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Future Investment Initiative Institute
Impact on Humanity

AI-ENABLED CARBON MARKETS

IDENTIFYING AI SOLUTIONS FOR THE VOLUNTARY CARBON INDUSTRY

Priority Champions | Carbon markets

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ARTHUR D LITTLE

INTRODUCTION

IN A CONTEXT OF EMISSIONS REDUCTION, companies face mounting pressure to reduce their greenhouse gas (GHG) emissions – and to do it fast. In response, whether by choice or government mandate, organizations across sectors have pledged to drive down their CO_2 output, with nearly half of the world's largest publicly traded companies committing to a voluntary net zero target.[1] To reach this lofty goal, carbon credits are emerging as an attractive tool, but there is a caveat: the carbon landscape is still evolving and close scrutiny from stakeholders has revealed shortcomings, from greenwashing to pricing, that must be overcome. It is here that artificial intelligence (AI) emerges as a solution, with the power to boost comprehensiveness, consistency and integrity, possibly unlocking the potential of carbon credits to deliver emissions reduction.

The potential for impact is great. According to BloombergNEF, were it not for limitations imposed by a UN-backed standards body – Science Based Targets Initiative (SBTi) – demand for carbon offsets in a high-quality market would grow from 164 million tons of carbon dioxide equivalent (CO_2e) today to 1.37Gt CO_2e in 2030, with demand peaking at 5.9Gt CO_2e in 2050.[2]

Driving this growth is tangible demand. A 2024 study from Net Zero Tracker[3] reveals that of the Forbes 2000 companies with stated net zero pledges, 40% plan to use carbon credits, either to offset hard-to-eradicate emissions or to voluntarily advance their targets.

Hitting these targets will not be easy; the path to net zero is uncharted and the carbon market is marked by uncertainties. However, for companies determined to incorporate carbon credits into their emissions strategies and harness the power of AI, this white paper provides insight and guidance on the way ahead.

1 Net Zero Tracker | Welcome
2 Mega Boost for Carbon Offsets Market Seen from SBTi Easing | BloombergNEF (bnef.com)
3 Net Zero Stocktake 2024 | Net Zero Tracker

THE CARBON MANAGEMENT HIERARCHY

BEFORE EXPLORING THE ROLE OF AI, IT IS USEFUL TO show structure and clarity to the carbon credit journey. The carbon management hierarchy presented below (Figure X) provides organizations with clear steps to follow in order to complete their full decarbonization strategies and achieve their emissions goals.

Figure X. Carbon management hierarchy

1. **Prevent:**
Prevent emissions by updating operations, logistics, and raw materials

2. **Reduce:**
Reduce and replace emissions by decreasing material use, increasing energy efficiency and changing existing operations to lower-carbon alternatives, such as replacing older gas boilers with more efficient electric ones.

3. **Inset:**
Use carbon insets – investments in sustainable practices within the company's own supply chain

4. **Offset:**
Use carbon offsets, outside the company's immediate value chain, as explored in this report

For some organizations, following steps one and two – prevent and reduce – may yield sufficient results. For others, there is a need to go further. Achieving net zero emissions is a formidable challenge and many companies struggle to meet their obligations for a variety of reasons. Supplies of products, resources and technologies can be limited, and costs can be high. For instance, sustainable aviation fuel is currently around 2.5 times more expensive than conventional kerosene.

Some companies are also limited in their ability to monitor and control the activities of their supply chain, Organizations can encounter difficulties in removing residual emissions due to to technological, economic and regulatory constraints. Adding to the complexities, regulatory uncertainties and an absence of certification standards, especially around certificates of origin for low- or no-emission products, can lead to consumer wariness about their adoption and slow their rollout.

These factors mean that, having done all they are capable of in terms of avoiding and reducing emissions, companies are looking at options that 1. bridge the gap until new emissions reduction technology is in place, 2. voluntarily reduce emissions (such as from historic activities), 3. enable compliance with national regulatory schemes, or 4. compensate for hard-to-abate emissions.

