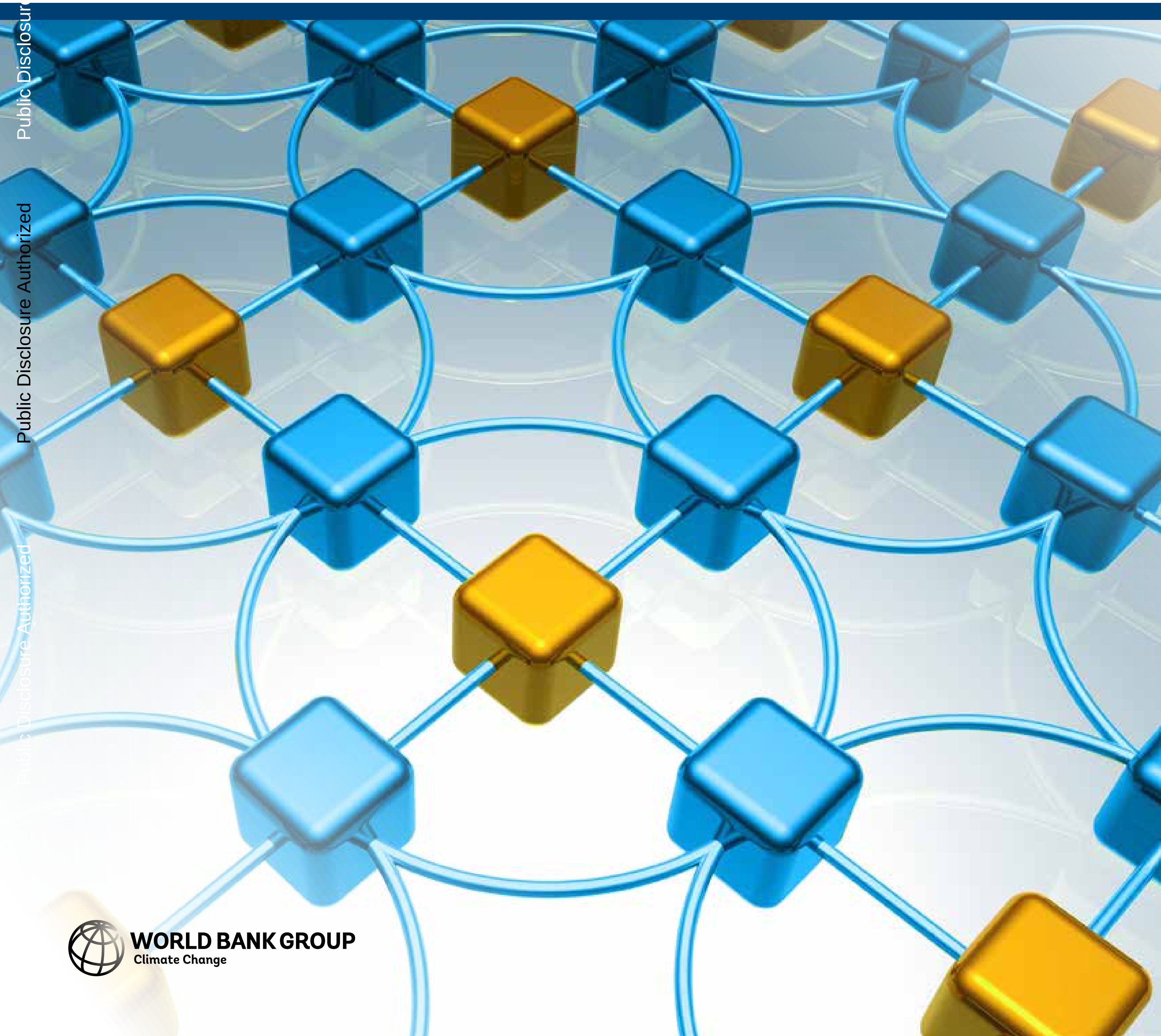
Blockchain and Emerging Digital Technologies for Enhancing Post-2020 Climate Markets



WORLD BANK GROUP
Climate Change

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

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Acknowledgments

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The Xpansiv team included Joe Madden, Tom Baumann (also Collaborase), Jason Libersky, Eamonn McCormick, and Jeff Cohen.

The World Bank's Climate Change Group team included Xiaoqun Dong, Rachel Mok, Durreh Tabassum, Pierre Guigon, Eduardo Ferreira, and Chandra Shekhar Sinha under the guidance of and support from Neeraj Prasad (Practice Manager) and James Close (Director).

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1. Executive Summary

Scientific consensus is that rapid and aggressive reductions in greenhouse gas (GHG) emissions are needed if significant climate disruption and irreversible environmental impacts are to be averted. The changes required necessitate large-scale investment and governments at all levels are responding with combinations of regulatory mandates, incentives and market-driven solutions. In this post-Kyoto Protocol era, there is a growing application of pricing mechanisms, especially markets, in multiple contexts to address mitigation of emissions. The new generation of climate markets is thus likely to develop as a network of decentralized markets, linking at regional, national and subnational levels.

