BLOCKCHAIN
x CLIMATE

DIGITAL CARBON MARKETS REPORT

In collaboration with

COOREST

KlimaDAO

REGEN NETWORK

CARBONMARK

EcoRegistry.

GBBC Global Blockchain Business Council

Digital Carbon Markets Report

Case Studies

Organization
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EXECUTIVE SUMMARY

Blockchain x Climate is an activist-to-industry network of global stakeholders working together to define and author principles that govern climate-related blockchain efforts, develop shared understanding and narratives across sectors, and design tangible and meaningful cross-chain and cross-industry climate initiatives and projects.

BxC sits under the umbrella of Global Blockchain Business Council (GBBC), the trusted non-profit association for the blockchain, digital assets, and emerging technology community. Founded in 2017 in Davos, Switzerland, GBBC comprises more than 500 institutional members and 284 Ambassadors across 124 jurisdictions and disciplines.

GBBC furthers adoption of blockchain and emerging technologies by engaging regulators, business leaders, and global changemakers to harness these transformative tools for more secure and functional societies.

For the past six months, BxC has engaged a number of blockchain-based organizations that are developing solutions for environmental markets.

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This engagement has led to cross-collaboration across the networks of the participants and yielded a number of case studies exploring the use case of distributed ledger technology across the environmental market value chain, particularly within the voluntary carbon market (VCM).

By leveraging web3 technology to align the global financial system with environmental needs, the utilization of blockchain technology aspires to increase transparency, security, and enable new and exciting applications for environmental assets. The case studies outlined in this report highlight the successes and challenges of these endeavors, while helping to paint a picture of the next few years of development for the VCM, and ultimately present actionable implementations of DLT that benefit market stakeholders.

The structure of this report follows the value chain of the carbon market, with an initial exploration of the value of DLT for securing the issuance of carbon credits into the market, i.e. serving as a bedrock for a trusted carbon registry infrastructure exemplified by the work of EcoRegistry.

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We then explore novel credit issuance mechanisms using digital monitoring, reporting, and verification (dMRV) using distributed oracle systems, a framework pioneered by Coorest.

Following these case studies we include two organizations utilizing these assets and automated DLT systems, both to connect with traditional market stakeholders and to provide novel funding streams. These two case studies are provided by Carbonmark and KlimaDAO. Lastly, we include a governance-focused case study examining the work of Regen Network to create a more inclusive carbon registry with greater distributed participation across their 'EcoCredit' value chain.

BxC is proud to present these novel applications of blockchain technology to the market and hopes this report will help spur further collaboration and innovation across our stakeholder network.

EcoRegistry Private Blockchain Backend

Introduction

Distributed Ledger Technology (DLT) entered the carbon market ecosystem with the promise of giving access to a broader type of customers and connecting different participants around the world with modern financial infrastructure. One of the most important capabilities of DLT to achieve this goal is the capacity to maintain traceability and the ability that it offers to the general public to track every single transaction on the network. This issue is critical for carbon markets, enhancing their integrity, as well as supporting new functionality, greater efficiency and fairness.

Some important characteristics of DLT are:

- **Attribute management:** DLT solutions offer the deployment of tokens to differentiate assets that have different attributes, but represent the same type of asset. EcoRegistry implements this functionality to include the attributes of each environmental asset in the creation process of each carbon credit unit.

- **Robustness:** DLT solutions have been in the market for over 20 years and have been supported by many cloud providers like AWS, Microsoft Azure and others. By their nature, DLT solutions are redundant to failure of an individual node and resilient to infrastructure failures like local power outages. This provides a robust and stable implementation suitable for specific applications, like environmental assets.

- **Issuance traceability:** With the capacity to natively work with cryptographic signatures, the system allows multiple signatures to be required prior to issuing any type of asset. This prevents a single user from abusing the system unilaterally, requiring multiple approved users responsible for issuing the asset to enter the platform and execute a digital signature approving the creation of an asset.

- **Smart decisions:** With Smart Filters and Smart Contracts, developers can create customized validation rules that enforce integrity in the registry's backend systems.

EcoRegistry uses a Multichain Blockchain Network solution, with capability to connect to other networks, including Ethereum, Polygon, the Chia network and many others. EcoRegistry focuses on the issuance and tracking of carbon units, safeguarding all the supporting evidence for the quantification of issued units from carbon projects.

EcoRegistry also collaborates with platforms like Carbonmark (see case study below) to develop the actual market for carbon. Through Carbonmark's marketplace and API solution, brokers and end buyers can access units issued by EcoRegistry, along with rich data about the projects, including the full description and location of each project. This collaborative, interoperable approach ensures that all buyers have full access to the information about the units Carbonmark provides.

Background

EcoRegistry is a solutions provider that believes in the positive impact that technology can bring to the carbon markets and any other environmental asset.

Through the implementation of technology, and data driven decisions, EcoRegistry focuses on providing solutions that can bolster the implementation of more sustainable solutions around the globe.

Since 2017, EcoRegistry is recognized as a robust registration platform provider to independent standards for the voluntary carbon market, biodiversity, and the circular economy. EcoRegistry has already implemented demo solutions for specific country needs, like a Monitoring, Reporting and Verification (MRV) platform, Nationally Determined Contributions (NDC) tracking systems, and general Greenhouse Gas emissions from countries, corporates, and industry.

In the voluntary carbon market, EcoRegistry has issued more than 100MtonCO2 on its platform, with most coming from the Cercarbono Standard. In addition, EcoRegistry is connected with the Climate Action Data Trust via an API, and also has the capability to connect to other platforms, exchanges, and marketplaces, regardless of the technology used.

Liquidity and access to broader markets is key for the continuous development of multiple projects. Environmental projects need to have consistent cash flows that allow them to implement, ensure a return on the investment, and continue new developments. When market activity slows or stops, for any reason, projects are hurt the most because they stop getting the income needed to support conservation, reforestation, or more generally, continued implementation of any solution.

The main reason for these marketplaces to exist is to give new opportunities for all projects to access multiple markets, thus supporting ongoing cash flows. Through the integration of these technologies, the expectations from project developers, communities, and project owners is that market activity continues and expands.

The Importance of the Innovation

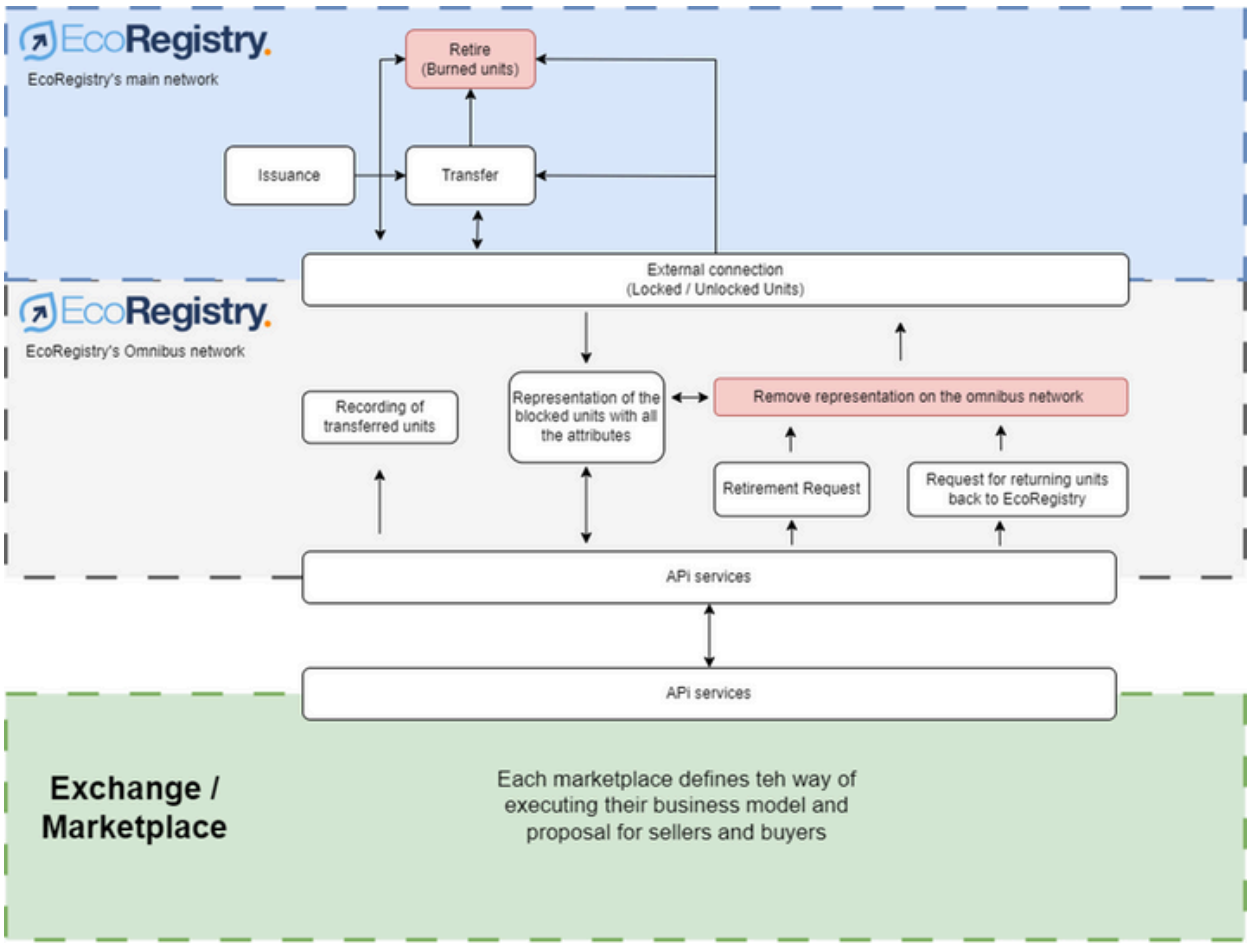
To support the liquidity of markets, technology platforms need to work together to develop a fully integrated environment. Such a solution must be agnostic to the technology implemented by any of the parties that connect to the system.Yet this solution also has to be robust, practical in use, and standardized for all users.

