CarbonNo™ Team | October 2021

CarbonNo®

Blockchain-Validated Carbon Credits

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Abstract

The world’s carbon credit market is broken. While the technology used in buildings has made leaps and bounds in efficiency and cost-effectiveness, the carbon offset markets are essentially the same as the day the first carbon credit was traded. They are unverifiable, rife with fraud, and generally untrustworthy. As a result, carbon offset markets have stagnated in a murky, “wild west” environment. Until carbon offset markets can produce robust, verifiable, trustworthy, and consistent credits, they will remain underdeveloped. Stagnated and scarcely used carbon offset markets fail to enable a healthy trading economy with the high volume of activity required to move the needle on climate change. CarbonNo is here to change this and provide carbon offset markets with the trading system needed to reach their full trading potential required to facilitate a sustainable and meaningful reduction in carbon emissions.

The founders of CarbonNo have a deep well of knowledge and experience in businesses related to energy-based tax incentives, rebates, and credits (such as carbon offsets). They have witnessed what does work and, more importantly, what doesn't work. Now, with the help of some like-minded folks and the newly unlocked capabilities of technology, they aim to fix the core of the problem: verification of carbon offset markets. CarbonNo does this by tracking energy consumption accurately and providing attribution to the source of its savings. Their solution has the added benefit of creating a global, grid-independent incentive for making energy-efficient improvements to any building on earth.

Carbon offset markets are global by nature, and thus distributed technologies like blockchain are a natural match for tackling this problem. Unfortunately, the high energy requirements for blockchain operation have limited its applicability. However, the recent inventions of the Ouroboros network, the Cardano blockchain, and non-fungible-tokens (NFTs), allow us to track and verify energy credits securely and without wasting excessive amounts of energy in the process due to proof of work.

We proudly present CarbonNo, a carbon-negative cryptocurrency and NFT pair that reinforce the carbon offset markets while creating an incentive to perform energy improvements to all commercial buildings around the world.

Introduction

Mission

CarbonNo's mission is to reverse the effects of global warming. We achieve this by using blockchain technology [1] to properly register, track, and incentivize carbon offset projects by leveraging its three assets in harmony:

1. CarbonNo Coin (CNC)
2. CarbonNo Carbon Credits (CNFTs)
3. CarbonNo Platform

Today's Carbon Credit Markets and Carbon-Offsetting Projects

The demand for carbon offsets [2] is immense and increasing rapidly. However, supply cannot meet demand until carbon offset markets become a large-scale, verifiable, and accountable marketplace. It has to be a market that people can trust and that industry can build upon before carbon offsets can start to have a positive sign for the environment on the climate change scale.

How do we get there? CarbonNo equates the energy reduced in registered building improvements to their respective equivalent amount of carbon reduced. For example, consider two identical LED lighting retrofit projects in identical buildings, where one building is in a utility that gets its power from mostly clean hydropower (like many parts of Washington), and the other building is in a utility that derives most of its power from coal power plants. They both save the same amount of kilowatt-hours, but the prior should receive significantly fewer carbon credits than the latter.

Our goal is to provide a uniform, trusted, and impartial ecosystem for carbon offset markets in order to boost trust and early adoption of carbon reduction initiatives. These include but are not limited to carbon reduction initiatives such as Energy Efficiency (EE) [3] projects that result in fewer carbon emissions and Carbon Capture and Storage (CCS) [4] initiatives that capture carbon through processes such as afforestation, reforestation, coastal enhanced weathering

and more. With better technology, easier access, and transparent monitoring of these projects, we can garner more public interest resulting in more investments being made, leading to a carbon-neutral future, sustainable and environmentally aware development.

One of the most important aspects of halting climate change is the reduction of carbon emissions into the atmosphere. Throughout recent years, mandatory and voluntary carbon credit markets have seen unprecedented growth, constantly adding new market entities and various offset mechanics. The rapid growth rate in tandem with the diversity, and lack of widely accepted standards and regulations, rendered the market difficult to understand and track. This polyglossy of various standards inhibits markets and provides for a problematic trading environment making it hard to track carbon credits, identify their source, legitimacy and verify their amount or authenticity.

An important method to achieve carbon emission reduction is by achieving better energy efficiency. This can be accomplished by reducing energy consumption by upgrading various technologies. Recent technological advances in everyday devices, such as energy-efficient lighting, HVAC, controls, and sensors, can have dramatic effects on the overall energy use of buildings. The recent drop in the cost of production of such technologies, coupled with rising energy prices, have made those building improvements also cost-effective, which has a large multiplying effect on the adoption of these measures.

CarbonNo founders came up with the idea for a carbon-negative coin in 2017 when the explosive growth of cryptocurrency “mining” was consuming an impossibly large amount of electricity because of a large amount of computing required for proof-of-work blockchain verification. At the time, the technology to create CarbonNo did not exist, but now, with everything in place, CarbonNo is the first carbon-negative coin that creates a direct incentive to remove carbon from the atmosphere.

A carbon credit is a tradable certificate or permit that represents the right to emit one ton of carbon dioxide or the equivalent amount of different greenhouse gases [5][6]. These credits are generated by projects that create a reduction in carbon emissions, like upgrading a company’s facility, shipping products via more efficient channels, turning off equipment when not used, etc. Some companies that are only allowed to generate a certain amount of carbon, can purchase these credits in order to offset their own production of carbon, effectively increasing the amount of carbon they are allowed to produce. Furthermore, in cases where carbon credits prove to be

nonessential by the company, they can then trade them on the open market to another company that is willing to pay for them. Figure xxx shows the number of carbon credits purchased by various companies on a yearly basis.

Energy Efficiency

The energy efficiency market [7] is a $240 billion dollar market according to the International Energy Agency.

Everyone uses energy. Businesses use significant amounts of energy to power lighting, heating, ventilation, air conditioning (HVAC), and refrigeration systems. These systems are crucial to daily operations of any business type, and as such, reducing energy consumption without compromising daily operations is of paramount importance as it can lead to significant cost savings. This ability to achieve the required functionality with the optimal amount of energy is the concept of energy efficiency and constitutes a principal component of CarbonNo.

EE refers to the ability to use less energy to perform the same function by eliminating energy waste. As such, EE improvements reduce greenhouse gas emissions, demand for energy imports, and energy costs on a household and economy-wide level. Using a Light-Emitting Diode (LED) [8] light bulb that requires less energy than an incandescent or CFL light bulb [9] to produce the same amount of light is a simple example of energy efficiency.

The building sector is responsible for 40% of global energy [10] use. Although it is widely understood that efficiency upgrades can dramatically reduce energy use and carbon emissions, many building upgrade projects are often not pursued due to uncertainty about energy savings and financial returns. The McKinsey study [11] estimates the U.S market for energy efficiency at $1 trillion. Europe would need to invest heavily in the energy sector to reach its energy and climate targets by 2030. Yet, current assets are below half of these requirements and one-fifth of that required to deliver 2050 decarbonization targets for buildings.

