Improving Voluntary Carbon Markets Through Standardization and Blockchain Technology

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IMPROVING VOLUNTARY CARBON MARKETS THROUGH STANDARDIZATION AND BLOCKCHAIN TECHNOLOGY

Nicholas P. Espenan*

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* J.D./M.A. Candidate, University of Wyoming College of Law and Haub School of Environment and Natural Resources, Class of 2023. In my time at law school, I have taken every opportunity to explore new environmental policy surrounding the management and trade of carbon offsets and I look forward to what the future may bring. I would like to extend my sincerest gratitude to my editors Jenna VonHofe and McCade Wing, along with the rest of the Editorial Board of the Wyoming Law Review, for their help in editing this article. Finally, thank you to my amazing wife and her unwavering support while writing this piece.
Abstract

The impacts of climate change, if left unchecked, will result in significant economic and ecological harm globally. While reducing carbon emissions in a sustainable manner may mitigate these effects, a concerted effort is required from all nations. Carbon markets present an opportunity to address emissions while promoting economic growth and technological advancement in carbon sequestration initiatives. However, the current state of the global voluntary carbon market is fragmented, with little uniformity and lacking transparency, which can undermine its effectiveness. To address these challenges, an industry-wide carbon sequestration standard, supported by a transparent blockchain protocol, should be implemented to enhance the existing voluntary carbon market structure in the United States. This new standard would require market participants to comply with uniform and transparent reporting protocols, mandating the reporting and disclosure of carbon inventory and methodology by carbon registries in the United States. The combination of a standardized carbon market and blockchain protocol will provide autonomous reporting of all carbon credit transactions, from creation to retirement. In conclusion, this proposal aims to enhance the voluntary carbon market through proper standardized emission offsetting, promoting economic growth and technological innovation, as the market scales over time.

I. Introduction

Rising global temperatures due to climate change is a prominent obstacle in modern history.1 While limiting energy consumption of fossil fuels and transitioning toward more sustainable energy sources will decarbonize the economy and reduce the impacts of climate change,2 transitioning from fossil fuels without an established, sustainable energy infrastructure will cause significant economic disruption.3 Emission trading systems, such as carbon markets, are a flexible solution to prevent disruption to the economy and cut back on carbon emissions through the trade of carbon credits.4 Over the past decade, however,

global initiatives have failed to establish a universal carbon market model. The availability of viable carbon market solutions has not been sufficient to facilitate their use by global participants as a means to address the issue of climate change.

One of the most pressing challenges to the widespread adoption of voluntary carbon markets is the lack of uniformity in carbon calculation standards. Furthermore, a lack of transparency in carbon market methodologies undermines the effective implementation of voluntary carbon markets globally. As a result of both issues, concerns of fragmentation, additionality, leakage, and overall quality assurance are inherent in the current voluntary market structure.

This Comment advocates that the uniformity and transparency issues within the voluntary carbon market structure in the United States can be solved by implementing a proposed carbon credit standard, regulated by blockchain protocol to monitor carbon credit transactions. The new standard and protocol, combined into one mechanism, can resolve the significant issues currently limiting carbon markets and carbon credit creation, while promoting economic growth and technological innovation. In arriving at this conclusion, Part II discusses the creation of carbon markets and carbon credits, introducing compulsory and voluntary carbon markets and their factual differences. Part II also analyzes Verra’s methodologies, the most widely used carbon registry within voluntary carbon markets. Part III then highlights the current issues faced by the U.S. voluntary carbon market structure and introduces the ideal carbon credit. Finally, Part IV provides a solution for voluntary carbon markets, proposing a desired carbon credit creation standard and a transparent blockchain protocol to enforce this standard.

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7 See Sovacool, supra note 5, at 683–86.


9 See id. at 9–13.


11 See Jurado, supra note 10; The EM Insights Team, supra note 10; Needelman et al., supra note 10 at 2159–71.
II. Understanding Carbon Markets

The Biden Administration established a goal for the United States to reach net-zero carbon emissions by 2050.\textsuperscript{12} However, the United States currently lacks the energy infrastructure and alternatives necessary to meet current energy consumption needs from zero-carbon sources.\textsuperscript{13} To achieve carbon neutrality, the United States must reevaluate national energy consumption.\textsuperscript{14} Fossil fuels represent 79\% of the energy currently consumed in the United States.\textsuperscript{15} The remaining 21\% of the U.S. energy production sector would be unable to sustain the current demands of U.S. infrastructure.\textsuperscript{16} Fossil fuel production and usage will likely remain the primary energy source in the United States, until a self-supporting, clean energy infrastructure can be implemented.\textsuperscript{17}

The voluntary carbon market in the United States provides a path forward to help balance current fossil fuel usage while transitioning to clean energy, by allowing carbon market participants to offset their emissions with carbon credits to meet net-zero goals.\textsuperscript{18} But given the lack of low-carbon alternatives, aggressive net-zero goals could cause unsustainable economic stress.\textsuperscript{19} Requiring an immediate shift from fossil fuels would create severe energy shortages and disrupt economic

\begin{itemize}
  \item \textsuperscript{16} \textit{See U.S. Energy Facts Explained, supra note 15.}
  \item \textsuperscript{18} \textit{See Carbon Offsets – How do They Work, and Who Sets the Rules?}, supra note 13 (“Proponents say offsetting, if done properly, can help channel funds to conservation and sustainable development projects that will reduce emissions, giving companies time to work towards zero emissions.”).
\end{itemize}
Voluntary carbon markets help bridge this gap by offsetting the emissions from difficult-to-abate sectors with carbon removals from other sectors that might otherwise be difficult to monetize.\footnote{21}

The economic principles that drive the success of current voluntary carbon markets date back to the Kyoto Protocol of 1997.\footnote{22} The Kyoto Protocol gives effect to the United Nations Framework Convention on Climate Change through commitments from countries to limit their greenhouse gas (GHG) emissions.\footnote{23} To facilitate these commitments, the Kyoto Protocol established three critical mechanisms to help participating countries achieve their GHG emission reduction goals.\footnote{24} The first mechanism established a carbon trading scheme that allowed participating countries to sell their auxiliary emission credits to another participating country.\footnote{25} Therefore, the structural foundation of the modern voluntary market can be traced back to the Kyoto Protocol’s first widespread carbon trading mechanism.\footnote{26}

The remaining Kyoto Protocol implementation mechanisms classified international carbon emissions investments.\footnote{27} The second implementation mechanism allowed “developed nations with economies in transition,” labeled “Annex I” countries, to invest in existing GHG reduction projects in any other Annex I country.\footnote{28} The third implementation mechanism of the Kyoto Protocol introduced the Clean Development Mechanism, which permitted participating Annex I countries to create emission reduction ventures in non-developed, or “Non-Annex I,” countries.\footnote{29} These new emission reduction projects created Certified


\footnote{21} See Blaufelder et al., \textit{supra} note 6.


\footnote{23} See \textit{Mechanisms Under the Kyoto Protocol, supra} note 22; \textit{see also} \textit{Handbook, supra} note 22, at 22–23.

\footnote{24} \textit{Mechanisms Under the Kyoto Protocol, supra} note 22.


\footnote{26} See \textit{Mechanisms Under the Kyoto Protocol, supra} note 22.

\footnote{27} See \textit{id}.


\footnote{29} \textit{The Clean Development Mechanism}, U.N. CLIMATE CHANGE, https://unfccc.int/process-and-meetings/the-kyoto-protocol/mechanisms-under-the-kyoto-protocol/the-clean-development-
Emission Reduction (CER) credits that could be applied toward both the Annex I and Non-Annex I countries’ emission goals.\textsuperscript{30} Additionally, the Clean Development Mechanism introduced the first authoritative entity to regulate emission reduction projects and the creation of CER credits.\textsuperscript{31} This is the first instance where a governing body required a universally accepted standard to create carbon offset.\textsuperscript{32} Despite the probable success of the Kyoto Protocol, the United States never ratified any Kyoto Protocol mechanism due to a lack of repercussions for missed emissions targets and the inability to hold participating countries accountable.\textsuperscript{33}

Through its novel implementation, the Kyoto Protocol introduced concepts and standards to regulate a potential carbon market in the future.\textsuperscript{34} The Kyoto Protocol provides an example of the requirements necessary for a carbon market to function properly: a universal carbon standard and a central regulating entity.\textsuperscript{35} The current voluntary market in the United States has neither.\textsuperscript{36} The United States can remedy many of the issues associated with voluntary markets by implementing mechanisms similar to those introduced by the Kyoto Protocol.\textsuperscript{37}

Before turning to the proposal for a proper solution to the current voluntary carbon market issues, this Part provides a foundation for carbon markets with a discussion on carbon market creation, the differences between compulsory and voluntary markets, and the growth of carbon registries and carbon capture standards in voluntary markets.

