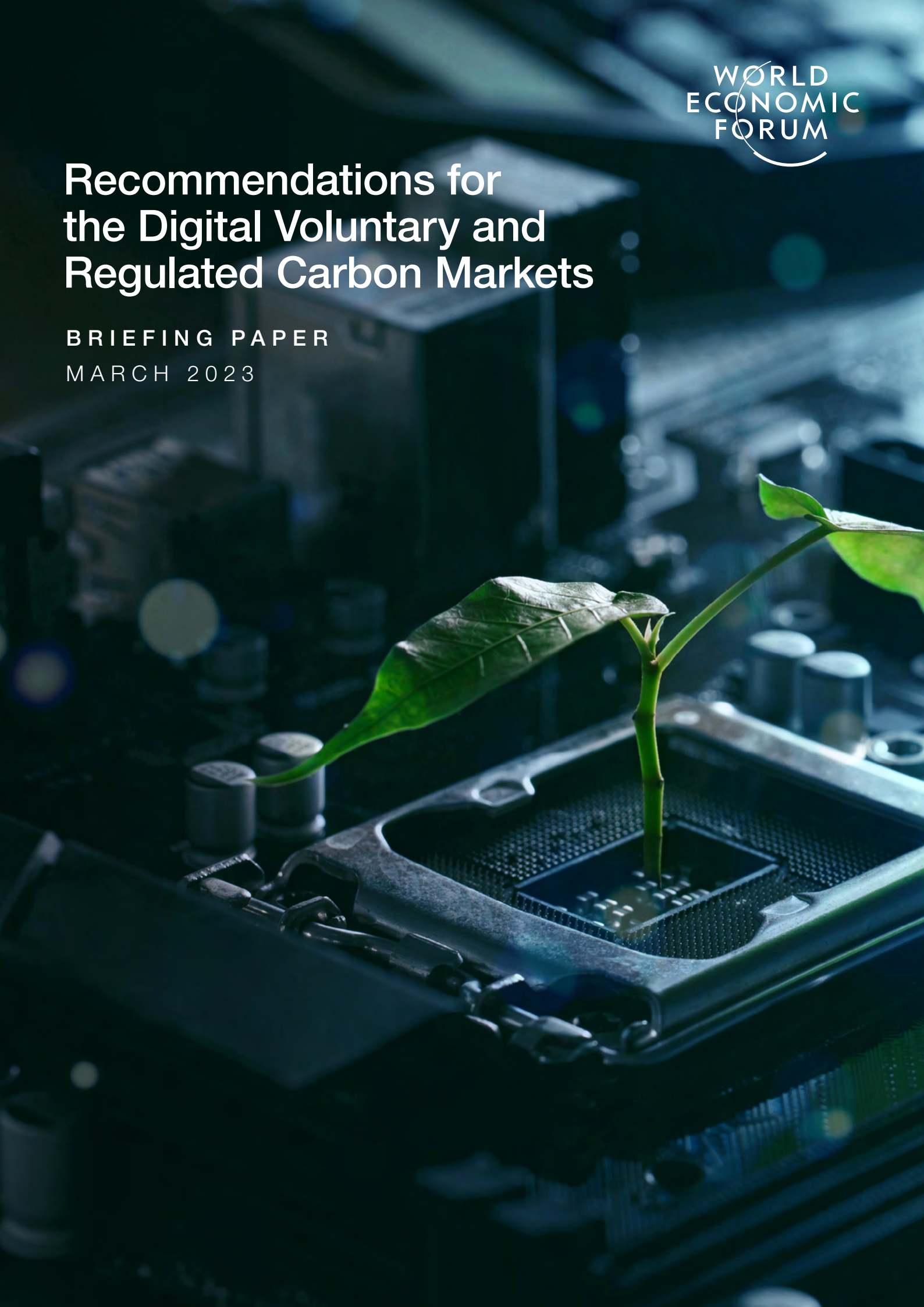
WORLD ECONOMIC FORUM

Recommendations for the Digital Voluntary and Regulated Carbon Markets

BRIEFING PAPER

MARCH 2023



Images: Getty Images

Contents

Introduction

In order to meet the Paris Agreement's goal of limiting the global temperature increase to below 1.5°C, it is necessary not only to reduce carbon emissions quickly but also to continuously remove and store existing and future excess atmospheric carbon dioxide. This will require a broad array of mitigation activities, including a transition away from fossil fuels, emissions reduction programmes and carbon emissions offsetting through carbon credit markets.[1] At their core, carbon credits are a financial technology that enables capital to flow towards a variety of direct, verifiable actions for mitigating the impact of the changing climate. Many jurisdictions manage carbon crediting for organizations and municipalities via regulatory bodies (these are regulated carbon markets), while much of the private sector participates increasingly in voluntary carbon markets. In this paper, "carbon markets" refers to both.

Carbon markets have come under heavy criticism for their lack of transparency, accessibility, equitability and quality. Despite broad corporate interest, they also remain underused and fragmented. Along with this criticism, and the growing demand for effective and high-quality carbon credits, there is a renewed enthusiasm for applying emerging technologies and new approaches to expand the reach, credibility and scalability of carbon markets. However, significant work still needs to be done. This paper touches on the myriad challenges facing current carbon markets and suggests an ambitious path forward so that they can deliver positive long-term environmental, social and economic impact.

