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# Towards a Tech-Enabled Climate System: Technology Can Unlock Finance for Climate Action

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# Contents

01

# Executive Summary

Global decarbonisation requires unprecedented levels of investment, with estimates of the capital needed to reach net zero ranging from $7 trillion to $9 trillion per year from now until 2050. Investment is needed in emissions reductions and in nature and biodiversity in order to limit temperature rise to less than 2 degrees and secure a sustainable future for all.

Current investment into actions that will reduce emissions is woefully inadequate. Estimates suggest that annual expenditures need to increase at least five-fold annually to limit the impact of global temperature rises, with delays in capital deployment resulting in higher future costs in both decarbonisation and adapting to climate change. Governments should urgently consider how to harness the potential of new solutions to improve the flows of public and private capital into climate projects and maximise the investment needed to deliver on the global challenge.

Across both developed and developing nations, there are a range of barriers impeding the flow of investment necessary to meet emission-reduction goals. These challenges include understanding the integrity of climate action (for example, is the investment delivering real change?), creating and calculating value in new asset classes to provide a return on climate financing (such as creating income to protect forests and other natural resources), and ensuring trust in the execution of the financial transactions underlying climate investment.

Without transparency and integrity, investment in actions to reduce emissions may not deliver the outcomes investors expect. And if investment doesn't result in emissions reductions as anticipated, investors risk missing sustainability targets, non-compliance with climate-related financial-disclosure requirements and exposure to accusations of greenwashing. Purchasers of credits to offset corporate emissions risk finding out their investments were worthless, while elected leaders risk being unable to evidence the impact of their overseas climate-finance contributions to voters at home.

However, there is now potential to harness the power of new and emerging technologies to accelerate the flow of finance into emissions reductions. New tools can enhance the transparency, efficiency and security of climate

investment, allowing greater confidence in capital deployment.

The example of international carbon markets illustrates the significant potential of new solutions and how these can address some of the challenges that are preventing the deployment of capital. New technologies, working together in an integrated system, can remove some of the key barriers to climate investment and facilitate the flow of finance to climate projects.

02

# Technology Can Enhance the Integrity of Emissions Reductions

Investment in climate action often requires both an accurate baseline against which to measure progress and ongoing transparency about the impacts of investment. As such, monitoring, reporting and verification (MRV) systems are crucial for the integrity and effectiveness of climate action, including where this action occurs within the context of international carbon markets.

Traditional MRV methods can be costly, time-consuming and prone to inaccuracies, as they rely on static assessments of abatement. They also entail risk around double counting and claiming, and questions of whether the action has integrity (does what is promised). Traditional MRV also cannot prove whether the action is additional (wouldn't have happened without the investment).

New technology solutions provide a leap forward by offering precise and cost-effective ways to establish baselines, monitor progress and verify outcomes of climate projects. This in turn could shift the dial on the integrity issues that have plagued some climate investments in recent years, including the reputation of voluntary carbon markets. These markets have suffered as a result of multiple instances where credits to offset emissions were issued but where subsequent investigations exposed that the emissions reductions that the credits represented were exaggerated or did not occur. New tech solutions, especially when paired with AI forecasting, can reinstate confidence by providing detailed data to inform accurate baseline setting and near-real-time measurement of emissions-reductions activities. As such they can both reduce risk to project performance and reinvigorate interest – and trust – in carbon-reduction investments.

Satellite technology and real-time sensors are examples of these new solutions. Satellites equipped with advanced imaging technology can capture high-resolution data across large geographic areas. This capability is hugely promising for establishing accurate baselines for carbon projects such as reforestation or energy initiatives. For instance, satellites can measure forest cover, detect changes in biomass, and track land-use changes in near real

time, with technologies evolving rapidly.[1] These data provide both a reliable baseline against which forest-project outcomes can be measured and ongoing monitoring potential.