\textbf{A. Creation of Carbon Markets and Carbon Credits}

Carbon markets are a global economic system in which participating parties can trade, purchase, or sell carbon credits.\textsuperscript{38} Carbon credits are created by practices that reduce or remove GHG from the atmosphere, through carbon sequestration.\textsuperscript{39}
Carbon sequestration is the act of capturing and storing atmospheric carbon dioxide and can occur by direct air capture or indirect biological sequestration. A carbon credit represents one metric ton of carbon dioxide (MTCO2e) reduced or removed from the Earth’s atmosphere, or the equivalent in terms of radiative forcing of another GHG. Therefore, the majority of carbon registries use MTCO2e as a universal unit of measurement for carbon credits. However, carbon registries still disagree on the appropriate process for creating carbon credits.

Early initiatives, like the Kyoto Protocol, showed promise for establishing a carbon market foundation, but problems arose when participating countries could not agree on carbon calculation processes. After the Kyoto Protocol introduced the Clean Development Mechanism, there was a significant demand for quantified carbon offsets. A coalition of countries proposed a carbon credit system with accompanying market infrastructure to integrate carbon into market practices. The new market integration led to the first widespread carbon offset trading infrastructure.


41 Carbon Credits: What are Carbon Credits?, Corp. Finance Inst. (Dec. 19, 2022), https://corporatefinanceinstitute.com/resources/knowledge/other/carbon-credit/ [https://perma.cc/5W8Y-V5PD]; Intergovernmental Panel on Climate Change, supra note 1, at 136–40 (explaining that carbon dioxide accounts for the highest share of radiative forcing—the net change in energy flux in the Earth’s atmosphere due to a specific climate driver—and that increases in radiative forcing cause less radiation to leave the atmosphere; this trapped radiation causes the atmosphere to warm, thus, causing global warming).


43 Blaufelder et al., supra note 6.

44 See Hovi et al., supra note 33, at 130–31.


46 See Mechanisms Under the Kyoto Protocol, supra note 22; see also Handbook, supra note 22, at 22–23.

47 See Mechanisms Under the Kyoto Protocol, supra note 22; see also Handbook, supra note 22, at 22–23.
An emission trading scheme (ETS), like carbon markets, can provide proper carbon pricing.\textsuperscript{48} The World Bank refers to an ETS as a strict carbon pricing instrument that caps GHG emissions and allows emitters to trade their excess GHG emission allowances.\textsuperscript{49} In essence, an ETS is a market instrument for selling and buying GHG through carbon credits.\textsuperscript{50} Notably, the majority of ETSs are compulsory markets that require participants to meet predetermined standards.\textsuperscript{51} Currently, 39 national and 23 sub-national jurisdictions have implemented or plan to implement ETS programs across the globe.\textsuperscript{52}

Since the inception of carbon credits, the price of carbon has continued to increase.\textsuperscript{53} Global carbon markets reached a record net worth of $851 billion in 2021, fifteen times the markets’ net worth in 2017.\textsuperscript{54} Though this is a global figure, the value of the compulsory market European Union ETS accounts for roughly 90% of the global carbon market.\textsuperscript{55} The U.S. voluntary carbon market is currently appraised at $2 billion, has more than doubled in size in the last five years,\textsuperscript{56} and the Taskforce on Scaling Voluntary Carbon Markets suggests that the price of carbon will continue to increase as countries strive to meet their GHG emission reduction goals.\textsuperscript{57}

The recent influx of financial investments into the voluntary carbon market raises significant integrity concerns for market participants.\textsuperscript{58} Without a universally


\textsuperscript{52} The Global Rise of Emissions Trading, supra note 51.


\textsuperscript{54} Chestney, supra note 45.

\textsuperscript{55} Id.


\textsuperscript{57} TASKFORCE ON SCALING VOLUNTARY CARBON MKTS., FINAL REPORT 33 (2021) https://iif.com/Portals/1/Files/TSCVM_Report.pdf [https://perma.cc/B6XP-VDH5]. The Taskforce of Scaling Voluntary Markets is sponsored by the Institute of International Finance. Id.

\textsuperscript{58} See Pamela T. Wu & Levi McAllister, Newsletter, Recent Developments in Voluntary Carbon Markets: Empowered, MORGAN LEWIS (Sept. 21, 2022), https://www.morganlewis.com/
followed carbon calculation standard, investors are free to create their own carbon registries and follow independent carbon credit creation processes. The lack of a uniform carbon calculation standard implies that any entity could create illegitimate carbon credit creation and verification processes. To mitigate these concerns, administrative bodies and federal agencies are in discussion on how to properly regulate the voluntary carbon market; currently, however, no federal law explicitly addresses authority to regulate the trade of carbon credits and carbon offsets.

The lack of federal regulation creates inherent risks to not only carbon market participants, but the environment as a whole. Further, the current lack of federal regulation for the voluntary market has created a dichotomy between market stakeholders and environmental scholars. Market participants and project developers pour money into the market due to the lack of federal influence, which in turn prioritizes financial gain over carbon neutrality. Environmental scholars are concerned the market is growing at an unsustainable rate, and that without proper regulation there will be catastrophic damage to the environment from faulty credit production.

Recent economic growth of the voluntary carbon market illustrates the immediate need to resolve significant market issues. Despite the evident need to correct the deficiencies in the voluntary carbon market, transitioning to a compulsory carbon market would not benefit the United States because compulsory markets lack the ability to innovate. While the voluntary and compulsory markets

59 See Blaufelder et al., supra note 6.

60 Id. ("First, the heterogeneous nature of credits creates potential for errors and fraud.").


65 Id.

66 Id. at 5, 12.

67 Blaufelder et al., supra note 6.

68 Jurado, supra note 10.
have similarities, their structural differences create a significant dichotomy for proposing new carbon calculation strategies. The following section briefly examines the origins of both compulsory and voluntary carbon markets and highlights the corresponding market challenges.

1. Compulsory Carbon Markets

The majority of the global carbon economy is classified as a compulsory market, which requires participants to meet predetermined net GHG emission standards by either generating or purchasing offsets. Compulsory markets are governed by national or independent entities that annually issue a specific amount of carbon credits to qualifying companies. Within a compulsory market, the regulator may mandate carbon emissions reduction through carbon offset or direct abatement. The regulator can penalize participants for failing to comply with GHG emission allowances. For example, the EU’s ETS can levy fines of €100 per one MTCO2e over the emission allowance. Therefore, the strict enforcement and compliance requirements of compulsory markets encourage the achievement of emission reductions.

Compulsory carbon markets began after the Kyoto Protocol with the application of the Clean Development Mechanism. The Clean Development Mechanism allows developed sovereignties with binding emission reduction goals to construct emission reduction plans in other countries. When these other projects authenticate their reductions, they are awarded CER credits, each credit representing one MTCO2e. CER credits are certified by independent auditors who are approved by the Clean Development Mechanism executive board. When
the credits are validated, the entity financing the project may use them to help reach Kyoto Protocol goals.\textsuperscript{80}

Participants in compulsory markets must adhere to their GHG emissions cap set up by the governing entity and are allowed to trade their excess credits, a mechanism known as “cap-and-trade.”\textsuperscript{81} The only compulsory market currently operating in the United States is California’s compliance offset program.\textsuperscript{82} California’s program is characterized by cap-and-trade dynamics, in which a governing body delimits the quantity of emissions allowed within its jurisdiction, grants access to emissions with carbon credits, and authorizes the trade of permits within its jurisdiction.\textsuperscript{83}

Compulsory markets seem to be immediate and efficient due to regulatory oversight and governance.\textsuperscript{84} However, despite the regulatory fundamentals of compulsory carbon markets, the market lacks the efficiency to create new carbon sequestration projects.\textsuperscript{85} In a compulsory market, carbon credits are certified through third-party verifiers that calculate the project’s removed carbon from the atmosphere.\textsuperscript{86} Due to the nature of this certification, and because there is only one regulating entity that can validate and certify carbon credits, compulsory markets can take considerably more time to approve a new carbon sequestration project.\textsuperscript{87} After the project and credit are verified, the consumer must retire the credit and report it to the governing body.\textsuperscript{88} Appropriately reporting the retirement of a carbon credit is necessary to properly account for the consumer’s net GHG emission level.\textsuperscript{89}