Innovative technological and social infrastructure play equal roles in enabling the next generation of digital carbon markets. This paper focuses on emerging forms of distributed ledger technology (DLT) and their applicability to carbon markets, although this is just one of the many technologies needed to fully enable a digitally native carbon market. DLT allows carbon credits to be represented as universally unique data entities in a digital end-to-end environment. Doing so makes it possible to verify a credit's provenance, track its secondary exchange and retire it permanently, without the need for centralized intermediaries.

The lead authors of this briefing paper are: Evîn Cheikosman, Director, Blockchain Law for Social Good Center, University of San Francisco; Policy Analyst, CISA, World Economic Forum, USA (2020–2023); Josh Knauer, Co-Founder, ReSeed.farm; Lauren Serota, Advisor, Funga.

1 Challenges facing carbon markets

These are the biggest challenges to be overcome:[2]

Lack of transparency, integrity and confidence in the monitoring, issuance, sale, retirement and benefits distribution of carbon credits, as well as in third-party certifications

Without auditability and visibility into the supply chain, it is difficult for buyers to make informed decisions. This is where blockchain technology could play a role, although systems that use blockchain still rely on data from legacy systems and can be difficult for non-experts to audit and understand.[3] Many current verification bodies have opaque and outdated processes and have been slow to integrate new technologies that could help scale the entire onboarding and verification process. One result is that carbon buyers have a hard time determining the quality of the credits they are purchasing, and so they manage reputational risk by hiring intermediaries, who drive up costs and have no incentive to make changes and adopt emerging technologies. This stifles market activity and makes it even harder to meet climate targets.

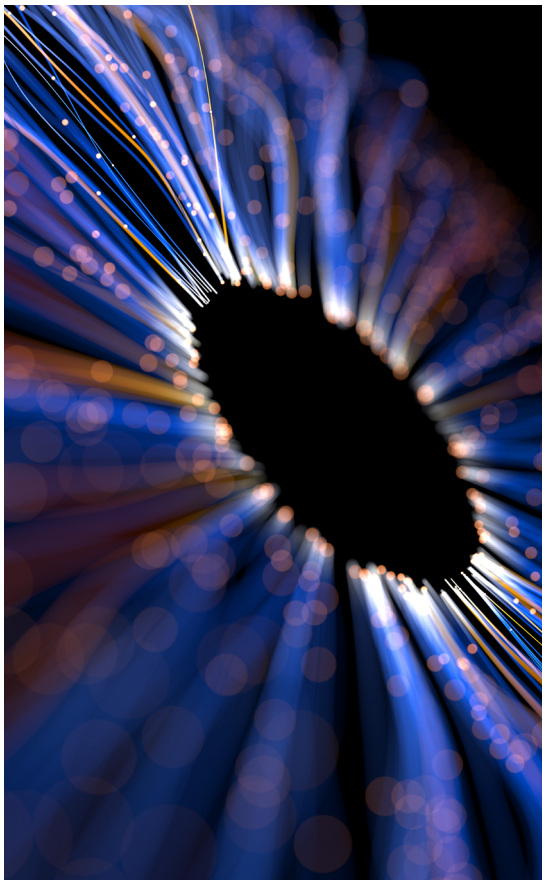
The lack of a standardized terminology for describing carbon credits makes it hard for potential buyers to compare credits from different sources and confidently purchase without the help of intermediaries. The use of the term “token” (rather than “credit”) in the blockchain industry has only added to the confusion and has raised regulatory concerns.

