STATE STREET®

Carbon Assets

Category Growth, Strategies and What Comes Next

April 2023

Preface

Emissions trading may be approaching its tipping point. Last year as global carbon emissions hit a record high of 58 gigatons, some 12.5 gigatons traded in the world's carbon compliance markets. Although voluntary trading is still quite low, total traded volume on emissions exchanges was roughly 20 percent of global emissions. Demand for carbon assets is expected to grow substantially as governments, companies, and communities tap into the power of markets to facilitate the energy transition. A study by GIC (a sovereign wealth fund in Singapore that manages its foreign reserves), the Singapore Economic Development Board, and McKinsey & Company forecasts a 15-fold increase in demand for carbon credits between 2021 and 2030. Alongside the exponential growth in volume, there are further opportunities to increase the quality and efficacy of tradeable carbon assets. International efforts to develop governance and market infrastructure for carbon trading is adding momentum to this emerging asset class.

With this collection of articles by experts across State Street, we provide a guide for institutional investors looking to understand the importance of carbon markets and how to approach them. Our first piece explains the mechanics of carbon markets: their role in the global transition to net zero, their structure and evolution, and, more importantly, some of the challenges involved.

In the next article, we explore carbon asset strategies for institutional investors. From portfolio diversification to hedging risk, carbon assets hold the promise of both facilitating the energy transition and generating returns for investors with carbon assets in their portfolio. Lastly, we look at opportunities for tokenization to increase liquidity and growth in the future.

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Chapter 1

The Growing Importance of Carbon Markets

By Hanbin Im, Allison Norman, and Priyaam Roy

The world is facing an unprecedented challenge from climate change. While many nations are committed to the goal of net-zero emissions by 2050 to limit global warming to 2 degrees Celsius relative to the pre-industrial era, progress has been slow.

The capital required to enable the energy transition is vast, technological advances for hard-to-abate sectors is needed, and private sector investment is critical to bridge gaps in public sector funding. One way to enable the energy transition is to promote well-functioning carbon markets. By pricing carbon, these markets help put the cost of greenhouse gas (GHG) emissions on to those who are responsible for them. The higher the cost of carbon, the more expensive high GHG production and consumption energy systems become, encouraging the use of renewable and net-zero emissions systems. There are two main mechanisms for creating a carbon price today: emissions trading systems (ETS) where the trade of carbon allowances determines the price of carbon and carbon taxes, which directly set the price of carbon. An increase in carbon prices, therefore, can be achieved through a combination of lower supply of allowances, increased demand for allowances, and an increase in carbon taxes.

In this article, we explore the current state of global carbon markets and the role they play in the energy transition. We also discuss the challenges carbon markets face as well as the efforts by investors and counterparties to overcome those challenges.

How Carbon Markets Work

There are two types of carbon markets: compliance where carbon allowances are traded, and voluntary where carbon offsets are traded. As the name suggests, compliance carbon markets primarily trade in carbon allowances in order to comply with regulations in respective jurisdictions, whereas voluntary carbon markets allow market participants to voluntarily purchase and trade carbon offsets (also known as credits) for other reasons, including to fulfill emissions goals or commitments to stakeholders. While the structure and purpose of the two markets are different, they are complimentary to each other (See Exhibit 1).

Exhibit 1: An Overview of Carbon Markets

CARBON ASSETS

	CARBON ALLOWANCE	CARBON CREDITS
TYPE OF MARKET	**Compliance Market**	**Voluntary Market**
ASSETS ISSUERS	Governmental	Certifiers of private projects
HOW IT WORKS	For Cap and Trade programs, Governments ***issue*** carbon allowances to companies based on defined emission thresholds: **Under-emitting companies:** ***Sell*** unused allowances; **Over-emitting companies:** ***Buy*** allowances ***to retire*** them and avoid penalties; **Financial institutions:** ***Buy*** allowances ***to sell*** them at a higher price.	For Voluntary carbon offsets programs, Organizations ***issue*** tradable carbon credits to project developers, after quantification of the achieved carbon reductions: **Project developers:** ***Sell*** carbon credits generated by the project; **Corporations:** ***Buy*** carbon credits ***to retire*** them and offset their own emissions (voluntary basis);[1] **Financial institutions:** ***Buy*** carbon credits ***to sell*** them at a higher price
MAIN MARKETS/ ASSETS	**Program Name** / **Registry** / **Asset Name** **WCI** (Western Climate Initiative) / CITSS / **CCA** (California Carbon Allowance) **EU ETS** (Emission Trading System) / Union Registry / **EUA** (European Allowances) **UK ETS** / UK Registry / **UKA** (UK Allowance)	**Program Name** / **Registry** / **Asset Name** **VCS** (Verified Carbon Standards) / **Verra** / **VCU** (Verified Carbon Units) **ACR** (American Carbon Registry) / APX / **VERs** (Verified Emissions Reductions) **CAR** (Climate Action Reserve) / The Offsets Marketplace / **CRT** (Climate Reserve Tonnes) **GS** (Gold Standard) / Impact Registry / GS Credits

A Closer Look at Compliance Carbon Markets

Compliance carbon markets (CCMs) are primarily operated through ETS where registered companies can trade carbon allowances created by the respective jurisdictions to comply with local emission cap requirements. The total traded value of CCMs was $925 billion in 2022.[2] As of April 2022, there were 68 carbon pricing schemes in operation globally with 3 more scheduled for implementation, covering approximately 23 percent of total global GHG emissions (this includes 34 ETS and 37 carbon tax schemes).[3]

The EU ETS is the biggest and most liquid carbon market globally. Most regional ETS allowances are available under cap-and-trade schemes on publicly traded exchanges, where investors can participate in an auction or by buying physical certificates or futures contracts in secondary markets.[4] The other mechanism of carbon pricing, carbon taxes, comes in two forms: emissions taxes, which are levied based on the quantity an entity produces; and taxes on goods or services that are generally GHG-intensive, such as a carbon tax on gasoline.[5]

More importantly, it remains unclear whether institutional investors will be allowed unrestricted access to compliance markets as they develop. McKinsey (2021) reports that discussions are underway in relation to several ETS on whether to impose constraints on the banking of allowances in order to minimize speculative trading and stabilize markets. As we discuss further below, it will be important for investors to focus not only on financial returns but also on enhancing liquidity and contributing to emissions reduction.

A Closer Look at Voluntary Carbon Markets

Voluntary carbon markets (VCMs) allow carbon credits to be traded by companies and individuals on a voluntary basis. Carbon credits are created by different projects related to protecting nature, nature-based sequestration, avoidance or reduction of emissions, and technology-based removal of carbon dioxide from the atmosphere. When a company engages in carbon removal activity, they capture an offset which can be purchased by other firms to reduce their own footprints. These projects are typically verified by a third party registry in order to ensure legitimacy of the project and avoid double counting.

According to Trove Research, the total traded value of VCMs was $1.2 billion in 2022.[6] Unlike compliance carbon markets where sizeable liquidity is already established, there is low liquidity and price discovery as prices have historically largely been determined via non-standardized processes between project developers, registries, and brokers. Trading in voluntary carbon markets is over the counter, with a lack of consistent contracts or agreed upon standards as well as the absence of market infrastructure, hampering the growth of these markets. However, several initiatives are underway aimed at improving the functioning of VCMs. For example, the Taskforce on Scaling Voluntary Carbon Markets (TSVCM) is working to establish the attributes and governance of a well-functioning global VCM while CBL Markets, a global exchange for transacting energy and environmental commodity products, is working to facilitate the delivery of standardized contracts.

