory national, regional, or international carbon reduction regimes. The compliance market is divided into two market systems: cap-and-trade, and baseline-and-credit. Figure 6 shows the multiple sub-systems within each market system.

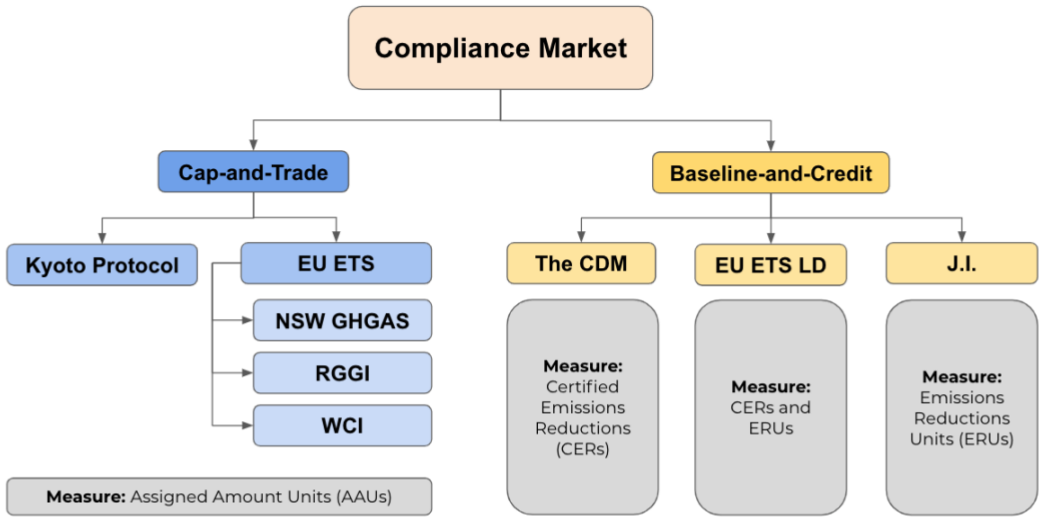

Figure 6 – Compliance market system breakdown

Voluntary markets function outside of the compliance market. They enable businesses, governments, non-government organizations (NGOs), and individuals to offset their emissions by purchasing offsets that were created either through the compliance market or in the voluntary market. The latter are called verified or voluntary emissions reductions (VERs).

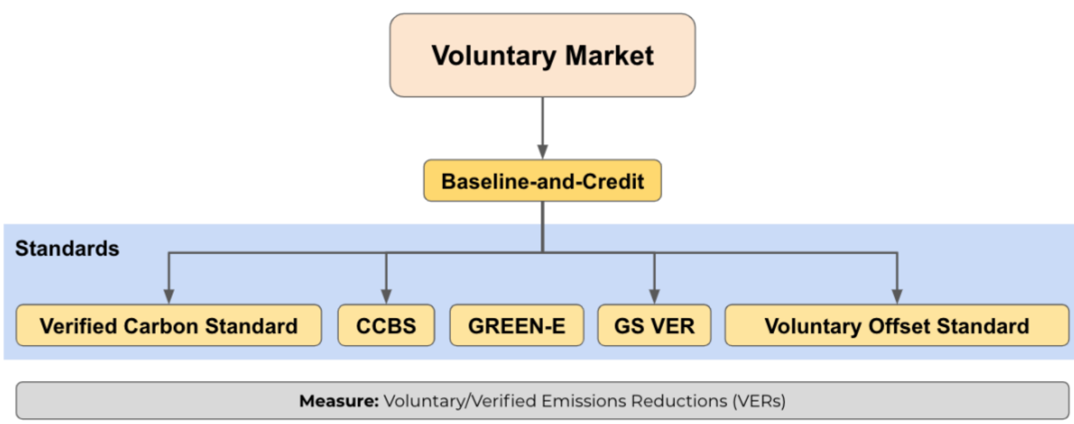

Figure 7 – Voluntary market system breakdown

Both markets suffer from fragmented implementation, lack of cross-market value exchange, and often incorrect carbon ratio parameterization of given projects such that carbon offsets granted and/or retired often do not actually reflect their true environmental effect, creating demand-supply imbalances. Additional systemic issues include double counting environmental impact through redundant accounting regulations, inconsistent availability of market registries that enable consumers to verify the authenticity of their commodity, and inaccurate pricing due to inadequate pricing mechanisms. Lastly, there is no globally robust system of checks and balances to ensure projects are appropriately parameterized. Without a global methodology for determining net environmental-effect, wide-scale fraud has set in.

This fragmentation has resulted in hyperinflation, leading toward the undervaluation of the true cost of offsetting emissions, saving energy, and generating renewable energy. Market imbalance disincentivizes good behavior and leads to a lack of trust in environmental commodity markets generally.