Real-time sensors that offer continuous monitoring also offer significant improvements in MRV, easing concerns about whether projects are actually delivering real outcomes. In the course of forestry projects, sensors can track tree growth, soil moisture levels and carbon-sequestration rates; these data can then be compared to business-as-usual growth projections informed by AI modelling. For renewable-energy projects, sensors can not only measure the performance of solar panels or wind turbines but can also help optimise energy output – with insights into advantageous sites for wind farms for example – and increase the penetration of renewable-energy generation by providing system-optimisation data. This continuous stream of data enhances the accuracy and reliability of MRV systems, building trust among both investors and regulators.

Satellite imagery also has potential for wider high-impact climate-mitigation projects. One example can be seen in MethaneSAT, a satellite that provides high-resolution measurement of fugitive methane emissions from the oil and gas supply chain. Recent data from MethaneSAT, and its jet-aircraft counterpart MethaneAIR, showed that methane emissions from oil and natural-gas producers were four times higher than the rates estimated by the Environmental Protection Agency in the United States, wasting enough gas to meet the annual energy needs of more than half of US homes. Reducing such leaks is not only of benefit to the climate, but also to producers' bottom lines.

Integrating satellite data with information from real-time sensors creates a robust verification system. For example, in a reforestation project, satellite images can verify the extent of forest cover, while ground sensors measure carbon-sequestration potential. These data can be additionally enriched by stratospheric data collection, as has been proposed by the aerial-imagery company Kea Aerospace.

This multi-layered approach to near-live data ensures that reported outcomes are accurate and verifiable, reducing the risk of fraudulent claims and enhancing the credibility of the carbon credits generated.

Real-time data solutions offer significant potential not only in carbon markets, but also for a range of results-based financing mechanisms such as impact

investments, green bonds and debt-for-nature swaps. They additionally bring value for securing or unlocking export opportunities and the associated investment. For example, the upcoming EU Deforestation Regulation will ban commodities from entering EU markets unless exporters can show that these goods (including palm oil, coffee and cocoa) have not been produced on land subject to deforestation after 2020. Similarly, those exporting to countries with Carbon Border Adjustment Mechanism (CBAM) requirements will likely need onsite monitoring of emissions, in addition to limiting their direct and indirect emissions in order to maintain competitiveness. Furthermore, capital-market participants with climate-related financial-disclosure reporting requirements could also benefit from tech solutions that offer ways to prove the integrity of climate action.

03

# Technology Can Create New Value out of Emissions Reductions

New technology solutions are revolutionising traditional financial and payment systems. Advances include real-time settlement options, digital currencies and the tokenisation of real-world assets. Combining these technologies with real-time environmental data and AI creates new opportunities for investing in climate action. The linking of efficient and secure value-transfer systems to live environmental information creates the necessary integrity and trust needed to facilitate this investment.

Digital tokens provide an illustration of this. These tokens can digitally represent real-world environmental assets whose value can, in turn, be linked to real-time environmental outcomes. For example, Single.Earth's MERIT tokens represent the ecological value of action taken by landowners to preserve nature on their land.[2] Single.Earth uses a digital twin to monitor and evaluate nature, which in turn is given a digital – and investable – value in the MERIT token.

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. For instance, a programmable token could represent the amount of carbon sequestered by a block of forest in a reforestation project. As sensors confirm sequestration levels,[3] the token's inherent value would automatically adjust accordingly. Investors thus derive value from both the status of the real-world underlying asset (in this case, the changing health of a block of forest) as well as the tradeable market value of a specific volume of sequestration (generally a ton of carbon, traded on a secondary market). The token could also capture other sources of value, such as biodiversity, on the same block of land.

This linkage between the real-world asset and the token enables trustworthy real-time financial transfers based on verified environmental outcomes.

In this example, transparency of the investment and outcomes could also be enhanced using distributed-ledger technology (DLT). This would ensure that

all contracts and transactions based on programmable tokens were recorded on an immutable ledger, enhancing accountability and ensuring all stakeholders can track their investments and trust that transactions occur as intended. In the context of carbon markets, programmable tokens could simplify the trading of carbon credits, making the market more efficient and accessible.