The Mechanics of Carbon Allowances and Offsets in Enabling the Energy Transition

Carbon Allowances

Carbon allowance prices are determined by the market. Cap-and-trade is the most common system. It works by typically issuing a declining number of emissions allowances each year, effectively limiting, or capping, GHG emissions within the system.

Covered entities – primarily companies that generate electricity, supply transportation fuels and natural gas or operate large industrial facilities – may acquire allowances to emit carbon or other greenhouse gases in the following ways:

1

Receiving allowances assigned directly from the program administrator

2

Buying allowances in an auction

3

Buying allowances in the secondary or futures market

Covered entities then surrender carbon allowances commensurate with the amount of carbon they emit each year.

As the supply of allowances decrease each year, the cost to reduce emissions typically increases and the market must provide greater incentives to balance demand with shrinking supply. Furthermore, a number of market features have been established to reduce the impact of an economic downturn on carbon prices and support the robust functioning of these markets, including carbon price floors below which trading is not permitted, reduced auction volumes when allowances exceed a certain limit, and free allocation of allowances to companies based on benchmarks that reward the most installations in each sector.

The adjustment of auction volumes depending on the level of surplus allowances in the system in particular allows "non-compliance" investors such as asset managers or trading firms to contribute towards net zero by buying and holding physical allowances in some markets. In the EU ETS, specifically, the Market Stability Reserve reduces the supply of future EUAs held by investors directly, thereby increasing the scarcity of EUAs in the market. A recent report by the European Securities and Markets Authority (ESMA), however, notes limited impact from such behavior to the supply of allowances so far.[7]

Carbon Offsets

Carbon offsets are created through different types of crediting mechanisms including:

1

International crediting mechanisms established under treaties such as the Kyoto Protocol and the Paris Agreement

2

Domestic crediting mechanisms established by regional, national, or subnational governments such as the California Compliance Offset Program and the Australia Emissions Reductions Fund

3

Independent crediting mechanisms by registries such as Verra and Gold Standard

Corporations, institutional investors, and governments are the primary participants in the offset market. Participants can invest directly by commissioning their own offset projects and receiving portions of the credits generated by projects. They can also invest indirectly by purchasing offsets from the issuing project developers or retailers, with companies like Shell[8], BP[9], and Apple[10] making direct investments.

The key motivation for purchasing offsets is to fulfill net-zero or other emissions targets a company has set by compensating for and neutralizing their emissions. The interest in voluntary offsets has increased over time as new regulations such as Sustainable Finance Disclosure Regulation (SFDR) in the EU and voluntary disclosure frameworks such as from the Task Force on Climate-related Financial Disclosures (TCFD) have increased the awareness of and scrutiny around carbon emissions.

To ensure carbon emissions are avoided or reversed, offsets must meet the following requirements:

1. **Additionality:** carbon offsets cannot be something that would have occurred even in the absence of the offset project
2. **Permanence:** impact of carbon offset projects should not be reversed in the future
3. **No Double Counting:** emission reductions from an offset should be recorded once only

4. **No Leakage:** reducing emissions in one place should not lead to higher emissions elsewhere
5. **Verification:** reduction of emissions of the offset projects should be monitored and verified by accredited and independent third parties

In order to use a carbon offset to compensate for or neutralize emissions, fulfill regulatory or industry association requirements, or claim additional positive impact, a carbon offset must be purchased and then retired through a process completed by a registry so that no other participant can claim a benefit against the same credit. On the other hand, speculative investors have the intention to buy an offset, hold it and then sell it at a higher price at a later date. A buy-and-hold strategy, while not directly affecting a buyer's compensation or neutralization of emissions, indirectly impacts the supply of available offsets thus driving up demand and often the price, especially for high quality offsets. Buy-and-hold and speculative investors provide an additional benefit by improving the liquidity of the market, which is expected to increase as more participants become involved in the coming years.

To ensure carbon emissions are avoided or reversed, offsets must meet the following requirements: Additionality, permanence, no double counting, no leakage, and verification.

Overlap between Carbon Allowances and Carbon Offsets

While compliance carbon markets and voluntary carbon markets largely work independently, a few compliance carbon markets allow the use of carbon offsets for partial fulfillment of regulatory requirements. For example, the California Compliance Carbon Offset Program adopted the voluntary carbon offset project protocols developed by the Climate Action Reserve (CAR), albeit with some modification. The China ETS will also allow carbon offsets (China Certified Emission Reduction) to fulfill up to percent of allowances towards regulatory compliance. In addition to these markets, South Korea ETS, Regional Greenhouse Gas Initiative (RGGI), Quebec Cap-and-Trade System, Singapore Carbon Tax, and Colombia PNCTE allow the use of carbon offsets to fulfill some allowance requirements, albeit minimal amounts.

More importantly, carbon allowances and carbon offsets can both help reduce GHG emissions when firms are primarily incentivized to become less carbon intensive in their processes under the cap-and-trade system mechanism (via the "polluter pays" principle) while carbon offsets provide greater opportunities for more participants to contribute to emissions reductions (through subsidizing emission abatement).

Offsets as Interim Solutions for Hard-to-Abate Sectors

While not the only way to reduce the energy intensity of a company's operations, the purchase of carbon offsets can serve as a cost-effective head start on net -zero alignment for companies in hard-to-abate sectors that do not yet have viable solutions to abate their emissions. Studies suggest that early emission reductions yield greater benefit than later reductions. For example, an analysis of carbon pricing's impact on emissions found that a $35 per ton carbon tax would reduce cumulative U.S. emissions by 58 billion tons over a 30-year period, whereas regulation aimed at delivering the same annual emissions at the end of the same period would reduce emissions cumulatively by only 37 billion tons.[11] In a similar vein, creating opportunities for earlier emission abatement through the purchase of carbon offsets can be greater than waiting for later reductions in high emitting sectors. The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) is a notable example of a hard-to-abate sector using offsets as solutions, in which international airline operators participating in CORSIA have pledged to offset all the CO2 emissions they produce above a baseline level.[12]

Carbon offsets are not a perfect substitute for emission abatement, but they can provide opportunities for environmental benefits and reduced climate impacts that may not otherwise be attainable due to the high cost of some emission abatement opportunities or due to a lack of feasible solutions. Given the long timelines for emission-reducing technology development in many sectors, carbon offsets can serve as both a compelling investment opportunity for external parties and an incentive for high emitters to reduce emissions as the cost of emitting increases over time.

Challenges for Carbon Markets

Despite an increased focus on greenhouse gas reductions and a growing number of net -zero commitments by governments around the world, carbon markets are still very much an emerging asset class. That's primarily due to a number of challenges associated with carbon markets that need to be overcome.

1 Access & Coordination Issues in CCMs

In CCMs specifically, the linking of emissions trading systems across regions and jurisdictions – despite incremental gains in terms of liquidity and stability – has proven difficult. Systems can link bilaterally, unilaterally, or indirectly via commonly accepted international standards.

However, different emissions trading systems in operation across the globe diverge in terms of system compatibility, mandatory nature of the systems, the existence of absolute caps, etc. So far, the success stories include the linkage between EU ETS and Switzerland ETS[13], and

California Cap-and-Trade Program with the Quebec Cap-and-Trade System.[14] Successful linkage between these systems required yearslong negotiations on the agreement, alignment of regulations in two different systems,[15] and change of existing rules to extend the coverage.[16]

A lack of broad international coordination among regional ETS can result in carbon leakage, where local firms move abroad to a country with a lower carbon price.

In order to address this issue, the European Commission proposed the Carbon Border Adjustment Mechanism (CBAM) in July 2021 as part of its Fit for 55 legislative packages, which is an import tax on carbon emissions that are attributed to imported goods.