Global Carbon Market

The value of the global carbon market increased by 20% in 2020 to ($272 billion) according to the financial analysis company Refinitiv published in their report in January of 2021 [12]. Refinitiv's report also noted that the carbon market has expanded more than fivefold since 2017 and has hit record growth for four consecutive years.

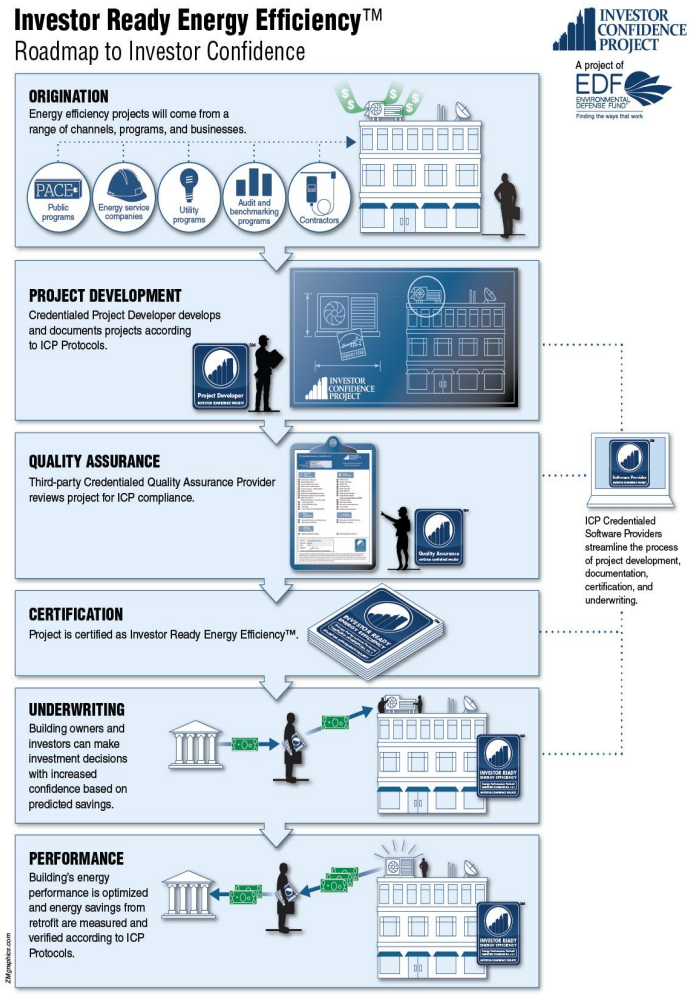
Investor Confidence Project (ICP)

The Investor Confidence Project (ICP) is a global initiative and protocol that aims to standardize the way energy certification is done. ICP ensures that projects are engineered thoroughly, financial returns are met, and underwriting can be streamlined.ICP refers to and provides information about energy efficiency retrofit projects that conform to the requirements of the ICP Protocols. These protocols ensure that the project has been reviewed by ICP Quality Assurance Assessors and has received Investor Ready Energy Efficiency™ (IREE) certification.

To be IREE certified, project developers (PD) must choose the appropriate protocol for their application. The PD must then follow all of the procedural and documentation requirements associated with each stage of the ICP Protocols. This process includes baselining energy usage, operations, savings calculations, verification, construction/design, system monitoring, maintenance, measurement, verification.

ICP Protocols: The foundation of the ICP standard is the ICP Protocols that define a standardized road map for EE upgrades. The ICP Protocols use existing and commonly accepted standards such as ASHRAE Guideline 14, ASTM-BEPA, and EVO-IPMVP. ICP specified elements, procedures, and documentation based on the various stages of a project life-cycle to create standardized projects with reliable returns. Six protocols cover the majority of commercial energy efficiency projects. Protocol selections are based on the type of buildings, project size, project complexity.

ICP System: The ICP system leverages the use of the ICP Protocols, industry certifications, and third-party verification. To create engineered projects that will provide building owners, investors, and project stakeholders confidence in the project's anticipated energy savings and financial return. IREE projects are similar to other heavily audited sectors such as audited financials and different industry workflows that have robust securitization and classification by rating agencies.



Climate Change Issues

Overview

“It is, I promise, worse than you think. If your anxiety about global warming is dominated by fears of sea-level rise, you are barely scratching the surface of what terrors are possible, even within the lifetime of a teenager today.” [13] - David Wallace-Wells

According to NASA [14], some things we have to look forward to due to climate change are increased heat, drought, insect outbreaks, increased wildfires, declining clean water supplies, rising sea levels, reduced agricultural yields, adverse health impacts due to heat, flooding, and erosion, just to name a few.

Global warming is expected to have severe, long-lasting, and devastating consequences for planet earth. Our very existence is at risk; sea levels are rising, ice caps are melting, and heat waves are hitting all-time highs. Absent immediate and drastic changes, our world as we know it will forever be changed ---potentially irreversibly--- and not for the better.

Industrialization’s Impact

According to the Guardian [15], 20 companies on the list have contributed to 35% of all energy-related carbon dioxide and methane worldwide, totaling 480bn tonnes of carbon dioxide equivalent (GtCO2e) since 1965.

Upon closer inspection, several of these companies have initiatives for carbon-sequestering but still fail to produce meaningful carbon reduction.

The CarbonNo team has worked for years upgrading various businesses’ buildings, reducing their carbon footprint substantially. According to their data, verified by 3rd-party engineering companies, along with the CoolClimate tool [16] published by the University of Berkeley, we have highlighted two industrial opportunities below.

An average-sized medical facility produces approximately 4,246 tons of carbon per year, totaling 25,699,800 tons of carbon per year, globally.

An average-sized secondary school with a football field produces approximately 570 tons of carbon per year for a total of 13,612,740 tons of carbon per year, globally.

That's almost forty million tons of carbon from just two very specific building types, every year.

The Impact of Crypto Mining

Mining coins consumes excessive amounts of electricity, but the actual number is staggering. According to the Cambridge Center for Alternative Finance (CCAF) [9] [17], it is estimated that Bitcoin currently consumes about 110 Terawatt-hours (TWh) per year, roughly equivalent to the annual energy draw of small countries like Malaysia or Sweden. Ethereum miners currently consume 44.49 TWh per year which works out to 5.13 gigawatt continuingly. These are only 2 of over 6,500 coins in existence [18]. According to the DOE and the U.S. Energy Information Administration [19], the electricity consumption in the United States throughout 2020 was about 3.8 trillion kilowatt-hours (kWh). To give a perspective, 110 TWh per year equates to CO2 emissions equivalent to 8,534,200 homes per year or Greenhouse gas emissions equivalent to 15,412,400 passenger vehicles driven for an entire year. Some argue that mining has effectively undone *all* solar panel electricity production ever created. A completely unnecessary and useless task to some has unwinded everything that the solar industry has accomplished.

carbon-neutrality. The term "carbon-neutral" dictates that there is an equilibrium between the carbon dioxide someone emits into the atmosphere and how much they remove from it. In turn, "carbon-negative" corresponds to someone removing more carbon dioxide from the atmosphere than they emit.

