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Navigating Blockchain and Climate Action

2020 STATE AND TRENDS

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climateledger.org

Editorial Information

CONCEPT AND PROJECT MANAGEMENT

JUERG FUESSLER	Managing partner, INFRAS	
MADELEINE GUYER	Project Manager, INFRAS	

LEAD AUTHORS

JUERG FUESSLER	INFRAS, Switzerland	chapter 1
SVEN BRADEN	Climate Ledger Initiative, Peru	2
OWEN HEWLETT	Gold Standard, UK	3
MADELEINE GUYER	INFRAS, Switzerland	4

CONTRIBUTING AUTHORS AND INTERVIEW PARTNERS

MICHAEL FABING	Wood Tracking Protocol, Peru	2
CRISTIÁN MOSELLA	EnergyLab, Chile	2
DMITRY HALUBOUSKI	European Bank for Reconstruction & Development, UK	3
INGO PUHL	South Pole, Switzerland	3
WERNER BETZENBICHLER	Verico SCE, Germany	3
FLORIAN DOEBLER	IOTA Foundation, Germany	4
MARIANNA BELOTTI	INATBA and Caisse des Dépôts, France	4
MONIQUE BACHNER	INATBA and Bachner Legal, Luxembourg	4
SUSAN DAVID CAREVIC	World Bank, USA	4
RACHEL CHI KIU MOK	World Bank, USA	4
THOMAS NÄGELE	NÄGELE Attorneys at Law LLC, Liechtenstein	4
ANIK KOHLI	INFRAS, Switzerland	4

COORDINATION, EDITING AND PRODUCTION

MADELEINE GUYER	Project Manager, INFRAS, overall coordination
GEOFF HUGHES	Zoï Environment Network, copy edit
MANUEL EHRENFELD	Non-Linear, design

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Preface

This report was prepared by an international team of authors with a diverse set of experiences and insights. It is a knowledge product of the Climate Ledger Initiative (CLI) published on an annual basis to track progress according to latest research and use cases – supporting CLI's role as an international knowledge platform to accelerate climate action through blockchain based innovations.

The Climate Ledger Initiative (CLI) and its mission

The mission of the Climate Ledger Initiative is to accelerate climate action in line with the Paris Agreement and the Sustainable Development Goals (SDGs) through blockchain and other digital innovations applicable to climate change mitigation, adaptation and finance. The Climate Ledger Initiative was started in 2017 by Nick Beglinger of Cleantech21 and is jointly operated by INFRAS Consulting, Analysis and Research and the Gold Standard Foundation. The CLI is financially supported by the Government of Switzerland and the Government of Liechtenstein, and maintains an ever-expanding platform of donors, partners and collaborators. The initiative sits at the nexus of one of the world's most pressing problems, climate change, and the world's most promising technological innovations – blockchain and, more broadly, distributed ledger technology, the Internet of Things and artificial intelligence. CLI addresses policy and research questions and identifies specific innovation opportunities at the intersection of climate and digitization. Over the last two years, the work has greatly benefited from the contributions of participants in various workshops and events and from the support of partner use cases.

For more information, to register for our newsletter or to pursue an interest in partnerships and collaboration, please visit climateledger.org

JUERG FUESSLER
Managing Partner
INFRAS

OWEN HEWLETT
CTO
THE GOLD STANDARD FOUNDATION

MADELEINE GUYER
Project Manager
INFRAS

SVEN BRADEN
Programme Manager
CLIMATE LEDGER INITIATIVE

The Climate Ledger Initiative's third edition of Navigating Blockchain and Climate Action

The Climate Ledger Initiative's third edition of the Navigating Blockchain and Climate Action Report has been released in a very special year.

The first edition of the CLI Navigating Report[1] set the scene and provided a broad overview of the newly emerging climate action potential of blockchain and related technologies. The second edition[2] zoomed in on three emerging topics – the development and adoption of digital approaches to measuring, reporting and verification (MRV) of reductions in greenhouse gas emissions; the gap between a physical asset and its digital representation on the chain; and the need to improve climate finance.