However, not all raw products or sectors are involved in CBAM, which raises the risk of potential carbon leakage in downstream sectors in the supply chain of manufactured products.[17] Several other countries are also exploring the adoption of carbon border adjustment. For example, Canada is looking to develop a way to apply border adjustments to emission-intensive imports like steel, cement and aluminum.[18] The United Kingdom parliament is also exploring potential adoption of the border adjustment mechanism.[19] Lastly, in July 2021, the United States introduced legislation to apply a carbon border tax on fossil fuel imports and emission-intensive imports.[20]

2 Integrity & Opacity Issues of VCMS

Due to its unregulated nature, the voluntary carbon market or the carbon offset market has been a subject of criticism from experts and market participants across the globe.

Companies buying offsets may be perceived as greenwashing their ledgers or "buying" their way into net zero rather than reducing emissions organically. Many of these activities have also been accused of worsening living conditions of inhabitants in areas where offset projects are underway. In 2021, Compensate, a Finnish nongovernmental organization and offset brokerage, analyzed 100 offset projects which were certified by Gold Standard and other groups. In their study, it was revealed that about 90 percent of these projects caused biodiversity loss and disruption of lives in local communities on top of failing to offset as much as they claimed. In the meantime, countries like Papua New Guinea, Indonesia, and Honduras have imposed a moratorium on VCMs until their governments are comfortable with the existing deals. This issue of "additionality" partly stems from the complexity of identifying the "baseline" level of emissions without the carbon offset project. Several registries of carbon credits acknowledge this issue and are undertaking efforts to ensure the legitimacy of the projects they certify. For example, the Climate Action Reserve is using the performance standard approach rather than individual project-based approach in assessing additionality,

where common practice and activities above common practice are researched to set up the performance threshold that can be applied to different projects.[21] American Carbon Registry employs a three-prong additionality test which requires projects to demonstrate exceedance of all currently effective laws and regulations, exceedance of common practice management of similar forests in the region and the implementation barrier. Mendelsohn, Litan and Fleming (2021) recommend the simplification of the baseline measurement using industry emission levels and measurement of carbon reductions or captures at a broad scale as potential solutions to overcome this challenge.

Another major drawback of the voluntary carbon markets is a lack of transparency. There is limited clarity on methodologies deployed for emissions calculations, making it increasingly difficult to judge the value of or actual amount of emissions reduced by offsets. A lack of standards and regulations further raises questions about the integrity and functioning of these voluntary markets, something that a number of international agencies are trying to improve.

Due to its unregulated nature, the voluntary carbon market or the carbon offset market has been a subject of criticism from experts and market participants across the globe.

What's Next for Carbon Markets?

Despite the challenges mentioned above, both compliance and voluntary carbon markets have shown exponential growth over the past few years[22] and are expected to grow further in the future. Some of the key driving factors are:

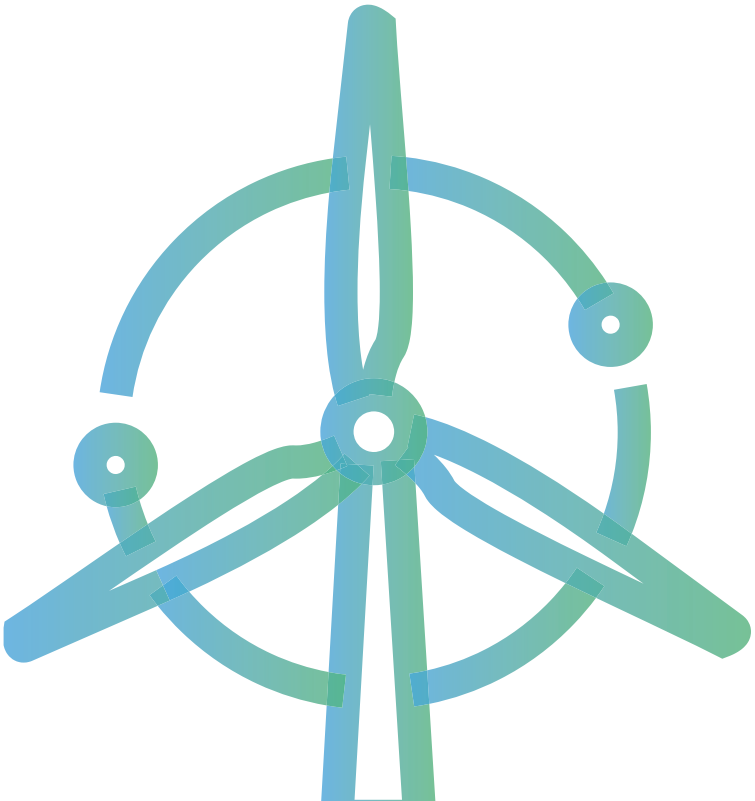
a. Increasing global demand for carbon allowances and offsets in the face of ever-tightening net-zero commitments of nations and climate mitigation efforts. With the disclosure of Scope 3 emissions nearing execution and many major economies expected to require emissions disclosure in the future, organizations will find themselves requiring more allowances and offsets to meet their emissions reduction plans.

b. Increasing demand for energy amidst rising gas prices, which has led to firing up of coal plants which is expected to increase the demand for carbon allowances and offsets thereby increasing carbon prices.

c. More stringent international standards to improve the legitimacy of and access to various global carbon markets, which should attract more demand from new market participants.

In accordance with such growth, the November 2022 United Nations Climate Change Conference (COP27) witnessed the announcement of multiple plans to expand and improve the carbon markets, such as Energy Transition Accelerator[23], African Carbon Markets Initiative[24] (ACMI), and Global Carbon Trust (GCT) and Carbon Storage Governing Council.[25] Along with these announcements, adoption of the rules under Article 6 of the Paris Agreement, which opens the pathway for international voluntary cooperation towards meeting the Nationally determined contributions (NDC) goals and also the need for project developers and market participants to adapt to new infrastructure, will likely accelerate the growth of carbon markets.

However, the growth and scaling of carbon markets cannot be achieved without addressing key challenges.



The TSVCM identified six key priorities needed for scaling up the voluntary carbon market:[26] 1) creating shared principles for defining and verifying carbon credits, 2) developing contracts with standardized terms, 3) establishing trading and post-trade infrastructure, 4) creating consensus about the proper use of carbon credits, 5) installing mechanisms to safeguard the market's integrity and 6) transmitting clear signals of demand.

Some recent and notable steps along the lines of the TSVCM's priorities have already been taken including:

- Core Carbon Principles (CCP) and Assessment Framework (AF) by the Integrity Council for the Voluntary Carbon Market (ICVCM) is aiming to set new threshold standards for carbon credits of high quality with the aim to provide investors with a deeper understanding of which offsetting projects are truly high quality.[27]
- International Organization of Securities Commission (IOSCO) provided recommendations for various jurisdictions and concerned parties to help them ensure integrity and orderly functioning of the compliance carbon market and voluntary carbon market.[28]
- The Voluntary Carbon Markets Initiative (VCMI) introduced the Provisional Claims Code of Practice, which helps investors and interested parties to appropriately scrutinize the voluntary carbon credit claims made by companies through their Gold, Silver, and Bronze markers.[29]

- The Climate Action Data (CAD) Trust, which is a joint initiative between the World Bank, International Emissions Trading Association (IETA), Singapore government, along with multiple governments, public and private entities, aims to integrate multiple registries to ensure a smooth sharing of data and information with the overall ambition to prevent double counting of carbon emissions, improve trust in carbon data, and help organizations and governments to meet their climate goals.[30]

Carbon markets, both compliance and voluntary, have experienced exponential growth in the past few years and this is expected to continue as long as key challenges are overcome. Indeed, efforts are already well underway to enhance the functioning of these markets by a range of public and private organizations as well-functioning carbon markets hold an important key to accelerating the global energy transition.