\textsuperscript{80} See Handbook, supra note 22, at 22–23.
\textsuperscript{81} Jurado, supra note 10.
\textsuperscript{82} Cal. Air Res. Bd., Cap-and-Trade Program, CA.GOV, https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program [https://perma.cc/EPA9-BRMP] (last visited Jan. 2, 2023); Jurado, supra note 10 (“The most active compliance carbon offset program is the United Nations Clean Development Mechanism (CDM) that was born from the Kyoto Protocol. But other well-known ones are the cap-and-trade systems from California, Canada, the UK, China, New Zealand, Japan, and South Korea, with many more countries and states considering implementation.”).
\textsuperscript{84} What Is Emissions Trading?, supra note 83.
\textsuperscript{86} What is a Carbon Offset?, Carbon Offset Guide, https://www.offsetguide.org/UNDERSTANDING-CARBON-OFFSETS/WHAT-IS-A-CARBON-OFFSET/ [https://perma.cc/FS7C-RVBK] (last visited Jan. 2, 2023) (“A carbon offset credit is a transferrable instrument certified by governments or independent certification bodies to represent an emission reduction of one metric tonne of CO\textsubscript{2}, or an equivalent amount of other GHGs.”).
\textsuperscript{87} Riehl et al., supra note 75, at 246.
\textsuperscript{89} Struan Clark et al., The Lifecycle of a Voluntary Carbon Credit, JDSupra (Sept. 1, 2022),
The established market is therefore restricted by the limitations of the market's governing body, unlike voluntary markets that are driven by individual and social interests.  

2. Voluntary Carbon Markets

Voluntary carbon markets are self-governed markets with no underlying government regulation or legally-enforceable mandates for the participants. The implementation structure of a voluntary market allows immediate participation from new participants. This type of carbon market is generally adopted by either corporations or businesses that choose to restrict their carbon emissions as an expression of corporate social responsibility or in response to constituent demand to restrict GHG emissions. Under this implementation structure, voluntary carbon market participation serves as an exchange for entities wanting to meet self-determined emissions goals. The market is therefore driven by corporate social responsibility to stakeholders that want to meet emission standards set by their governments. Through this social responsibility structure, voluntary carbon markets facilitate the formation of trade and use within verified emissions reduction credits. Therefore, the potential success or collapse of a voluntary carbon market is largely determined by the authentic measurement of sequestered carbon.

Compulsory market systems are used significantly more than voluntary markets. However, the majority of the growth for carbon credits in the United States is taking place in voluntary markets, due to the markets' quick and efficient project creation and validation process. Voluntary markets have no central regulator requiring projects to go through a specific review process. This lack
of regulatory oversight allows independent verifiers to create their own validation methodology, thus promoting new project efficiency. Therefore, independent methodologies for issuing carbon credits continue to grow for voluntary markets. These new mechanisms are responsible for 65% of carbon credits issued in 2019. In recent years, demand for carbon credits has increased exponentially, creating a need for efficiency within carbon registries and compliance with a uniform carbon standard.

Despite the challenges facing voluntary carbon market implementation, there remains a demand for a U.S. voluntary carbon market, but also a need to create well-developed and robust global voluntary carbon markets as a means of managing carbon economics and combating the threat of climate change. The United Nations wrote in its 2019 Emissions Gap Report that GHG emissions “will remain a staggering 32 billion metric tons . . . higher in 2030 than they need to be in order to meet the Paris Agreement’s 1.5°C target.” In order to mitigate the effect of the overflow, “companies must not only slash their [GHG] but offset any emissions they cannot eliminate and actively support activities that remove carbon from the atmosphere.” As a result of this trend, there is a predicted shortfall in verified carbon offsets. Voluntary carbon credits are expected to be in high demand into the long-term future.

B. Carbon Registries and Verra’s Verified Carbon Standard

The recent growth of voluntary carbon markets in the United States can be attributed to carbon registries and new carbon capture methodologies. Carbon
registries validate carbon sequestration projects and the total amount of credits generated from the project.\footnote{112} Carbon sequestration is the natural or artificial process by which carbon dioxide is removed from the atmosphere.\footnote{113} Without a carbon registry, there would be no way to confirm the validity of a carbon sequestration project;\footnote{114} the verification and validation of a carbon sequestration project is paramount in ensuring that legitimate carbon credits are being created.\footnote{115} Several registries, verified by the International Organization for Standardization, have created accreditation systems that standardize the development of carbon credits, lending legitimacy and value to global carbon markets.\footnote{116} However, every registry has a different process for calculating sequestered carbon for specific projects.\footnote{117} Although registries play a critical role in the voluntary market’s functionality, their shortcomings hinder its full potential.\footnote{118}

A substantial distinction between compulsory and voluntary markets is the universal carbon sequestration standard utilized by compulsory markets.\footnote{119} Compulsory markets have a central regulator that determines the carbon standard;\footnote{120} in the EU ETS, a carbon sequestration project seeking to generate carbon offsets must follow the predetermined carbon sequestration methods established by the EU ETS.\footnote{121} Conversely, voluntary markets do not have any regulatory oversight that establishes a universal carbon sequestration standard.\footnote{122} The voluntary market’s carbon sequestration standards are primarily driven by end-consumer interests and not mandatory compliance mechanisms like compulsory carbon markets.\footnote{123}


\footnote{112} Id.}

\footnote{113} What is Carbon Sequestration, supra note 40.}

\footnote{114} See Sullivan, supra note 112.}

\footnote{115} Id.}


\footnote{118} Fredman & Phillips, supra note 63.}

\footnote{119} Jurado, supra note 10.}

\footnote{120} Id. (“In the case of cap-and-trade (or Emissions Trading Systems - ETS) programs, regulators set a limit on carbon emissions - the “cap”, which slowly decreases over time.”).}

\footnote{121} Newsletter, supra note 73.}

\footnote{122} See Jurado, supra note 10.}

\footnote{123} See Kollmuss et al., supra note 106, at 12, 31.
The ability to subjectively create and approve new carbon sequestration methodologies without regulatory guidance or affirmation is problematic.124 Currently, there are four prominent carbon registries that help drive the usage of voluntary markets by verifying carbon sequestration project applications and issuing their own independently verified carbon credits,125 and each registry has its own independent carbon sequestration standards.126 This lack of carbon sequestration standardization in the market promotes an unhealthy competitive nature between the registries, which can potentially lead to carbon credit verification manipulation.127 A universal carbon sequestration and calculation standard would promote a comprehensive approach to ensure carbon credit verification manipulation does not occur.128

Verra created the Verified Carbon Standard in 2006, standardizing carbon credits for the voluntary carbon market.129 Currently, Verra is the most widely used carbon offset standard with just over 410 million carbon credits generated from almost 1600 projects.130 Project developers under the Verified Carbon Standard can be awarded Verified Carbon Units (VCUs) if their project meets Verra’s rules and standards.131 Projects must apply to the Verra program, which accepts projects when they are deemed real, additional, measurable, permanent, independently verified, and transparently registered.132 Leakage and uncertainty are measured against a credible emissions baseline.133 VCUs are made from a five-step process, beginning with “project developers choos[ing] a pre-approved methodology that applies to their project or develop[ing] a new methodology using the methodology approval process.”134 Second, the project developers describe and list the project on the Verra Carbon Standard project pipeline.135 Third, the project developer validates

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124 Kreibich & Hermwille, supra note 103, at 951.
126 Jurado, supra note 10.
127 Fredman & Phillips, supra note 63.
128 Newsletter, supra note 73; see Kreibich & Hermwille, supra note 103, at 951–53.
129 See Needelman et al., supra note 10, at 2159–71.
132 Id.
135 Id.
its project description via a validation/verification body.\(^{136}\) Fourth, the project developer must verify its emissions reductions data and a validation/verification body must verify the data.\(^{137}\) Finally, the project developer must request issuance of the credits.\(^{138}\) Once issued, the carbon credits can be held, sold, and retired.\(^{140}\)

