Harnessing Technology and Finance to Unlock Climate Investment: Shaping the Future of Carbon Markets in Africa

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Carbon markets have the potential to make a significant contribution to achieving the scale of decarbonisation required to keep the global average temperature rise within 1.5˚C of pre-industrial levels. But these markets will only be able to deliver their potential if people have confidence in their integrity. For example, a drop in the size of the voluntary carbon market from 2022 to 2023 may be the result of reputational issues that have arisen since *The Guardian* and *Die Zeit's* revelations about "phantom credits" for so-called 'avoided' deforestation.

A key step to ensuring integrity is focusing on emissions removals and reductions, rather than on avoided emissions. Next, the establishment of a common UN-framework for carbon trading will help reduce the fragmentation between myriad standards. Complementing this harmonisation, technology can rebuild confidence by enhancing continual measurement and monitoring, traceability, and transparency, especially in resource-constrained African countries. Furthermore, innovative financial instruments help ensure additionality: contractual obligations to offer results-based financing conditional on emissions outcomes being achieved allow project developers to raise upfront investments, while real-time settlements ensure that they and their financiers are paid quickly. Together, these interventions hold the promise of supporting African governments' priorities of pursuing sustainable development, where projects for carbon credits promise social development co-benefits.

Carbon market potential

McKinsey estimates that voluntary carbon markets could grow to $50Bn/year by 2030, driven by increasing corporate demand for carbon credits as part of their decarbonisation strategies.

Additionally, demand for credits under Article 6 of the Paris Agreement could attract billions more as countries trade emissions reductions and removals to meet their Nationally Determined Contributions (NDCs), facilitating cross-border climate finance and channelling funds to mitigation projects, especially in developing economies. We estimate the market size for Article 6 credits to be 1.91 $GtCO_2e$ by 2030, assuming that OECD countries achieve approximately 75% of their unconditional NDC targets. This translates to a market value of approximately $50Bn, based on an average price of $25 per tonne of CO_2e.

Barriers to ensuring market integrity

Competing methodologies and inconsistent standards: Different carbon markets operate under varying methodologies, making it difficult to verify the authenticity and additionality of carbon credits. **Inconsistent standards** lead to concerns over whether credits genuinely represent emissions reductions, while **limited transparency** around how credits are generated and traded erodes trust among market participants. Related to this is the **fragmentation of carbon markets across regions,**

countries, and mechanisms, which creates inefficiencies that limit scalability and liquidity. The existence of multiple, disconnected markets with varying prices and quality standards creates arbitrage opportunities and weakens market confidence, with low-quality, low-cost carbon credits often crowding out high-quality, high-cost credits. In some cases, poorly designed projects can even lead to negative social and environmental outcomes, such as land-use conflicts or biodiversity loss, which damage the reputation of carbon markets. This has led a number of governments to close their Emissions Trading Schemes to foreign carbon credits.

A uniform approach to deal with the **risk of reversals and leakages** is also lacking. Often, standard setters 'tax' projects around 15-20% of carbon credits. These credits are placed into a buffer pool of carbon credits in an attempt to insure projects approved under their standard for permanence against the subsequent release of greenhouse gases. An example: wildfires releasing sequestered carbon. This 'tax' (or buffer contribution) is either based on a simple risk-assessed contribution or a flat rate, depending on the carbon standard. Then, credits are retired from the buffer pool if there is a reversal. This mode of insurance is neither standardised nor regulated. Issues that undermine confidence and market efficiency with this approach include

i. standard setters lacking the professional actuarial capacity to assess the risk and so either
    a. create unnecessary inefficiencies with the level of 'tax' they impose, leading to illiquidity – project developers think the 'tax' standard setters impose is too heavy, and that the upfront payment is too burdensome; or
    b. insufficiently insure their entire base of clients.
ii. having buffer pools consisting of disparate low- and high-grade credits.

Adequate Monitoring, Reporting and Verification: Another major challenge is the **inadequacy of Monitoring, Reporting, and Verification (MRV) systems**. Weak or outdated MRV frameworks result in inaccurate assessments of project performance, making it hard to ensure that claimed emissions reductions and removals are **real and lasting**. Traditional MRV methods can be costly, time-consuming, and prone to inaccuracies, as they rely on static assessments of abatement. This challenge is exacerbated by the absence of unified legal and regulatory frameworks, which opens the door to market manipulation, fraud, and inconsistencies in how carbon credits are valued and traded.

Lack of additionality: If critics believe that projects would have occurred regardless of the results-based payments for carbon removal or reduction, then the entire *raison d'être* of carbon markets is undermined. For carbon markets to serve a purpose, the results-based payment needs to have made possible a removal or reduction that would otherwise not have happened. Projects surviving without timely settlement of results-based payments undermine that argument of additionality because they make the results-based payment seem like a windfall profit rather than a necessity to enable action.

Double-counting risk: The risk of **double counting and double claiming**, where multiple entities claim the same emissions reduction (or claims are unclear as to whether the credits are counted by both a country and a company) further undermines the market's credibility, especially in international trading mechanisms.

How these barriers can be overcome with the help of technology and financial innovation

So how can institutional change, technology and financial innovation overcome barriers to carbon market integrity and restore faith?