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Endnotes

1. The organization uses the credit to compensate against one ton of Co2 equivalent it produces, thereby retiring the credit once used as an offset. A retired credit is moved to a separate register so it is no longer tradeable, reducing the possibility of double-counting.
2. See Refinitiv (2023) for more details.
3. See World Bank (2022) for more details.
4. For example, in the EU ETS, market participants without compliance requirements such as credit institutions, investment firms, and commodity trading firms can participate in the primary market for EU allowances in addition to compliance entities.
5. c2es.org/content/carbon-tax-basics/
6. "Voluntary Carbon Market 3Q22 in Review Webinar," Trove Research, Oct 27, 2022.
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21. https://www.climateactionreserve.org/blog/2022/07/26/the-importance-of-being-additional/
22. Global carbon markets value surged to record $851 bln last year-Refinitiv | Reuters

23. The US Climate Envoy John Kerry, in partnership with the Rockefeller Foundation and Bezos Earth Fund, announced plans to launch the Energy Transition Accelerator which has the intention of channeling private money to the poorest of nations to promote renewable energy plants, reforestation, etc. in lieu of carbon offsets. With a "fixed price" for corporates, this plan is meant to "supplement" and not "substitute" an organization's emissions reduction activities. This plan will not be open to fossil fuel companies and aims to spend 5% of the carbon credit value to support climate adaptation efforts in poorer countries. These carbon credits are to be tied to the decarbonization plans of governments and regions. The plan is still a work in progress and expected to be in action by COP28. Nigeria and Chile have already expressed interest in the Energy Transition Accelerator.

24. Inaugurated at COP27, the African Carbon Markets Initiative or ACMI aims to provide a push to Africa's carbon credit production while also creating jobs and ensuring equitable distribution of revenue across communities in the nation. By 2030, the ACMI is projected to produce 300 million carbon credits, which is expected to reach 1.5 billion by 2050. In terms of revenue, it aims to generate 6 billion by 2030 and more than 120 billion by 2050. Kenya, Malawi, Gabon, Nigeria and Togo joined the ACMI launch at COP27 while organizations like Exchange Trading Group, Nando's, and Standard Chartered expressed interest in setting up an advance market commitment (AMC) worth millions of dollars for the high-integrity carbon credits offered by the ACMI.

25. At COP27, Bloomberg Philanthropies and Three Cairns Group announced the formation of two new initiatives – Global Carbon Trust and the Carbon Storage Governing Council – with the aim to provide governance, management of the supply and liquidity of high-quality carbon credits, fill the gap created by the lack of standardized contracts, etc. The Governing Council which will constitute subject matter experts and civil society, will work with the GCT to achieve this goal.

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29. VCMI-Provisional-Claims-Code-of-Practice.pdf (vcmintegrity.org)

30. Climate Action Data Trust: Connecting Carbon Markets Through Open Data (zscaler.com)

Chapter 2

Carbon Asset Strategies

By Rick Lacaille and Richard Fontes

Carbon markets can no longer be ignored. As an important tool of transition finance, carbon markets can not only help close the enormous funding gap that exists today in the global transition to renewable and net-zero production and consumption systems but offer investors a return in the process.

Yet, given the complexities surrounding both voluntary and compliance emission trading systems, what are the considerations for investors looking to build carbon assets into their portfolios? In this article, we explore this emerging asset class and potential investment strategies.

Carbon Assets as an Idiosyncratic Asset Class

Carbon assets are an emerging, idiosyncratic asset class with their own risk return profile. Whereas traditional asset classes derive their risk-return profile from the forecasted performance of a firm or a series of cash flows, carbon assets derive their value from the forecasted "price" of carbon emissions and the perceived rate at which the global economy — and its constituents — will decarbonize. Thus, the performance of carbon assets is likely to have a low correlation to traditional asset classes. What makes carbon a unique asset class is the ubiquity of its reach — every portfolio of traditional asset classes is exposed to the priced and unpriced cost of carbon regardless of its composition as every entity has a carbon footprint.

To understand why carbon assets are idiosyncratic, look closer at the diversity of the ecosystem of carbon credits and carbon offsets. Compliance carbon markets (allowances) and voluntary carbon markets (offsets) have unique actors on the supply side impacting the mechanics of these markets.

In compliance markets, the main actor is the various sovereign regulatory bodies adjusting the supply of emissions allowances each year, thus impacting the price of carbon for that year — sometimes referred to as a vintage — as well as the potential return for any previously issued allowance that is not retired. For voluntary markets, the supply side is much more diverse, composed of a wide range of carbon offset project originators. Of course, sovereign regulators have a second order impact on offset demand in the voluntary market — as allowance supply and regulations on a company's ability to emit carbon get tighter, demand for offsets on the secondary market is likely to increase — however that impact is not as direct as with compliance markets.

Project geography, marketplace and regulatory jurisdiction also play a role in creating diversity in carbon assets in two ways. First, carbon offsets purchased on one registry/exchange are not — at least for the time being — portable to another market. For example, if a multinational corporation based in the United States wanted to purchase an offset in Indonesia in order to satisfy a foreign regulatory requirement, or a voluntary pledge, to decarbonize their Indonesian operations, it could not purchase an offset from the California marketplace and use it to offset their Indonesian emissions. Given this segmentation, the prices on these markets are driven by local attitudes towards decarbonization (local demand for offsets and the pace of regulatory advancements), project origination and local macroeconomic particularities.[31] It's worth noting that concepts such as a Carbon Border Adjustment Mechanism (Carbon Border Tax), Internationally Transferred Mitigation Outcomes and other efforts to unify the global pricing of carbon may reduce these segmentations, but for the time being they persist.[32]

The second way that geography plays a role in driving credit diversity is through the underlying offset project location. When one considers the intersection of carbon credit types (more on this below) with local market demand and supply preferences for such project types, it is easy to see how the prices for offsets linked to a clean water distribution project in the Nordics may be different from prices for offsets linked to a Reduce Emissions from Deforestation and forest Degradation (REDD+) project in Saharan Africa.

To this end, there has been much discussion on prioritizing the development of carbon markets in the countries that stand to bear the greatest brunt from climate change, which will influence the supply for certain offsets.

Another major component driving carbon asset diversification is the project type underlying the offset. There can be many different project types generating carbon offsets including for forestry and land use, renewable energy, household and community, chemical and industrial, agriculture, energy efficiency, and so on. Then there are subdivisions within those categories. For example, renewable energy can be divided into biomass, hydropower, solar, wind, geothermal and so on.[33] Typically, carbon offset projects can be thought of as either "removals" of carbon from the atmosphere (such as direct air carbon capture and storage or afforestation projects) or "avoidance" projects (such as renewable energy infrastructure development or deforestation protection projects).

Each project type has its own characteristics as it relates to supply and demand creating unique price pathways for the offsets associated with these projects and, as a result, unique correlations with other assets — carbon or otherwise.

There has been much discussion on prioritizing the development of carbon markets in the countries that stand to bear the greatest brunt from climate change, which will influence the supply for certain offsets.

There are also "co-benefits" associated with the different project types. For instance, a cookstove project that, in addition to reducing the GHG emissions of cookstoves, simultaneously results in a reduction in instances of respiratory issues, especially in women, caused by using older, less efficient, and "dirtier-burning" cookstoves. The biodiversity co-benefit was a focus at COP 15 late last year.[34] It's been shown that these co-benefits can impact the price profiles of the associated offsets as well.[35] So if you consider that the price profile of an offset is driven by the regulatory regime that pervades the geographic market on which it trades and the diversity of project types that exist within these markets, it is logical that the means for portfolio diversification should exist in this asset class.