In this regard, EcoRegistry has already connected its system to multiple systems to understand the different representations, interactions, engagement approaches across a broader market. To achieve general connectivity between all platforms, EcoRegistry's use of interoperable technologies like standardized APIs, DLT, and public blockchains enables a step by step implementation that allows the ecosystem to evolve organically and benefit from the value added by each connection.

The Underlying Technology

For each connection that EcoRegistry implements in the ecosystem, the process involves the creation of an omnibus account in a parallel blockchain (Multichain) for each of the connecting platforms. EcoRegistry blocks the units on its main network and swaps them into the omnibus account of the parallel network, creating a representation of the units that can be accessed by external platforms. From this parallel chain, external platforms can access these units, with the required credentials and token IDs. Once the other platform has accessed the units, EcoRegistry shares all the information and attributes of the units through an API call. All transfers must be reflected on the parallel chain to maintain integrity. Finally, each of the retirements must be sent back to EcoRegistry.

EcoRegistry is the only platform that can execute a retirement process of those units and generate the corresponding PDF representation for claiming any environmental benefit from a given asset.



EcoRegistry does not allow other platforms to execute retirements, and the units are recognized as a representation of the blocked units safeguarded in the EcoRegistry environment. To participate in this interaction, the other platform must have the capability of executing the following actions:

- **Create the Representation of the Asset:** The connecting platform must be able to request information about the attributes and projects that support the issuance of every unit, as well as create a representation of that asset, without losing any information.

- **Transaction Tracking:** The connection platforms must report all transactions with the volumes transacted between different accounts.

- **Returning Representations of the Asset:** When required by any user, the connecting platform must allow the return of the asset to the origination registry (EcoRegistry), burning any representations of the asset and returning the same asset the user is expecting. This is a completely different process from retiring the asset.

- **Retiring the Asset:** The connecting platform must have the capability to fully recognize the required information for a retirement process and send this information to EcoRegistry. The connecting platform will ensure the proper management of a retired unit, differentiating it from the returned units, and EcoRegistry's retirement is the only one valid for claiming purposes.

User Experience & Business Impact

From EcoRegistry's side, the user experience is almost the same, because users can select the units they want to "transfer" to the connecting platform, select the connecting platform, and enable MultiFactor Authentication, with the purpose of blocking the units within EcoRegistry's system and represent them an external platform. The user must have an account in the connecting platform, where the units will be received. Once the units are on the user's account in the connecting platform, the user can use all the functionalities that the connecting platform offers.

The interoperability and tech-enabled nature of EcoRegistry allows it to seamlessly connect with other tech-based platforms, such as Carbonmark.

Carbonmark leverages blockchain technology to automate various market processes, including carbon credit purchase and retirement. Its API system plugs into other demand aggregation platforms, and thus serves as a finance funnel to projects such as those hosted on EcoRegistry.

Initially connected in early July, the Carbonmark platform is able to fulfill demand for Cercarbono certified credits via EcoRegistry. Thus far, Carbonmark has helped service the retirement of over 600,000 carbon credits across a variety of standards, and the EcoRegistry connection will help diversify the types of credits available to its clients.

Importantly, through the usage of smart contracts and EcoRegistry's API, Carbonmark's platform can connect with EcoRegistry to keep carbon credit retirements in sync, and quickly provide retirement certificates to clients purchasing credits through their automated system.

Of particular interest to existing Carbonmark clients are high quality nature-based projects that include a host of social and economic co-benefits. Projects which help support local communities – and involve their participation in the project's development – will be increasingly available on the Carbonmark platform thanks to the integration with EcoRegistry.

Challenges, Solutions & Future Prospects

Since the case study is developed under a web3 working group, only challenges and solutions according to such connections will be described below.

1- Understanding the market is very important to start a connection between different participants. As experienced by the team, marketplaces and exchanges must be clear about their expectations and functionalities they want to bring, because the teams may focus a lot on the technical side, but not on understanding the market. As EcoRegistry, we always recommend starting with a manual approach, where all the functionalities can be tested separately and manually. After this, the technical connection can be implemented, when there is a market solution fit.

2- The units' attributes such as owners, developers, validation and verification bodies, and certification body are important to the market. These attributes must not be lost during any connection process, and the end buyer must be able to track every single step of the issuance process and recognize where every single unit comes from.

3- Owners and project developers must have full access to the units at any point in time. They also must be able to recognize where the units are and define whether they want to bring the units back to the registration platform.

4- Owners and project developers expect to get paid with a monetary transaction in USD or any other traditional currency.

EcoRegistry is willing to participate in additional interactions and integration opportunities where the connecting platforms are bringing liquidity to the market and opportunities to the sellers.

Importantly, from the view of EcoRegistry, both the traditional carbon market and the new entrants, such as web3 stakeholders, need to understand more about the other participants. This is important because web3 technology is just a tool providing solutions that will emerge if they really fit the expectations of parties across the market landscape.

Coorest Public Blockchain Issuance with Satellite dMRV

Overview & Background

This case study delves into Coorest's pioneering efforts in revolutionizing the voluntary carbon markets through the integration of blockchain and DeFi technology. Focused on building an on-chain registry, Coorest aims to address the longstanding challenges plaguing carbon offset transactions. By standardizing critical processes such as project registration, measurement, reporting, verification, and tokenization, Coorest leverages the power of a decentralized form of digital measurement, reporting, and verification (dMRV), which leverages the benefits of blockchain technology. This innovative approach promises to bring about transparency, efficiency, and accessibility to carbon markets, ultimately facilitating a more sustainable future.

Origin

Traditional carbon credit registries suffer from fragmentation, lack of transparency, and susceptibility to fraud. These shortcomings are significant barriers to the scalability and integrity of carbon markets.

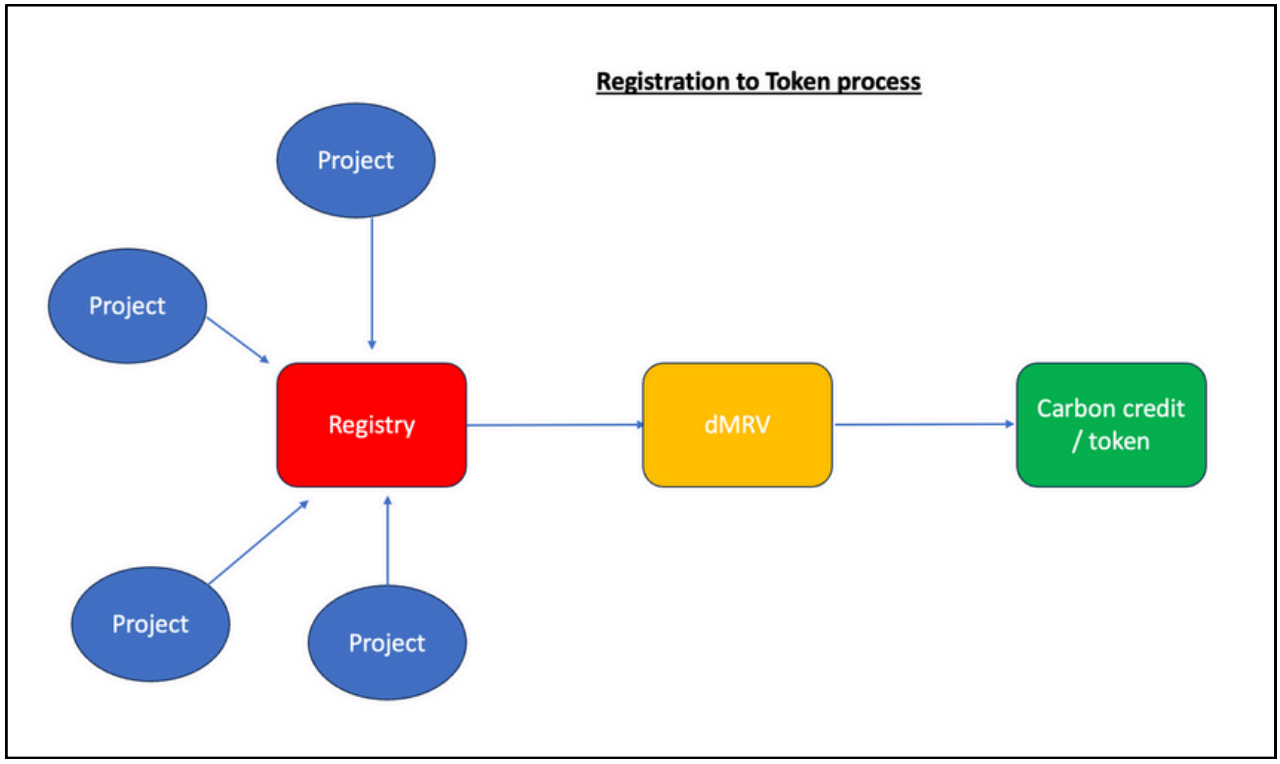
In response to these challenges, Coorest embarked on building a blockchain-based registry to address the shortcomings of traditional registries. Through collaborative efforts and iterative development, key lessons were learned, including the importance of transparency, neutrality, decentralization, and community consensus.