04

# Technology Can Improve Trust in Climate Transactions

Countries and businesses can purchase and trade carbon credits internationally, often allowing greater ambition and abatement than can be undertaken domestically. However, the generation and transfer of credits between countries, particularly those known as Internationally Transferred Mitigation Outcomes (ITMOs), can involve significant counterparty risk, and require trust between parties that mitigation outcomes will be delivered as promised. This trust extends from whether investment will deliver the promised emissions abatement through to the "corresponding adjustment" that is required to ensure that the abatement is only counted by one party. Smart contracts offer a solution by automating and securing these transfers.

Smart contracts are self-executing agreements with the terms and conditions of the contract written directly into the computer code that executes them. As such, they can automate the settlement of funds when a set of pre-agreed conditions are met. For example, a smart contract could release payment for carbon credits only when satellite data and sensor readings confirm that the emissions reductions have been achieved. This would ensure that funds are released when verified environmental outcomes are delivered, reducing a range of risks for investors and ensuring that countries undertaking projects under Article 6 of the Paris Agreement receive timely and adequate funding.

Smart contracts could also potentially automate and secure ITMO corresponding adjustments, especially if countries moved to digital inventories of emissions. The terms of the ITMO transfer could be programmed into the contract, which would then automatically settle and transfer the ownership of ITMOs, at a pre-agreed price, when the predefined conditions were met. This would ensure that emissions reductions were accurately accounted for in both the transferring and receiving countries, ensuring compliance with international rules.

Furthermore, the terms of the agreement for trading carbon credits internationally could be transparently and immutably recorded on a DLT platform. This platform could also be designed to interface with the Paris

Agreement Crediting Mechanism created under Article 6.4. This transparency could increase the efficiency of ITMO transfers, as transactions could 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.

05

# Policy Frameworks for Tech-Enabled Climate Finance

Governments should ensure their policy frameworks – and digital infrastructure – allow technology solutions to facilitate investment in emissions reductions. Solutions such as satellite data, real-time sensors, programmable tokens and smart contracts address critical barriers to the climate finance needed by enhancing the accuracy and reliability of MRV systems, enabling real-time value determination and transfer and mitigating counterparty risk in ITMO transfers. By leveraging these innovations, the international community can unlock significant finance for climate projects, driving progress towards global climate targets.

In order to capitalise on these solutions, governments – whether funding or receiving climate finance – should consider whether they have the right policy settings and digital infrastructure needed to harness their full potential. This includes:

- **Developing AI-era digital infrastructure.** This includes the capacity to facilitate the creation and adoption of platforms that use DLT, including secure and scalable platforms that can handle large volumes of transactions while ensuring data integrity and security.
- **Developing robust governance, legal and regulatory frameworks.** This encompasses not only addressing issues such as data rights and privacy, but also ensuring foundational policies are in place including, for example, that both digital transactions and electronic records are legally binding. Examples include the EU's DLT Pilot Regime, which focuses on digital-native market infrastructures for the trading and settlement of tokenised assets, and the UK's Electronic Trade Documents Act 2023.
- **Ensuring that data and standards are interoperable.** These building blocks of the tech-enabled climate-finance system need to be consistent across sectors and harmonised between local and regional carbon markets and international platforms.

Countries should also harness the support of both traditional financial-service providers and private tech-solutions companies, including creating supportive

regimes that encourage – and incentivise – innovative solutions to key barriers.

Furthermore, capacity building in the context of Article 6 of the Paris Agreement should include the provision of funding and technical support to help developing countries implement both advanced MRV systems and digitalised national inventories. Such capacity would ensure that developing countries can participate effectively in international carbon markets and assist them to leap-frog over legacy systems that require labour-intensive manual compilation of national emissions to meet transparency requirements.

By implementing these policy reforms, governments can help facilitate an enabling environment that leverages new technologies to overcome existing barriers in climate finance, accelerating the flow of capital into crucial climate-action initiatives.

# Endnotes

1 For example, the European Space Agency's satellite ***Biomass*** is due to launch in 2025. It will carry "P-band synthetic aperture radar" and is designed to deliver richer data about the state of forests and the carbon they store. https://www.esa.int/Applications/Observing%5Fthe%5FEarth/FutureEO/Biomass

2 https://www.single.earth/nature-token-merit

3 This value can change – for example, the sequestration could increase due to the impacts of a pest-eradication programme or decrease due to illegal logging.

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