This year's edition of the Navigating Report aims to capture the essence of the observations made during the implementation of an array of CLI activities and the interactions with policymakers, stakeholders, practitioners and tech experts around the globe. The focus is on three topics that recurred in the field and in discussions with our partners – open data and interoperability (Chapter 2), digital MRV in carbon markets post-2020 (Chapter 3) and governance (Chapter 4). This edition also reports on the progress of CLI-supported use cases (Chapter 5) and provides reflections on the implications of the COVID-19 pandemic.

We are grateful to the authors and interview partners who have contributed their vision and real-world experience. As the findings show, the technologies are developing fast and innovative businesses are being tested in use cases. We hope this edition helps practitioners and policymakers alike navigate the rapidly evolving field and take inspiration from the experiences of countries already using blockchain to achieve the goals of the Paris Agreement.

1 Climate Ledger Initiative, Navigating Blockchain and Climate Action - An Overview (2018), climateledger.org
2 Climate Ledger Initiative, Navigating Blockchain and Climate Action - 2019 State and Trends (2019), climateledger.org

Summary and key findings

In the COVID-19 pandemic of 2020, many governments struggled to agree on adequate response measures in a timely manner, and for many the pandemic emphasized the importance of independent scientific knowledge in the public policy debate. The unprecedented short-term financial stimuli that many governments quickly released to mitigate the economic impacts of the first wave showed that governments can act strongly in the face of systemic disruptions.

COVID-19 also shows how a systemic shock can trigger a leapfrog in digitization as working from home and the extensive use of videoconferencing quickly became the new norm. Governments worked with technology companies to develop tracing apps, with mixed results. The rapid digitization under COVID-19 mirrors a lesson of our earlier CLI Navigating Reports – digital solutions for complex challenges generally rely on strong and well-functioning social and institutional frameworks.

Although blockchain has lost a lot of its hype and matured a lot during 2020, we're still at the beginning of a major technological revolution and a long way from using the technology on a broad and mainstream basis. Governments in particular need further encouragement to use and apply blockchain and Digital Ledger Technologies (DLT) to accelerate climate action.

Chapter 2

Interoperability and Open Data challenges

- Compiling and encouraging open access to climate-relevant data empowers public and private sector stakeholders to better inform investment decisions and allows civil society to participate more effectively in climate policymaking. Moreover, it opens the door for new business models and digital applications.
- Interoperability is key to the success of climate applications of digital technology and extends beyond the technical side to non-technical interoperability at the human, organizational and institutional levels.
- Blockchain networks are operating according to their own mechanisms and protocols. Enabling the interoperability of blockchains without the need for a centralized intermediary remains a challenge, and standard solutions are urgently needed.
- Open Data fosters transparency, promotes greater participation of stakeholders and encourages the sharing of ideas. Open Data can be sourced top-down or bottom-up, and the approaches can complement each other.
- Crowdsourcing data – a bottom-up approach – offers the potential for credible verification of emissions data, especially in the international transportation sector.

Chapter 3

Digital MRV in carbon markets post-2020

- Carbon markets will fragment along a wider variety of use case lines than previously experienced, and will need to deal with policy externalities and emerging updates to core provisions.
- To navigate these fragmented markets, proponents will need to understand both the core provisions of markets and the variable provisions that can make them eligible to apply. This situation may result in both risk and opportunities.
- Standards systems and assurance providers will need to be consistent in their understanding, application and assessment of core and variable provisions.
- Digital MRV can track the provisions and attributes needed to access certain markets and link to interoperable registries to create seamless and immutable tracking of assets and to ensure their correct usage.
- Digital MRV is less reliant on direct, manual collection and assessment of data, and can thus reduce exposure to COVID-19.

Chapter 4

Governance challanges

- Creating confidence in technologies, and specifically in DLT, is a prerequisite to broad participation, and because governance establishes the rules or participation, governance is the main vehicle for creating confidence. One-size-fits-all solutions to governance challenges do not exist, and trade-offs have to be expected.