By leveraging blockchain technology, Coorest created a registry that enables seamless project registration, transparent measurement, reliable reporting, and verifiable issuance of carbon credits.

Development & Challenges

dMRV can be applied in many different ways leading to a lack of clarity in the market. Companies providing dMRV services can come to a consensus on how to standardize their services in order to remove this lack of clarity. Consensus around sensor usage and data storage is essential.

The process Coorest utilizes for registration, dMRV and tokenization is visualized below.



Coorest highlights a number of challenges related to centralization that remain as they have further developed their dApp and carbon standard. These are outlined below:

I) Registry Centralization

A centralized registry implies that the data storage and management for users, assets, or transactions is controlled by a single entity or authority, which contradicts the decentralized nature of blockchain systems. This setup can lead to vulnerabilities such as:

- **Single point of failure**: If the central authority is compromised, the entire registry becomes vulnerable.

- **Lack of transparency**: A centralized approach can reduce visibility into how data is handled and processed.

- **Reduced user control**: Users may have limited control over their own data and assets, relying on the central authority for changes or corrections. In a decentralized system, a distributed ledger would store this information, reducing reliance on a single entity and enhancing security and trustworthiness.

II) dMRV Centralization

The use of a centralized dMRV system limits the core principle of decentralized monitoring and verification. Coorest's dMRV system involves tracking environmental data (e.g., carbon sequestration, emissions), but centralization introduces the following issues:

- **Data Integrity Concerns**: A centralized authority might control or influence data reporting, which undermines the trust in the accuracy and transparency of reports.

- **Scalability Limitations:** A centralized architecture may not scale effectively with growing numbers of data sources and stakeholders, leading to bottlenecks and inefficiencies.

- **Data manipulation**: A single point of control increases the risk of manipulating or falsifying data without the ability to cross-check against other sources. To overcome these limitations, the adoption of a decentralized dMRV would allow for greater transparency, enhanced security, and the prevention of data tampering.

III. Tokenization Centralization

Tokenization typically involves converting rights to an asset into a digital token on a blockchain. In Coorest's case, centralized tokenization indicates that the process is governed by a single entity. This centralization can present the following challenges:

- **Trust Issues**: Centralized control over the token issuance and management means users need to place trust in the entity managing the tokens. This undermines the principle of trustlessness in decentralized finance (DeFi).

- **Regulatory Risks**: Centralized control could make the system more prone to regulatory scrutiny or government intervention, where tokens could be restricted or altered by the issuing authority.

- **Liquidity Constraints**: If tokenization is controlled by a single authority, it can limit access to wider markets, making it harder for token holders to trade their assets freely and securely. Decentralized tokenization would allow for better distribution of control, creating a more open and trustless ecosystem where users have more control over their assets.

    - *No decentralized data storage for registry and dMRV yet*

Pending Decentralized Data Storage for Registry & dMRV

Currently, Coorest has not yet implemented decentralized storage solutions for its registry and dMRV data, which presents several challenges:

- **Data Security:** Centralized storage makes data more susceptible to hacking, corruption, or unauthorized access.

- **Dependence on Central Servers:** If the central server is down or compromised, data access could be interrupted, leading to operational inefficiencies.

- **Decentralization Gap:** The lack of decentralized data storage undermines the core value proposition of blockchain applications — ensuring immutability, transparency, and distributed control. Utilizing decentralized storage solutions (such as IPFS or Arweave) for the registry and dMRV data would increase system resilience and security, ultimately ensuring data permanence.

The Innovation & Real-World Applications

Coorest's blockchain-based solution utilizes distributed ledger technology to standardize project registration, measurement, reporting, verification, and tokenization processes. Smart contracts automate the execution of agreements, ensuring trustless and efficient transactions. Chainlink technology is leveraged for secure and reliable data oracles, enabling the integration of external data sources into the blockchain pertaining to carbon project performance.

In practice, a number of key steps must be undertaken along the credit generation and usage journey.

In practice, a number of key steps must be undertaken along the credit generation and usage journey.

1- The registry is deployed on a decentralized storage system like Filecoin. Filecoin provides a robust and distributed system for storing large datasets securely and transparently. By leveraging this type of decentralized storage, Coorest ensures that the registry data—comprising project information, asset tracking, and transaction histories—is:

- **Immutable**: Once recorded, data on a decentralized storage system cannot be altered without consensus, ensuring that records remain trustworthy and secure.

- **Resistant to Censorship**: A decentralized network is not controlled by any single entity, making it less vulnerable to interference, shutdown, or censorship by governments or corporations.

- **Fault-Tolerant**: Distributed storage allows for data replication across multiple nodes, making it highly resilient to outages or attack. These features provide reliability and continuity for the project registry. This deployment onto decentralized storage also strengthens Coorest's commitment to a transparent, open, and resilient ecosystem for carbon credit generation and usage, supporting the integrity of the entire project lifecycle.

2- Monitoring, reporting and verification (MRV) data sets are stored on Filecoin. MRV data is also stored on Filecoin, which plays a critical role in ensuring that carbon project performance metrics are securely recorded and made accessible in a decentralized manner. The MRV process includes the collection of environmental data, such as biomass changes, which directly impacts the calculation of carbon credits. By storing this data on decentralized storage, we can ensure:

- **Data Integrity**: The MRV datasets, such as satellite imagery and other environmental measurements, are stored immutably, ensuring that the data remains tamper-proof and accurate for verification purposes.

- **Scalability**: Filecoin's architecture is designed to handle large-scale datasets, making it ideal for MRV data, which can be voluminous, especially when integrating satellite imagery and real-time environmental monitoring.

- **Transparency**: Decentralized storage allows various stakeholders (such as auditors, project developers, and token holders) to access the MRV data, promoting transparency in the verification process.

- **Cost Efficiency**: Filecoin offers a cost-effective solution for long-term storage, reducing the overhead costs associated with maintaining centralized storage systems, especially for large datasets such as satellite imagery or IoT sensor data. This ensures that the data used to generate carbon credits is trustworthy and accessible, thus enabling a higher level of transparency and accountability throughout the entire carbon credit process.

3- Satellite data is provided via Chainlink's Floodlight Oracle. This provides updates on carbon project performance via changes in biomass levels

4- Smart contracts generate carbon tokens based on satellite MRV data on the Polygon PoS blockchain.

5- Smart contracts are invoked when carbon retirements are initiated. These ensure the tokens are not double counted and provide a carbon retirement proof.

User Experience: The innovation transforms how users interact with carbon offset markets, offering a seamless and transparent experience. Through user-friendly interfaces and decentralized registries, participants can easily browse and select carbon offset projects that align with their sustainability goals. Feedback from users highlights the simplicity and trustworthiness of the platform, with testimonials praising the newfound accessibility and clarity in carbon offset transactions. For example, project developers express appreciation for the streamlined project registration process, while buyers and investors commend the enhanced transparency and reliability of project data.

Business Impact: The innovation has a profound influence on the business operations of organizations involved in carbon offset markets. By standardizing processes and leveraging blockchain technology, participants experience increased efficiency and reduced costs throughout the value chain. Metrics indicate significant improvements in transaction processing times, with smart contracts automating agreements and reducing administrative overhead.

Additionally, organizations benefit from enhanced market liquidity and improved risk management strategies, leading to revenue growth and increased investor confidence.

Industry Impact: The solution has far-reaching implications for both supply-side and demand-side players within the carbon offset market ecosystem.

Supply-Side Players: Project developers and carbon credit issuers benefit from streamlined project registration and verification processes, reducing administrative burdens and time-to-market. The standardized approach to tokenization ensures wider market access and improved liquidity for carbon credits, facilitating project financing and scaling up emission reduction activities.

Furthermore, decentralized registries empower project developers to showcase their environmental impact transparently, attracting investors and buyers seeking credible carbon offset opportunities.