Inaccessibility, inequity and lack of participation in carbon markets by women, local communities, smallholder land stewards, Indigenous people and other vulnerable populations

Concentrations of power and vulnerabilities to corruption undermine the credibility of carbon markets. Participation is prohibitively expensive and operationally intensive, making it difficult for even well-funded carbon projects to get off the ground. The high costs associated with legacy carbon market participation mean that billions of smallholder land stewards globally are excluded from the market.[4] Despite clear guidance from the Intergovernmental Panel on Climate Change (IPCC)[5] on social and environmental justice standards, credits brought to market rarely have any socioeconomic impact data associated with them. While inclusion of these majority populations requires fundamental shifts in business practices and governance, such engagement and equitable distribution of corresponding carbon credit revenue could be automated, documented and monitored using a blockchain.

Insufficient scale to meet climate commitments

Current measurement, reporting and verification (MRV) methodologies are numerous, require significant manual work, are slow to follow and measure against and are often redundant. Many methodologies for the collection, analysis and distribution of data remain non-digital and lack machine-readable auditability. The lack of a clear value structure and methodological inclusion of other ecological and socioeconomic factors – such as biodiversity, watershed protection and community impact – make it even harder to create meaningful impact given the current market dynamics.



2 Recommendations for the next generation of digitally native carbon markets

The following pages detail recommendations for developing a next-generation carbon market infrastructure that powers a more efficient and transparent environment for project developers, local populations and buyers alike. For each recommendation, there is an outline of what is required and why. There is also an analysis of the potential for specific applications of DLT to facilitate coordination of global and diverse stakeholders, and the activities required to see large-scale climate impact from the carbon market.

2.1 Improvement of governance

Governance of carbon markets refers to the processes and mechanisms by which carbon credits are issued, verified and traded. Governance can have a significant impact on the effectiveness and credibility of carbon markets and their overarching objective of reducing greenhouse gas emissions and promoting sustainable development. Good governance of carbon markets requires tenets of transparency and rigour of data, meaningful inclusivity and diversity in participation, as well as flexibility and scalability of processes.

Promote inclusive, equitable and transparent governance.

Healthy environmental systems need healthy human systems. To enable better-informed decisions and address the complex challenges posed by climate change, governance must be inclusive, flexible and multidimensional at all levels of engagement. This includes technological flexibility – governance must support inclusive, informed and transparent participation, both online (using technologies such as smart contracts and video conferencing) and offline (e.g. community roundtables and other community education efforts). It is critical to include provisions for equitable participation, safeguards to protect whistleblowers and sanctions to punish malicious actors. Governance at scale may require investments in education and including stakeholders to ensure full engagement in the system.

Include vulnerable populations and women's empowerment in governance and benefit sharing.

Including vulnerable populations[6] and promoting women's empowerment in carbon market governance processes ensures equitable decision-making and distribution of benefits, enhances the credibility and viability of carbon projects and minimizes the negative consequences of design by isolated industry players and systems. To encourage transparent and inclusive governance of carbon credit projects, it is necessary to ensure equitable representation of land stewards early in the design and implementation process, as well as in the creation of policies, programmes and funds.