The Paris Agreement (the Agreement) recognizes the heterogeneity of approaches. To foster higher ambition and sustainable development, and encourage large-scale financing towards the most effective mitigation measures, Article 6 recognizes that parties may engage in cooperative approaches, including the use of internationally transferred mitigation outcomes (ITMO) towards their individual nationally determined contribution (NDC).

Such a bottom-up framework promotes innovation and addresses jurisdictional priorities. Nevertheless, the growing diversity in the type, design, and scope of schemes does not encourage economic efficiency or the effective application of available financial resources. As such, an identified need is development of tools, services and institutions to foster and enhance this next generation of climate markets that accommodate such a "patchwork" of different domestic climate actions.

Different climate markets trade different units (assets), have differences in structure and governance, and rely on separate, centralized registries. The result is a multitude of schemes trading instruments within closed technological systems (with centralized registries) and differing rules, such as those associated with monitoring, reporting and verification (MRV). To facilitate larger, more liquid and resilient trading across heterogeneous climate markets, a new architecture is needed.

There is a corresponding need, also, for the capability to generate, manage, and harmonize information representing the outcomes of GHG mitigation actions across multiple industry sectors and governmental jurisdictions. The complexity of conducting transactions between heterogeneous climate actions across jurisdictions increases when additional instrument types (that is, not just emission allowances) are traded. Thus, the next generation of bottom-up climate markets must include mechanisms to address these differences so that the technological limits of an infrastructure based on centralized registries does not inhibit achieving the scale, heterogeneity, and functional complexity required.

At the same time, a rapidly evolving technological landscape presents opportunities for efficient and robust design and development of this next generation of climate markets, as well as risks, both in terms of failure to engage, or in failing to understand how to engage effectively. Blockchain, Big Data, the Internet of Things (IoT), smart contracts and other disruptive technologies hold out the promise of addressing the needs of new generation climate markets post-2020.

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Blockchain, in particular, provides data sharing and transaction management elements well aligned with the requirements of climate markets. Blockchain is an implementation of distributed ledger technology (DLT), which, broadly, combines a distributed ledger (that is, a copy of the ledger is held by all network participants), public/private key encryption, and a decentralized infrastructure. The ledger is organized into blocks of information, each block containing information, such as a collection of transactions. Once there is consensus, the block is added to the ledger, which is immutable and accumulative. These characteristics support data integrity and security, while the distributed nature of the ledger promotes transparency.

There are also challenges associated with blockchain, both technical and non-technical. The former includes the fact that certain types of blockchain networks require high energy consumption (although these are unlikely to be suitable for climate markets), and potential issues with the speed and security for data transfers to and from blockchain applications, for example, with other digital systems.

Non-technical challenges include a paucity of understanding of the technology and its applications by many stakeholders. In particular, a challenge for adoption of the emerging digital technologies that must be resolved quickly is a culture change among regulators, standards developers, and policymakers. It is important to recognize that established interests and legacy systems could inhibit the adoption of digital technologies.

Significant factors characterizing the changing landscape of stakeholder needs, driving the transition from current to emerging technologies and practices, thus include the increasing diversity of regulations, MRV systems, climate assets, and values of mitigation outcomes, within and across jurisdictions; the increasing size and scale of post-2020 climate markets, as well as linkages with related climate actions and other markets; the expectation of new cross-jurisdictional trading arrangements (e.g., clubs, regional trading schemes, sectoral trading schemes); and greater financial flows and types of transactions, such as peer-to-peer and results-based finance.

It is concluded that digital innovations can help address these challenges firstly, through blockchain-enabled distributed ledgers that provide transparency and robust rule implementation via smart contracts; secondly, through collaborative governance systems that enable more efficient development of MRV standards structured as holistic systems of modular, compatible and extensible methods and rules; and finally, through smart meters and other devices associated with the IoT, combined with big data analytics, so as to facilitate the automated data flows necessary to harness the potential of blockchain technology in supporting new generation climate markets.

It is recommended that:

1. A roadmap for the implementation of blockchain and other emerging digital technologies in climate markets should be developed with the objective of making substantive progress on overall design, demonstration activities, and implementation. There should be close coordination with the technical policy agenda, both at the international level, for instance, in terms of the Article 6 work schedule and milestones, and at the national level. Specifically, these new technologies are most relevant in helping to address agenda items such as transparency, double counting, environmental integrity, and alignment with NDCs.

2. Additional research should be conducted, firstly, to clarify and elaborate how other types of emerging technologies, such as smart meters and other devices associated with the IoT and Big Data, can complement applications of blockchain that support new generation climate markets; and secondly, to confirm the technical, economic and legal underpinnings of the perceived advantages of blockchain applications in addressing the challenges that confront the new generation climate markets.