Verra’s carbon calculation process is the most widely utilized methodology for voluntary markets.\(^{140}\) Its validation methodologies exhibit advanced scientific innovation for carbon monitoring and reporting.\(^{141}\) However, Verra is not without problems. Being the most used service causes significant delays in project applications.\(^{142}\) The delay in the project application timeline has led many project developers to seek verification from other registries,\(^{143}\) most of which are smaller operations that implement arguably more efficient verification processes.\(^{144}\) Thus, while Verra remains the most used registry from a global perspective, other registries, such as Gold Standard, are increasing in the United States due to the registries’ expedited timelines to get projects approved.\(^{145}\) Further, despite promoting new carbon measurement technologies, Verra cannot realistically guarantee that a proposed project is seen to fruition over time, nor is there a consistent measurement input requirement from project developers.\(^{146}\) Verra does account for potential permanence issues in its project verification process, but proper calculation of carbon permanence is highly debated in the environmental community.\(^{147}\) And although requirements for ongoing data and input from project developers have been established in Verra’s bylaws, manually inputted data is not audited consistently.\(^{148}\)
Despite these ongoing data auditing problems, Verra’s carbon calculation standard consistently outperforms other registries.149 If Verra can overcome its inefficient verification process and resolve its auditing issue of manual data entries, its carbon calculation standard would be the ideal universal carbon calculation standard for voluntary carbon markets to follow.

III. Issues Facing the Voluntary Carbon Market

Current voluntary carbon markets achieve the goal of providing carbon credits to private companies or entities to offset their emissions, regardless of how carbon was sequestered.150 Though the primary purpose of the market is functional, significant structural issues regarding market uniformity and transparency remain.151 And the highlighted participation growth within these structurally problematic voluntary markets poses a threat of instability.152

A lack of uniformity in the market drives confusion and misunderstanding with carbon offset calculation.153 The lack of transparency within this fragmented market raises concerns over carbon credit quality assurance due to misunderstandings of best practices.154 Additionally, without a uniform acceptance and implementation of best practices, emitters can take advantage of the fragmented market and double-dip on the usage of carbon credits.155 Finally, the market does not seem to have a solution to address the problems of additionality in flawed carbon offset projects, or to prevent emissions leakage from compliance.156

A. Lack of Uniformity

Despite the complex growth of ETSs, carbon markets have yet to reach their true potential in the United States.157 Currently, carbon markets are underdeveloped
and inefficient in achieving their goal of supplying an effective mechanism for offsetting GHG emissions. Voluntary carbon markets in the United States possess various problems that prevent accountability and transparency for the consumer. Therefore, U.S. voluntary markets are not currently situated to properly scale to their predicted net worth due to a discord among participating parties.

The first overarching issue with voluntary carbon markets is lack of uniformity. Currently, there is no universal standard for the establishment or accreditation of carbon credits, which creates confusion within the marketplace. This confusion leads to disputes over what factors should be considered when creating carbon credits, volatility in prices, and a lack of consumer confidence. For example, there are four carbon registries that validate and verify carbon sequestration projects. This fragmented market approach creates significant disputes over how carbon sequestration should be calculated. The majority of disputes concern proper carbon calculation and quality ratings of offset projects, including how offsets should be rated based on the creation process.

Another problem that arises in a non-uniform carbon market is the quality assurance of carbon credits. This is the most important consideration when assessing the efficacy of the carbon market. Without proper quality assurance,
the value of carbon credits is dubious, and the entire system fails as a reliable means of offsetting GHG emissions.\textsuperscript{169} For example, a carbon registry that does not appropriately record the carbon project’s methodologies runs the risk of creating faulty credits.\textsuperscript{170} Early standards by which carbon credits were issued failed to meet acceptable quality levels due to a lack of oversight; thus, the entire industry suffered from a loss of credibility.\textsuperscript{171} Additionally, early reports state that “[p]roject developers must demonstrate, beyond any doubt, that the project and associated credits compensate for the quantity of emissions that they are supposed to. However, verification can be costly, especially for smaller-scale project developers.”\textsuperscript{172} Assuring quality is challenging with multiple certification bodies and evolving criteria for determining acceptable carbon credits.\textsuperscript{173} Quality assurance drives the legitimacy of the market through social adherence to participants’ GHG emission goals.\textsuperscript{174} Without proper quality assurance, an emitter using the credit to offset its emission runs the risk of being associated with faulty credits because it does not know the history of the credit.\textsuperscript{175}

Finally, lack of uniformity leads to problems of leakage and additionality.\textsuperscript{176} Leakage happens when emissions are not reduced on net because reductions in one geographical location merely shift emissions-intensive activities elsewhere.\textsuperscript{177} For example, a company could offload all of its higher emitting practices to a country that is not a part of a cap-and-trade system monitored by its government.\textsuperscript{178} Additionality occurs when an offset is produced over and above “business-as-usual.”\textsuperscript{179} Over and above business-as-usual means that the emission reduction would
not have been built without the investment through selling carbon offset credits. Additionality concerns are rising due to the voluntary market’s exponential increase and more market participants applying to receive carbon credits for practices that are already in place.

B. Lack of Trust and Transparency

The second overarching issue in voluntary carbon markets is the lack of trust and transparency in the system. Almost all voluntary carbon market registries validate projects and calculate carbon credits through their exclusive methodology. For many projects, the validation and creation process takes place in a black box where the project developers are not aware of the criteria for validation. Restricting disclosure of the offset validation process results in poor transparency to the project developers and its end consumers, delegitimizing the market. For example, when a project developer applies to receive carbon financing for a forest preservation project on its land, the registry must ensure that the land is going to be used for a consumptive purpose prior to the owner’s desire to preserve the land. It is common for registries not to launch a full investigation into the prior expected usage of the land. This conduct creates faulty credits and causes distrust for the end consumer.

Double spending is an issue that arises in the current voluntary carbon market as a result of the lack of transparency. Double spending occurs when

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184 See Junghoon Woo et al., Applying Blockchain Technology for Building Energy Performance Measurement, Reporting, and Verification (MRV) and the Carbon Credit Market: A Review of the Literature, 205 BLDG. & ENV’T 1, 6–10 (2021).

185 Id.; see also The VCS Project Cycle: Step by Step, supra note 134; Merger & Pistorius, supra note 39, at 2.


187 See id.

188 See id.

189 See Needelman et al., supra note 10, at 2159–71; see also TRANSFORMING CLIMATE FINANCE AND GREEN INVESTMENT WITH BLOCKCHAINS 233, 236 (Alastair Marke ed., 2018).
a carbon credit is sold for one purpose in one market and then resold again in a separate market or to a private entity. This causes the credit to be spent twice, since the two parties believe they possess an authentic credit which represents an offset of one MTCO2e. The risk of double spending in carbon markets is a critical problem that must be quickly addressed. Double spending is a detriment to the environment and gives market participants the ability to legitimize GHG emissions using credits that have already been redeemed.  

C. The Ideal Carbon Credit

Meeting the ideal standard for the voluntary carbon market remains an unattainable goal under the current regime. The ideal carbon credit would be an exact representation of one MTCO2e, calculated by a universally-accepted standard and affirmed by independent third-party validators. Pursuant to this standard, certified entities would issue carbon credits in compliance with transparent data reporting. Validation by independent third-party validators would alleviate the regulators’ responsibilities and promote an efficient validation process. Following a universal carbon calculation standard would ensure a uniform carbon calculation methodology. Certified entities must have a clear methodology for assessing

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193 See Si Chen et al., supra note 191, at 17.

194 See Phase II REPORT, supra note 8, at 41.

195 See id. at 9–13.


197 KOLLMUS ET AL., supra note 106, at 2, 31 (“[T]he emphasis is on creating a market for innovative projects with as little administrative burden as possible.”); see Guthrie & Kumareswaran, supra note 196, at 276–78; see also Sedjo & Marland, supra note 196, at 440–43; Jennifer L., What is the Best Carbon Credit to Buy?, supra note 196.