Build local/global capacities for participation, and industry capacities for understanding.

Incumbent power structures have excluded diverse perspectives, by design or through ignorance. Facilitation of diverse voices needs more than an invitation. It requires investment, the provision of tools and information to bring all representatives to the same baseline of understanding on varied topics, from the complexities of carbon markets to the intricacies of Indigenous land practices.

2.2 An accessible marketplace, product definition and clarity

Digital
carbon credits can enable unique demand-side use cases

Effective markets can create the conditions for the emergence of dynamic and adaptable products to solve the challenges facing diverse stakeholders. But this functionality is possible only if purchasers can effectively distinguish signal from noise. Bringing this clarity to carbon products requires reducing obstacles, redundancy and confusion while streamlining and defining the underlying benefits to climate and society.

Ensure carbon markets adopt a common baseline taxonomy to provide clarity.

Carbon credits should have standardized and detailed labels to enable ease of understanding and comparability.[7] Important non-carbon attributes, such as achieving the Sustainable Development Goals,[8] including enhanced biodiversity and meaningful community benefits, should be clearly defined and easily identifiable.

Expand carbon markets to include efficient price discovery and the creation of innovative new financial products and "beyond-carbon" tradable assets including factors such as biodiversity, social value and Indigenous rights.

Digital carbon credits can expand the market by trading on open and accessible exchanges that highlight the auditable data-backed differences among the credits. This promises to remove the considerable friction and uncertainty surrounding buying and selling credits that currently exists, to increase visibility for price discovery and make it easier to fund the market's expansion.

Use an "end-to-end" digital environment, including DLT, to enable efficient data capture, analysis and auditability.[9]

Using technology-based data collection tools such as digital decentralized measurement, reporting and verification (MRV), and making such data available in an open-source and human-readable format (e.g. on a blockchain-based ledger with a non-technical interface), can resolve challenges associated with trust, transparency and interoperability in current systems. This can lead to enhanced confidence in the market, better and more seamless participation for both sellers and buyers and greater scale.

Digital carbon credits can enable unique demand-side use cases. Everyday purchases can more easily and credibly have the cost of their emissions baked into their purchase, as seen already with airline bookings and some e-commerce platforms. Industries can integrate the retirement of digital carbon credits directly into their operations so that emissions are compensated for in real time, rather than on a quarterly or annual basis.

2.3 Applied technology for radical scalability

This is an unprecedented time in terms of the capability and abundance of sophisticated technologies. Using available and affordable emerging technologies such as near-field communication devices and robust LIDAR satellite imaging, it is possible to scale innovations in digitally representing real-world assets with integrity.

Use digitally native credits to support more automation in validation and verification.

The immediate advantage of digitally native[10] credits over their past iterations is a reduction in the overhead expense through a credit's life cycle. Machine readability and automation further contribute to the streamlining of processes. One example is the translation of protocol documentation into a standard set of data points, enabling the monitoring of protocol adherence via a combination of data feeds such as satellite imagery or internet of things (IoT) sensors (rather than relying solely on consultants from a validation and verification body physically visiting the project site).

Ensure better use of emerging technologies.

Technologies such as advanced remote sensing, artificial intelligence and machine learning and IoT sensors, incorporating auditable records written by DLT, are examples of combining emerging technologies, tools and modelling to help achieve scale. For example, blockchains and smart contracts can support MRV as a coordinated and repeatable effort across a diverse group of sensors and stakeholders.

Reduce friction and increase connectivity between buyers and sellers.

Digitally native carbon credits improve the verifiability and transparency of credit information by providing an immutable record of credit provenance, as well as attaching credit metadata, such as verification reports, in machine-readable formats.

Connecting buyers more directly to sellers reduces the number of intermediaries needed in

the marketplace, thus removing opportunities for extractive fees and delivering a higher percentage of revenue to suppliers, project developers and land stewards. A more direct connection to markets may also increase access for marginalized populations, efficiency and price transparency.