- As a new technology, blockchain needs to attract the attention of policymakers, users and other stakeholders. Active engagement with governments and policy-makers appears to be crucial in informing the public dialogue and legislative process on blockchain applications.

- Technical interoperability – the ability to exchange data with other platforms and the off-chain world – and legal interoperability are crucial for blockchain applications.

The CLI will continue to engage and bring together practitioners, technology proponents, government officials and researchers to overcome hurdles and allow full utilization of the potential of blockchain and related innovative technologies for urgently needed acceleration of climate action. CLI will continue to support use cases that allow practitioners to gain further experience with different solutions to various governance questions. The CLI looks forward to collaborating with a broad group of partners in this quest.

If you want to be part of this, contact us; we are happy to partner with you.

Abbreviations

ADS-B	Automated Dependent Surveillance Broadcast receivers
AI	Artificial Intelligence
AIS	Automatic Identification System
API	Application Programming Interface
CDM	Clean Development Mechanism
CLI	Climate Ledger Initiative
COP	Conference of the Parties
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DES	Data Exchange Standards
DLT	Distributed Ledger Technology
DIA	Independent Entities Association
EBRD	European Bank for Reconstruction and Development
ETS	Emissions Trading System
EU ETS	EU Emissions Trading System
EUTL	European Union Transaction Log
GDPR	General Data Protection Regulation
GHG	Greenhouse Gas Emissions
GPS	Global Positioning System
ICAO	International Civil Aviation Authority
IoT	Internet of Things
INATBA	The International Association for Trusted Blockchain Applications
IPCC	Intergovernmental Panel on Climate Change
IPFS	InterPlanetary File Systems
ITL	International Transaction Log
MDB	Multilateral Development Bank
MRV	Measuring Reporting Verification
NAMA	Nationally Appropriate Mitigation Actions
NDC	Nationally Determined Contributions
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goals
TVTG	Token and VT Service Provider Act
UNFCCC	United Nations Framework Convention on Climate Change
UNSD	United Nations Statistics Division
VVB	Validation and Verification Bodies
WEF	World Economic Forum
WTP	Wood Tracking Protocol

1

Blockchain and climate action state and trends

Blockchain and climate action state and trends

JUERG FUESSLER
Managing Partner
INFRAS

The 2019 United Nations climate conference, COP25 in Madrid, took place under special circumstances. The short-term postponement from Santiago de Chile to Madrid certainly did not promote the conditions for productive discussions. Furthermore, the relevance of having a strong host became apparent as the postponement led to unclear leadership. The conference became the longest on record when it concluded after more than two weeks of fraught negotiations.

Ultimately, the Parties were unable to reach consensus in many areas, pushing decisions into next year under Rule 16 of the UN climate process. Matters including Article 6 market mechanisms, reporting requirements for transparency and common time frames for climate pledges were all punted into 2020, when countries are also due to raise the ambition of their efforts. UN Secretary-General António Guterres said he was disappointed with the results of COP25 and that "the international community lost an important opportunity to show increased ambition on mitigation, adaptation and finance to tackle the climate crisis."

COVID-19 AS A GAME CHANGER

Due to the COVID-19 pandemic, the environment for climate discussions in 2020 was not much better and will remain unstable at least during the first half of 2021. Blockchain technology, however, has matured substantially since the publication of the 2019 edition of this report. This technology, or more generally Distributed Ledger Technology (DLT), introduces a new and innovative form of decentralized database that enables the secure exchange and storage of data and digital assets, primarily designed for peer-to-peer transaction platforms. Blockchain holds great potential for accelerating climate action in three main areas – next-generation registries and tracking systems; the digitalization of measuring, reporting and verification (MRV); and

> "Blockchain is a great tool to bring transparency to the entire world, and therefore keep everyone accountable for their obligations."
>
> **Michael Fabing,** Wood Tracking Protocol

decentralized access to clean energy and finance. In pushing ahead general digital transformation across various sectors, COVID-19 showed how systemic shocks can trigger a leapfrog in digitalization, and the process is most likely to continue. Companies and governments have seen an increase in the pace of the digitalization of data systems and applications both in promoting remote working options and in developing tracing apps.