On the last point, organizations are increasingly turning to carbon credits in the form of insets and offsets as solutions to reducing their hard-to-abate emissions, as shown in Figure X.

THE DEVELOPING CARBON CREDIT MARKET

For organizations that have exhausted other avenues to reduce emissions and opt for carbon credits, the market is split into two groups of buyers: those who purchase carbon credits out of compliance and those who do so voluntarily.

Compliance: Many governments are now using carbon pricing to enforce greater sustainability. There are currently about 70 carbon-pricing initiatives in place globally, covering 24% of 2024 global emissions. Examples include carbon tax and the EU Emissions Trading System (ETS). Many of these schemes, such as those in Japan, Korea and China, allow the use of offsets/carbon credits in addition to government-issued carbon allowances that permit their owners to emit one ton of CO_2 equivalent, with specific limitations. Historically, the EU ETS also permitted offsets, but they are no longer accepted in the fourth phase of the scheme (2021–2030).

Voluntary: Voluntary carbon credits are driven by the private sector. Buyers use them to reduce their overall emissions or to compensate for historical emissions. Companies including Microsoft, Frontier, NextGen and Meta count among the prominent companies that purchase carbon credits by choice.

Microsoft: Microsoft has committed to removing, by 2050, the equivalent of all its emissions since the company was founded in 1975. More than 85% of the company's carbon-removal portfolio in 2022 was made up of forest-based carbon credit initiatives. In 2023, the tech giant announced it would purchase 2.7 million tons of carbon credits over the next decade generated from Ørsted's biomass-burning power plants; the carbon will then be buried under the North Sea.