198 See Blaufelder et al., supra note 6.
the validity of project data, and this process must be properly peer reviewed and guaranteed in case of inaccuracies.\textsuperscript{199} Having a clear methodology of potential carbon projects seeking carbon financing adds a layer of consumer protection to the purchaser.\textsuperscript{200} Implementing sufficient requirements for carbon calculation should defend against any faulty project applicants.\textsuperscript{201}

The carbon credit itself should be globally recognized as the standard for representing the sequestration or avoided GHG emission of one MTCO\textsubscript{2}e, allowing it to be liquidly traded across the world.\textsuperscript{202} More importantly, the credit should be able to be burned, representing its finality of use as a carbon offset, preventing double spending.\textsuperscript{203} With all these factors set forth as the standard, a voluntary carbon market could be created that is scalable, accessible to consumers and participants, and transparent.\textsuperscript{204} The following Part will illustrate how a new blockchain protocol, coupled with uniform carbon credit standardization, could be implemented to create such a carbon credit.

IV. ENVISIONING A BETTER VOLUNTARY CARBON MARKET

If the United States does not pursue an alternative approach to correct the U.S. voluntary market, consumers and the environment will be negatively impacted.\textsuperscript{205} For the voluntary market to overcome its substantial issues, there must first be widespread standardization for carbon sequestration methodologies.\textsuperscript{206} Standardizing the carbon calculation process for new sequestration projects promotes uniformity and quality assurance in the market.\textsuperscript{207} Once a standard has been set, a new blockchain protocol can be applied to implement those standards.\textsuperscript{208}

\begin{footnotesize}
\begin{enumerate}
\item[199] See id.
\item[200] See id.
\item[201] See id.
\item[202] See id.; Mandatory & Voluntary Offset Markets, supra note 85.
\item[205] Int’l Swaps & Derivatives Ass’n, Legal Implications of Voluntary Carbon Credits 23 (2021) [hereinafter ISDA Legal Implications], https://www.isda.org/a/38ngE/Legal-Implications-of-Voluntary-Carbon-Credits.pdf [https://perma.cc/U3CZ-E7NQ]; see Marchant et al., supra note 182, at 168; Kollmuss et al., supra note 106, at 2, 13, 20, 24, 73.
\item[206] See Phase II Report, supra note 8, at 9–13.
\item[208] See Marchant et al., supra note 182, at 174–75.
\end{enumerate}
\end{footnotesize}
Blockchain reporting would provide an open database containing the origin and transactional history of all carbon credits, promoting transparency and creating trust in the market. The following section introduces how voluntary carbon market uniformity allows for the implementation of blockchain as a vehicle to help implement standardization for the voluntary carbon market.

A. Standardizing the Carbon Market

Given the lack of uniformity in carbon credit standards and the lack of transparency in carbon credit methodology, voluntary markets struggle with a number of issues, including additionality, leakage, and quality assurance concerns. As mentioned earlier, quality assurance is the most important consideration when assessing a new carbon market scheme; by improving quality assurance, concerns of additionality and leakage are resolved. This is because end consumers for voluntary carbon markets must be assured that the carbon credit they are purchasing will legitimately help mitigate their GHG emissions. The higher the risk of illegitimate credits, the less consumers will participate in the market due to overall mistrust in the system. Quality assurance is difficult to attain with multiple certification bodies and shifting compliance criteria for an acceptable carbon credit.

These market issues can be addressed through industry-wide agreement regarding benchmarks and baselines to standardize the calculation of voluntary carbon credits. The specific accreditation system would provide a standardization methodology from a singular credit-issuing entity. This would create a trustworthy precedent for participants and energy consumers while ultimately helping scale the market properly over time. First, the market must regulate how sequestered carbon is calculated and the permittable carbon sequestration project types.

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209 See id.
210 See Blaufelder et al., supra note 6; ISDA LEGAL IMPLICATIONS, supra note 205, at 17.
211 See supra notes 168–77 and accompanying text.
212 See The VCS Project Cycle: Step by Step, supra note 134.
213 Kreibich & Hermwille, supra note 103, at 941; The VCS Project Cycle: Step by Step, supra note 134.
214 See Needelman et al., supra note 10, at 2159–71; The Global Rise of Emissions Trading, supra note 51; The VCS Project Cycle: Step by Step, supra note 134.
216 See Guthrie & Kumareswaran, supra note 196, at 276–78; see also Sedjo & Marland, supra note 196, at 440–43; Jennifer L., What is the Best Carbon Credit to Buy?, supra note 196.
217 See Guthrie & Kumareswaran, supra note 196, at 276–78; see also Sedjo & Marland, supra note 196, at 440–43; Jennifer L., What is the Best Carbon Credit to Buy?, supra note 196.
218 Blaufelder et al., supra note 6.
Agreeing how to calculate sequestered carbon and providing confirmed carbon sequestration project types would ensure legitimate carbon credits are issued.\textsuperscript{219} Implementing Verra’s Verified Carbon Standard as the universal carbon calculation method would require all carbon registries to comply with Verra standards, and Verra would only approve projects in accordance with the VCS.\textsuperscript{220} This would eradicate illegitimate carbon credits that are incompatible or non-compliant with the uniform standard.\textsuperscript{221}

Industry-wide carbon calculation standards could overcome market fragmentation, leakage, and additionality concerns.\textsuperscript{222} The fragmentation of the voluntary market would cease after standardizing a carbon calculation process such as Verra’s VCS.\textsuperscript{223} Carbon sequestration project owners would not be able to shop for verification at other registries with unsatisfactory calculation standards, solving domestic leakage concerns.\textsuperscript{224} Additionality could be addressed through an industry-wide carbon standard by ratifying an algorithm that can determine if the carbon sequestration project would be classified as business-as-usual.\textsuperscript{225}

Importantly, widespread standardization for carbon sequestration calculation is just one example of an industry-wide standard that can benefit the voluntary carbon market.\textsuperscript{226} A standardized approach to creating and issuing carbon credits connects the supply of the credits to purchasers in a seamless, cost effective, and transparent way.\textsuperscript{227} This would promote usage within the market and build trust between carbon project developers and carbon credit consumers.\textsuperscript{228} Standardizing the verification and authentication procedures guarantees the legitimacy of every carbon credit involved in a transaction.\textsuperscript{229} The uniform standard ensures that the purchaser understands the history of how the carbon credit was made and ensures certainty in the quality of the credit.\textsuperscript{230} An industry-wide standard for the creation, issuance, and exchange of carbon credits promotes proper market advancement over

\textsuperscript{219} Id.\textsuperscript{220} See Validation & Verification, supra note 140.\textsuperscript{221} See id.\textsuperscript{222} Kreibich & Hermwille, supra note 103, at 951–53.\textsuperscript{223} Id. at 953; see VCS Program Details, supra note 131.\textsuperscript{224} See Kollmuss et al., supra note 106, at 2, 20, 73; see Mandatory & Voluntary Offset Markets, supra note 85.\textsuperscript{225} See Cullenward, supra note 176, at 41.\textsuperscript{226} Blaufelder et al., supra note 6; ISDA Legal Implications, supra note 205, at 24.\textsuperscript{227} See World Bank Grp., State and Trends of Carbon Pricing 2020, at 6–8 (2020), https://openknowledge.worldbank.org/bitstream/handle/10986/33809/9781464815867.pdf?sequence=4&isAllowed=y [https://perma.cc/H5NJ-9PPQ]; Blaufelder et al., supra note 6.\textsuperscript{228} See World Bank Grp., supra note 227, at 6–8; Blaufelder et al., supra note 6.\textsuperscript{229} See Blaufelder et al., supra note 6.\textsuperscript{230} See World Bank Grp., supra note 227, at 47–53; Blaufelder et al., supra note 6.
Without proper scaling infrastructure in place, the current issues plaguing the voluntary market will continue to persist. Thus, there are two additional mechanisms of the U.S. voluntary carbon market that must be standardized. In addition to carbon calculation processes, the market must standardize the creation and issuance of carbon credits. In order to mint a carbon credit, the sequestration project must follow all reporting requirements from the VCS. Once the project is verified and the amount of sequestered carbon from the project is confirmed, carbon credits would be minted and issued to the project owner on an annual basis. A standardized carbon credit creation and issuance process ensures that noncompliant sequestration projects do not receive carbon credits.

Finally, the market must standardize the historical carbon credit record. The recording process tracks the history of the carbon credit, from creation to retirement. When the end consumer has access to the metaphorical carbon credit lifespan, this transparency promotes carbon credit legitimacy. Proper carbon credit archiving ensures project transparency and accessible documentation to auditors. Once the industry-wide standard is established for carbon calculation, credit issuance and archiving blockchain could serve as a vehicle to properly implement the uniform standard.