There is a small but growing body of work analyzing the portfolio diversification benefits of adding exposure to this asset class. Much of the work to date focuses on the compliance market which is currently more liquid than the voluntary market and has the most robust historical pricing data set to analyze. But the research still provides insights into the diversification potential for the voluntary carbon market. Several recent analyses have found low correlations between carbon allowances, trading on many of the world's leading exchanges, and most major asset classes.[36] In its analysis, SparkChange, a provider of carbon data and analytics, also found that the structural differences — and lack of interoperability — between the various allowance markets created further unique price movements amongst the assets resulting in diversification within the asset class itself.

Similarly a report by GIC, The Singapore Economic Development Board and McKinsey & Company, found that the inclusion of allowances into a sample 60/40 portfolio was accretive to returns and lessened portfolio volatility under certain climate transition scenarios.[37] Finally a study from Erasmus University Rotterdam and Robeco Institutional Asset Management reveals several insights related to offset diversification potential. The study found price diversity amongst the different global offset markets and even within the various markets within a single geography. The researchers also showed that a portfolio of different offsets outperformed, on a risk adjusted basis, a portfolio of just a single offset. Finally the team reported on the low correlation between offsets and traditional asset classes and an ability to lower portfolio risk statistics and improve portfolio efficiency by including carbon assets alongside traditional asset classes.

While research provides a compelling case for the diversification benefits of carbon allowances, we can extrapolate that voluntary offsets will convey similar, if not additional diversification benefits, given that voluntary offsets are driven more so by market dynamics and less so by regulatory control. In essence, CCM pricing mechanics are tied to the decarbonization aspirations of the various sovereign and supranational entities that control them. VCMs, on the other hand, are much more of a free market, matching the various corporate entities and investors that seek to use these offsets to meet their net zero commitments and customer demand for "carbon-neutral" products and

services with offset project originators. In short, one would expect that with greater diversity of participants in the VCM market, the greater the opportunity would be for portfolio diversification opportunities to occur within this asset class relative to the already diverse CCM market.

These potential diversification benefits of carbon assets are not limited to ESG focused investors. In fact, traditional investors may consider this asset class to leverage potential portfolio diversification benefits. In addition to diversification, carbon assets may serve as a hedge on carbon prices or regulatory risk within a non-ESG focused portfolio. While we look closer at carbon assets and hedging price risk in the next section, analytically reframing carbon assets as a derivative where the underlying asset is the ability of regulators to effect climate policy, means carbon assets may serve as an instrument to hedge a portfolio's exposure to the regulatory "risk" in each jurisdiction.

Regardless of what an investor believes about climate related regulation, if they judge the value of their portfolio will be negatively impacted by decarbonization regulation in a certain jurisdiction, they could purchase carbon assets in that jurisdiction in proportion to the value at risk as a hedge (given regulators have a first- or second- order impact on carbon asset prices). Similarly, Golub, Lubowski, and Piris-Cabezas refer to a conundrum that both ESG and non-ESG investors face, referred to as a "tween deferral strategy." The "tween deferral strategy" is defined as the deferral of investments into carbon intensive assets, while simultaneously delaying investment into low carbon investments unless they are exhibiting competitive comparable returns due to climate policy change uncertainty.[38] Carbon assets can help alleviate this deferral for both groups insofar that a small allocation to such assets can convey a meaningful exposure.

Key Takeaways:

- Carbon assets are a unique and emerging asset class for investors to consider including in their asset allocations.
- The asset class itself has sufficient diversity to warrant exploring how adding CCM and VCMs to a portfolio of traditional and alternative assets may enhance risk adjusted returns.
- There is compelling evidence that adding carbon assets can enhance portfolio diversification and efficiency for both ESG-focused and non-ESG focused investors.

Carbon Assets as part of an ESG Investment Strategy

State Street Global Advisors identifies five main ESG strategies: divestment, engagement, tilting (or positive screening), integration, and impact.[39] Access to offsets has the potential to make those strategies more dynamic and introduce greater flexibility by unlocking new ways to facilitate the global energy transition.[40]

For example, carbon assets can create greater diversity in the various tilting and screening strategies that are used in ESG-style portfolio management. According to Boston-based FCLT Global, reducing the carbon footprint of a portfolio at the security level is hard to do and carving out an allocation to carbon assets helps to quickly decarbonize the portfolio's footprint "top-down" while a more robust decarbonization strategy is implemented.[41] An allocation of carbon assets addresses the struggle between balancing conflicting time horizons of meeting return requirements versus the decarbonization transitions of companies, sectors, economies etc. Moreover, even the most rigorous ESG investor is challenged to properly comprehend and position a portfolio to react to the systemic implications of a transition to a low carbon economy. Carbon assets are, by their very nature, forward looking and sufficiently diverse to address the systemic issues caused by climate change.

Adding carbon assets to a portfolio has benefits for investors who would ordinarily be limited to exclusion or divestment strategies. For example, adding carbon assets to a fund would allow an investor to offset the emissions burden of holding emissions intensive firms in order to engage with them, thus allowing them to be more of a catalyst in the company's transition, potentially reaping the alpha generated from catalyzing the firm's transition. Or, in another example, a fund that had to divest from specific sectors or geographies could get exposure to those through carbon assets.

Offsets also provide a method for smoothing the nonlinear lumpy decarbonization pathways of a portfolio's underlying holdings. As FCLT Global reports, non-linear progress is an issue in portfolio decarbonization. As such, an allocation to carbon assets (through offset retirement) would help an investor smooth out their portfolio's decarbonization pathway as various sectors, companies and jurisdictions make progress, backslide, or stagnate on their own decarbonization efforts. Similarly, an allocation of carbon assets could serve to take some of the volatility out of some ESG-aware benchmarks. Because ESG and climate benchmarks are a derivative of a non-ESG/climate benchmark there's often a lot of "tracking" that occurs when you compare such a benchmark with its "parent." Using carbon offsets an investor could optimize the ESG/climate benchmark by either adding back-in some of the high emitters, or tilting the weighting of certain benchmark constituents, and use the offsets to bring the portfolio back

in line with the decarbonization pathway that has been selected for the portfolio mitigating some of the effects of "churn" that are caused by strictly replicating the benchmark.

Carbon assets have a clear role in facilitating "net-zero" investing. The Amundi Institute present an interesting discussion on the dichotomy of net-zero investing which, they define as dynamic portfolio decarbonization in line with a 1.5 degree Celsius warming target and investing in the transition to a low carbon economy (not simply decarbonizing or neutralizing the carbon footprint of a portfolio).[42] While not explicitly discussed in their paper, the utility of incorporating carbon assets into the portfolio construction process is clear. Carbon assets can simultaneously help with the dynamic, year-to-year portfolio decarbonization targets and support the sector and jurisdictional decarbonization efforts germane to net-zero investing (by providing capital to transition oriented solutions). And again, while not explicitly stated in their paper, carbon assets could help to address the portfolio churn and tracking error issues that accompany dynamic portfolio decarbonization efforts. Carbon assets, in essence, are the only asset class that allow an investor to directly decarbonize and neutralize the footprint of a portfolio while simultaneously investing in the transition. Similarly, the combination of carbon assets with the portfolio construction techniques discussed in State Street Associates' *Climate Solutions Investments* paper afford ESG investors with new possibilities to position their portfolios to capture opportunities in the transition economy in an integrated fashion, while addressing the multifaceted components of such a transition.