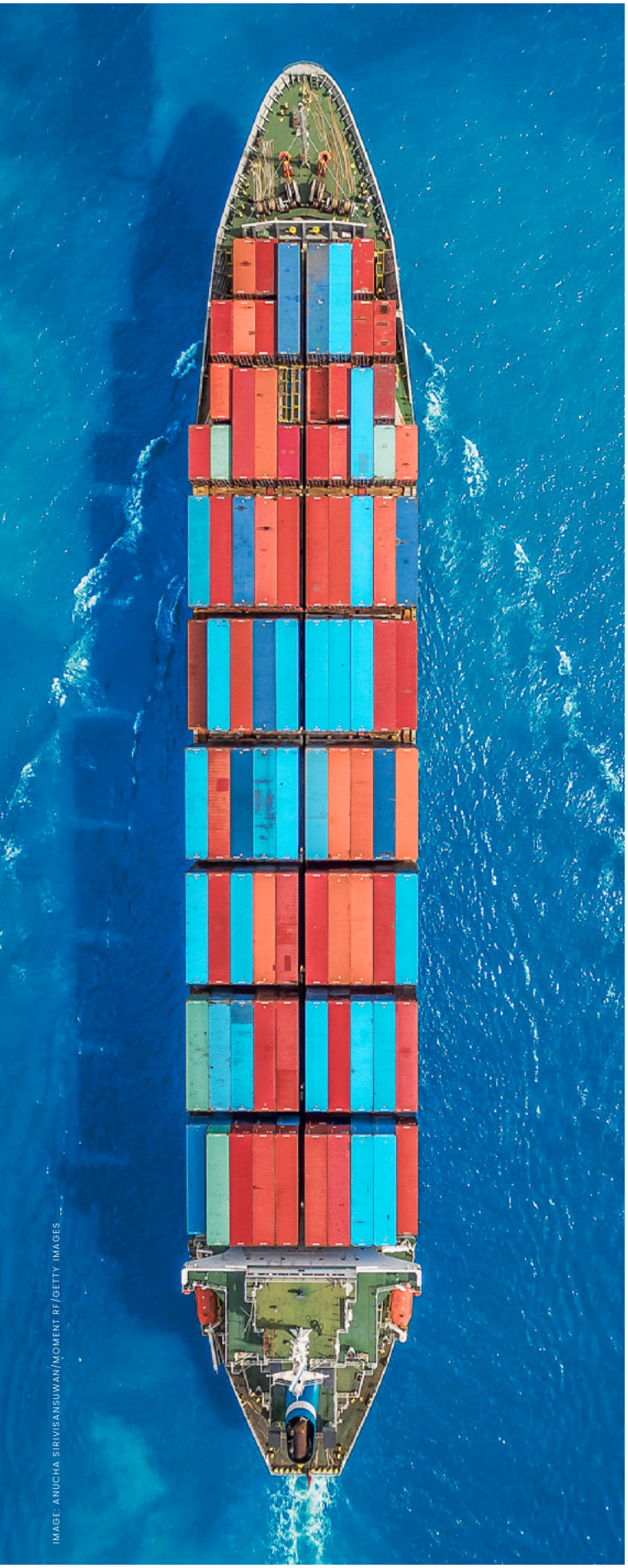


IMAGE: ANUCHA SIRIVISANSUWAN/MOMENT RF/GETTY IMAGES

→ **Frontier:** A consortium involving Alphabet, Meta, Stripe and Shopify, Frontier has announced a $53 million deal with Charm Industrial to remove 112,000 tons of CO_2 between 2024 and 2030 by converting agricultural waste into an oil that can be stored underground.

NextGen: This joint venture between Mitsubishi Corporation and carbon-removal project developer South Pole plans to purchase more than 1 million tons of carbon credits by 2025, and has already bought 200,000 tons.

UNDERSTANDING CARBON MANAGEMENT OPTIONS

In addition to the existence of different types of carbon credit buyers, there are different forms of carbon credits: offsets and insets. When setting their strategies for hard-to-abate or historic emissions, organizations must understand the differences between the two.

A **carbon offset** is an activity that compensates for the emission of CO_2 or other GHG by providing for an emission reduction elsewhere. For example, Disney has purchased carbon offsets in the form of REDD+ projects in Peru. REDD+ stands for reducing emissions from deforestation and forest degradation.

A **carbon inset** involves emission-reduction activities implemented within a company's value chain. For example, IKEA has bought carbon-reduction certificates for a fuel switch, using sustainable biofuel in a vessel that would normally have burned fossil fuel. This "insets" a portion of IKEA's marine transport emissions.

Experts estimate that insets are typically more expensive than REDD+ offsets, with marine biofuel insets standing at ~$150 per ton of CO_2 versus ~$7 per ton of CO_2 for REDD+ offsets. With insets, carbon reductions take place in the company's own value chain and contribute to transforming its own supply chain toward a more sustainable future. They therefore have increased credibility with stakeholders and consumers. That said, there can be significant differences between the quality of credits based on factors such as the type of technology- or nature-based solutions involved, and the co-benefits received. →

Using sustainable biofuel instead of fossil fuel can "inset" marine transport emissions.

→ OPPORTUNITIES FOR ORGANIZATIONS

As demand for carbon credits increases, companies should consider what offsets can mean for them. Broadly, there are four strategic approaches that businesses can take to unlock the potential of carbon offsets:

1. **Buy credits to supplement decarbonization programs and achieve targets.** Examples include: 1. meeting regulatory requirements in hard-to-abate areas or sectors, 2. temporarily reducing current footprint until real abatement projects are implemented, 3. compensating for residual carbon footprint after emissions-reduction programs have been developed, and 4. compensating for historic emissions since the organization was founded.

2. **Use carbon credits to finance sustainable activities.** For instance, an industrial company may invest in carbon-reduction equipment and then utilize it to capture or sequester more carbon than is needed for the company's own compliance. The excess carbon captured can then be sold at attractive rates as high-quality carbon credits to partially finance the overall installation cost.
Additionally, organizations can take advantage of subsidies such as the US Code Section 45Q Credit for Carbon Oxide Sequestration. This enables companies to generate between $60-$180 per ton of CO_2, depending on the type of activity. In a further example, companies that have set targets to increase reforestation or afforestation, can use the resulting carbon credits to cofinance their efforts.