Uniform carbon market standards could overcome market fragmentation, leakage, and additionality concerns, and create a foundation for ensuring legitimacy and quality assurance in voluntary carbon markets; however, standardization on its own might not overcome issues of transparency. Trust and transparency concerns within voluntary carbon markets can be settled by revealing internal processes from

232 See id.
233 Blaufelder et al., supra note 6.
234 See id.
235 See Validation & Verification, supra note 140.
237 See Validation & Verification, supra note 140.
238 Blaufelder et al., supra note 6.
239 Clark et al., supra note 89.
240 Consultation Document, supra note 171, at 34.
241 Id. at 77.
242 Marchant et al., supra note 182, at 174.
243 See Kreibich & Hermwille, supra note 103, at 950–53.
244 See Guthrie & Kumareswaran, supra note 196, at 276–78; see also Sedjo & Marland, supra note 196, at 440–43; Jennifer L., What is the Best Carbon Credit to Buy?, supra note 196.
the carbon registries’ verification process. Full transparency requires the public to have viewing access to all carbon credit transactions and how each credit was created. Providing accessible data that tracks the history of all tradeable carbon credits from creation to retirement would hold the registry accountable and build trust in the market. By standardizing carbon market processes, and implementing an immutable blockchain protocol, the strict rules established by the protocol will eliminate doubts of confusion, distrust, and credibility.

B. Blockchain with Carbon Credit Creation: Creating Trust and Transparency

Blockchain technology can solve the lack of trust and transparency within voluntary carbon markets. The issues that affect voluntary markets—lack of infrastructure connectivity, price availability, carbon credit valuations, and asset liquidity—can be resolved through a blockchain protocol. As envisioned, blockchain was created as a medium of transparent, accurate transactions between third parties. Therefore, fundamentally, a blockchain protocol for carbon markets increases connectivity to the market and carbon credit information, given the nature of an open-public-facing platform. Using blockchain technology would allow new project developers to easily join the program by following the predetermined rules. Considering the global initiative to address climate change, a novel implementation of blockchain within carbon markets could further progress the voluntary carbon market.

245 See Marchant et al., supra note 182, at 166–67.
246 See Phase II Report, supra note 8, at 28.
247 See id.
251 Lewis Popovski & George Soussou, A Brief History of Blockchain, LEGALTECH NEWS (May 14, 2018), https://www.pbwt.com/content/uploads/2018/05/010051804-Patterson.pdf [https://perma.cc/5GLJ-4JZK].
253 See Michael Crosby et al., Blockchain Technology: Beyond Bitcoin, APPLIED INNOVATION REV., June 2016, at 6, 7.
254 See id.
In essence, a blockchain mechanism would implement an immutable public ledger that holds all participants accountable. The protocol would make a platform for handling the measurement, reporting, and verification of carbon credits. More specifically, the new mechanism would provide a tool to help scale voluntary carbon markets around sustainability and transparency. A blockchain mechanism, utilized within a voluntary carbon market system, would create an unprecedented level of accountability for offset project owners.

Blockchain automation produces an immutable receipt or ledger that is dispersed, agreed upon, and validated by the participants in the collective operation. The first instance of blockchain dates back to the creation of Bitcoin in 2009. Bitcoin is an established cryptocurrency that created blockchain technology for processing transactions remotely through a peer-to-peer network that does not use a bank. The premise for blockchain was founded on the capability to reach a consensus between dispersed parties. The creator of Bitcoin developed blockchain technology in response to the exposed structural trust issues of the 2008 housing market crash. This novel system generates proof of ordered transactions that are chronologically validated by peer-to-peer systems.

The fundamental structure of a blockchain involves a new block of transactions bound to the preceding block. In order to establish a new block of data on the chain, multiple different verifying systems must concur on the legitimacy of the transaction. The action of attaching the new block to the preceding block requires solving a cryptographic problem; while significant computational power

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256 See id. at 4–7.

257 Marchant et al., supra note 182, at 174.


261 See What is Blockchain Technology?, supra note 259.

262 See id.

263 See Nakamoto, supra note 260, at 1, 3, 8; Malcolm Campbell-Verduyn, Beyond Scandal: Blockchain Technologies and the Fragile Legitimacy of Post-2008 Finance, 5 Fin. & Soc’y 126, 127 (2019).

264 Nakamoto, supra note 260, at 1, 3, 8.

265 Id. at 3.

266 Id. at 3–5.
is used to solve the problem, less computational power is used to validate the solution.\footnote{See id.} Once the new block is attached, it passes the current data of transactions along with the data from the preceding block.\footnote{Id. at 1, 3, 4–8.} When a transaction is recorded on the blockchain, a single verifier solves the cryptographic problem established by the predetermined rules and provides its solution for other verifiers to confirm the transaction’s legitimacy.\footnote{See id. at 3–4.}

“Smart contracts” are programs that automatically run when specific predetermined conditions are met.\footnote{What are Smart Contracts on Blockchain?, IBM, https://www.ibm.com/topicsSMART-contracts [https://perma.cc/LY63-JWTS] (last visited Jan. 2, 2023).} Once the program protocol is created, no external forces may influence the rules unless stipulated in the programming.\footnote{See id.} All automated actions or transactions from smart contracts could be compiled at preset intervals and recorded in a block where they are chained together with all previous transactions that have been performed on the blockchain.\footnote{See id.} Smart contracts can contain rules for calculating financial assets and decode complex mathematical problems.\footnote{See What is a Decentralized Autonomous Organization, and How Does a DAO Work?, COINTELEGRAPH, https://coingecko.com/decentralized-automated-organizations-daos-guide-for-beginners/what-is-decentralized-autonomous-organization-and-how-does-a-dao-work [https://perma.cc/XNH6-XUEV] (last visited Jan. 2, 2023); Alexandra Sims, supra note 248, at 429–30.} More importantly, smart contracts have the ability to perform institutional bylaws, enabling organizations to operate autonomously and with a higher level of efficiency,\footnote{See What is a Decentralized Autonomous Organization, and How Does a DAO Work?, supra note 272; see also Youssef El Faqir et al., An Overview of Decentralized Autonomous Organizations on the Blockchain, OPENSYM’20: PROC. 16TH INT’L SYMP. ON OPEN COLLABORATION (2020); Alexandra Sims, supra note 248, at 429–30.} thus opening up the potential for the creation of decentralized autonomous organizations (DAOs). A DAO is established when multiple smart contracts are created in unison to run an autonomous entity.\footnote{See What is a Decentralized Autonomous Organization, and How Does a DAO Work?, supra note 272; see also El Faqir et al., supra note 273; Lu Liu et al., From Technology to Society: An Overview of Blockchain-Based DAO, 2 IEEE OPEN J. COMPUT. SOC’Y 204, 205–06 (2021); Alexandra Sims, supra note 248, at 429–30.} There is no central authority within a DAO; rather, the entity is run collectively by its stakeholders.\footnote{Samer Hassan & Primavera De Filippi, Decentralized Autonomous Organization, INTERNET} The voluntary carbon market could implement a DAO as an additional smart contract to follow the standard, but creating an entire new governance model would take years to perfect.\footnote{See id. at 433–44.} Voluntary markets could entertain
the idea of automated smart contracts, which would automate the entire credit verification process so long as carbon project developers remain in compliance with the reporting standard. Implementing a DAO for the voluntary market would automate market facilitation from carbon credit creation to retirement.

C. Implementing Blockchain with Carbon Credit Creation in Carbon Markets

Connecting a blockchain protocol to a standardized carbon calculation process creates a sustainable, data-backed mechanism for creating new carbon credits. When project developers consistently upload data relating to the specifics of their sequestration projects, the data establishes a precedent that must be followed to receive credit issuance. The ongoing data entry from project developers would be on a publicly accessible chain. The chain would therefore record both trading and retiring of data-backed carbon credits. In addition to the automation capabilities, a blockchain approach can improve the efficiency of verifying carbon sequestration projects. Further, a blockchain-backed carbon credit would fix the carbon double spending problem and transition the existing carbon economy into a standardized, globally accessible, and liquid carbon economy built upon transparent verified carbon credits.

Blockchain implementation serves as a secured ledger within the voluntary carbon market that also calculates and produces carbon credits. For example, reforestation projects are projects commonly utilized to produce carbon credits. When trees grow, they naturally remove carbon from the atmosphere and store it internally and within soil. Planting new trees at a large scale sequesters enough

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278 Jurado, supra note 10.