There are many different types of investment products that could be brought to market to take advantage of the benefits of carbon asset integration such as carbon "hedged" funds, carbon price trackers, transition catalyst funds, engagement oriented funds, and more.

The price movements that carbon markets provide have interesting implications on portfolio construction and ESG investing techniques as well.[43] First, they provide a signal on how well the transition is going in certain sectors, and given the diversity of carbon assets, and therefore the granularity of the signal, this information can be leveraged to strategically (re)position the portfolio — regardless of whether the investor is motivated by ESG considerations or not. Another application of this interpretation of these price signals, is to use them as a company engagement prioritization barometer — the worse or better the transition is going, the higher or lower priority your engagement with them should be.

Access to offsets has the potential to make ESG strategies more dynamic and introduce greater flexibility by unlocking new ways to facilitate the global energy transition. There are many different types of investment products that could be brought to market to take advantage of the benefits of carbon asset integration such as carbon "hedged" funds, carbon price trackers, transition catalyst funds, engagement oriented funds, and more.

Given most portfolios have exposure to the risk of fluctuations in the price (or unpriced cost) of carbon emissions it makes sense for investors to explore the possibility of hedging this risk.

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Global Head of ESG

A second implication of carbon price signals is that these signals can be used as a quasi-momentum factor, giving investors insight into the technologies and solutions that will "power" the global economic transition, especially given offset originators may be private entities. And there are myriad applications of the inclusion of carbon assets alongside traditional ESG tilting and screening strategies.

Carbon assets may also be used as a hedging mechanism. Given most portfolios have exposure to the risk of fluctuations in the price (or unpriced cost) of carbon emissions it makes sense for investors to explore the possibility of hedging this risk as they do other types of risks, for instance currency or volatility risks. Such carbon price risk hedging is consistent with the normal assessments of bearing certain risks in a portfolio which include the contemplation of the risk/reward of being exposed to carbon price fluctuations, impacts to portfolio efficiency, as well as the market's ability to price this risk into asset values. Of course, carbon price risk hedging using carbon assets also brings the consideration of the non-financial impacts that they can carry into the discussion.

Several studies have discussed a carbon risk premium and there is an emerging consensus that investors demand a premium for holding carbon intensive assets.[44] Needless to say, the explicit price of carbon as well as the progression of GHG emission regulation will become an increasing driver on asset values. Ochoa et al provide evidence that this type of hedging, that is hedging asset values' reaction to the advancement of carbon emissions policies, is not only possible but may outperform simply investing in high performing ESG securities. In a Federal Reserve working paper, the authors find that a hedging strategy based on carbon emissions metrics outperformed a hedging strategy on more generic ESG metrics.[45]

On a related note, Morningstar's view is that carbon asset prices are more of a reflection of the (potential) success, or lack thereof, of a jurisdiction's ability to implement strong GHG emissions regulation than a true measure of the price of carbon.[46] They provide EU ETS flow data to substantiate their idea. Yet regardless of whether an investor is an ESG-skeptic or ESG-oriented, an allocation to carbon assets to serve as a carbon price risk hedge may be beneficial.

In practice, there's evidence that this type of hedging can be done with a relatively low exposure to the asset class. SparkChange claims that a "one percent of AUM" allocation to carbon can mitigate the entire footprint of a portfolio and provides other examples of carbon-overlay strategies mitigating the carbon footprint exposure of sample portfolios using a sub-eight percent of AUM average exposure to allowances.[47] Similarly, McKinsey reports that a 0.5 to 1 percent allocation of carbon allowances provided downside protection under certain transition scenarios.[48] Additionally McKinsey reported that a 5 percent allocation of allowances resulted in a reduction of portfolio volatility by 30 to 50 basis points. If an investor prefers not to hold the asset class directly, there already exists a liquid futures market for this asset class. Furthermore, carbon market participants are exploring how to enable some of the more exotic types of hedging, currently done for traditional asset classes, using over-the-counter (OTC) derivatives, for instance, for carbon assets.[49] So the possibility to use such derivative instruments, as a complement to the established carbon hedging that occurs today via the liquid futures market for carbon assets is imminent.

For impact investors, carbon assets provide compelling opportunities to facilitate the global energy transition. First, by providing capital to (sometimes undercapitalized) offset originators through the purchase of the offsets. Given the geographic dispersion and diversity of the projects, as well as the potential for co-benefits, impact investors can express a modicum of "targeting" in their selection of offsets should they have preferences for specific geographies or populations they seek to have an impact on. Impact investors may also be interested in their impact on that rate of decarbonization of certain geographies or jurisdictions through the purchase and retirement of carbon assets.

As discussed in the preceding article, by reducing the available number of offsets or allowances in the market, impact investors can promote higher rates of decarbonization through price pressure. SparkChange has done extensive research in this area and also illustrates how this price pressure provides an enduring impact through the ETS's Market Stability Reserve.[50] Research has also shown that the ETS has helped to drive innovation in low-carbon technologies such as renewable power sources and energy efficiency.[51] Thus, in the short run, not only can impact investors take advantage of the portfolio diversification and hedging benefits from carbon assets but they may be able to capture impact returns as well.

A final investment use case to consider for carbon assets is the impact on corporate treasury/balance sheets. Clearly the primary corporate use-case for carbon assets is neutralizing a firm's carbon footprint. Major corporations are increasingly familiar, or becoming so, with calculating their emissions footprint and entering the allowance and offset market to purchase the carbon offsets necessary to neutralize their emissions for any given year (or leveraging Renewable Energy Certificates (RECs) or Guarantees of Origin (GOs) to similar effect). Leading corporations will be very familiar with the nuances of selecting high quality offsets and may even have a strategy for purchasing offsets with specific co-benefits that

are aligned with other overarching corporate ESG priorities. Even more advanced firms will have begun exploring the allocation of carbon costs to specific business units and divisions.[52] And while carbon offsets will never displace the traditional allocations to cash and fixed income securities that corporations use to manage their liquidity and cashflows, they may become an increasing part of the conversation — especially as Chief Financial Officers begin to understand how climate may impact a firm's liquidity needs over the short- and -long term. For one thing, corporations will need to more closely manage the expense of neutralizing their carbon footprint and that will certainly factor that into cash forecasting. Such management techniques have, and will, raise questions about purchasing carbon assets today, cheaply, in the spot market for future retirement, or entering into forward contracts or carbon streams in order to manage the expense over the long-term, always in conjunction with a good faith effort to make net reductions to GHG emissions.

As such, carbon assets could be viewed as an emerging way to diversify a corporation's balance sheet, given the idiosyncrasies of the asset class, and may form an increasingly important part of a corporations decarbonization strategy. The selling of extra allowances and offsets that become extraneous if a firm can decarbonize "ahead of schedule" may also help to lift profitability or satisfy a liquidity crunch as well. Finally carbon assets may even come to serve as a better alternative to the "brown-spinning" or carbon arbitrage that firms may be inclined to participate in. Given, carbon assets help companies quickly neutralize their carbon footprint and given they help fund transition to a low carbon economy — which is generally viewed favorably by the public — they provide a preferential, potentially more strategically constructive, alternative to simply offloading brown assets through brown-spinning and carbon arbitrage schemes, which are becoming increasingly scrutinized by regulators, investors and the general public.