3. By way of extension of the research carried out under the preceding recommendation, pilot markets should be established to test research outcomes in “real world” environments. Such pilots should also serve to elucidate stakeholder understanding of how, in practical terms, the new technology will interface with existing technologies, will be embedded, implemented and operated.

2. Introduction

Market Provisions Under the Paris Agreement

Since its adoption in December 2015 by the 21st Conference of Parties (COP21), within the United Nations Framework Convention on Climate Change (UNFCCC), 175 countries to date have ratified the Paris Agreement ("the Agreement"). These countries have made commitments (NDCs), in some cases contingent on financing by developed countries, to limit or reduce their GHG emissions through a variety of measures including more significant deployment of renewable power, energy efficiency, land-use controls such as conservation of forests and grasslands, carbon pricing, and other measures compatible with each country's national circumstances and capabilities.

Even with full ratification of the Agreement by all 197 signatories, the aggregate effect is projected only to slow the rate of GHG emissions growth from the 24 percent increase, between 1990 and 2010, to an anticipated increase between 2010 and 2030 of between 11 and 23 percent.[1] Far greater reductions, approaching net zero emissions, will be needed after 2030 to meet the Agreement's goals of limiting the rise in global temperature to below 2° C, or ideally below 1.5° C.

To foster higher ambition and sustainable development, and also encourage large-scale financing towards the most effective mitigation measures, Article 6 of the Agreement recognizes that countries may engage in cooperative approaches, including the use of ITMOs towards their individual NDC. Unlike the Kyoto Protocol, under which emissions trading was restricted to developed countries, who also could purchase emission reductions generated by projects in developing countries, Article 6 of the Agreement potentially allows countries to contribute a diversity of climate actions with mitigation outcomes that can be transferred in any direction between cooperative Parties.

In this new, complex and diverse environment, this paper aims to examine emerging digital technologies and architectures that could be used to enhance and connect the heterogeneous climate actions across countries, thereby supporting post-2020 climate markets that facilitate the most cost-effective achievement of the highest possible ambition. Given the speed with which information technology, system architectures, domestic policy, and other relevant elements are developing, the roadmap laid out in this paper will likely continue to evolve significantly over the next few years.

Objective: Development of the Next Generation of Climate Markets

Today, there is a broad use of pricing mechanisms, especially markets, in multiple contexts to address mitigation of emissions. Market mechanisms have proven to be an economically efficient way to mitigate GHG emissions to deliver a specific objective (e.g., an emissions reduction target by a specific date). There are 40 countries and more than 20 cities, states, and provinces that have already established or will soon be implementing some form of carbon pricing system—either cap-and-trade or a carbon tax, including seven of the world's ten largest economies. Carbon pricing initiatives now cover approximately 13 percent of annual global GHG emissions.[2] There are jurisdictions engaging in cooperative programs (e.g., EU Emission Trading System (ETS), Regional

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1 UNFCCC, 2015, "Synthesis report on the aggregate effect of the intended nationally determined contributions," UNFCCC COP21, October 30, https://unfccc.int/resource/docs/2015/cop21/eng/07.pdf.

2 World Bank and Carbon Pricing Leadership Coalition, 2017, "2016-2017 Carbon Pricing Leadership Report," http://pubdocs.worldbank.org/en/183521492529539277/WBG-CPLC-2017-Leadership-Report-DIGITAL-Single-Pages.pdf.

Greenhouse Gas Initiative (RGGI), California-Quebec-Ontario[3]) but even connecting independent emissions trading schemes necessitates mechanisms to deal with different accounting rules, scope, pricing, offset eligibility, governance, complementary policies, and other key features. In reality, pricing mechanisms may take a variety of forms including as carbon taxes, schemes generating project-based credits, or certificates schemes for fuel switching or renewable energy. All these have the potential for integration in the broad mix of global "climate markets" post-2020.

While such a bottom-up framework promotes innovation and addresses jurisdictional priorities, the growing diversity in the type, design, and scope of schemes does not foster the most efficient and effective application of the financial resources available. Against this backdrop, the World Bank is working with governments, the private sector, academia and civil society to develop the tools, services and institutions needed to foster and develop the next generation of climate markets that accommodate such a "patchwork" of different domestic climate actions.

To ensure an efficient and robust design and development of this next generation of climate markets, it is critical to consider the rapidly evolving technological landscape. The goal of this paper is to provide background clarity to understanding the emerging technology trends that can support both the design and function of new climate markets from the bottom-up. While other technologies such as the IoT and big data analytics are mentioned (and elaborated briefly in Section 5), specifically, this paper will focus on the application of blockchain technology, and how it can work cumulatively with those other technologies.

To achieve the vision of a new generation of climate markets driving higher mitigation ambition, it is essential to first consider the current practices and technologies that have been used to support pricing and the challenges they present. Understanding the issues and gaps is essential to assessing the potential for emerging practices, technologies and architectural frameworks to harness the power of markets in delivering on the objectives outlined in the Paris Agreement.

3 California, Quebec, and Ontario established a linkage agreement that became effective on January 1, 2018.