FROM BLOCKCHAIN HYPE TO REAL WORLD APPLICATIONS

Blockchain has proven to be more than a passing fad, demonstrating that it can serve as a pragmatic solution to business problems across industries. The difficulties in communicating across disciplines on blockchain have faded, and more and more interdisciplinary teams are using blockchain applications and solutions. Users are deciding which applications make sense, and whether a blockchain solution really adds value. The current focus of blockchain discussions is on realistic tools for real world applications. Experts see that one of the greatest successes in recent months is that an enormous consolidation has taken place across the industry, and providers that were not fit for market have disappeared or have merged. Furthermore, there are more and more projects and new areas of applications.

THE WAY FORWARD

For all the progress, however, the broad and mainstream use of the technology remains a long way off. The public perception of the technology is still very much connected to cryptocurrencies, and governments in particular need to be informed about the potential of using blockchain for climate applications. The core purpose of blockchain is to establish trust. Climate change is a problem that concerns everyone and every country on our planet, but at the same time, each country defines its own policies. These technologies are seen as game changers that can create completely new approaches to how we find collective solutions in mitigation, adaptation and climate financing.

> “We are just starting an extremely exciting journey where DLTs, like blockchain, the Internet of Things, artificial intelligence and others are coming into the climate arena to disrupt the way we have been working for the last two decades.”
>
> **Cristián Mosella,** EnergyLab

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Interoperability & Open Data challenges in implementing digital technologies for climate action

Interoperability and Open Data challenges in implementing digital technologies for climate action

SVEN BRADEN
Programme Manager
CLIMATE LEDGER
INITIATIVE

Digital technologies such as the Internet of Things (IoT), DLT and artificial intelligence (AI) have the potential to manage the increasing amount of climate-relevant data in a way that brings down carbon emissions and boosts energy efficiency across industries.

The great potential of digital applications that address the challenge of climate change lies in their capacity to process a huge amount of data that comes from various sources in a short time, and the importance of Open Data approaches to climate information is growing every day. The use of digital applications on Open Data sources enables the interpretation of data on an unprecedent scale. The CLI OpenSurface use case in Chapter 5, for example, deploys a digital MRV system that analyses satellite images of forest areas and compares planned and authorized activities with actual forest conditions. Outcomes can be linked to alerts or payments that create accurate, timely and automated services for different stakeholders. To enable the generation and use of digitally accessible data, all participants – the provider of satellite images, forest authorities, banks – need to ensure that their activities interoperate with each other.

2.1

Four layers of interoperability

The ability of technology to connect and communicate is a precondition to unleashing the potential of digital technologies to accelerate climate action, but interoperability is not limited to the exchange of data through technological means. Human and institutional aspects of interoperability are just as important. According to the United Nations Statistics Division, four layers of interoperability may be distinguished in complex systems – technology, data and format, human and institutional and organizational.[1] While interoperability of the technology and data layers is a precondition for many applications, in-

| 1 UNSD, Introduction to data interoperability across the data value chain, p. 2

TABLE 1: Layers of interoperability. Source: Adapted from UNSD presentation.

LAYER	REQUIREMENTS	BEST PRACTICES	EXAMPLES
Technology	The hardware and the code must allow one system to connect to another and share data.	Technological interoperability through agreed-upon interfaces	Application programming interfaces
Data and format	Exchange of data must be enabled through common data formats defined for data encoding, decoding and representation.	Adoption of common data and metadata models	Data exchange standards for the UNFCCC International Transaction Log
Human	Users and producers of data must have a common understanding of the terms used to describe data contents and proper use.	Use of controlled vocabularies and classifications to standardize content	Agreement between partners on World Bank warehouse prototype pilot
Institutional and organisational	Allocation of responsibility (and accountability) for data collection, processing, analysis and dissemination both within and across organizations must be clear.	Enabled by legislation or by conclusion of data-sharing agreements, licenses and memorandums of understanding[2]	Legally binding elements of the regulatory framework of the EU Emissions Trading System

teroperability on the human and institutional layers can be more abstract but can provide important benefits to the overall value of connected systems.