Key Takeaways:

- Carbon Assets can complement new or existing ESG Investing Strategies (and non-ESG specific strategies too)
- Carbon assets are a tool for emerging carbon price risk hedging strategies
- A relatively small allocation of carbon assets is sufficient to potentially capture some of these benefits

~20%

The portion of global carbon emissions covered by carbon markets

$926B

Estimated total traded value of carbon markets in 2022

Challenges for investors in carbon markets

For investors in carbon markets, there are demand and supply side challenges to consider as well as market infrastructure and programmatic issues. Demand side challenges involve the proper use of such offsets in association with claims of net -zero alignment and carbon neutrality, whether the use of offsets is delaying the transition to a low carbon economy by facilitating greenwashing or by allowing firms to delay abatement of their emissions. On the supply side, challenges largely concern the integrity and opacity of the offsets. An additional concern is the liquidity of the markets; compliance markets being large, generally accessible to investors and liquid while voluntary markets, while accessible to investors are less liquid and much smaller. A final consideration is whether the compliance and voluntary markets are fit for purpose and whether cap and trade schemes are the right mechanism to bring about global decarbonization.

In response to these issues, organizations such as the Institutional Investors Group on Climate Change (who publish the net-zero investment framework) and the Net-Zero Asset Owners Alliance have expressed reserve and caution with using carbon offsets to make certain decarbonization claims in the near term. But these maturation issues are not unique to carbon assets as an asset class.

All asset classes go through growing pains — from the mutual fund to the ETF, "green bonds," and all manner of derivatives and securitized products have had to go through periods of tempering and refinement — and carbon assets are no different. What's different about the evolution of carbon assets is the sense of urgency of the issue that they seek to address.

At the same time, there are tailwinds for carbon assets, namely the enhanced scrutiny and interest in the carbon marketplace, which, inturn, is accelerating the rate at which regulators, industry consortiums and

practitioners address gaps in standards and infrastructure. Sustainability accounting framework setters such as the International Sustainability Standards Board (ISSB), are making specific provisions for the reporting of the use of carbon credits by corporations and investors. In December 2022, the European Commission put forth a proposal for the certification of carbon assets.[53]

As they have done in other markets, the International Swaps and Derivatives Association (ISDA) has developed standards and derivatives documentation templates for secondary market trading in VCMs.[54] Similarly the Commodity Futures Trading Commission (CFTC) has begun to mobilize to its efforts to establish frameworks for carbon offsets.[55] Finally COP27 reignited discussions of and momentum behind cross-jurisdictional carbon asset trading under Article 6 of the 2015 Paris Climate Accord.[56]

Simultaneously and in parallel with the resolution of the regulatory and methodological discussions, innovation in this space will continue. Securitization of carbon offsets, RECs and GOs has already begun to be explored which will have implications on the investment use cases discussed above. Already a new form of crediting aimed at offsetting natural capital and biodiversity harm have started to come online.[57] Offset originators are even going as far as creating credits aimed at providing the oil and gas sector more constructive ways to decommission assets.[58] Carbon assets may even be keenly oriented to address the intersection between E and S investing (who some refer to as "systems level investing" given their potential for diverse and varied co-benefits.[59] Interest in this space has even reignited discussions around carbon abatement policies such as "Carbon Dividends" and "Carbon Luxury Taxes".[60]

What makes carbon markets an interesting and idiosyncratic marketplace for investors to investigate is the speed at which the market is developing, from an innovation and regulation standpoint. Asset managers and other financial services firms are already bringing to market a whole host of carbon assets-oriented funds and ETFs.[61] Industry consortiums are well funded and quickly working to close the market infrastructure gaps making the carbon asset marketplace less accessible.[62] And allowances markets should be winding down over the course of this and the next decade, resulting in a corresponding need to have exposure to and an understanding of voluntary markets.[63]

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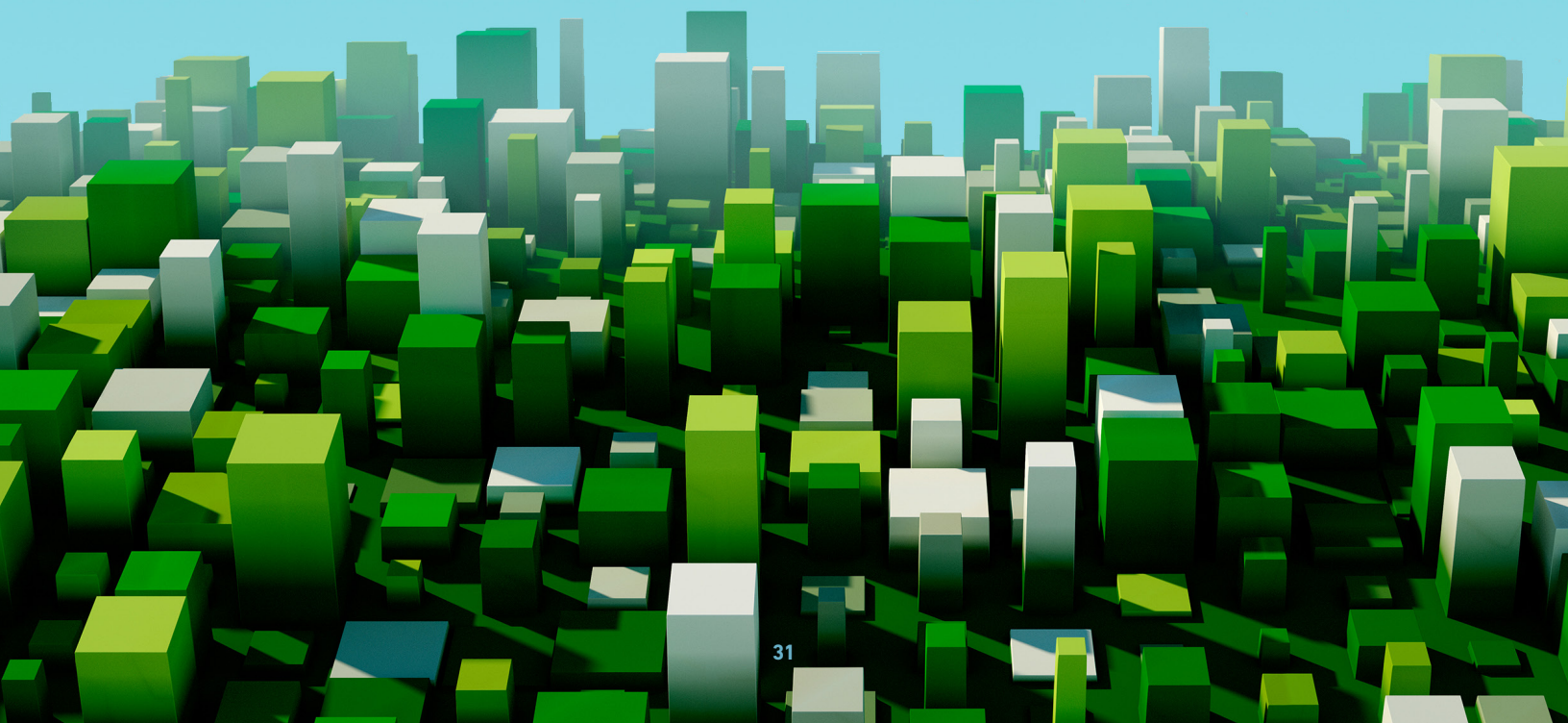
Chapter 3

Tokenization of Carbon Assets

By Barbara Widholm and Ekaterina Stolyarova



Tokenization is the process of utilizing Blockchain technology throughout an asset's lifecycle. It can make the process more effective and efficient for both the fund issuer and the end investors by allowing shares of a fund to be freely traded on a digital ledger.

The recent crypto downturn has revealed some "elasticity in demand" among institutional investors who understand blockchain is here to stay and are enthusiastic about the wider opportunities that tokenization can offer.

The Advantages of Tokenization

Tokenization can increase accessibility to markets, create liquidity in historically illiquid markets, and generate efficiencies and cost savings. Like markets for real estate, infrastructure, and private equity, carbon assets are less efficient, more customized, have different operating models and requirements, and require a human settlement process.