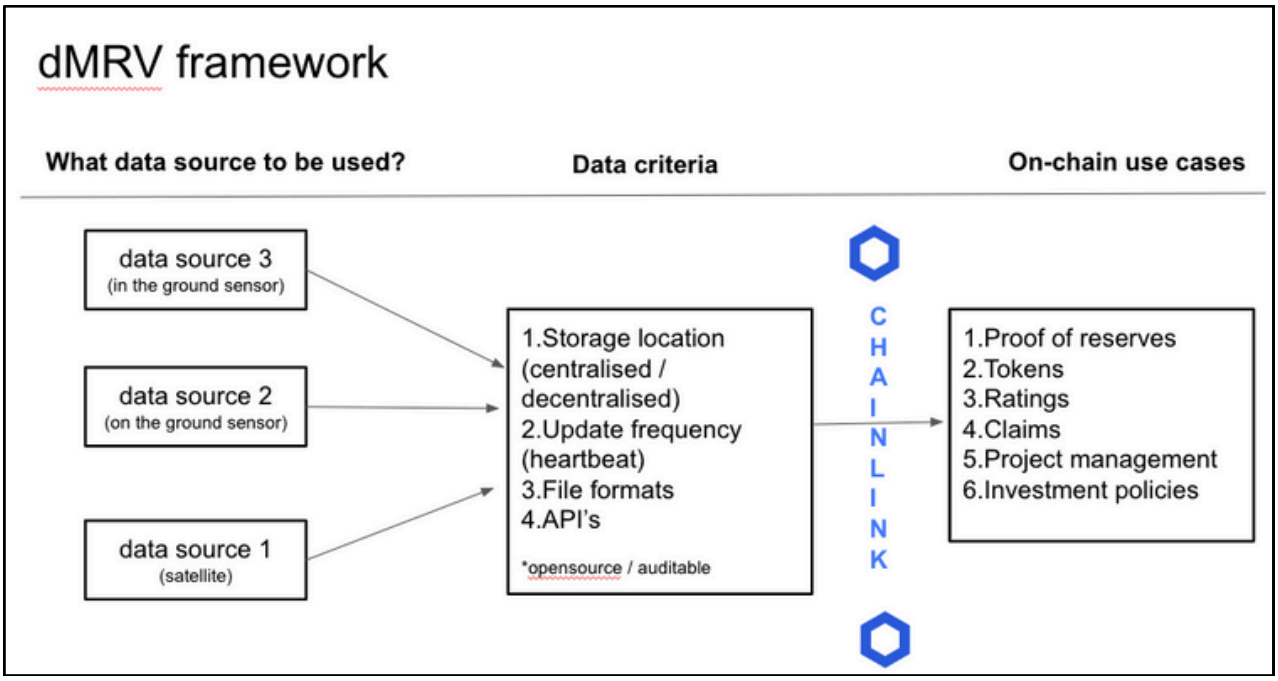
Demand-Side Players: Buyers and investors enjoy increased transparency and trust in carbon offset transactions, thanks to immutable records and transparent audit trails facilitated by blockchain technology. Standardized protocols for measurement, reporting, and verification provide assurance of project integrity and emission reductions, mitigating risks associated with greenwashing or double counting. As a result, demand-side players can confidently invest in carbon offset projects, aligning their sustainability objectives with tangible environmental impact while contributing to the transition to a low-carbon economy.

Challenges and Solutions

A number of distinct adoption challenges were identified by Coorest, primarily on the technical side. These include designing a blockchain-based architecture framework to enable decentralized data flow resulting in the tokenization of green assets. Additionally, MRV data sources were also cited as a challenge, as currently there is a limitation in the number of blockchain-enabled sources of such data that they can draw from.

More broadly, challenges around the standardization of data for their assets, and aligning such standards with other tokenized carbon credits were highlighted. This particular challenge relates directly to adoption, as there was a highlighted need for industry-wide collaboration to establish and adhere to standardized protocols for project registration, measurement, reporting, verification, and tokenization. Education initiatives and pilot programs demonstrate the feasibility and benefits of decentralized standardization efforts.

Furthermore, funding for this space was cited to better support teams working to ameliorate the aforementioned challenges.



Related technical challenges involved data security and privacy. As a solution, Coorest pointed to the potential of ZK technology to be utilized to protect user privacy regarding the transaction of tokenized carbon credits. ZK technology allows transactions occurring on a blockchain to be made private, wherein the address of the sender and receiver of a transaction are obfuscated.

Future Prospects

Market Expansion

Expanding the application of Coorest's and ancillary technologies centers on the following:

- Developing enhancements to project registration processes, integration of additional data sources for measurement and reporting, and further optimization of tokenization mechanisms using Chainlink technology. These features will strengthen the integrity and scalability of carbon offset markets.

- The innovation holds potential for expansion into other environmental commodities such as renewable energy certificates and biodiversity offsets. Strategies for market expansion include targeted outreach to new sectors and partnerships with industry stakeholders, facilitated by standardized protocols.

New Features & Product Development

A number of areas have been identified to address user needs, including:

- **Enhanced Accessibility:** By standardizing project registration processes and utilizing decentralized registries, the innovation will lower barriers to entry for green projects seeking to participate in carbon offset markets. This will empower a broader range of project developers, including smallholders and community-based initiatives, to access financing and contribute to climate action.

- **Improved Transparency:** Through the integration of additional data sources for measurement and reporting, users will have access to more comprehensive and reliable information about carbon offset projects. This transparency will enable investors and buyers to make informed decisions, fostering trust and confidence in the integrity of carbon credits.

- **Streamlined Tokenization:** The implementation of Chainlink technology for tokenizing carbon credits will ensure secure and tamper-proof transactions, addressing concerns related to double counting and fraud. Users will benefit from a standardized and auditable process for token issuance and transfer, enhancing the fungibility and liquidity of carbon credits.

Addressing Industry Gaps

- **Standardization:** The introduction of standardized protocols for project registration, measurement, reporting, verification, and tokenization will address the fragmentation and lack of interoperability that have historically plagued the voluntary carbon market. This will facilitate seamless integration across different platforms and registries, enabling efficient trading and settlement of carbon credits.

- **Market Integrity:** By leveraging blockchain technology and decentralized governance mechanisms, blockchain-based innovations hold promise to enhance market integrity and reduce the risk of fraud and double counting. Immutable records and transparent audit trails will provide assurance to regulators, investors, and buyers, fostering greater trust and confidence in carbon offset markets.

- **Scalability:** The scalability of the solution will enable the voluntary carbon market to accommodate a growing number of participants and transactions, supporting the scale-up of climate finance and the achievement of emission reduction targets. Standardized processes and interoperable infrastructure will facilitate market expansion into new sectors and geographies, driving innovation and impact at scale.

Conclusion

A number of success stories have been highlighted below:

- Coorest had initial success with the NFTrees, CCO2 tokens[1] and Proof of Carbon Compensation (PoCC) certificates to give retail access to the carbon credit market. This new yield bearing token, utilizing dMRV via Chainlink Oracles, is a new way to generate full on-chain carbon credits avoiding bridging from traditional registries. Both Polygon and Chainlink were very interested and partially funded the tech development with grants. Coorest became a Chainlink BUILD partner after going live with the dApp.

- Development and audit of the Coorest Carbon Standard for opening a new registry for the VCM allows smaller sized projects to generate carbon credits / CCO2 tokens.

- Coorest sold NFTrees to Tommy Hilfiger during a VIP promotion in Dubai to help offset carbon emissions within the fashion industry.

Key Takeaways

Coorest identified several key takeaways from the development of their carbon standard and offsetting product. Chief among these includes a reflection on development time, which they categorized as lean and fast, highlighting "Blockchain infrastructure and dMRV integration can be done with small teams." Despite the quick development, they noted that gaining mainstream adoption of the solution remains difficult. Companies are unfamiliar with the tech and lost a lot of trust in the VCM in general.

[1] Each CCO2 token represents one kilogram of CO2 captured by trees adhering to the Coorest Carbon Standards

Regarding the technology, Coorest found the token ecosystem to be very useful to have full on-chain carbon accounting. However, the user experience needs improvement to take away direct interfacing with the underlying blockchain infrastructure.

Lastly, regarding the carbon credits themselves, Coorest highlighted the need for an integrated insurance finance solution to protect consumers and investors against project failure. This is important to realize the ultimate function of the credits, which is to finance agriculture projects and to offer an investable real-world asset class for investors outside of the VCM.

Carbonmark Programmatic Retirement

Overview & Background

Carbonmark leverages advanced digital infrastructure to provide secure, auditable, and interoperable products and services to facilitate the trade and usage of environmental commodities. Carbonmark leverages a number of blockchain-native technologies, including a variety of smart contracts and data indexing solutions, with the objective to implement a user-friendly marketplace, as well as a powerful Application Programming Interface (API) product for buying, selling, and retiring carbon credits.

Carbonmark believes blockchain technology provides the infrastructure necessary to create a universal settlement layer for the carbon market and other environmental commodities. Leveraging this technology stack will help transition from a highly fragmented carbon market with little interoperability to a unified, composable, and interoperable market: conditions necessary to enable more innovative and efficient interactions between market participants.

Important to advancing Carbonmark's vision is the focus on increasing access to this technology. This requires abstracting away certain technical complexities from the user experience, including the requirement to use a web3 wallet to sign transactions. Beyond interface improvements, Carbonmark's API removes the need to directly interface with a blockchain to access the on-chain carbon market. Users simply connect their bank account or credit card and are billed monthly for their usage on the platform, similar to any other software product.

Significant fragmentation of liquidity in the VCM has created an inefficient trading environment where asymmetric information related to the availability and pricing of environmental commodities is the norm. Concurrently, the technological platforms that traditional market infrastructures are built on do not enable streamlined connections for asset trading – nor do they provide strong data availability. The aforementioned factors negatively impact the velocity of the market and the throughput of capital to carbon mitigation and removal projects.