279 See Hassan & De Filippi, supra note 277, at 4.

280 See Saraji & Borowczak, supra note 252, at 1–3.


282 See Saraji & Borowczak, supra note 252, at 4–5; see also The Global Rise of Emissions Trading, supra note 51.


284 See Hassan & De Filippi, supra note 277, at 2–3.

285 Marchant et al., supra note 182, at 176.

286 See Saraji & Borowczak, supra note 252, at 4; see also The Global Rise of Emissions Trading, supra note 51.

287 See Saraji & Borowczak, supra note 252, at 3.

carbon to create carbon credits so long as the trees continue to grow. The process begins with the project developer selecting a plot of land where the new trees will be planted. The developer then submits specific information about the plot of land to the carbon registry for credit issuance. The carbon registry evaluates the application to determine if the project qualifies for carbon credit issuance. If the project is verified, the registry requires consistent data submission from the project developer on the health and growth of the trees. If the project developer consistently complies with the data submissions and the trees remain healthy, the registry annually issues the carbon credits earned by the project.

A new blockchain protocol could expedite the verification process and protect against falsified data submissions from project developers. If the proposed protocol is put in place, the carbon registry verification process would be entirely automated. Once the carbon project developer applies for credit issuance, the protocol would create a non-fungible token (NFT) on chain tethered to the project application.

An NFT is a smart contract mechanism that is used to represent ownership on the blockchain. In this proposed blockchain protocol, it represents that the developer of the reforestation project is the verified owner. For example, once

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292 See Validation & Verification, supra note 140.

293 See id.

294 See id.

295 See SARAJI & BOROWCZAK, supra note 252, at 4–5; Marchant et al., supra note 182, at 175.

296 See SARAJI & BOROWCZAK, supra note 252, at 4–5; Marchant et al., supra note 182, at 179.

297 See Jessop et al., supra note 252; SARAJI & BOROWCZAK, supra note 252, at 4–6.


299 See SARAJI & BOROWCZAK, supra note 252, at 5.
the blockchain protocol creates the NFT and tethers the ownership to the project developer, the project would receive its credit issuance as the owner of the NFT.\footnote{See id. at 6.} Under an NFT protocol, all newly minted carbon credits would have unique addresses with data on the chain to confirm its validity through to creation.\footnote{See id.} The unique NFT signature from the project would be archived on the carbon credit.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} The NFT owner would possess the carbon credits generated by and issued to the tethered sequestration project at the time of creation.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} Effectively, a single NFT can be tethered by any specified amount of carbon credits.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} When a transaction is made, the purchaser receives an NFT which contains the number of credits purchased.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} This process ensures that historical data dating from the time the project applicant applies to the creation of the credit is recorded to the database.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.}

Under an NFT blockchain protocol, all new carbon credits would have a burn function which would serve the same purpose as an entity retiring a carbon offset—i.e., the credit could no longer be used toward offsetting emissions.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} Implemented smart contracts automate the transfer of the carbon credits after the transaction; when the carbon credits reach the end consumer, the credits are burned and archived.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} Once a carbon credit is burned, the smart contract would generate a certificate to confirm that the credit was retired at a specified date and time.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} As all new carbon credits are tracked on chain and correlated with the finalization of a project developer’s verification period, it would be possible to track the carbon credits from creation to burn.\footnote{See generally Jessop et al., supra note 252; Saraji & Borowczak, supra note 252.} The implementation of smart contracts expedites
the transaction verification process and archives all burned credits to ensure no double spending occurs.\textsuperscript{311}

This process effectively solves the issue of double spending because the newly minted carbon credits are effectively burned out of existence.\textsuperscript{312} Blockchain-backed carbon credits are unable to be double spent due to a built-in burn feature that would properly retire the token once used and recorded on chain.\textsuperscript{313} The NFT serves as an indicator and notifier by maintaining the amount, account, date, and time of the burn stored on chain.\textsuperscript{314} When an offset is created by a carbon project on chain, the history of how the offset was made is attached.\textsuperscript{315} Once the offset is sold to the purchaser, the transaction of the offset is recorded on chain.\textsuperscript{316} When the purchaser retires the offset, a new NFT will be issued to the offset consumer.\textsuperscript{317} In essence, the NFT would be tethered to the entire history of the carbon credit, portraying creation, retirement, and history of ownership.\textsuperscript{318} This process would make it impossible to forge a retired offset NFT due to the token’s need for verification on chain.\textsuperscript{319}

The use of blockchain promotes a transparent and trustworthy marketplace for the consumer and seller.\textsuperscript{320} However, additionality and leakage cannot be solved without first establishing industry-wide carbon market standards.\textsuperscript{321} Thus, blockchain can serve only as a vehicle for trust and transparency; by itself, it is unable to solve additionality and leakage concerns.\textsuperscript{322}

\textsuperscript{311} See Marchant et al., supra note 182, at 175.

\textsuperscript{312} Id.

\textsuperscript{313} See Saraji & Borowczak, supra note 252, at 4; see also The Global Rise of Emissions Trading, supra note 51; Validation & Verification, supra note 140.


\textsuperscript{316} See Pearson et al., supra note 315, at 4–8; see also What is Blockchain Technology?, supra note 259.

\textsuperscript{317} See Pearson et al., supra note 315, at 4–8; see also What is Blockchain Technology?, supra note 259.

\textsuperscript{318} See Pearson et al., supra note 315, at 4–8; see also What is Blockchain Technology?, supra note 259.

\textsuperscript{319} See Pearson et al., supra note 315, at 4–8; see also What is Blockchain Technology?, supra note 259.

\textsuperscript{320} Marchant et al., supra note 182, at 177.

\textsuperscript{321} See Saraji & Borowczak, supra note 252, at 1. See generally Crosby et al., supra note 253.

\textsuperscript{322} Axel Michaelowa et al., Additionality Revisited: Guarding the Integrity of Market Mechanisms Under the Paris Agreement, 19 CLIMATE POL’Y 1211, 1213, 1219 (2019); see Cullenward, supra note
The implementation of blockchain into current voluntary carbon markets would solve several of the challenges carbon markets face today. Additionally, the transition to blockchain would promote future innovations and technology to help solve the challenges of carbon markets. The following section explores the current regulatory landscape surrounding carbon credits and blockchain technology and demonstrates the viability of blockchain with federal and state policy.

D. Regulating Carbon Market Solutions

Despite the lack of federal regulation for voluntary carbon markets, federal agencies such as the Commodities Futures Trading Commission (CFTC) are beginning to realize the necessity to step in and help regulate the market. The CFTC recently hosted the first-ever voluntary carbon market on June 2, 2022; the event brought in climate policy scholars to discuss issues relating to carbon credits and their ability to properly offset GHG emissions. After the convening, the CFTC released a Request for Information to seek public comment on climate-related financial risks in regards to the voluntary carbon market. The CFTC does not have explicit jurisdiction over carbon credits on the voluntary market. And while there is an argument that carbon offsets could meet the definition of a “commodity” under § 1a(9) of the Commodity Exchange Act, at the time of this writing, the CFTC has yet to make a formal decision on its role in regulating the voluntary carbon market.

At the moment, there are no nationally accepted definitions of cryptocurrency, digital assets, or digital tokens in the United States. In SEC v. Ripple Labs, the SEC claims that specific cryptocurrencies are classified as unregistered securities, which would give the SEC regulatory oversight. Until

176, at 37–38.

See Saraji & Borowczak, supra note 252, at 1–3; see also Crosby et al., supra note 253, at 7.

See Saraji & Borowczak, supra note 252, at 1–3; see also Crosby et al., supra note 253, at 7.


Id.; Press Release No. 8541-22, supra note 325.

ISDA Legal Implications, supra note 205, at 14.