Prioritize trust and transparency through open-source MRV protocols.

Using scalable, inexpensive and easily peer-reviewed MRV protocols can help improve carbon markets' transparency, credibility and effectiveness. Access to a schema in an open format allows for more inclusive and transparent decision-making from all sectors, resulting in more impactful interventions and effective climate policies. Protocols that are easily peer reviewed can help ensure the accuracy and reliability of data and build trust and confidence in the market.

2.4 Interoperability and transparency across exchanges and platforms

The participation of a decentralized and distributed group of diverse players operating on vastly different technologies builds trust in the validity of carbon credits and helps achieve scale in the markets. Market players should consider the following recommendations to maximize interoperability and transparency across the industry.

Build for systems, not silos.

Open application programming interfaces (APIs) accessing blockchain data have the potential to improve verifiability, reduce transaction costs and, to a lesser degree, address the concerns of some projects. While not a new trend, the availability of well-documented and accessible public APIs is critical. As industries – especially those that have been slower to adopt technology – undergo digital transformation, accessible APIs play an important role in delivering transparency, connectivity and innovation.

There is also a need to develop a data standard that harmonizes the data points available for each carbon credit in different registries and enables interoperability across different issuers of carbon credits.[11]

Design for how and why a stakeholder wants to consume your data.

Understanding why and how third parties will consume your data is critical to affecting API development. Consider, as an example, a carbon credit registry. By developing an API that allows a third party to interact with carbon credits more directly, the registry could establish an automated carbon credit usage reporting function that automates a process that normally takes weeks and involves manual intervention. Appropriate use of smart contracts would minimize manual reconciliation efforts between disparate systems by creating machine-readable agreements and auditable tracking of credits throughout their life cycle.

Create digitally networked carbon credits.

APIs play an important role in connecting consumers, devices and services through the IoT. The IoT creates more communication points among devices and users, requiring secure APIs to effectively receive data and create ledger entries for data analysis and to drive insights.

For carbon credits, this enables transparency through the effective use of sensors, drones, etc. Sellers of carbon credits could use readings from IoT devices to differentiate their carbon credits in a crowded market, enabling buyers to view forests in real time or read soil-sensor data to highlight carbon captured.

Demand and build towards industry standards.

As infrastructure matures, standards and established ways of working will accelerate the rate and speed at which new credits come to market. Collaborating with industry working groups such as the Crypto Sustainability Coalition,[12] the Crypto Council for Innovation,[13] the Blockchain Law for Social Good Center[14] or the Global Blockchain Business Council's InterWork Alliance[15] group will enable carbon market participants to further drive standardization.

3 The time is now

Climate change is the greatest existential threat that humanity faces and many actions are needed in response. A comprehensive transition away from fossil fuels to reduce emissions is essential, as is the drawdown of hundreds of gigatons of carbon dioxide[16] from the atmosphere. The main outcomes the carbon credit markets need to focus on are: the **reduction** of emissions as quickly as possible, the **protection** of natural carbon sinks and the **removal** of carbon dioxide from the atmosphere. Credits issued to certify these outcomes are falling short, with reduction, protection and removal credits achieving less than 20% of IPCC goals.[17]

Disruption of the legacy carbon markets is currently occurring as a result of the urgency of solving the problem, combined with the advances in emerging technologies that can support new transformative solutions for engaging broader communities of stakeholders with greater transparency, efficiency and equity. Emerging technologies such as blockchain are not a panacea, but understanding their benefits and how they work enables broader and more informed experimentation to help achieve humanity's goals.

How effectively the potential solutions to this global existential threat are navigated may well determine the future of life on this planet. The recommendations in this paper on harnessing emerging technologies, empowering greater numbers of people to participate and creating equitable economic incentives can help meet this challenge at scale.