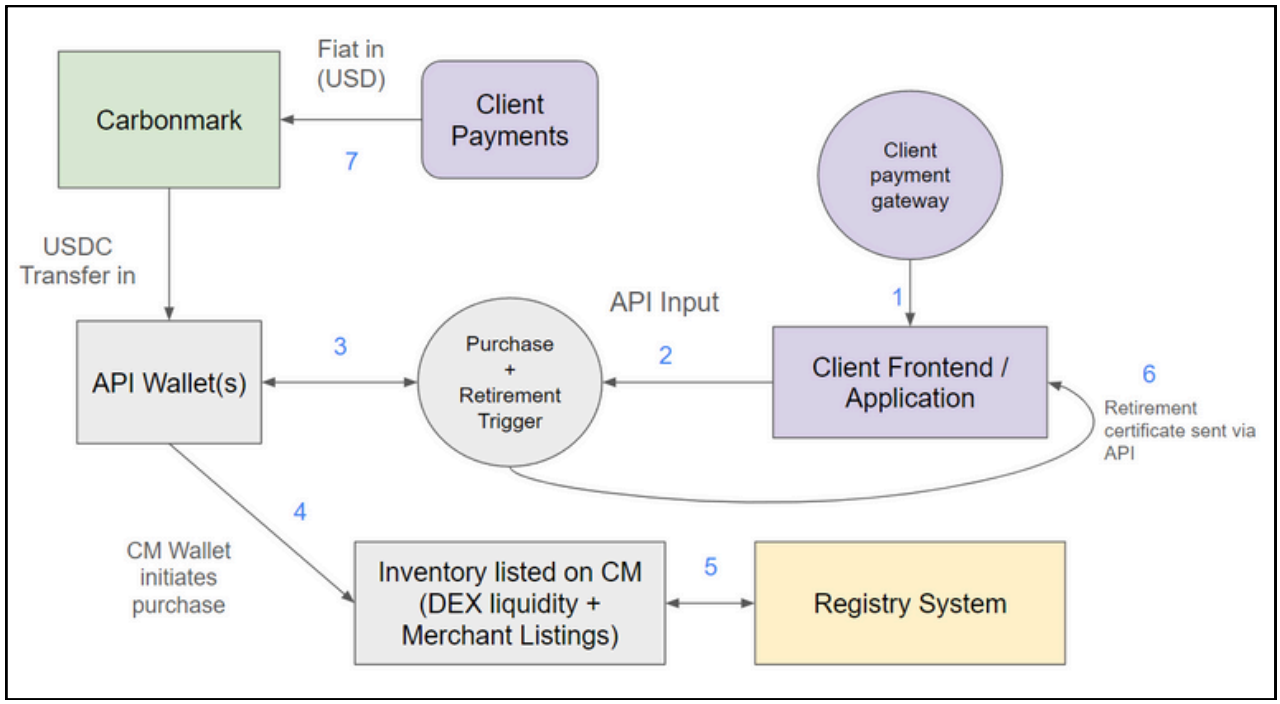
Origin - Carbonmark's API

Carbonmark's API product is the result of work on a 'fiat to retirement' module that was utilized by Carbonmark to facilitate credit card transactions from customers unfamiliar with blockchain technology to retire carbon credits on-chain. This removed the need for clients to have a web3 wallet in order to purchase assets for retirement.

The above solution utilized Stripe payments to facilitate credit card transactions. The API is an evolution of this product, as it provides clients with the means to track retirements via their own API connection and pay for said retirements in arrears on a monthly basis. As stated by the Director of Carbonmark, Andrew Bonneau: "The Carbonmark API enables demand-side participants to programmatically and conveniently source high integrity carbon credits, automating purchases and enabling fractionalized retirements, if desirable, all without these users requiring a web3 wallet."

The Innovation & Real-World Applications

The Carbonmark retirement API triggers on-chain carbon acquisition and retirement via a Web2-style REST API. The carbon utilized for this process is 'tokenized,' meaning that these are digital twins of carbon credits held in registry systems, such as EcoRegistry. The credits made available to the API are listed on Carbonmark's marketplace by merchants (including traders and project developers) or via carbon credits held in DEX liquidity pools.



Key Steps Overview:

1- Client's payment gateway is utilized to initiate a payment for a carbon credit.

2- API input parameters from this purchase are utilized to prepare an on-chain retirement.

3- Carbonmark API Wallet is informed of a commencing purchase and retirement.

4- Carbonmark's on-chain tooling initiates a retirement of carbon available on its platform (via either a merchant listing or DEX pool).

5- Via Carbonmark's software infrastructure (in collaboration with third party registry interfaces, as necessary), a carbon retirement within a registry is initiated. This is then logged by our system to inform the on-chain system that retirements have been completed both on the blockchain and at the underlying registry level.

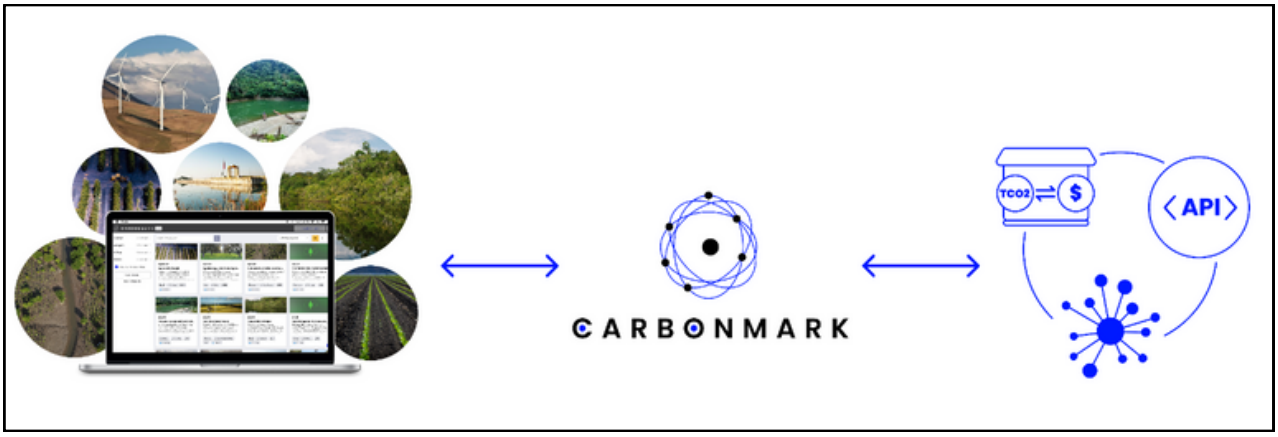
6- Retirement certificates (including a unique shareable URL) are sent to clients via the API.

7- Client payments occur off-chain for funding future on-chain operations.

The application of Carbonmark's API hinges on a few key advantages of tokenized carbon credits. First and foremost, this solution makes assets programmable. Smart contracts provide a basis for automating various market operations, including sourcing and retiring the assets. Sourcing includes filtering projects based on certain criteria and initiating the purchase of them. By delivering these assets to clients in this way, Carbonmark streamlines their own operations, and ensures advantageous pricing compared to traditional delivery methods.

Market delivery via the API when pulling inventory placed on Carbonmark's marketplace by project developers has a number of real-world impacts. On the supply-side, it opens direct demand channels and can lead to disintermediation, providing a more direct connection and potentially a greater share of revenue from the sale of offsets directly to the carbon project originators themselves.

On the demand side, in contrast to the usual mode of transacting via OTC channels, the API provides a more transparent pricing experience and richer market data. Additionally, automation opportunities via the API create a basis for novel integrations and new products leveraging environmental assets, such as embedding carbon credits into e-commerce transactions to achieve carbon neutrality in a live and verifiable fashion.



Readers can explore additional use-cases and access an overview of Carbonmark's API documentation here: https://docs.carbonmark.com/.

Users familiar with implementing other REST APIs should be quite comfortable utilizing Carbonmark's API.

Market Expansion & Looking Ahead

Providing automation opportunities for environmental market processes can certainly expand beyond carbon credits themselves; indeed, we're already seeing activity tokenizing and bringing other environmental assets on chain, including energy attribute certificates (EACs).

Carbonmark envisions a similar delivery and usage of such assets via the API, particularly by users that may want to source EACs to match against energy usage in a 'live' fashion, whereby activities can be proven to support renewables infrastructure via clear and transparent blockchain traceability.

As with any new technology, there are efforts required to educate and onboard new users who may be unfamiliar with how blockchain technology works or require further information on how they can leverage our API to streamline their current environmental asset sourcing and consumption practices. Webinars, training sessions, and case study development (as is being done here) are crucial to disseminate information about the benefits and use-cases that blockchain technology affords the industry.

Carbonmark has already onboarded a number of entities working in the e-commerce and carbon software space (e.g., automated emissions analysis providers). Given the diversity of carbon currently available on the Polygon blockchain, and the benefits of programmatic carbon retirements, the API provides our clients with an easy-to-implement solution that can reduce their inventory risk and automate purchase and retirement processes.

The Carbonmark API also marks an important step toward 'embedding' the cost of carbon into daily financial and business transactions. For example, one of Carbonmark's clients utilizes the API to programmatically offset the emissions associated with supply chain activities, such as shipping packages. Rather than bundling retirements together manually at the end of each month, they now can allow their own users to select specific projects they want to support – Carbonmark's API does the rest.

Additionally, Carbonmark has a number of upcoming features which will enhance the productivity of API usage by clients.

As asset usage is governed by blockchain transactions, there is a tremendous opportunity to provide real-time data insights for clients – not only for their transactions, but also for the broader market and the dynamics of on-chain carbon trading activity.

Ultimately, Carbonmark views their API as an important step toward increasing the overall demand for carbon credits by opening new and exciting use cases for environmental assets. Meanwhile instant transaction settlement, improved traceability and transparency, and automation opportunities yield better market efficiency. With key partners and users, Carbonmark increases the velocity of finance flowing into carbon mitigation and removal projects globally.