Issues with Carbon Credit Markets

The article "These Trees Are Not What They Seem" by Ben Elgin [20] explains why many carbon offsets or credits are not what they seem. They are referred to as "empty offsets" because, according to academics that study these projects, a large portion of carbon offset projects (about two-thirds) allowed into the market don't represent *true* emissions reductions.

According to Ben Elgin [20], lecturer at Stanford and policy director at CarbonPlan, a non-profit that analyzes climate solutions based on the best available science and data, “For the credits to be real, the payment needs to induce the “environmental benefit”. CarbonPlan analyzed detailed public records to show how statistical flaws in the program's design have led to over-crediting — at a scale of tens of millions of tCO_2 and hundreds of millions of dollars. For example, a scheme that attempts to solidify carbon offsets can do so by enrolling landowners with forested areas assets as carbon offset credits, but if by doing so they enroll landlords that had no intention of cutting their trees in the first place is irrelevant and as Ben Elgin places it, “they’re engaged in the business of creating fake carbon offsets.”

After twenty years of existence, carbon offset markets are still thought of as the “wild wild west” of energy markets, with little to no regulation, littered with unsupervised and unorganized transactions.

Michael Parkin [21] at the Washington Post puts this well:

“Voluntary offsets are the dietary supplements of the climate world — no federal agency regulates them to make sure they deliver the benefits they promise. You have to do your own research to make sure you get what you pay for.”

In order to explain why this is happening, we need to start with the term “additive”. Additive is a term used in carbon credit markets to demonstrate that a project that reduces carbon is provably and uniquely reducing carbon. A good example of a definitively “additive” carbon offset project is planting a single tree. The *newly planted* tree has absorbed and solidified carbon emissions in the growth process and is continuously removing carbon emissions from the atmosphere, a persistent and provably “additive” carbon reduction project.

However, the concept of requiring “additive” approaches when verifying carbon credits is a broken concept. It is one that was created by necessity at the time, mainly because they lack validation of non-additive projects led to fraudulent registration of credits. But the problem is that “additive” has its own large-scale problems, but the world needs something much wider in scope and more verifiable without relying on a project being “additive” as a crutch for this verification. ”

As an example to demonstrate why a better metric is required, take the cases in Pennsylvania at Hawk Mountain. Hawk Mountain is where an incredible amount of carbon credits were

registered for avoiding a “tree massacre,” or so-called scenario of deforestation. Later, it was found that those trees were never in any danger. The landowners themselves said that they had no intention to cut down all of their trees; it is the Hawk Mountain Sanctuary Association's mission is to preserve the forested land as a natural habitat for the migrating birds. The credits sold obviously are not equivalent to the true carbon offset of the “saved trees", as those trees were never in any real danger. Despite being “additive,” the verification of the carbon offset is the real issue.

The end result, and where we stand today, is that the overall solution to fraud and verification has been to limit the registration of credits to an impossibly small and inconsequential group of projects.

Carbon credits purchased by companies transfer emissions from one place to another rather than reducing them. The problem is that the market for registering and trading these credits is very loosely organized and poorly understood. Only once registered credits become both verifiable and accountable, or, for lack of a better term, commoditized, will carbon credits be tradeable at scale and begin to put an actual dent in the amount of carbon generated each year. In other words, until the companies purchasing credits can be confident that what they are paying for actually offsets that amount of carbon, as well as have the available inventory that they need to purchase, the carbon credit market will always be small and inconsequential.

Right now, Amazon can purchase carbon offsets from a variety of markets in order to achieve its carbon reduction goals. In a world where any citizen can personally verify that those carbon credits are truly offsetting the amount of carbon they claim to be, the carbon credit market can begin to solidify and grow the industry around it. It can become a behemoth compared to the motley crew of carbon credit markets that exist today.

A verifiable market that anyone can look under the covers of, can turn those carbon offsets into something meaningful. And it’s not just that Amazon now has to play by the rules and buy offsets that are legit. That’s not the important part. The *far more* important part is that the people certifying these carbon offsets now have to be legit. Once that’s a thing and policy builds around it, well, now people have *real* incentives to make carbon offset projects. The current system only incentivizes scams.

A carbon credit is more or less a certificate that accredits the entity that created one ton's worth of carbon offsetting, through a project that has clear boundaries, title, project documents, and verification. In today's carbon offset markets, most carbon credits are from projects that generate reductions outside the walls of a building in most cases. Projects like planting trees, coastal carbon sequestering, and preserving forests are examples of common carbon offset projects that are viable for existing "additive," markets. These types of projects are viewed as the most definitive types of carbon offsetting measures, yet they are outside of regulatory requirements and ease-of-measurement because they are, literally, *outside*.

Blockchain

A Blockchain [1] is a fault-tolerant distributed record system that orders a list of blocks of transactions. These transactions are recorded on distributed nodes. In order to securely write records on Blockchain, consensus algorithms [22] are used as the backbone of this technology. Bitcoin [23] is the first cryptocurrency that implemented Proof of Work (*PoW*) on a distributed record. While Bitcoin provides on-chain executable code, its script language used to write this executable code in the blockchain is not Turing Complete [24], i.e. a language that is unable to perform all possible computation. Ethereum [25] emerged as a second-generation cryptocurrency, bringing a Turing Complete script language that is easy to implement and standardize. This allows anyone to write smart contracts (implemented with a Turing Complete language, i.e. it is able to perform any computation.) and decentralized applications with their own arbitrary ownership rules, transaction format, and state transition functions. There are two primary categories of consensus algorithms that are utilized by blockchains. Those are:

- **Proof of Work (PoW)** selects the node leader that produces the next block of validated transactions by solving cryptographic puzzles and is proportional to the computational resources. This method of validating transactions results in an incredible and unnecessary amount of electricity consumption. [26] [27].
- **Proof of Stake (PoS)** has no explicit node leader but instead selects validators based on the proportion of stake to the system. All nodes come to a consensus of what the next block is through different voting protocols. [28]

Bitcoin and Ethereum both use the first type of consensus algorithm, in which all bitcoin nodes are competing for node leaders by solving a cryptographic puzzle. The solution to these puzzles is found randomly with brute force processing by computers, hence, the unnecessary electricity load. CarbonNo requires the second type of consensus algorithm, PoS, in order to address the sustainability issue that is obviously required for any carbon-negative coin. Incidentally, while Ethereum has claimed for quite some time that it will be moving to a PoS, even if that becomes reality, they wouldn't solve the issue of scalability required in order to build a fully decentralized DeFi application because it cannot bridge to other blockchain networks [29] [30]].