Promoting greater accessibility

Market participation and capital inflow are constrained by limited access points or complicated restrictions of some investment instruments, such as carbon credits. The barrier of entrance into a market can be decreased and access points to tokenized assets can be standardized with blockchain technology.

Enhancing Liquidity

Tokenized assets increase transaction flow competition which benefits issuers and leads to better pricing and more secondary market liquidity. Assets that have been tokenized can be immediately exchanged on-chain or across-chain.

Generating efficiencies

In certain markets, inefficient transfer of ownership leads to loss of alpha. Tokenization allows the settlement process to become almost instantaneous while the transfer of value and the validation of ownership are simultaneous. Processing of complicated events, such as corporate actions, can be expedited.

Additionally, some blockchains integrate smart contracts, self-executing programs with rules established in code. Smart contracts allow automated transactions by defining a set of parameters that, if met, execute automatically.

For instance, smart contracts can start making payments at predetermined benchmarks or on specified dates. As a result, tokenized platforms may one day enable investors to purchase, sell, and swap tokens in accordance with predetermined guidelines and with little assistance from outside brokers.

The Tokenization Opportunity for Carbon Assets

Over the past ten years, investments in climate technology have grown at a rate five times[64] that of global start-ups, helping with efforts to achieve decarbonization goals and to create regulations for emissions disclosure.

One of the key drivers of growth in carbon credits has been ongoing efforts to reach net-zero emissions goals. However, the market is divided in terms of value and structure due to the vast range of standards being released and the lack of transparency in the data on underlying carbon intensity. Since the majority of agreements are OTC and carbon credits are distributed through a number of registries, market efficiency and transparency are necessary for scalability.

Blockchain technology can help overcome some of these key challenges. Its effective real-time settlement can promote greater volumes and liquidity by making carbon credits more composable.

A carbon credit needs an audit trail of the components contributing to its carbon intensity, and open blockchain could produce useful price data to encourage asset comparability.

Tokenized carbon credits can be representations of off-chain Verified Carbon Units (VCU) or natively digital carbon credits distinguished by traceability across underlying carbon offsetting chain to enable the scalability of carbon credits market.

Events affecting carbon intensity would be recorded on a distributed ledger and traceability would ensure a carbon credit's value on the market by creating inherent quality. Therefore, a VCU's value would be more accurate and not dependent on a manual, non-standardized audit evaluation of the underlying project. As a result of incorporating safe Internet of Things (IoT) and Blockchain, a credit's underlying data would be programmable, comparable, and produce price signals.

In digital asset markets, the ability of an asset to interact with other assets in the market, or interoperability, defines an asset's worth. Creating a worldwide data infrastructure that is constantly updated (e.g., using oracles to feed data to an asset, which cascade to other assets in the chain) makes sure that businesses cannot double spend by offsetting the same credit again. With smart contracts, the programmable capability of a token and underlying traceable data may be used to design the workflow, integrate regulatory requirements, and add business logic across the whole lifecycle of a carbon asset.

As a result, a carbon credit token is composable and opens up new types of trading and capital development.

A carbon credit's success, even when tokenized, depends on the way it was created and how well a smart contract was written. Understanding the foundations of a successful carbon credit token is crucial.

Fundamentals for Tokenized Carbon Credits

When working to build a composable structure for carbon credits, the fundamentals of decentralized finance must be considered. These fundamentals, often called primitives,[65] are the essential building blocks of technology that can be combined and leveraged in a variety of ways. Oracles, blockchain protocols, smart contracts, token standards are all key primitives to consider when issuing a carbon credit token. Indeed, a blockchain can be chosen over another for its characteristics including the number of users, number of smart contracts available, activity and rules.

For example, Ethereum is open source, which means that smart contracts are public and any logic worked out once is available for reuse by the entire ecosystem (syntactic composability). The multitude of smart contracts are as much reliable code already tested by the protocol to which projects can integrate the carbon credit specific components.

The smart contract is as good as the rules it is governed by and a blockchain protocol is as composable as the data available in it. Therefore, a carbon credit quality is influenced by the blockchain it is issued and the smart contract governing it.

Ethereum facilitates composability by its architecture but that does not guarantee that tokens morphology is comparable by nature. For this purpose, a number of standards have been agreed to and are known as Ethereum Requests for Comment (ERC). The famous ERC20 and ERC721 define characteristics of fungible and non-fungible tokens. They define the parameters for a token interaction with other elements in the protocol and increase their comparability. On one hand, ERC721 has been utilized by carbon offsetting projects for its non-divisibility. Certain carbon credit tokens may represent a collection of multiple projects or activities contributing to creating a single carbon offset unit. Therefore, an NFT provides the exclusivity and unity required for a carbon offset to faithfully reflect real world activity. On the other hand, ERC20 are interchangeable and can be divided. Used by the majority of existing tokens, the standard is, therefore, more interoperable and unlocks new opportunities for targeted investments, portfolio diversification, and greater capital flows to facilitate the transition to net-zero emissions.

Unlocking the Opportunity for Institutional Investors

When considering tokenization opportunities, institutional investors must take into account the technology and tangible assets as investments vehicles, but also the technology applications in improving processes and products offered today.

Investor interest in an asset class is driven by tokenization's ability to diversify investable assets, creating an ability for new investment strategies and allowing investors to move assets more seamlessly. Today, investors in tokenized securities are mainly wealthy individual (accredited) investors and the market is challenged by a lack of participation from high-quality institutional investors. Creating an effective marketplace to support institutional participation will drive overall issuance. Additionally, exploration of smart contracts and distributed ledger technology to automate certain processes, such as tokenization of trade collateralization, can help enhance servicing of these assets and reduce risk.

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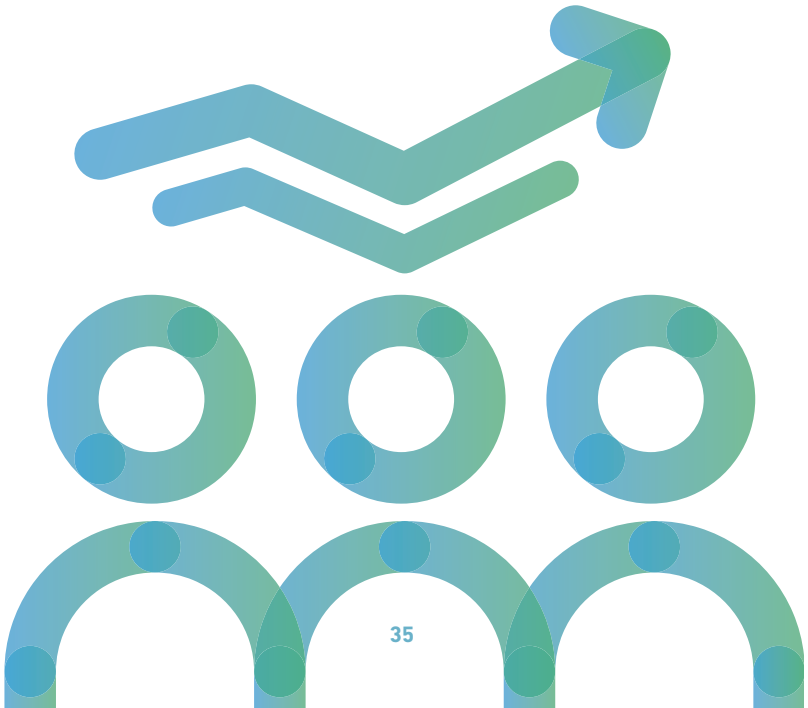

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