TECHNOLOGY LAYER

Technical interoperability covers the systems and services that link applications and infrastructure. The internet, for example, allows for access and modification of numerous datasets through specific application programming interfaces (APIs). APIs empower users to submit their own data and share it both inside and outside of the application.
An important business benefit of APIs is that they may be used to prototype projects with minimal investment and can capitalize on data resources that they do not own while opening their own data to partners. APIs prepared the ground for the technological interoperability of the so-called web 2.0.
Legacy interoperability problems between older and newer systems create a major constraint to achieving technical interoperability among systems, and some systems employing old or minimal IT may not be adaptable to interfacing with new systems. In the implementation of the Wood Tracking Protocol, for example, the IT protocols of existing traceability software did not allow the integration of protocols that manage remote devices such as IoT. The analysis of the issue revealed that technical interoperability often becomes an issue when proprietary software attempts to interact with open-source software.

DATA AND FORMAT LAYER

This layer covers the exchange of data through common formats. An example how interoperability needs are addressed on this layer (and the technology layer) is provided by the data exchange standards (DES), established by the Internation-

2 González Morales L., Orrell T., Data Interoperability: a Practitioner's Guide to Joining Up Data in the Development Sector, data4sdgs.org, p. 10
3 UNFCCC, Data Exchange Standards for Registry Systems Under the Kyoto Protocol - Technical Specifications (Version 1.1.10) (2013), unfccc.int

al Transaction Log (ITL) of the UNFCCC[3]. The ITL tracks greenhouse gas (GHG) reductions under the Kyoto Protocol. The DES define how data are to be exchanged between national registries, the Clean Development Mechanism (CDM) Registry and the ITL under the Kyoto Protocol, and supplementary transactions logs such as the transaction log of the EU Emissions Trading Scheme. The technical specifications include the communication protocols to be used and a messaging architecture that includes an overall design for message management, message content and data transfer formats. They define in detail the specific data elements to be exchanged between registry systems to support designated functionality throughout the process.

The data and technological layers are often considered together because they are inextricably linked in many ways, but anyone who has ever received an email attachment that their computer could not open understands that simply having the technological capacity to receive data is not the same as interoperability at the data and format layer.

HUMAN LAYER[4]

A common language is one interoperability need on the human layer, and a willingness to work together is another. Interoperability often succeeds or fails based on the individuals and personalities at the end points of the data exchange, and the level of effort and the goodwill they are willing to expend in order to work together successfully. Interoperability needs on the human layer are more abstract than on the technology or on the data layer, but when it comes to testing and piloting new approaches, the human layer allows for exploration of new data exchange channels at an early stage. The simulation of the Climate Warehouse prototype of the World Bank Group may serve as an example of interoperability elements tested on the human layer. The Climate Warehouse prototype operates as a meta-registry system that surfaces publicly available information on mitigation outcomes such as greenhouse gas (GHG) emissions reductions. The focus of the simulation was on understanding the process for onboarding to a common data model for a Climate Warehouse. The simulation did not dictate the format of information nor did it address the suitability of potentially complementary technologies, such as AI and machine learning[5]. According to the team behind the Climate Warehouse, the simulation of information exchange focused on transparency. The actual information on the various domestic mitigation outcomes could have been a dummy variable since it was up to the participants to choose what data to share. Participants did not provide data through common interfaces or based on data exchange standards. Within the scope of the Climate Warehouse testing, interoperability on the human layer worked.