Cardano emerged as a third-generation blockchain that aims to be a future financial system that utilizes these properties. This potential interaction with other blockchains is enticing to CarbonNo for two reasons. First, because if other carbon credits or carbon-offset verification solutions end up being placed on other blockchains, visibility of those will be crucial for the robustness of our own verification. Today, it's not an issue, but tomorrow, we may need to make sure that no one else is attempting to register the same carbon offset on another blockchain network. Secondly, while esoteric, Carbanno has made a visceral movement towards projects that actually help solve climate change, such as their new project called Cardano Forest [31], which grants anyone who plants a tree one ADA coin.

Ouroboros and the Benefits of Proof of Stake

The consensus problem is one of the most fundamental problems in computer science. It has recently received renewed interest over the past decade due to its relevance to blockchain systems and cryptocurrencies. Ouroboros [32] is the first blockchain protocol of its kind. It combines the advantages of proof of stake with the security of rigorous security analysis, which is the first provable secure PoS blockchain protocol. Ouroboros achieves two properties that are fundamental to building a robust transaction ledger: persistence and liveness. Ouroboros provides two formal properties of a robust transaction ledger: *persistence* and *liveness.* These two properties provide a robust transaction in the sense that honestly generated transactions are adopted and become immutable, i.e. once a transaction is created, it remains the same in the ledger (persistence), and lives in the blockchain forever (liveness). Ouroboros is provably secure, it guarantees both properties, in other words, it is infeasible for an adversary to break. The protocol also presents a novel reward mechanism that provides a positive payoff for those

protocol actions that cannot be stifled by a coalition of parties that diverge from the protocol. Therefore, by design, Ouroboros can mitigate attacks like *block withholding* and *selfish-mining*. The stake delegation mechanism introduced in Ouroboros can enable stakeholders to delegate their "voting rights," and also revoke them independently if they wish. This kind of liquid democracy is more environmentally friendly compared to proof-of-work networks, which consume immense and unnecessary physical resources. The experiment test [32,33] shows that Ouroboros provides 99% transaction confirmation time assurance and does it ten to sixteen times faster than Bitcoin. At the same time, the protocol addresses nefarious attacks by bad actors such as double-spending attacks, transaction denial attacks, 51% attacks, nothing-at-stake, and desynchronization attacks.

UTxOma Model and Native Tokens

Bitcoin and Ethereum are distributed ledgers tracking a single asset (bitcoin and ether, respectively). One important use case of an Ethereum smart contract is to create a wide range of user-defined tokens. However, this kind of user-defined asset is non-native to Ethereum. This means that the tokens do not live in a user's account. To send another user a token on Ethereum, the sender must interact with the governing smart contracts for currency, meaning that users must build their own internal ledger, which makes them unnecessarily inefficient, expensive, and complex.

Unspent Transaction Outputs (*UTxO*) is a ledger model used in Bitcoin. *UTxOma* is an extension of *UTxO, but which has* multi-asset support, and is implemented in the Cardano blockchain. By combining the creative use of custom tokens in Ethereum and *UTxO* model from Bitcoin, *UTxOma* generalizes the value that is used in a ledger to include *token bundles* that freely and uniformly mix tokens from different custom assets (both fungible and non-fungible). Meanwhile, *UTxOma* avoids any global state by linking a currency to a governing policy via a hash, as a result, *UTxOma* is a multi-asset ledger system with native, lightweight custom tokens. To achieve this UTxOma model, the following three major extensions are essential:

1. Transaction outputs lock a *heterogeneous token bundle* instead of only an integral value of one cryptocurrency.
2. Transactions are extended with a "*forge" field*, a bundle of tokens that are minted and burned by that transaction.

3. *Forging Policy Scripts* (FPS) were introduced to govern the creation and destruction of assets in forge fields.

UTXOma model is formally specified and proved in Agda [34], this is the basis for the smart contract system of the Cardano blockchain.

Smart Contracts

Smart contracts pave the way to flexible development of domain-specific applications that run on a blockchain platform, it helps build a robust and diverse ecosystem in the crypto world. Plutus [35] is the Cardano smart contract platform that is built on the top of a purely functional programming language Haskell, which ensures secure formal verified code, due to the nature of functional programming. Applications built on Haskell are highly modular, reusable, and safe. This is a huge advantage, especially when compared to other smart contract scripting languages in Ethereum, which invented a new language Solidity [36] that is running on-chain code, while Javascript is running off-chain. Two separate languages writing the same contract introduce potential security concerns and suffer from modularity (e.g. Tierless web programming [36,37]). Plutus smart contracts can be written in on-chain and off-chain code Interleavely, with on-chain code being a pure side-effect-free predicate that gives the power to easily reason about on-chain code concerning functional correctness and resource consumption. These two parts have plagued Ethereum since its inception and have led to many vulnerabilities and exploits. Combining both on-chain and off-chain code, Plutus can ensure higher secure code without losing its expressiveness.

On the front end, the Plutus smart contract platform is a suitable basis for embedded domain-specific languages, like Marlowe [38], a blockchain variant of DSL for financial contracts. Marlowe allows financial professionals who are not skilled in programming to write smart contracts in the Cardano blockchain. Other front-end programming languages contracts can also be compiled to Plutus core to run on the Cardano blockchain, giving them the power to integrate external blockchain applications seamlessly.

NFTs

An NFT (Non-fungible token) is a digital recording of a unique digital identifier that cannot be copied, substituted, or subdivided since it is recorded in the blockchain. Similar to a one-of-a-kind collectible, this token is unique and cannot be replaced with anything else. An NFT holder has digital proof of ownership over the asset. We want to build a ledger of all verified carbon credits on the blockchain. [39]

Project Catalyst

In the Cardano ecosystem, power is in the hands of its users who have the right to vote not only in what is being written into the ledger but also in what is built on the blockchain. Cardano Project Catalyst aims to build a global robust voting, innovation, on-chain governance treasury system that works for everyone. It allows the community to self-determine priorities for growth, and it lets participants deploy funding to proposals that tackle different challenges. Everyone can participate in Project Catalyst, which paves the way towards a democratic and sustainable governance system, deciding the future of the platform in a decentralized way.

Benefits of Blockchain

We believe that the power should be held by individuals who play a key role in their presented communities. Centralized organizations put too much power in one place, fostering corruption and unfairness to those not in power. Blockchain technology provides a foundation for building a fair autonomous system, in which decisions are made by everyone within the community instead of centralized institutions. The top 5 benefits of the blockchain are:

- **Enhanced Security**: Records on the blockchain are hashed [40] and immutable.
- **Transparency**: In principle, each individual who runs a blockchain node keeps the whole copy of the database, while transactions and data are recorded identically in multiple locations.
- **Efficiency**: Transactions with documents are stored digitally, avoiding the need to exchange paper, ledger clearing while settlements can be much faster.
- **Traceability**: Data provenance can be shared directly with customers between peers.

- **Automation**: Transaction and financial protocols can be encoded in smart contracts, achieving full automation.