One of the biggest issues with existing carbon markets is the potential for double-counting a carbon offset, or having multiple stakeholders take credit for the same offset. Carbon offset registries keep track of offsets and are vital in minimizing the risk of double-counting. Registries also clarify ownership of offsets. A serial number is assigned to each verified offset. When an offset is sold, the serial number and “credit” for the reduction is transferred from the account of the seller to an account for the buyer. If the buyer “uses” the credit by claiming it as an offset against their own emissions, the registry retires the serial number so that the credit cannot be resold.

However, there is no single registry for the voluntary market, as registries for the voluntary market have been developed by governments, nonprofit organizations, and the private sector. Some of the registries are tied to certain standards, whereas others function independently. Moreover, registry data is typically held in databases that can be tampered with. Such an open attack vector leaves the entire carbon offset market open to changing the ownership of assets and manipulating offset serial numbers.

Transactions also occur without registry administration, and in that case, providers and buyers must find other ways to ensure the integrity of the delivery process. Since offsets have no physical form, buyers must be given proof that the stated emission reductions have taken place. A verification report from an independent third party can serve this purpose. Furthermore, buyers must obtain all rights and titles to the emission reductions and assurance that the provider did not and will not double-sell the offsets. Confirmation usually takes the form of a “transfer of title and ownership” document signed by the provider. But unless the provider engages an independent third party to verify its internal processes, the buyer cannot be sure that the provider has retired the stated number of offsets. This form of delivery is often time-consuming, may require extensive negotiations, and demands a great deal of know-how on the part of the buyer. It is primarily suitable for deliveries of large quantities of offsets.

Blockchain-powered solutions

The carbon market is an excellent use case for the application of blockchain technology. Amazon Managed Blockchain can be used to address the market's challenges, including transparency, immutability, and security within the context of a publicly verifiable ecosystem. It can also enable operational attribution of assets, proving how efficiently assets are created. Tokenizing carbon offsets can solve many of these issues, enabling more accurate ownership tracking, increasing market liquidity, and enabling cross-market exchanges.

Double-counting can be eliminated by creating a tamper-proof, universal registry of all tokenized offsets issued and retired. Such an on-chain registry would provide lower-level standard, geography, co-benefits, compliance, generation-type, ownership, and project-type details associated with each carbon offset. Additionally, these registries are easily audited, and the audit results could be publicly available for consumers and standards bodies alike.

Given that these environmental commodity protocols are still in the early stages of development, a sizable opportunity exists to create an open source protocol that supports the measurement, verification, and issuance of climate change assets. By partnering with the appropriate standards bodies, an automated compliance checking mechanism could be added to check against a registry of approved methodologies. This approval would likely include a cryptographic signature from the standards body itself within the metadata of a token.

One proposal from AWS Technology Partner Emerging Impact is the Climate Change Asset (CCA) Protocol. The CCA protocol is a multi-token protocol, with both CCA token-templated assets, as well as a governance token that manages how the platform evolves. The governance token enables a knowledgeable community of governance token holders to vote on items such as standards, audit processes, and registry organization.

All project verification, auditing, and initial reporting is done off-chain via traditional processes. Once the verification is complete, and a standards body has issued carbon offsets to a project, the CCA tokenization process can occur. The resulting tokens can be sold on a digital asset issuance platform and traded on digital asset trading venues.

The advent of Climate Change Asset tokens could modernize environmental finance markets. By developing protocols that support the CCA token template, social enterprises could build digital platforms that accountably and transparently liaise the project methodology submission, assessment, auditing, and approval processes on the blockchain and issue tokenized impact assets in a simple and verifiable manner.

Conclusion

In this paper we explored how blockchain technologies and Amazon Managed Blockchain can be used as a critical component within an overall sustainability solution. Blockchain's decentralized, immutable properties enable organizations to gain visibility into their entire supply chain, allowing accurate tracking of the provenance, authenticity, and carbon footprint of goods, as well as sustainability practices of the supply chain participants.

Learn more about how Amazon Managed Blockchain can help you work toward your own sustainability goals.

Contributors

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Further Reading

For additional information, see:

- Amazon Managed Blockchain
- Amazon Managed Blockchain – Contact Us
- Sustainability at Amazon

Document Revisions

Date	Description
December 2020	First publication

Notes

[1]Ethereum Plans to Cut Its Absurd Energy Consumption by 99 Percent https://spectrum.ieee.org/computing/networks/ethereum-plans-to-cut-its-absurd-energy-consumption-by-99-percent

[2]https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Intelligent_Assets_080216.pdf

[3] https://www.forbes.com/sites/amazonwebservices/2019/08/28/accenture-and-amazon-managed-blockchain-connecting-small-scale-producers-into-the-value-chain/#33a320313adc

[4] https://haelixa.com/proposition/#process