3. **Sell credits as a key revenue stream by leveraging existing capabilities.** Today, many organizations possess the key assets and capabilities required to develop carbon credits, such as mid-scale project management expertise, access to land, access to resources, stakeholder management and marketing capabilities. Harnessing these capabilities provides the opportunity to generate new income streams around carbon credits. For example, a partnership between oil and gas companies Wintershall Dea and Equinor has secured licenses to store carbon under the North Sea.

4. **Develop new products and value propositions based on high-quality carbon credits.** Many companies are already offering retail clients opportunities to offset their activities, including travel and hotel stays or e-commerce purchases. Energy companies are also offering a mixture of biogas and natural gas known as "green gas" combined with carbon credits at a higher price. →

Carbon credits can reduce current footprint while real abatement projects are prepared.

PHOTO: ADAM SMIGIELSKI/E+/GETTY IMAGES

→ CHALLENGES IN THE MARKET

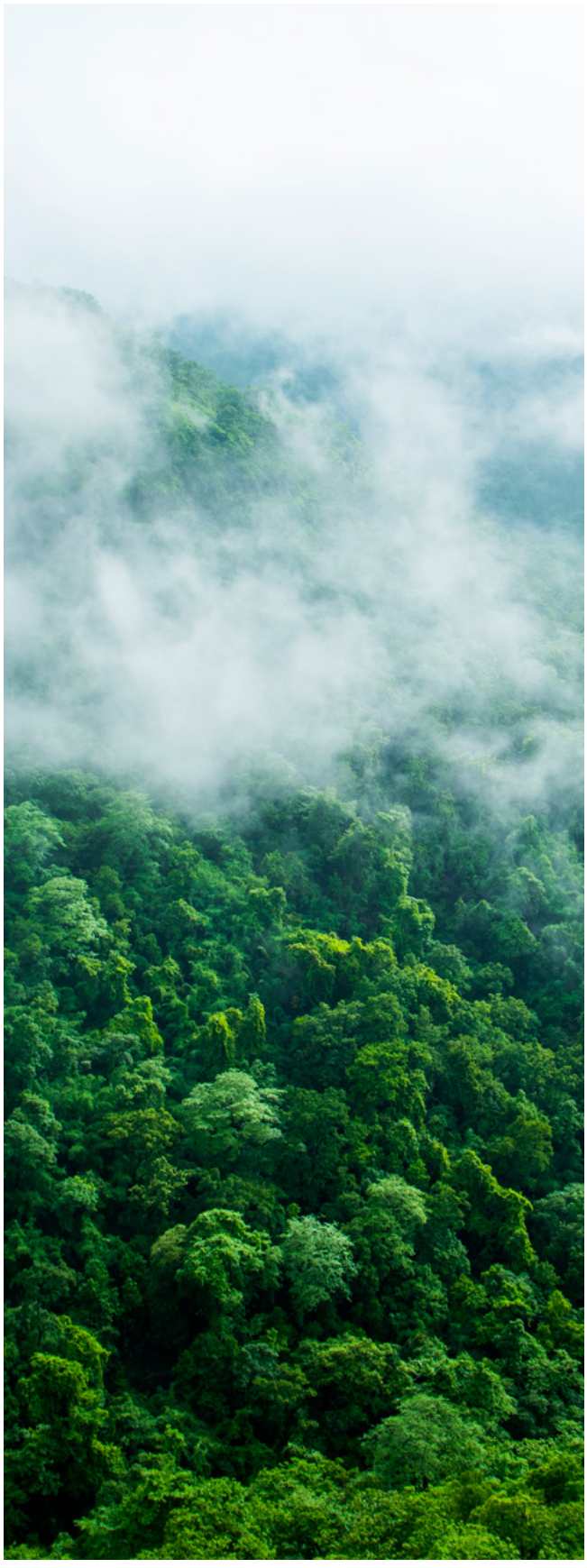
Whether buying or selling carbon credits, companies must understand and overcome a variety of challenges within the market, ranging from accusations of greenwashing and a lack of pricing transparency to changing regulations and developing the ecosystem needed to thrive. These and other key challenges are outlined below:

Quality, cost and budget overruns. Project identification, development, approval and execution can be challenging and time-intensive, especially in environments where carbon credit development is still a new topic. These challenges have been apparent with, for example, Shell removing mention of its $100 million per year carbon credit program from its recently updated strategy.