Id.; 7 U.S.C. § 1a(9).


legislation is passed or *Ripple Labs* is decided, federal law and regulation remain at issue for cryptocurrencies.\textsuperscript{333} There is an even greater legal question as to who would have federal oversight with a carbon credit NFT.\textsuperscript{334} This question would result in a battle of definitions.\textsuperscript{335}

State legislatures are making attempts to advance blockchain law. The State of Wyoming recently passed legislation that exempts cryptocurrencies from securities law by defining cryptocurrencies as intangible property if they meet the State’s test set forth within the Wyoming Utility Token Act.\textsuperscript{336} Under the Wyoming Utility Token Act, the open blockchain token must meet specific criteria to be considered personal intangible property.\textsuperscript{337} First, the predominant purpose of the token must be consumptive, meaning the token is exchangeable for “services, software, content, or real or tangible personal property, including rights of access to services, content or real or tangible personal property.”\textsuperscript{338} Second, the creator of the token must not market the token to the buyer as a financial investment.\textsuperscript{339} According to the Wyoming Utility Token Act, a financial investment is defined as a “contract, transaction, or arrangement where a person invests money in a common enterprise and is led to expect profits solely from the efforts of a promoter or a third party.”\textsuperscript{340} Third, one of the following must be met:

(A) The developer or seller reasonably believed that it sold the token to the initial buyer for a consumptive purpose;

(B) The token has a consumptive purpose that is available at or near the time of sale and can be used at or near the time of sale for a consumptive purpose;

(C) The initial buyer of the token is prohibited by the developer or seller of the token from reselling the token until the token is available to be used for a consumptive purpose; [or]

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\textsuperscript{335} See Press Release No. 2020-338, supra note 332.


\textsuperscript{337} § 34-29-106(b).

\textsuperscript{338} § 34-29-106(g)(ii).

\textsuperscript{339} § 34-29-106(b)(iii)(D).

\textsuperscript{340} § 34-29-106(g)(v).
(D) The developer or seller takes other reasonable precautions to prevent an initial buyer from purchasing the token as a financial investment.\textsuperscript{341}

A blockchain-backed carbon credit mechanism would likely comply with the Wyoming Utility Token Act.\textsuperscript{342} First, the predominant purpose of the carbon credit would be consumptive.\textsuperscript{343} A carbon credit is the purchase of a sequestration project’s service to capture carbon.\textsuperscript{344} The credit would tether to an NFT and would be exchangeable for a certified emission reduction toward the consumer’s emission levels.\textsuperscript{345} The token would be exchangeable for the right to emit one MTCO\textsubscript{2}e without regulatory consequence.\textsuperscript{346} Second, carbon credits are not marketed as financial investments.\textsuperscript{347} A purchaser does not receive a profit when purchasing carbon credits, though they can be resold after issuance;\textsuperscript{348} the purpose of a carbon credit is to offset emissions, not establish a commodity.\textsuperscript{349}

Finally, the issuance of a carbon credit would likely satisfy each of the possible options listed in § 34-29-106(b)(iii), rather than just one.\textsuperscript{350} The developer or seller of a carbon credit could reasonably believe that the sale of the credit was for consumptive purposes.\textsuperscript{351} Additionally, the credit can be used for consumptive purposes immediately after the transaction in compliance.\textsuperscript{352} The developer can restrict the initial buyer from reselling the token until the token can be used for a consumptive purpose.\textsuperscript{353} A credit cannot be issued until the carbon project is

\begin{itemize}
\item \textsuperscript{341}§ 34-29-106(b)(iii).
\item \textsuperscript{342}See § 34-29-106.
\item \textsuperscript{343}§ 34-29-106(g)(ii); see Marchant et al., supra note 182, at 179.
\item \textsuperscript{344}Verified Carbon Units (VCUS), supra note 165.
\item \textsuperscript{345}See SARAJI & BOROWCZAK, supra note 252, at 5.
\item \textsuperscript{346}See id. at 6; see also Crosby et al., supra note 253, at 14.
\item \textsuperscript{347}David E. Reichle, The Global Carbon Cycle and Climate Change: Scaling Ecological Energetics from Organism to the Biosphere 273 (2020); § 34-29-106(b)(iii)(D).
\item \textsuperscript{348}See Carbon Offset Verification: Are Your Offsets Legit?, Terrapass (Nov. 21, 2022), https://terrapass.com/blog/carbon-offset-verification-are-your-offsets-legit [https://perma.cc/QV5A-KF4X].
\item \textsuperscript{350}See infra notes 351–57.
\item \textsuperscript{351}See § 34-29-106(g)(ii); see also Lokuge & Anders, supra note 349, at 9. See generally SARAJI & BOROWCZAK, supra note 252.
\item \textsuperscript{352}See § 34-29-106(g)(ii); SARAJI & BOROWCZAK, supra note 252, at 1–3. See generally Crosby et al., supra note 253.
\item \textsuperscript{353}See § 34-29-106(g)(ii); SARAJI & BOROWCZAK, supra note 252, at 1–3. See generally Crosby et al., supra note 253.
\end{itemize}
verified by the carbon registry, the carbon credit issued to the initial buyer will have a consumptive purpose. Further, a developer must take precautions toward preventing the initial buyer from purchasing the token as a financial investment. A carbon registry’s purpose is to verify carbon sequestration projects seeking credit issuance and issue credits to the project developer. The inferred mutual understanding between the registry and the project applicants seeking carbon credits is that the credits will be used for a consumptive purpose.

For a standardized carbon market underpinned by a blockchain mechanism to function properly, there needs to be acceptance from participating jurisdictions. Participating parties must put a price on carbon that all jurisdictions accept. If even a small number of parties do not accept the price, significant leakage emissions will occur due to parties transitioning to a cheaper approach. The governance dilemma of compulsory carbon markets does not pose as many issues compared to voluntary carbon markets, due to the ability of compulsory markets to determine baselines without friction from other jurisdictions. Voluntary markets trigger the question of how to address carbon pricing within an ETS, creating a significant issue for the future of voluntary carbon markets. A ready-to-launch infrastructure that shows transparency, accessibility, uniformity, and quality assurance must be established prior to the acceptance of a universal carbon price. This infrastructure can be built on blockchain technology so future generations can appropriately scale the methodology over time.

354 Verified Carbon Units (VCUS), supra note 165.
355 See § 34-29-106(b)(iii)(D); Validation & Verification, supra note 140.
356 See Validation & Verification, supra note 140. As seen here, Verra’s validation standards are in place to verify carbon sequestration projects and issue credits, not give out financial investments. Id.
357 See Lokuge & Anders, supra note 349, at 9; § 34-29-106(g)(ii).
358 Blaufelder et al., supra note 6.
360 See Blaufelder et al., supra note 6; see also Patnaik & Kennedy, supra note 359; see also Boyce, supra note 359, at 57.
362 See Bayon et al., supra note 4, at 60, 65, 96–98, 100.
363 See id.
364 See Saraji & Borowczak, supra note 252, at 1–3; see also Crosby et al., supra note 253, at 17.
V. Conclusion

The implementation of a universal or industry-wide carbon credit calculation and issuance standard, backed by a new blockchain protocol, would solve current issues facing the voluntary carbon market. The first step toward standardizing carbon calculation and carbon credit issuance is establishing a uniform standard—in this case, Verra’s Verified Carbon Standard. Once the uniform standard is established, widespread market implementation via smart contracts on a new blockchain protocol will facilitate a smooth transition. Standardization of the voluntary market will address fragmentation, leakage, and additionality concerns. A supplemental blockchain protocol will expedite project verification and promulgate trust. The new protocol would be in compliance with carbon credit creation and proper archiving methodologies to ensure trust and transparency to end consumers. Finally, the new protocol would be in compliance with current federal regulation and Wyoming requirements.

Current initiatives have already begun utilizing blockchain to solve carbon market issues. However, blockchain alone cannot solve the contention surrounding the voluntary carbon market; blockchain merely serves as a vehicle to legitimize and expedite the carbon credit transaction and verification process. Establishing an industry-wide carbon sequestration calculation standard is paramount to the longevity of the voluntary market. The U.S. voluntary carbon market is at a breaking point: without widespread standardization of carbon market processes, the market will continue to facilitate the trade of illegitimate carbon credits.

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365 See Blaufelder et al., supra note 6.
366 Marchant et al., supra note 182, at 176.
367 See Cullenward, supra note 176, at 36; see also Zhang & Wang, supra note 176, at 140–42.
368 See Marchant et al., supra note 182, at 177.
369 See id. at 179.
370 See supra notes 342–57.
372 See Blaufelder et al., supra note 6. As there are multiple areas of concentration needed to fix the current infrastructure of the voluntary market. Blockchain does not provide a universal fix to the entirety of the problem. Ultimately it only serves as a vehicle to get to the end goal of transparency and efficiency. Id.
373 See id.; Marchant et al., supra note 182, at 177.
374 See Blaufelder et al., supra note 6.
375 See id.