KlimaDAO Forward Financing via Public Token Governance

Overview

KlimaDAO utilizes innovative, open source technology to bring greater transparency, liquidity and access to carbon credits and other environmental assets.

KlimaDAO's activity can be broadly split into two categories:

1- Acquiring carbon credits to grow the treasury of carbon assets.

2- Providing liquidity for carbon credits on decentralized exchanges (DEXs).

KlimaDAO has also historically developed bespoke software solutions that supported the distribution of (tokenized) carbon credits, however this technology and operation were spun-out from KlimaDAO to a private limited company called Carbonmark (see case study above).

KlimaDAO utilizes the $KLIMA token for two primary functions:

1- It is used as a liquidity pair within DEXs, allowing KlimaDAO to develop liquidity for certain baskets of carbon types.

2- It is used to ratify or reject token-based governance decisions.

The governance rights over the DAO allow token holders to participate directly in economic decision-making, which primarily define which verified carbon credit projects the DAO will allocate its funding towards. KlimaDAO's primary funding is into forward funding agreements, which allow KlimaDAO to pre-finance the development of carbon projects and be an offtaker for spot carbon credits as and when they are issued.

Background & Origin Story

Initially focused on incentivizing the onboarding of carbon credits onto the blockchain, KlimaDAO quickly expanded its scope to develop infrastructure like forward funding, retirement tooling, marketplaces, and APIs.

A key challenge, after the protocol's initial launch and creation of the first public carbon liquidity pools, was the lack of a specific mechanism to effectively deploy KlimaDAO's idle capital (mostly in the form of a dollar-pegged stablecoin, USDC) towards project developers responsible for implementing carbon projects. In its initial state, KlimaDAO effectively relied on market intermediaries "bonding" spot carbon credits with its treasury. This arguably reduced the impact of KlimaDAO's financing, and also gave KlimaDAO less control over the types of credits it received, as "pool" criteria were defined by third parties (Toucan, Moss, C3).

Starting in 2022, KlimaDAO began to field offers from project developers for the DAO to provide capital directly to a project, in exchange for an agreement for the DAO to receive a portion of the credits generated by the project once they are issued (typically known as an Emissions Reduction Purchase Agreement, or ERPA).

This process would allow KlimaDAO's community of token holders to define exactly which carbon credit projects to support, while allowing a more targeted approach to the diversification of treasury assets. See this proposal on the KlimaDAO governance forum where this idea was first introduced.

Upon the closure of a vote to finance a specific carbon project, KlimaDAO will enter into an ERPA agreement with the project developer.

Due to the nature of KlimaDAO's governance process, where DAO contributors and community members are responsible for achieving consensus on proposals and formally voting on them via token weighted-governance, KlimaDAO effectively runs a public tendering process with project developers. This is a departure from the norm within the carbon markets, where deals are typically done behind closed doors through bilateral Verified Emissions Reduction Purchase Agreements (VERPAs). However, this does enable KlimaDAO to establish price signals within the market and communicate to project developers, and other market stakeholders, information around market pricing and process. This can allow project developers to leverage the DAO as a direct offtaker for carbon units.

The Underlying Technology & How it Works

KlimaDAO's forward funding initiatives leverage four elements of the DAO:

1- The USDC held in its treasury

KlimaDAO's treasury consists of carbon and the USDC stablecoin. KlimaDAO utilizes its stable assets as part of its forward funding process in order to convert into more treasury carbon.

KlimaDAO utilises a Safe Multisig solution to provide the financial backbone for secure financial operations as DAO, for purposes such as paying expenses, managing smart contracts, and deploying approved assets from the treasury.

2- Public governance and consensus-building processes

KlimaDAO builds consensus on its Forum (hosted by Flarum), and through conversation with its community (hosted on Discord).

3- Token-weighted voting mechanism

KlimaDAO's token $KLIMA has a one-to-one voting ratio; token holders have one vote for every token they hold.

KlimaDAO leverages Snapshot to implement its token voting process.

4- Carbon Credit Evaluation Framework

KlimaDAO developed a framework to inform community members of, and publicly evaluate, carbon credit projects for potential financing. This provides a first pass diligence for the market, reveals forward pricing information to the market, and gives project developers a well-known standing reserve for modest sums of capital.

This process involves public reviews on a governance forum, evaluation by expert contributors according to an evaluation framework, and final approval determined via token-weighted voting.

KlimaDAO's carbon credit evaluation framework utilizes a multi-dimensional scoring system to assess project viability, impact, and alignment with KlimaDAO's mission. The framework considers factors like certification standards, market demand, geopolitical risks, environmental/social impact, financial stability, and methodology robustness. Both quantitative on-chain data and qualitative insights from experts are incorporated.

In order to be considered for funding by the DAO, projects must score at least 50 points across weighted criteria such as financial runway, end market security, on-chain presence, purchase volumes, registry issuance, demand trends, scalability, co-benefits, verification, stakeholder engagement, additionality, diversification, and strategic value. This data-driven approach supports informed decision-making.

The process works as follows:

1. A project developer posts an RFC on the KlimaDAO Forum with terms for a forward agreement.

2. Community members evaluate the opportunity using KlimaDAO's evaluation framework

3. If deemed appropriate, the proposal moves to token-weighted voting.

4. If approved by >50% of token voters, KlimaDAO strikes a deal with the project developer.

Business Impact & User Experience

KlimaDAO's innovation has enabled the organization to become more engaged with project developers, expanding beyond its initial focus on spot credits and trading. This financing activity also provides the treasury with an opportunity to support net new climate action. Finally, it puts the DAO's idle capital to work and, once the credits are delivered, they can be used to launch new liquidity pools or create new publicly priced listings on marketplaces like Carbonmark.

For the broader market, on the supply side, project developers now have a direct route to funding, streamlining the process. On the demand side, individuals and organizations interested in sustainability can actively participate in the evaluation and funding process.

PROJECT	TONNES IN PIPELINE	CAPITAL ALLOCATED	COST PER TONNE	DATE PURCHASED	VINTAGE
Improved Cookstoves for Rohingya Refugees Bangladesh	31,250	$250,000	$8.00	27-JAN 2023	2023: 15,625 2024: 15,000 2025: 625
Kwamisa/Other Reserves Community Ghana	14,276	$227,000	$15.90	10-APR 2023	2023: 10,798 2024: 3,478
Ocean Alkalinity Enhancement with Limenet Italy	1,000	$600,000	$600.00	12-SEP 2023	2024: 1,000
GRO Foundation ARR Uganda, Kenya	15,151	$250,000	$16.50	07-DEC 2023	2024: 309 2025: 1,011 2026: 2,371 2027: 4,611 2028: 6,850
IOT Water Filtration India	16,667	$245,838	$14.75	11-DEC 2023	2024: 16,667
TOTAL	78,344	$1,572,838	$131.03 AVERAGE PRICE		

KlimaDAO

NOTE: the table above only includes forward deals executed by KlimaDAO as of the end of 2023.

Challenges & Solutions

Adoption Challenges

A key challenge was the uncertainty around interacting with a DAO and anonymous token voters. To address this, KlimaDAO established the Klima Foundation, a legal entity that could facilitate contracting with project developers and stakeholders.

While incentives are aligned between token holders and the treasury (because KLIMA is backed by the carbon credits sourced from these deals), typical voters in an on-chain governance system are not necessarily all experts in evaluating carbon credit projects. This leaves open the question of how effective the diligence process is with few engaged experts. Work is ongoing to further engage traditional VCM stakeholders in KlimaDAO governance, which will increase the credibility of KlimaDAO's project evaluations.

Data Security & Privacy

Data security and user privacy concerns were mitigated through robust security measures like secure multi-signature wallets, smart contract audits, and adherence to data privacy best practices.

Posts on the governance forum and votes on Snapshot are all public, so the DAO does assume some level of operational security on the part of its users not to reveal sensitive personal information. The DAO's contributors do take steps to remove spam proposals from the forum and moderate any inappropriate conduct on Discord or the forum.

Market Expansion & Upcoming Features

KlimaDAO's public token-based governance mechanism could potentially expand to other environmental commodities and markets, such as biodiversity conservation, renewable energy, or waste management.

KlimaDAO is also considering expansion of its environmental asset market infrastructure to additional blockchain ecosystems, both by offering cross-chain retirements and bringing the KLIMA token to additional blockchain ecosystems.

With the upcoming delivery of the DAO's first forward-purchased credits, if the underlying registry allows tokenization at the time of delivery, the DAO will be in a position to create new liquidity pools, or at the very least publicly priced listings on Carbonmark. This will provide greater price discovery for additional segments of the VCM that are not modeled by the current carbon pools.

Key Take-Aways

KlimaDAO's innovation has garnered recognition for its approach to democratizing climate finance and leveraging decentralized technologies for real-world impact. It has successfully onboarded carbon credits onto the blockchain, demonstrating the potential for tokenization of environmental assets.

Key lessons include the power of decentralized governance and tokenized incentives for addressing complex challenges, the need for innovative solutions to bridge traditional organizations and decentralized ecosystems, and the importance of robust security and data privacy measures.

KlimaDAO's precedent could inspire similar initiatives across various industries and sectors. Readers are encouraged to explore KlimaDAO's ecosystem and collaborate with the organization to drive sustainable initiatives forward.