Developing policies and ecosystems. The carbon credit market has existed for more than 30 years. However, its policies and ecosystems have been developing gradually, becoming more complex and decentralized in the process. Recent events, such as the inaugural auction on Malaysia's carbon credit trading exchange that saw only limited interest, highlight the market's ongoing evolutionary journey. As this journey continues, market maturity and engagement are likely to increase over time, potentially resulting in a global voluntary carbon market worth between $5 billion and $50 billion by 2030.[4] There is more cause for optimism: Despite a lack of consensus on carbon trading rules at the COP28 conference in Dubai, discussions continue, reflecting a firm commitment to finding a solution.

Changing regulations. The possibility of using carbon credits to meet emission-reduction targets varies between countries and regions, and even when the option exists, what constitutes an eligible credit is prone to change. For example, in the early phases of the ETS, the use of international credits was permitted, but this is no longer the case under phase four of the scheme (2021–2030). The EU has also banned the use of "climate neutral" claims based on carbon offsets.

More broadly, there is a lack of unified regulations around the carbon credit market. However, steps have already been taken to rectify this. The recently published Core Carbon Principles (CCP) of the Integrity Council for the Voluntary Carbon Market (ICVCM) focus on the supply side, while the newly issued guidelines of the Voluntary Carbon Market Integrity Initiative (VCMI) tackle regulations relating to demand. In light of these developments, new reporting regulations – especially the EU's Corporate Sustainability Reporting Directive and the International Sustainability Standards Board reporting standards S1 and S2 – are likely to increase overall data transparency. →



AI can be used to measure forest biomass through remote sensing.