Blockchain and Crypto Potential

Since smart contracts were introduced, the blockchain has evolved to a decentralized platform that companies have been utilizing for reducing cost, better tracing, and increasing transparency and productivity. Large corporations like Walmart have used the blockchain to improve supply chain transparency, allowing the tracing of contaminated food by locating the source efficiently and faster. This reduction in time is crucial as it can save lives, reduce manpower expenditure, and result in less wasted products before the contaminated source can be identified. Other examples include Ford that uses the IBM blockchain platform to trace minerals or DHL and Accenture that track pharmaceuticals through the supply chains. In addition, the blockchain is currently being used in banks and finance, health care, insurance, energy, real estate, trade, government, IoT, and travel. The global blockchain technology market size is expected to reach $72 billion by 2026, rising at a market growth of 51.8% CAGR during the forecast period. [1] In addition, based on coinmarketcap.com at the time of this writing, the entire cryptocurrency market is valued at 1.8 Trillion, not including the estimated market cap of blockchain technology itself.

CarbonNo

CarbonNo™ is a blockchain-based carbon reduction platform that incentivizes carbon reduction through multiple venues. The main goal of this project is to establish a truly equal and decentralized carbon offset platform that can be widely used and deployed by the global carbon market. By utilizing the Cardano network and its capabilities, we will be able to build a clean and adaptable energy ecosystem. This ecosystem is capable of disrupting and rebuilding the deprecated and ineffective carbon offset sector, reducing the carbon footprint, and redefining the carbon certification experience.

What is CarbonNo?

CarbonNo is comprised of the following three assets:

#1. CarbonNo Coin (CNC). This is an incentive token that is awarded for a specific amount of carbon reduced by a carbon-reducing building project registered with CarbonNo. CNC tokens are only generated when carbon is actively reduced, making it a genuinely carbon-negative token. CarbonNo verifies this amount of carbon reduction through either utility data or revenue-grade measurement of energy usage at the meter level.

#2. CarbonNo Carbon Credit NFT (CNFTs). Develop and implement carbon credit standards for digitally traded carbon credits through NFTs. By doing this, we wish to achieve the following goals.

- **Transform** existing legacy credits into digital NFT format.
- **Store** carbon NFTs on the Cardano blockchain.
- **Monitor** credits transparently and automatically, making it impossible to double-spend or counterfeit credits.
- **Generate** verified carbon credits from EE upgrades and carbon-sequestering projects.
- **Democratize** the carbon credit and the EE market allowing everyone to invest in a carbon-neutral future.

Each customer, once verified, can obtain one CNFT per metric ton of carbon reduced.

#3. CarbonNo Platform. This is a blockchain-based carbon trading platform that allows users to:

- **Register/Verify** new CarbonNo projects.
- **Trade** carbon credits (CNFTs) or CNC.
- **Stake/Invest** CNC coins to one of our Proof of Energy (PoE) stake pools and get rewarded for doing their part to reduce carbon.
- **Monitor** projected reward distributions.

CarbonNo Coin (CNC)

The CarbonNo Coin represents the carbon saved through different energy efficiency projects. CNCs are awarded to partners that enroll their projects with CarbonNo and meet the various requirements for data collection and proof of carbon reduction. These verification steps are based on the CarbonNo reward algorithm below and include ICP standards for metering energy

reduction. In order for our reward algorithm to produce consistent rewards, it transforms all kWhs saved or Therms saved into metric tons of carbon saved.

The amount of awarded CNCs can be calculated based on this algorithm, with ***k*** being a multiplier that changes as the value of CNCs changes.

kWh to carbon:

1,562.4 lbs CO2/MWh × (4.536 × 10-4 metric tons/lb) × 0.001 MWh/kWh =
= 7.09 × 10-4 metric tons CO2/kWh

Carbon to CNC:

*amount_of_rewarded_CNC = metric_tons_of_carbon _saved * **k***

CNC can be collected, traded, or even re-invested into other energy efficiency projects via the CarbonNo platform, incentivizing new projects that lower carbon emissions.

Proof of Energy Mode (POEM): In this reward program, customers are given the opportunity to earn CNC through energy efficiency upgrades by transforming saved kWh or therms to metric tons of carbon.

- **KWh to carbon:** Each saved KiloWatt per hour (*KWh = Watts * hours / 1000*) of energy is transformed to metric tons of Carbon using the formula based on the United States Environmental Protection Agency (**EPA**) standards *metric_tons_of_carbon = 1kWh/ 0.0007*.
- **Therms to carbon:** Each saved therm is transformed to metric tons of Carbon using the formula based on the United States Environmental Protection Agency (**EPA**) standards *tons_of_metric_carbon = 1Therm/ 0.005*.

Steps for submitting new or non-verified EE project to POEM:

1. Audit and engineering calculations performed by the PD
2. Project submitted for review to a qualified 3rd party
3. The approved and ICP certified project is submitted to CarbonNo
4. CarbonNo collects prior utility data and verifies project
5. EE project is approved by CarbonNo and POEM becomes effective

In cases where an EE project has already been verified by an ICP certified 3rd party, steps 1and 2 can be excluded.

Standard Staking*:* Any CNC holder is offered the ability to earn additional rewards by "staking" their portfolio in a standard Cardano stake pool.

Energy Staking: Any CNC holder is offered the ability to earn additional rewards by "staking" their portfolio in other energy efficiency projects. Each project will represent its own stake pool with its own reward system. Each of these project stake pools will have a "commitment period" that will be disclosed, locking the amount of CNC for a pre-disclosed amount of time. This means that until this period has been fulfilled, the staked CNC won't be available for transfer or removal.

CarbonNo Carbon Credit NFT (CNFTs)

The CarbonNo NFT program will allow CarbonNo members to convert verified carbon credits and carbon offsets into digital non-fungible tokens (NFTs). CarbonNo will convert, process, track and document verifiable carbon offsets/ credits allowing a Decentralized Network Governance (DNG). The DNG protocol will resolve existing market issues of double-spending, false ownership, tampering, and fraudulent activity. There are two ways CarbonNo NFTs are created. This can be done by either converting a "legacy credit" or by issuing "new credits" for projects started specifically through CarbonNo.

Legacy credits: Legacy credits will be verified by an ISO accredited third-party verifier. These include but are not limited to many of the major carbon standards (CAR, VCS, ACR, GS) and will have to have undergone a robust verification process before being submitted to Carbon. CarbonNo will also research the credits on various registries to ensure emissions reductions are not double-counted.

New credits: New carbon projects can be initiated with the help of CarbonNo. These projects are authenticated directly by the CarbonNo team.

CarbonNo is responsible for verifying and monitoring the existence of carbon credits throughout their life-cycle. In order to achieve this, we will be utilizing different ways of overseeing the existence of such carbon credits. For example, a forest registered for producing a certain amount of carbon credits will be monitored by utilizing satellite imagery, image processing, and machine learning algorithms that are able to verify its existence.