Governance in Regenerative Economics at Regen Network

Regen Network is a community of practitioners developing an open source protocol for the ethical valuation of ecosystem functions and their stewardship. Central to their theory of change is the belief that the instruments used to define regenerative value must be owned and governed by communities with a history and commitment to ecological stewardship. In their words, “This is the only way in which the system we build can be regenerative at its root.”

This presents both novel and time-honored challenges around the notion of governance across different scales and types of stakeholders. This case study introduces the basic mechanics of Regen Network and examines the role of governance across scales and layers in the protocol. It concludes by introducing the notion of a Community Staking DAO (csDAO), and finally it explores the technical and cultural ramifications of deploying a csDAO to support Regen’s application-specific blockchain which is dedicated to climate positive action.

Introducing Ecocredits

At the base of Regen Network, the primary vehicle used to catalyze the transition from an extractive economy to a regenerative one is called an ecocredit.

Ecocredits are discrete units of value which attest to human-environmental regeneration, conservation, and protection through verifiable means. As opposed to fines for degeneration and pollution, ecocredits are compensation for regeneration and repair, and the work necessary to sustain and reproduce life on this planet, whether that is done by humans or non-humans. Their value is thus both an expression of the intrinsic value of life-bestowing ecological processes (carbon sequestration, water purification, biodiversity, etc), as well as the labor of individuals stewarding ecosystems.

Ecocredits can be understood as an evolution of carbon credits, representing distinct ecological benefits while centering the context and needs of local populations responsible for restoration work.

Governing the Terms of Trust & Equivalence

Inherent in the notion of credits in the broader economic sense, is an agreement between different actors on a shared definition of value. We can understand these terms to include the composition, issuance, circulation, and access of ecocredits. These shared terms are the result of governance between different stakeholders across different scales to form common understanding and commitments around what environmental regeneration means.This process is multi-modal and multi-scalar, and the complexity of this coordination challenge is likely why high integrity frameworks for the definition of regenerative value have not existed to date.

In conventional carbon markets, parity in value between purchaser and originator is commonly brokered by an independent verifier / validator whose role is to ensure integrity in the regenerative value of a credit. When this is done successfully, resources flow from purchaser to originator.

Relational and Transactional Value in Regenerative Economics

Markets are mechanisms which connect originators/suppliers with demand/purchasers across different contexts. In a typical commodity exchange, the contexts between the parties are different, and in order to be fungible between source and destination, the good or service becomes a commodity, alienated from its origin.

Regen Network is building a protocol to form relationships between parties, in a way that does not sever nor alienate the credit of exchange from its source context. A system of relationships does not need to be severed, or harvested, in order to have value; in fact, our approach argues that the value comes from being situated, that is, from being *from somewhere*.

Can there be exchange based on mutually held terms of value, which does not require alienation or commodification? This is a crucial question, and at present few if any climate finance mechanisms have successfully implemented exchange based on mutually held terms of value. Ecocredits present a novel mechanism in climate finance to form broader coherence on how value is defined through living systems, and not solely through their extraction or harvest.

Decentralized networks of claims and attestations around impact are a critical enabling technology for this approach. These networks have the possibility to supplement, or even supplant, traditional verifying bodies (which rely on trust and reputation), so that systems based on transparency, interoperability, and public auditing support confidence in exchange between parties.

Scales of Governance in Regen Network

To pioneer frameworks for the definition of high-integrity ecocredits, Regen Network utilizes decentralized protocols to design, issue, circulate, and retire credits.

Governance through decentralized protocols at Regen Networks occurs at different layers of the technical stack. These scales traverse the local and contextually-specific design of the credit itself (credit composition), through the frameworks and data standards of credit exchange (crediting standards), to the level of the ledger or protocol which manages the environmental claims as well as various parties involved of the process of issuance and retirement (protocol).

- **Ecocredit Definition and Composition**
    - At the local level, the composition of an ecocredit is defined as the host of indicators and practices used to define what regeneration looks like in a local context. Ecocredits weave together ecological indicators, with social indicators as well. This form of governance is most closely aligned with vernacular practices to form coherence about what is best and may occur through rough consensus or formalized voting.
    - A critical aspect of localized definitions of value, is that they present the opportunity for communities to own and govern those terms, in a manner which has the potential to be translated into a DAO. Deciding what regeneration looks like in a particular context is a practice of collective determination for those involved in the creation of a credit.

- **Crediting Standards**

    - In the various markets which define value through ecosystem services, there are a wide array of standards, and accreditation bodies which vet the integrity of different claims made around GHG drawdown, ecosystem protection and conservation. By their nature of being integrated attestations of bio-cultural health, ecocredits may use multiple standards and systems of verification to certify and guarantee the integrity of credits. They may also develop their own.

    - Standards may refer to the certification bodies whose external guarantee substantiates the claims made about ecosystem regeneration. They are also frameworks for the formatting of data so that it is machine-readable and interoperable within a registry system and the broader market.

    - Credit issuers may choose a standard which appropriately reflects the composition and implementation of the credit. Claims of GHG drawdown or biodiversity protection must be structured in an appropriate manner to comply with different public or private institutions in order to be legitimate.

    - Much of the work of creating a viable credit, is to ensure that the monitoring and reporting fits within a standard that is appropriate to the claims being made. Here, credit class administrators as well as project proponents work to ensure claims are properly formatted for (and fulfill) appropriate standards to ensure legitimacy and credibility in exchange.

- Regen Registry provides a framework and a process in which ecocredits specify which data standard they are compliant with, allowing for a broad range of specifications to be implemented within its neutral and open registration framework.

- **Protocol Layer**

  - Regen Ledger is an application specific blockchain designed to attest to the state of the living world through credit methodologies or what are referred to as Ecological State Protocols (ESPs). There are many scenarios where governance processes are held to determine the state and function of the ledger. This may refer to software upgrades, forking the chain in order to "rewind" a previous set of actions, or voting to switch to a different consensus algorithm (e.g. proof of authority vs proof of stake).

  - Protocol governance of Regen Ledger takes advantage of the modular nature of the Cosmos SDK. This design format allows modules to be swapped or independently modified in a composable manner. The modular architecture of Cosmos informs protocol governance, as SDK components can be the specific focus of governance processes.

Critical to the notion of ecocredits as an instrument of regenerative finance on Regen Network is their ability to be governed across different levels. From the grassroots definitions of value, through the standards and frameworks used to define that value, to the maintenance and evolution of the ledger architecture which holds and manages those claims, governance is involved across all those phases. A unique challenge is thus the breadth of knowledge required to engage across these different levels. It is, however, not required that all understand the entire process.

Core to the governance of Regen Network is that participants engage with the forms of governance most pertinent and relevant to them, in a form of subsidiarity.

Modes of Governance in Regen Network

Complementary to the range of scales, are different domains in which governance is practiced.

These domains reflect the definition, implementation, and verifications of regenerative actions. They roughly match onto the different phases of project design, implementation, and ongoing verification of outcomes. Planning, Activity, and Monitoring (or PAM for short), comprise phases in a cycle which repeats. Each iteration may gather feedback based on the discrepancy between the anticipated outcome versus the actual outcome. Each cycle can thus be tweaked to ensure the anticipated and the actual converge in a dynamic process.

The process of planning an ecological or bio-cultural regeneration project, as well as its implementation and monitoring, all require dedicated teams which hold functional autonomy in the governance of their respective phases. Below we outline the role of governance in the PAM process for the creation of ecocredits.

- **Project Plan**
    - A project plan defines the scope and intentions of a regenerative initiative. It is closely correlated with the design of the composition of an ecocredit, however is more inclusive than just determining the contents of a particular credit. Project Plans outline the key activities undertaken to regenerate landscapes, the timeline within which this happens, and the personnel required to deploy such a plan.

- **Project Activity**

    - Project activities are the boots-on-the-ground efforts to protect, steward, and conserve ecosystems. Who is going where, when, and how does that reflect the intentions formulated in a project plan? Orchestrated efforts by regenerators are theoretically compensated via the sale of ecocredits. Determining who has done what when, and how the resources from credit sales should support implementers, is a matter of governance.

    - Project Activity is thus a way to describe the coordination of implementation. This may take many forms including volunteer engagement, professional intervention, integration with existing business models like eco-lodges, or in the form of citizen science, crowdsourcing, or gamified engagement.

    - Project activity does not exist in a vacuum. It is a moment where the creation of ecocredits interacts with existing business models, labor dynamics, legacies of stewardship and the like.

- **Project Monitoring**

    - Project monitoring refers to those actions which measure and report how actions undertaken by regenerators are in alignment with the project plan. Were the efforts effective, and if so, what outcomes occurred, and how might they be quantified in accordance with the anticipated impact? Monitoring closes out the feedback cycle which measures anticipated outcomes to actual outcomes and serves as a feedback process to dynamically update the project plan on an annual basis.

- This feedback process allows credits to grow in composition and integrity iteratively, ensuring that the proposed value, additionality, and net effects of the original credit do not diverge from what has happened in actuality.

- The governance process of project monitoring and how it is carried out, might also look like a large sense-making process akin to the project plan process. The focus of governance in this process is to form collective coherence around the efficacy of regeneration efforts, and to serve as a periodic system by which the models and practices of environmental stewardship are honed.

- The monitoring and reporting process are closely tied to the governance of data standards and crediting frameworks outlined in the Crediting Standards section. This process of collecting data around the efficacy of regeneration efforts. Moreover, formatting those findings in a manner which maximizes its legitimacy according to an established standard is a complex coordination effort. At what point in the process is the data structured in a manner which is readable to humans? At what point is it structured to be read by machines? All these questions require coordination across the different phases of PAM.