PHOTO: CR SHELARE/MOMENT RF/GETTY IMAGES

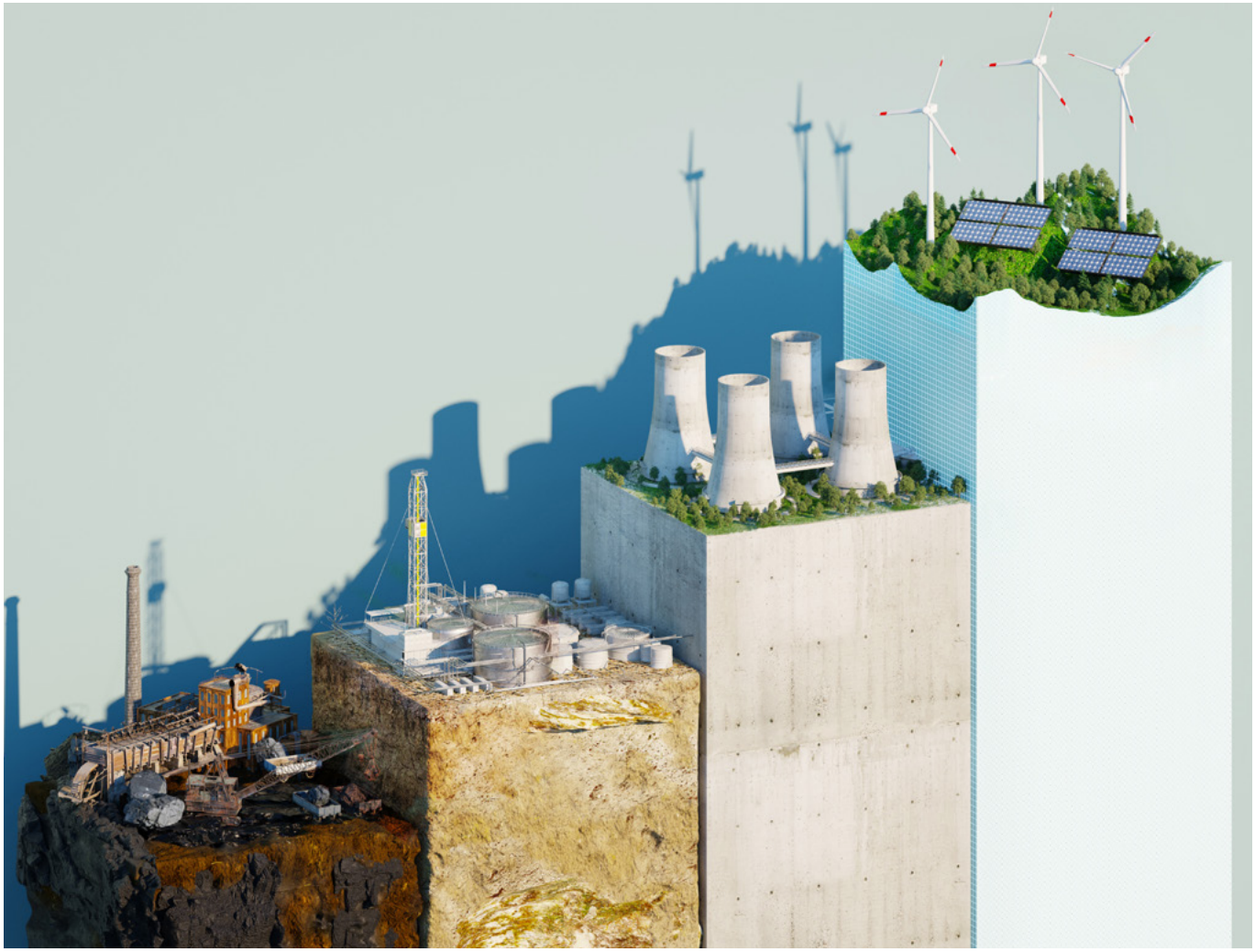
4 ADL analysis

→ **National climate goals.** Countries increasingly understand the value of their natural resources to the carbon offset market and are introducing new regulations to both maximize the revenues these generate and to ensure they benefit their own, national decarbonization targets. For example, Indonesia issued restrictions on the export of forest-based carbon credits – a decision driven mainly by the country's concerns over meeting its Nationally Determined Contributions.

Lack of pricing transparency. Most current carbon credit deals are over the counter, making it challenging for prospective buyers to price correctly. However, recently launched credit exchanges such as AirCarbon Exchange and Xpansiv CBL have already contributed to higher liquidity and price transparency.

Accusations of greenwashing. The practice of using credits to appear more sustainable but without changing underlying behavior or activities has led to skepticism around the market. A recent SBTi report on the effectiveness and use cases of carbon credits unearthed a worrying finding: that some projects claiming to protect forests have instead seen widespread deforestation. Meanwhile, a number of leading certification bodies have been accused of approving valueless offset schemes due to inadequate methodologies and improper baselining and quantification. These discoveries, along with other concerns, have served to undermine the integrity of the carbon credit market and hinder its growth.

To address these damaging findings, better monitoring, reporting and verification enabled through digital technologies, as well as robust base scenarios, are needed to rebuild confidence. Additionally, the recent emergence of independent rating agencies that quantify the likelihood that a benefit will be achieved will also increase transparency. →



What constitutes an eligible carbon credit is prone to change.

PHOTO: ANDRIY ONUFRIYENKO/MOMENT RF/GETTY IMAGES

PHOTO: FLORIAN KOPP/WESTEND61/GETTY IMAGES

→ THE ROLE OF ARTIFICIAL INTELLIGENCE

The solutions to the manifold challenges associated with carbon credits come in many forms, but a clear role is emerging for artificial intelligence (AI) in improving carbon quantification and price transparency – boosting the integrity of the entire industry in the process. Specifically, AI has the potential to support the carbon credit market in four main ways:

1. Carbon quantification

AI can analyze vast amounts of data to assess the feasibility of potential carbon sequestration projects. By considering factors like soil type, climate, vegetation and historical land use, AI algorithms can identify areas with the greatest potential for successful carbon farming initiatives. This allows developers to prioritize projects with the highest likelihood of generating verifiable emissions reductions. An industry-specific use case is offered by a sustainable agriculture solutions provider that uses AI to help farmers adopt carbon-sequestering practices, measure their impact and sell verified carbon credits on its marketplace.