CarbonNo Platform

The CarbonNo Platform allows people to monitor and manage their usage and rewards, trade CNCs or CNFTs, and invest in other Carbon offsetting projects. A new customer profile can be created by accessing the CarbonNo website or mobile application and providing the requested identification forms. This can be performed by either the customer or the involved project implementer. CarbonNo verifies the customer and creates a unique customer profile as well as a wallet that the customer will have access to. A verified customer can access all CarbonNo website/ application capabilities. These include:

- **Energy stats:** View statistics about monthly and yearly energy usage, reductions, and earned rewards.
- **CarbonNo Wallet:** View and manage CNCs and CarbonNo NFTs holdings.
- **Reward Programs:** Submit new or view and manage existing POEM projects and start earning CNCs as rewards.
- **Carbon Credit Center**: Submit and acquire legacy or new carbon credits as CarbonNo NFTs
- **Delegation Center:** Stake CNC on existing stake pools or create new energy and carbon stake pools.

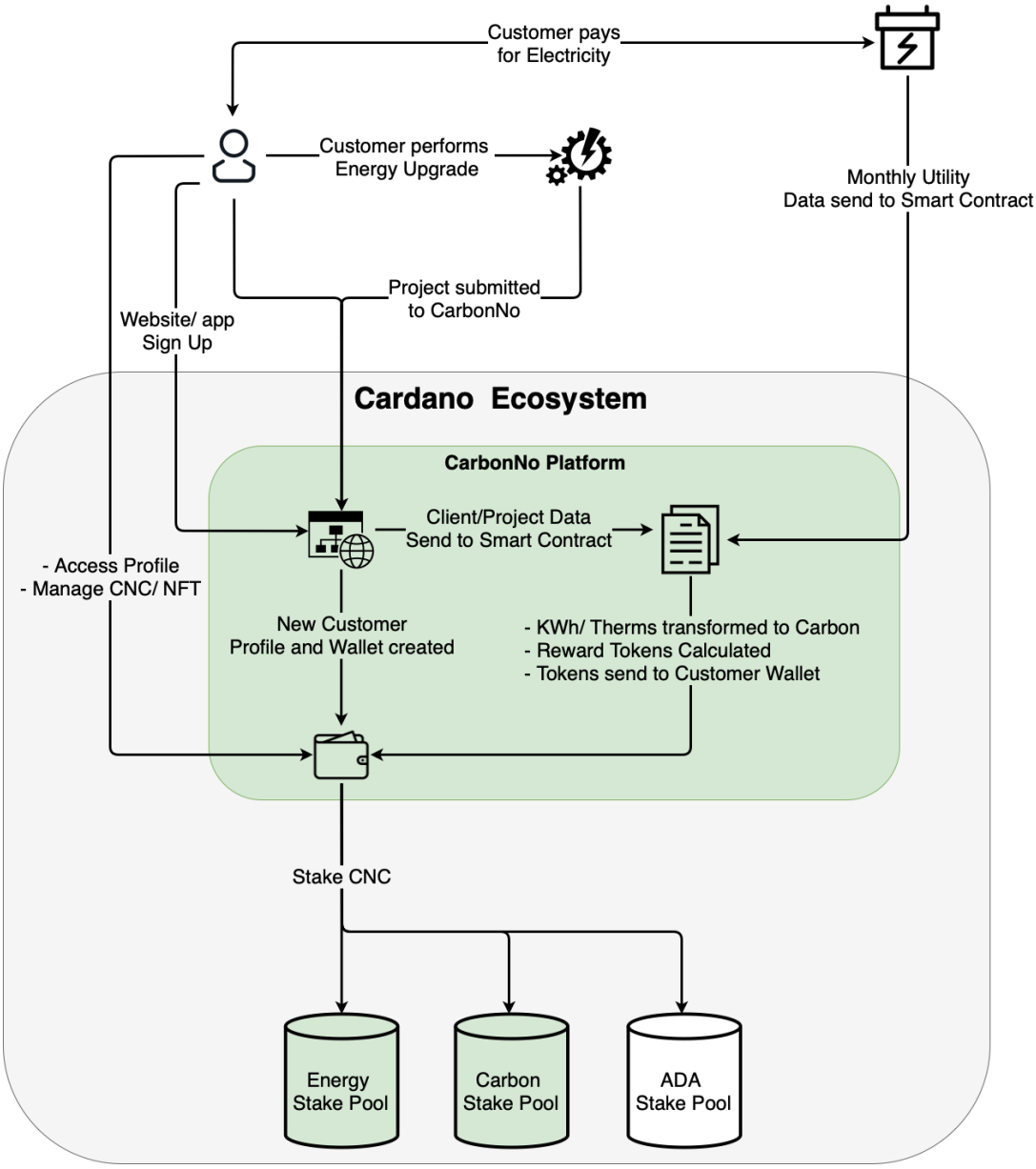


Fig. 1 Overview of the CarbonNo Platform

Figure 1 shows a high level overview of the process that needs to be followed for a customer in order to start earning CNC rewards through energy reductions.

A client performing an energy efficiency or carbon upgrade can submit any project for approval through the CarbonNo app or website. Every newly submitted project goes through several verification steps in order to ensure its existence and compliance with the ICP protocols. CarbonNo contacts the appropriate Utility/ Implementers, while a third-party company ensures

that the client and project exist and match the submitted information. After the project is fully verified, the customer's Utility data is added and linked to the customer's hash key in the blockchain. The customer is given access to a unique Project Dashboard where detailed information about the specific project and earned rewards can be seen.

Utilities are contacted monthly for each customer in order to receive the new readings, which are then uploaded into the blockchain. The CarbonNo™ smart contract calculates the rewards based on the received utility data and transfers the CarbonNo Coins (CNC) to the client's wallet. The reward tokens are then locked for a period of time before becoming available for spending in order to avoid fraudulent behavior.

Staking CNCs on different projects can be performed by choosing an existing energy or carbon stake pool. All available stake pools are presented with specific details, such as the duration of the project and average monthly rewards. A customer can choose to stake any amount of CNCs in one of those project stake pools, with the ability of multitasking in different ones. Once the staking amount has been confirmed, a Dashboard for each staking project the customer is participating in can be accessed.