Contributors

Lead authors

Evîn Cheikosman
Director, Blockchain Law for Social Good Center, University of San Francisco; Policy Analyst, CISA, World Economic Forum, USA (2020–2023)

Josh Knauer
Co-Founder, ReSeed.farm

Lauren Serota
Advisor, Funga

Contributing Authors

Gisel Booman
Head of Science, Regen Network Development

Claudia Herbert
Product Manager, Carbon Direct

Rachel Maher
Product Owner (2021–2023), OpsChain ESG, Ernst & Young

Antoinette Marie
Director, Heifer Labs, Heifer International

Adam Shedletzky
Director of Policy, Flow Carbon

Acknowledgements

Members of the Crypto Sustainability Coalition Working Group on Blockchain Carbon Credits

Luis Felipe Adaime
Founder and Chief Executive Officer, MOSS.Earth

Sadia Ahmed
Climate Change & Environment Studio Lead, Deloitte

Marcus Aurelius
Core Contributor, Data and Strategy, Klima DAO

Srikrishna Balachandran
Director, Recykal

Seth Baruch
Chief Executive Officer, Carbonomics

Gisel Booman
Head of Science, Regen Network

Kevin Christopher
Principal, Rockbridge Ventures

Dana Gibber
Co-Founder and Chief Executive Officer, Flow Carbon

Erin Grover
Impact Investment Advisor, Altai Digital Capital

Alexsandra Guerra
Head of Demand and Co-Founder, Nori

Joy Guo
Chief Operating Officer (2022–2023), CC Token

Claudia Herbert
Product Manager, Carbon Direct

Anirudha Jalan
Co-Founder and Chief Strategy Officer, Recykal

Josh Knauer
Co-Founder, ReSeed.farm

Larry Kopald
Co-Founder and President, The Carbon Underground

Renan Kruger
Chief Technology Officer, MOSS.Earth

Gregory Landua
Co-Founder, Regen Network

John Lee
Global Managing Director, Capital Markets & Exchanges, Accenture

Anna Lerner
Chief Executive Officer, Climate Collective

Mark Lewis
Managing Partner, Trailhead Capital

Zhiliang Li
Chief Executive Officer, CC Token

Rachel Maher
Product Owner (2021–2023), OpsChain ESG, Ernst & Young

Antionette Marie
Director, Heifer Labs, Heifer International

Daren McKelvey
Head of Crypto Partnerships, Nori

Radhika Moolgavkar
Program Manager Supply and Methodology, Nori

Charlie Moore
Head of Carbon & Sustainability Solutions, Chainlink Labs

Timothy Rann
Senior Advisor, Mercy Corps

Lauren Serota
Advisor, Funga

Adam Shedletzky
Director of Policy, Flow Carbon

Julian Sommer
Co-Founder, Chairman, Chief Impact Officer and Chief Financial Officer, Toucan Protocol

Ken Weber
Head of Social Impact, Ripple

Alasdair Were
Digital Innovation, International Emissions Trading Association (IETA)

Darren Wolfberg
Founder, Chairman and Chief Executive Officer, Blockchain Triangle

Special thanks to the CISA team, members of the Crypto Sustainability Coalition, the CISA Steering Committee and Expert Reviewers:

Nicolas Alexander
Head of Partnerships & Policy, Thallo

Hayley Anna
Project Coordinator, CISA, World Economic Forum, USA

Sam Azad
Product Owner, OpsChain ESG at Ernst & Young

Tillem Burlace
Regional Lead, Africa 1t.org, World Economic Forum

Brynly Llyr
Head of Blockchain and Digital Assets, CISA, World Economic Forum, USA

Michele Neitz
Founding Director, Blockchain Law for Social Good Center, University of San Francisco

Alexander Neumuller
Research Lead, Digital Assets Climate Aspects at Cambridge Centre for Alternative Finance, Cambridge Judge Business School, University of Cambridge

Stefan Renton
Sustainability Lead, Polygon Labs

Yip Thy-Diep Ta
Co-Founder, Unit Network

Tricia Wang
Executive Director and Co-Founder, Crypto Research and Design Lab (CRADL)