2. Transparency

AI can prove particularly valuable in addressing two critical issues within carbon markets: 1. precise monitoring of carbon sources and sinks where carbon accumulates naturally, and 2. benchmarking and monitoring projects. Today, the real impact of carbon credit projects is heavily scrutinized and "average out estimates" are no longer reliable. This makes accurate and precise monitoring of carbon sources and sinks critical to market transparency. AI also facilitates robust benchmarking, comparing and monitoring of projects – activities many market participants currently struggle with, due to inconsistent reporting standards.

One carbon credit platform launched from Silicon Valley uses AI to monitor forest carbon projects, providing accurate and real-time data on carbon sequestration, which is crucial for carbon credit verification. In another example, a company that provides identity assurance and password-free authentication integrates AI with blockchain technology to ensure the transparency and security of carbon credit transactions, verifying the authenticity of each credit. AI can also be used to measure forest biomass through remote sensing, data processing and machine learning techniques. This is crucial for calculating carbon sequestration and enables more accurate representation of CO_2 benefits, improving trust in the system.

3. Integrity

Alongside transparency, there is an inevitable need to ensure the integrity of carbon markets. In this context, AI can be used to identify unusual patterns in carbon credit transactions and can flag potential fraud, such as discrepancies between reported and actual carbon reductions. In a real-world example, one company specializing in carbon data management employs AI to automate the collection and validation of carbon emissions data. Its platform provides real-time tracking of emissions – crucial for identifying inconsistencies between reported and actual emissions. By leveraging AI, the company enhances the comprehensiveness, consistency and accuracy of carbon data, allowing companies to make well-informed decisions and reducing the risk of fraudulent reporting. A carbon credit pricing and data provider to the voluntary carbon market is also making a positive impact on integrity. The company helps identify discrepancies by aggregating thousands of data points related to carbon market activity, improving the reliability of carbon credit assessments. By offering insights into project details and market benchmarks, it aids participants in detecting potential fraud in carbon credit transactions.

4. Pricing

Another critical aspect for carbon markets is pricing. Here, AI can provide dynamic and accurate pricing of carbon credits by analyzing historical data, economic indicators and policy developments, helping stakeholders take well-informed decisions. Operating in this area, one company has developed a platform that analyzes historical trading data and market conditions to provide real-time pricing for carbon credits. The platform aggregates comprehensive data sets from over 16,800 carbon projects worldwide, including information on location, methodology, cobenefits and contributions to the UN SDGs. Another company specializing in carbon data management employs AI to automate the collection and validation of carbon emissions data. The company's platform provides real-time tracking of emissions, crucial for accurately pricing carbon credits based on actual emissions reductions.

AN OPTIMISTIC OUTLOOK

As companies and countries ramp up their efforts to decarbonize and turn the tide on climate change, there is a growing need for innovative solutions to combat the impact of CO_2 emissions. Here, carbon credits are a valuable tool as part of wider emissions strategies – but they are only part of the answer. Scrutiny from customers, consumers and governments has identified flaws in the market and raised concerns over greenwashing, transparency and pricing, among other issues. Yet, as with any nascent market, the carbon credit landscape is ever evolving, and AI is now emerging with the potential to address several of the key concerns. By embracing AI and following the steps of prevent, reduce, inset and offset, companies across industries can more comprehensively, consistently and accurately develop solid emissions reduction strategies and enhance them with carbon credits.

Despite well-documented challenges, the outlook is bright; appetite for carbon credits is rising, advancing regulations promise to add rigor and structure, and AI is paving the way for a market that is reliable, ethical and robust. To bring this promising future to life, stakeholders across the value chain must keep up with the pace of technological change. To this end, now could be the time for a permanent community of professionals to take root and share knowledge and best practices as the potential transformative role of AI in carbon markets continues to grow with more practical use cases prevailing and clear outcomes with impact documented.

PHOTO: ADOBE STOCK

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