Technical Specifications

CarbonNo Smart Contract

```
contribute :: Campaign -> Value -> MockWallet ()
contribute campaign value = do
  when (value <= 0) $
    throwOtherError "Must contribute a positive value"

  ownPK <- ownPubKey
  tx    <- payToScript
             (Ledger.scriptAddress (contributionScript campaign))
             value
             DataScript (Ledger.lifted ownPK)

  register (refundTrigger campaign)
           (refundHandler (Ledger.hashTx tx) campaign)

contributionScript :: Campaign -> ValidatorScript
contributionScript campaign =
  ValidatorScript (validator `apply` campaign)
    where validator =

      Ledger.fromCompiledCode $$(PlutusTx.compile
        [|| (\Campaign{..} action contrib tx ->
          let
            PendingTx ps outs _ _ (Height h) _ _ = tx
            isValid = case action of
                        Refund ->  h > collectionDeadline &&
                                   contributorOnly outs &&
                                   $$(txSignedBy) tx contrib
                        Collect -> h > deadline &&
                                   h <= collectionDeadline &&
                                   totalInputs >= target &&
                                   $$(txSignedBy) p campaignOwner
          in $$(P.errorIfNot) isValid ||])
```

(B)

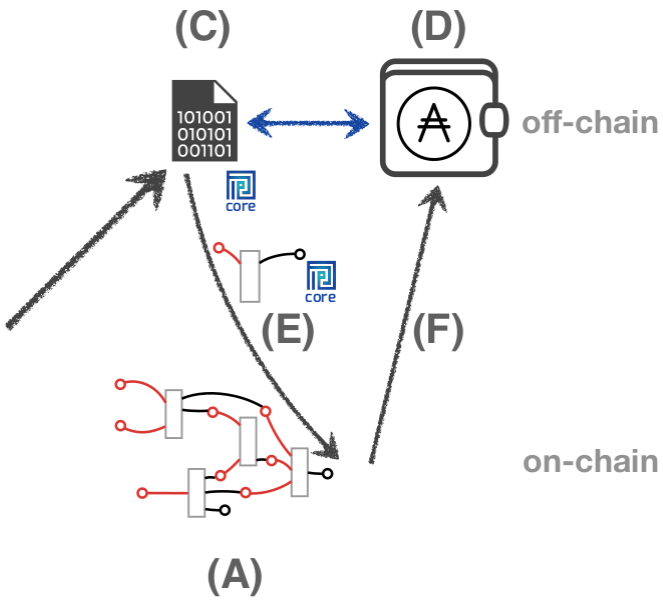


Fig. 2 Plutus Architecture

The smart contract builds the UTxO with metadata that specifies the carbons offset, with a policy script, guiding CNC token and NFTs minting. The Plutus architecture that smart contracts run on is shown in Fig. 2; when a smart contract (B) is deployed on Cardano blockchain, it is executed in two-part, on-chain (A) and off-chain (D), the off-chain code lives in the user wallet and is executed whenever the transaction is triggered, following with online code validation.

Fig. 3 is an overview of our smart contract functionalities. Users can submit all the energy savings (electricity bills etc.) and carbon credits (carbon reduction, tree planting, etc.) periodically through our dApp; CarbonNo smart contract would handle all the datum automatically, read the user information (left side inputs in Fig. 3) and calculate the rewarding amount, then build the transactions from the resulted data for each user, submit the transactions to the network (right side outputs in Fig. 3), while the online part serves the validation of the user transactions. When building the transactions, according to the user

requirement, the smart contract would send out energy-saving reward tokens (CNC) and build NFTs (minted CNCs will be held in CabonNo treasury account) to user accounts.

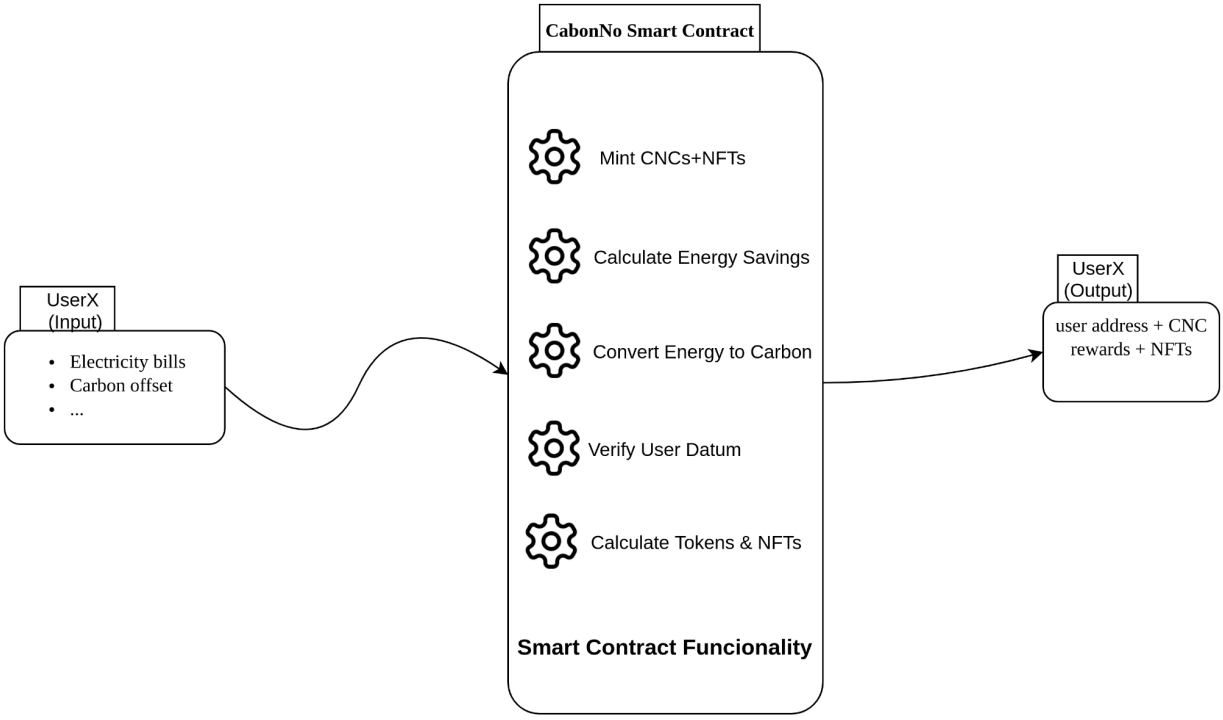


Fig. 3 How the CarbonNo Smart Contract Works

Token Usage Guidelines

Token Distribution

The total supply of CNC upon the CarbonNo platform's launch will be capped to 1,000,000,000 tokens, with the option for stakeholders to release more coins through PoS voting.

MToken ~= Monthly * Period, basically the token amount should fit in this equation, we mint only once ahead sitting in a governed account.

Monthly = UsersSaving * k, we should set Monthly a fixed cap, so the reward rate k is inversely proportional to UsersSaving(this is the expectation of maximal carbon tons monthly, assuming

we have a stable amount of users when the project goes mature, theoretically, it grows infinitely.).

Period = 10 years/15 years; after this deadline, all the tokens will be circulating in the system.