After outlining different scales and modalities of governance related to the creation of ecocredits, it is relevant to mention that the frameworks introduced above, and the governance processes which correspond to them, are not exclusive to ecocredits. Compliance and regulation bodies, reporting on grant expenditures, as well as certification systems may leverage the scales and modalities outlined above. Regen registry is designed to be instrumental in registering ecocredits, as well as virtually any other form of environmental contracts and impact attestations.

The role of governance which enfranchises local regenerators is consistently important across all these forms of impact verification, and is the hallmark of Regen Network's approach to supporting holistic stewardship.

The following sections explore how the governance of this ecological claims blockchain plays out in practice, via Community Staking DAOs.

Community Staking DAOs (csDAOs)

The csDAO is a demonstration of Regen Network's approach to building decentralized protocols which are in service to life and regeneration. At mainnet launch of the Regen Ledger blockchain on Cosmos, roughly 35% of $REGEN tokens were set aside to be distributed through the grants program known as the enDAOment program. The motivations for this are many:

- To counteract the plutocratic potential in PoS (proof of stake) blockchains, where token holding power is directly proportional to voting power.

- To bring a large sector of climate positive actors and organizers into the ecosystem of a software protocol who would otherwise have had no seat at the table, and no stake in the evolution of the protocol.

- To assert that the ownership structure of a business or protocol ultimately underwrites if and how a project can be defined as regenerative.

- To establish a community of early adopters of Regen Network who would seed the early iterations of ecocredits ensuring the protocol was in service to grassroots communities and Indigneous People and Local Communities (IPLC) from the very onset.

- To enable regenerative orgs to exert founder-level governance power over the protocol through their delegation power in on-chain governance.

The Regen Foundation, the non-profit arm of Regen Network controls these tokens, and disperses “enDAOment” grants to create csDAOs in a cohort cycle. Critical to the conception of the csDAO is the fact that the token grants are locked, or permanently vested, meaning that the csDAOs can not liquidate the principal grants, but only the interest earned in the form of staking rewards produced through a delegated proof of stake model.

Following the governance scales and modalities outlined above, the csDAO introduces important and pressing questions about the governance of impact-focused blockchains. Below we introduce those concepts through that outline, but in chronological order of their development rather than taxonomic order as above.

Community Governed Protocol - Internal Governance & Credit Design

At the level of the protocol, a csDAO enables grassroots organizations to vote on on-chain proposals, like ledger upgrades, the authorization of new credit classes, community spending pool allocations etc. This presents logistical challenges in implementation including:

- On-ramps - How does an organization of regenerators in India, Kenya, Ecuador, etc, who have historically had disproportionate access to technical knowledge and support, secure their private keys to hold authority over their addresses or DAOs? To resolve this hardware wallets were shipped in the mail to the primary points of contact, which operate as bridges between local communities and the larger protocol.

- Off-ramps - If a community should decide to sell their staking rewards, how will they receive that compensation? This introduces essential questions in governmental and financial compliance which are jurisdiction specific, and must be resolved and supported on a case by case basis.

- Technical Literacy - A great deal of capacity and skill building is required for groups which would otherwise be marginalized, to meaningfully participate in network governance. Weekly calls and ongoing support sessions work to culturally empower and support different csDAOs.

Recipients of token enDAOments become DAOs themselves. While their influence at the protocol scale is necessary to uphold a basis of integrity for Regen Network, the more significant work is to support each DAOs internal consensus and governance structure. How shall a csDAO spend its staking rewards? When? What begins as a measure to secure the integrity of the network becomes an issue of supporting smaller community groups to define and practice governance systems which reflect their context, values and priorities.

Integral to the role of the csDAO is the capacity to formalize existing governance practices into a system which can interact with a blockchain. In doing so, this governance approach is able to record and anchor events, outcomes, and datasets on-chain. These practices may have nothing to do with the protocol scale, but rather internal governance in a variety of forms. These can include:

- Credit Design - Who decides what should be included in an ecocredit which is intended to reflect the priorities and culture of a particular region, and through what processes? Internal to csDAOs, unique DAO governance frameworks can be developed and used to define a particular ecocredit.

- Governing PAM - The structure and implementation of planning, action, and monitoring must be coordinated between members of the DAO internally, as well as with external stakeholders such as scientists, remote sensing experts, data scientists. Governance through on-chain and off-chain processes around how to execute these various roles constitutes and the primary challenge for groups to develop ecocredits, or other impact claims.

- Internal Consensus Processes - For applications outside of credit creation, csDAOs explore how proposals, and voting systems of different kinds are relevant for their ongoing operation and function. This may include participatory budgeting, signaling proposals, or role nomination/election processes.

Governance for a regenerative future

Through the csDAO, Regen Network is developing pioneering processes for the integration of off-chain actors and events into the web3 world. This is notable given the insular nature of many web3 communities. To implement a permissionless registry for high integrity ecocredit creation, governance at a local and protocol level must be developed in parallel. This highlights the important role scholarship in political economy, sociology, commoning, and environmental resource management hold in developing governance for blockchains and decentralized protocols.

Glossary

Application Programming Interface (API) - includes a set of rules and protocols that allow different software applications to communicate with each other. It defines the methods and data formats that programs can use to request and exchange information, enabling them to interact without knowing the internal workings of each other.

Blockchain - A chronological collection of digital records (aka a distributed ledger), with each block referring to the block before it. Blocks can not be rewritten; instead, a new block is added to the chain that details the changes.

Carbon Credit - A carbon credit unit represents the removal of one tonne of carbon dioxide equivalent (t CO2-e) from the atmosphere, or the avoidance of one tonne of emissions.The term carbon dioxide equivalent refers to the summation of multiple greenhouse gases based on each gas's global warming potential (GWP). The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of 1 tonne of a gas will absorb over a given period of time, relative to the emissions of 1 tonne of carbon dioxide (CO2). For instance, methane has a GWP about 28 times that of CO2.

DAO (decentralised autonomous organisations) - A DAO is a transparent and member-driven organisation which has its rules written in code. It often has a governance token to vote on proposals but sometimes uses other governance mechanisms to make decisions.

Decentralised Exchange (DEX) - Peer-to-peer marketplaces where traders make transactions directly without handing over management of their funds to an intermediary or custodian. These transactions are facilitated through the use of self-executing agreements written in code called smart contracts. Carbon pool tokens typically trade on a DEX.

Decentralised Exchange: Automated Market Maker (AMM) - AMMs rely on blockchain-based services that provide information from exchanges and other platforms to set the price of traded assets called blockchain oracles. Instead of matching buy orders and sell orders, the smart contracts of decentralised exchanges use pre-funded pools of assets known as liquidity pools.

The pools are funded by other users who are then entitled to the transaction fees that the protocol charges for executing trades on that pair. These liquidity providers need to deposit an equivalent value of each asset in the trading pair to earn interest on their cryptocurrency holdings, a process known as liquidity mining. If they attempt to deposit more of one asset than the other, the smart contract behind the pool invalidates the transaction. Liquidity provision is 'permissionless'.

The use of liquidity pools allows traders to execute orders or to earn interest in a permissionless and trustless way. AMMs are the primary DEX infrastructure utilized by the on-chain carbon market, particularly on the Polygon blockchain.

Distributed Ledger Technology (DLT) - All transactions are synchronized across a network of independent computers with no central entity; blockchain and hashgraph are two types of DLTs.

Digital Measurement, Reporting, and Verification (dMRV) - Refers to the use of digital technologies like remote sensing, IoT (Internet of Things), and blockchain to improve the accuracy, transparency, and efficiency of tracking and validating carbon emissions reductions or sequestration activities. dMRV systems automate and streamline the collection and analysis of data, reducing the reliance on manual processes and ensuring more reliable carbon credit issuance.

Multisig Wallet - A multisig wallet (short for multi-signature wallet), in the context of web3 technology, refers to a type of blockchain wallet that requires multiple private keys, or signatures, to authorize a transaction. This feature enhances security and control over funds, as no single party can access or move the assets without the approval of other designated signers.

Omnibus Account - A type of account used by financial institutions, typically brokerage firms or fund managers, to hold the assets of multiple clients in a single account. Instead of maintaining individual accounts for each client, the omnibus account pools the funds and securities of many clients into one account.

Oracles - Tools that send real-world data (like weather measurements or asset prices) to smart contracts.

Retiring (offsets) - Retirement refers to claiming the environmental benefit of an offset and permanently removing it from the market to avoid double claiming.

Smart contracts - Computer programs stored inside a blockchain that deploy when a condition is met ("if this, then that").

Token - Digital assets that use an existing blockchain (and pay a fee to that blockchain) to operate and verify transactions, tokens enable interaction with decentralized applications. Tokens also allow one coin to be represented on another coin's blockchain network. Tokens can also represent assets existing off the blockchain, such as carbon credits. When such credits are placed on the blockchain they are said to be *tokenized.*

Web3 Wallet - According to Cody Simms: "The wallet is the core concept of web3. You use it to sign into web3 applications (websites) & to transact. It's your identity + your footprint + debit card." Wallets hold private keys which are the passwords that grant access to cryptocurrencies in a safe and accessible manner. Examples include Metamask (web browser based wallet) and Trezor (a hardware wallet).

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