Fragmented markets and inconsistent standards: Universally applied rules under Article 6.4 of the Paris Agreement for internationally traded compliance carbon credits bring us closer to bridging the

gap on fragmented markets and inconsistent standards. By creating a centralised UN-supervised carbon market, the Paris Agreement will harmonise standards to provide greater transparency, accountability, and additionality. For example, they clarify that 'avoided' emissions will not be countered as legitimate carbon offsets. Furthermore, the rules set baseline methodologies and track double counting so that emissions reductions cannot be claimed by more than one country or company.

To harmonise voluntary carbon markets with compliance Article 6.4 markets, governments can establish **regulatory frameworks for what constitutes offsets**.

Governments can also regulate with respect to how reversals and leakages are insured against. Governments could prohibit standard setters from self-insurance using their own buffer pools constituted of mixed products and lacking actuarial robustness. Instead, governments could require standard-setters to **outsource permanence risk to carbon credit insurers** with the actuarial expertise to inform appropriate (often cheaper for projects) premia pricing, and who can structure payments for the insurance in a way that is not onerous to projects (e.g. without large upfront 'payments' in kind).

Adequate Monitoring, Reporting and Verification: Investment in climate action requires both an accurate baseline against which to measure progress, and ongoing transparency about the impacts of investment.[1] MRV systems are therefore crucial for the integrity and effectiveness of climate action. New technology solutions provide significant progress in MRV by offering precise and cost-effective ways to establish baselines, monitor progress, and verify outcomes of climate projects.

Satellites equipped with advanced imaging technology can capture high-resolution data across large geographic areas. This capability, together with Artificial Intelligence (AI) projections, is promising for establishing **accurate baselines** and **ongoing monitoring** for carbon projects such as reforestation or renewable energy installations. For instance, satellites can measure forest cover, detect changes in biomass, and track land use changes in near real-time. They also offer solutions in ongoing monitoring of projects, including the measurement of **fugitive methane emissions** from the oil and gas supply chain. Identifying and reducing such leaks is not only a benefit to the climate but also to producers' economic performance.

Real-time sensors that offer continuous monitoring also offer significant improvements in MRV. In forestry projects, **sensors can track tree growth, soil moisture levels**, and **carbon sequestration rates**.

Together, near-live data from satellites and sensors help ensure that reported outcomes are accurate and verifiable, reducing the risk of fraudulent claims and enhancing the credibility of the carbon credits generated.

Additionality: Forward-agreements, such as Emissions Reductions Purchase Agreements, or commitments inserted into Power Purchase Agreements (conditional on successful outcomes achieved) help ensure that those committing upfront capital for carbon removal or reduction projects are relying on the results-based payments of verified, certified and issued carbon credits, and do not treat carbon credits as windfall profits.

Demonstrating additionality could be further enhanced with the use of Artificial Intelligence. For afforestation, for example, AI could project what forest cover would have been under a business-as-usual scenario using detailed longitudinal data collected from satellites and compare this with the forest cover achieved through the afforestation intervention.

[1] Towards a Tech-Enabled Climate System: Technology Can Unlock Finance for Climate Action (institute.global)

Timely settlement also helps ensure that projects get payments for carbon credit issuances on which they relied. New technology solutions are helping enable this. Advances include **real-time settlement options**, **digital currencies**, and the **tokenisation of real-world assets**, which facilitate transparent, efficient, and secure value transfer.

Digital tokens' value can be linked to real-time environmental outcomes and/or assets. Being able to programme a token to link it to real-time data, including data collected by sensors, drones, or satellites, adds the potential to create new sources of value in climate action – and the potential for new sources of investment capital. Tradeable tokens could represent the amount of carbon sequestered by a block of forest in a reforestation project, providing a source of value that is linked to both the performance of the real-world underlying asset (in this case, the block of forest) as well as the tradeable market value of a specific volume of sequestration (generally a ton of carbon). The token could also capture other sources of value, such as biodiversity, on the same block of land.

This link between the real-world asset and the token enables real-time financial transfers based on verified environmental outcomes. Investors can purchase programmable tokens, knowing their value is backed by real-time data from environmental sensors.

Similarly, distributed ledger technology could also enhance transparency of the investment and outcomes. This would enable all transactions based on programmable tokens to be recorded on a transparent and immutable ledger, enhancing accountability, ensuring all stakeholders can track the flow of funds and verify that they are used for their intended purpose.

Double counting: Immutable ledgers also help ensure that no two companies, countries or a mix of countries and companies can claim the same credit.

To ensure that two countries do not claim the same mitigation outcome that one has sold the other under Article 6.2 of the Paris Agreement, the selling country needs to make a 'corresponding adjustment'. **Smart contracts** could automate this process, especially if countries moved to digital registries, and ensure timely payment when satellite data and sensor readings confirm that the emissions reductions have been achieved.

Furthermore, the terms of the agreement for trading carbon credits internationally could be transparently and immutably recorded on a distributed ledger technology platform. This platform could also be designed to interface with the Paris Agreement Crediting Mechanism created under Article 6.4 of the Paris Agreement. This transparency could increase the efficiency of ITMO transfers, as transactions can be completed more quickly and with lower transaction costs, making it easier for countries and businesses to engage in carbon trading, and facilitating the flow of finance to climate projects.