Sheila Warren
Chief Executive Officer, Crypto Council for Innovation

Kieran White
Co-Founder & Chief Executive Officer, Return

Endnotes

1. Pomeroy, Robin, “Carbon Offsets – How Do They Work, and Who Sets the Rules?”, World Economic Forum Agenda, 2 September 2023: https://www.weforum.org/agenda/2022/09/carbon-offsets-radio-davos/.
2. “The Voluntary Carbon Market: Climate Finance at an Inflection Point”, World Economic Forum, 17 January 2023: https://www.weforum.org/whitepapers/the-voluntary-carbon-market-climate-finance-at-an-inflection-point/.
3. Auditing a blockchain requires navigating technical Web3 systems and interfaces; see Pejlatowicz, Pablo, “Democratic Principles and the State of Voting in Web3”, Medium, 31 January 2023: https://medium.com/cradl/democratic-principles-and-the-state-of-voting-in-web3-e5ea00c0adac#:~:text=Need%20for%20voters,with%20 blockchain%20 voting.
4. Knight, Aimée, “What Is a Smallholder Farmer?”, Heifer International, 14 April 2022: https://www.heifer.org/blog/what-is-a-smallholder-farmer.html.
5. “Working Group II Impacts, Adaptation and Vulnerability”, IPCC, 10 February 2023: https://www.ipcc.ch/working-group/wg2/.
6. “Climate Change 2022: Impacts, Adaptation and Vulnerability”, IPCC, 15 February 2023: https://www.ipcc.ch/report/ar6/wg2/.
7. The CAD Trust – an initiative of the World Bank, the International Emissions Trading Association and the Government of Singapore, with representatives of major carbon standards as well as governments participating in a governing council – has taken some important first steps to address this issue. For more information, see Climate Action Data Trust, “Connecting Carbon Markets through Open Data”: https://climateactiondata.org.
8. “The 17 Goals”, United Nations Department of Economic and Social Affairs, Sustainable Development, 10 February 2023: https://sdgs.un.org/goals.
9. For example, the World Bank has developed a blockchain climate warehouse and is currently onboarding national and private-sector partners. See Climate Warehouse, “Catalyzing the Next Generation of Climate Markets”: https://www.theclimatewarehouse.org/.
10. Digitally native or, in other words, tokenized carbon, is the digital representation of real-world carbon credits on the blockchain. See more here: https://blog.toucan.earth/tokenization-of-carbon-credits-explained/.
11. See work being done by the Climate Action Data Trist (https://climateactiondata.org) as an example.
12. “New Crypto Sustainability Coalition to Investigate Potential of Web3 Technologies in Fighting Climate Change”, World Economic Forum, 21 September 2022: https://www.weforum.org/press/2022/09/new-crypto-sustainability-coalition-to-investigate-potential-of-web3-technologies-in-fighting-climate-change/.
13. The Crypto Council for Innovation is the premier global alliance advancing crypto innovation. See more here: https://cryptoforinnovation.org/.
14. The Blockchain Law for Social Good Center was conceived and launched by Professor Michele Neitz in February 2022 to address a gap in awareness of and education about existing and innovative social impact projects happening in the blockchain space that would be of interest and importance to the public as well as legislators and policy-makers.
15. The InterWork Alliance (IWA), an initiative of the Global Blockchain Business Council (GBBC), empowers organizations to adopt and use token-powered services in their day-to-day operations and across use cases and networks, bringing inclusivity to globally distributed applications. See more here: https://gbbcouncil.org/interwork-alliance/.
16. “Special Report: Global Warming of 1.5ºC: Summary for Policymakers”, IPCC, 10 February 2023: https://www.ipcc.ch/sr15/chapter/spm/.
17. “The State of Carbon Dioxide Removal”, Carbon Dioxide Removal (CDR), 5 February 2023: https://www.stateofcdr.org/.

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org