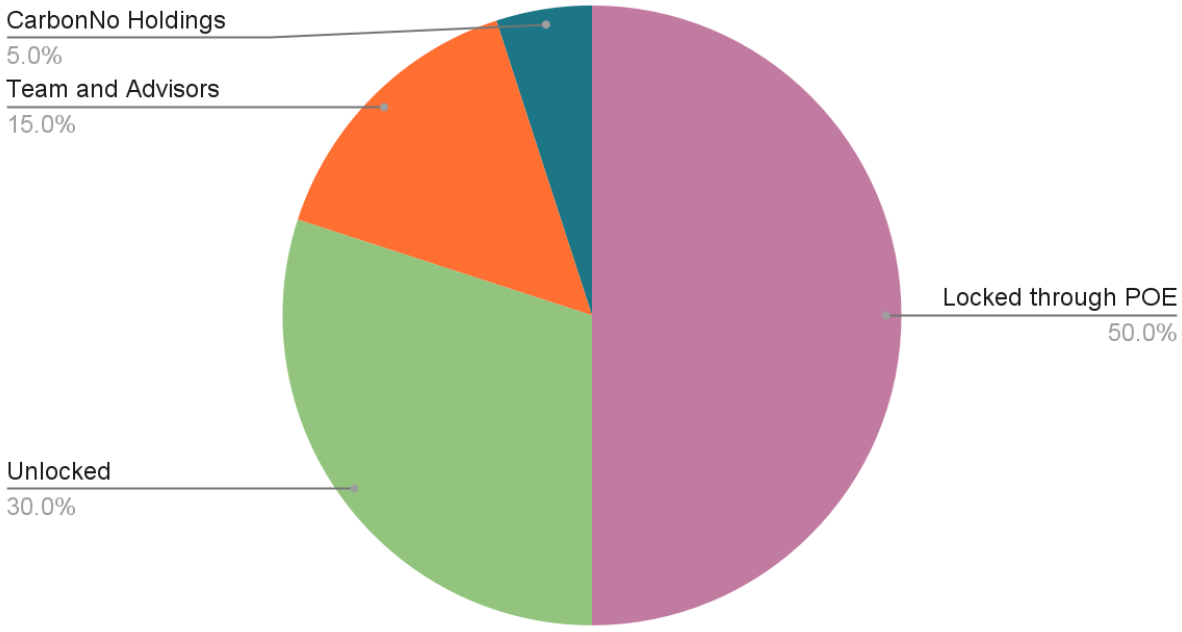


Fig. 4 Initial Token Distribution

Token Buybacks

In order to ensure the healthy and stable growth of the CarbonNo ecosystem, CarbonNo will periodically buy back CarbonNo Coins using some of its generated revenue. The buybacks will be executed periodically, randomly, and throughout the year to avoid price manipulation.

Tokenomics and Transactions

The CarbonNo Coin has a 2% fee per transaction. This fee will be used for the upkeep of the CarbonNo platform. At the end of each year, there is a PoS vote to determine what to do with leftover funds collected from transaction fees.

Carbon-Negative Generated CNC

The CarbonNo Coin has a 5% generation draw for customers participating in Proof of Energy contracts (PoE). This fee will be used for the upkeep and constant monitoring of the CarbonNo PoE partners, 3rd party verification fees, and other utility-associated costs for net metering. The 5% fee is not from the PoE partner but from the CarbonNo controlled wallet, meaning that the 5% is going from the locked CarbonNo wallet that is controlled by the smart contract system in place to the CarbonNo team wallet, which can be used for company-related expenses.

Roadmap

- 2021
    - Mint tokens and hold initial coin offering
    - Distribute tokens and wallets to project owners
- 2022
    - Publish smart contracts
    - Deploy web platform app
    - Deploy utility storage dApp
    - List CNC on DEX / CEX
    - Deploy POEM rewards programs
    - Allow staking (energy/carbon)
    - Deploy decentralized carbon credit NFTs

Team

Nikos Karagiorgos

Nik is passionate about innovation and reform that minimizes the carbon footprint. He has widespread experience working in the energy sector and was involved in billion-dollar solar projects such as the Genesis project in California and the Solano project in Arizona. Nik co-founded EverWatt, a leading Energy Service Company that provides energy-efficient lighting upgrades for commercial projects. Nik oversees the design, engineering, and manufacturing of energy-efficient products. Furthermore, he drives strategic partnerships, guides new opportunities, and manages the licensing relations in Asia and the United States. Nik first got involved in crypto in 2010 and Cardano specifically in 2017.

Konstantinos (Koss) Kleftogiorgos

Computer Science Ph.D. researcher/ Software engineer. Koss has worked on security projects for The Defense Advanced Research Projects Agency (DARPA) and the Office of Naval Research (ONR). Koss has studied cryptography and has a Master’s degree in distributed systems/ networks. He has a passion for blockchain, while his main research focus is operating systems, cyber/ systems security, and reverse engineering.

Dave Llorens

The CEO of EverWatt Lights and an electrical engineer. Before EverWatt, started One Block Off the Grid and raised $6MM from NEA, which sold to NRG in 2014 for $120 million. Before that, had started solarpowerrocks.com, which sold to Solar Reviews, Inc.

Cyrus Liu

Haskell/Plutus developer, second cohort Plutus pioneer, computer scientist lifetime. Cyrus holds a master's degree in information security, and he is now pursuing his Ph.D. with a research focus in programming languages, formal verification, and program analysis. He developed a sensitive API monitor for the Android mobile network and a binary de-compilation toolchain, the first automatic verification tool that combines binary analysis with formal methods. His ultimate goal is to help the world with secure and fair systems, and blockchain technology is bringing his goal closer to reality.

Dr. Ioannis Agadakos

Ioannis is experienced in both academic and corporate environments. He served as an Advanced Computer Scientist in SRI International, tackling hard cybersecurity problems during his three-year tenure. He is currently a research scientist in Khoury College of Sciences at Northeastern University, working in neural

binary analysis and software hardening. He holds a U.S. patent, and his research is published and awarded in top-tier conferences in software hardening, system security, deep learning, and the Internet of Things. He is well-versed in all phases of software development and has worked with a plethora of teams with diverse backgrounds. He holds a Ph.D. from Stevens Institute of Technology, a B.Eng, and an M.Sc in Electronic and Computer Engineering from the Technical University of Crete.

Dr. David Perlman worked in information technology and database development for many years before joining the University of Wisconsin-Madison, where he leveraged behavioral economics and game theory to study attention, emotions and identity in the neuroscience of mindfulness. Subsequently he worked in the User Research team at Twitter, and as a data scientist and consultant on emerging information threats at Leviathan Security Group. He has presented on social media and influence campaigns at SOCOM SOFWERX, the Black Hat conference, Naval Postgraduate School, CDANS, Lawrence Livermore National Labs (LLNL), and has been interviewed in publications including the Wall Street Journal. He is also lead author of the first discussion of social media and influence campaigns in the Strategic Latency book series published by LLNL, and published an article on the mathematics of modern big-data marketing in Cyber Defense Review. In 2021 he combined his knowledge of incentive-compatible economic systems with the principles of social engineering in information security to develop the technology of Validated NFTs (VNFTs), which he brings to the team at CarbonNo.

Conclusion

We know that earth is getting hotter. The ground-breaking 2021 IPCC report [41] surprised us all with how real, how now, and how much worse that fact is than we had previously imagined possible. If we are to reduce the amount of carbon in the atmosphere in a meaningful way, we are going to need carbon-offsetting markets that are robust, trustworthy, and that scale outside of today's arbitrary carbon offset requirements and into the larger arena of building improvements. CarbonNo exists only to be the solution to that specific and specifically large puzzle piece of solving climate change.

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