The testing confirmed the assumption of the team that the architecture of the warehouse provides a means to simplify integration between dispersed climate market systems. During the simulation, participants were able to integrate four different registry systems, demonstrating how different systems can be accommodated[6].

INSTITUTIONAL AND ORGANIZATIONAL LAYER

The legal framework is often referred to as a core condition for enabling interoperability on the institutional and organizational layer. The sharing and integration of data assets between organizations and across national borders is usually regulated through applicable legal systems. Laws set the boundaries of acceptable conduct, and in some instances, govern how data can be shared. Data protection and privacy laws govern what data can,

4 Gesser Urs, Interoperability in the Digital Ecosystem, dash.harvard.edu
5 World Bank Group, Summary Report: Simulation on Connecting Climate Market Systems (English) (2019), documents.worldbank.org, pp. 7-8
6 P. 7 and 8 on http://documents1.worldbank.org/curated/en/128121575306092470/pdf/Summary-Report-Simulation-on-Connecting-Climate-Market-Systems.pdf

or more often cannot, be shared and integrated[7].

The regulatory framework of the European Emissions Trading System (EU ETS) serves as a good example on how interoperability is enabled on the institutional and organizational layer. While fundamentals of the EU ETS are determined by an EU Directive and thus have to be implemented by EU Member States via domestic legislation, core provisions crucial for the operation of the EU. ETS such as the rules for monitoring, reporting and verifying GHG emissions have been legally binding for all.

The regulation on monitoring and reporting and the regulation on verification and accreditation are both directly applicable in all EU Member States. Both regulations provide legally binding guidance for monitoring plans, annual emission reports and verification reports[8] for more than 15,000 stationary installations and 1,500 aircraft operators in the European Union.

Information on emission levels of installations and aircraft operators becomes Open Data as soon as it is registered in the European Union Transaction Log (EUTL)[9]. The data is accessible for further use by other stakeholders. Free access and use of data extend the scope of applications of the data, promote cooperation and increase the benefits for the general public, and can contribute to the improvement of the overall system. In 2016, the UK-based non-profit organization Sandbag developed an online tool[10] that provides interactive access to emission trading data extracted from EUTL together with other data. An analysis of EUTL data by Sandbag discovered that the European Commission's emissions model was based on outdated assumptions[11]. The Sandbag analysis identified an important input in subsequent stakeholder consultations during the EU ETS revision.

7 González Morales L., Orrell T., Data Interoperability: a Practitioner's Guide to Joining Up Data in the Development Sector, data4sdgs.org, p. 19
8 European Commission, Monitoring, reporting and verification of EU ETS emissions, ec.europa.eu
9 European Commission, Climate Action - European Union Transaction Log, ec.europa.eu
10 Sandbag, EU ETS Dashboard, sandbag.be
11 Pareja Pablo, The EU ETS Dashboard: An Open Source Tool to Fight Climate Change, neo4j.com

2.2

Interoperability of blockchain networks

The interoperability of blockchain networks poses a special and relatively new challenge in the IT world. Most blockchains represent stand-alone, disconected networks with different ecosystems, hashing algorithms, consensus models and communities. As a result, the blockchains have become increasingly siloed, and the idea of decentralization is at risk of being undermined[1]. Achieving full interoperability of blockchains could open up the door for innovative solutions, and for linking different blockchain registries for mitigation outcomes. Moreover, interoperability for blockchains is not only desirable, but critical in a world where governments and enterprises depend on ever-greater levels of collaboration and interaction.

Blockchain interoperability will, in fact, become a core condition for the technology and data layers.

1 O'Neal Stephen, Blockchain Interoperability, Explained, cointelegraph.com

Without interoperability, blockchains will not work to their full potential. Climate relevant areas, where interoperability between blockchains will become increasingly relevant, include the management of supply chains, climate finance, transportation and industrial production processes. Moreover, the ability to ensure smooth information sharing across blockchains enables the opportunity to develop partnerships and the sharing of solutions – integrating payment options into climate risk insurance executed by smart contracts based on weather indices, or tracking renewable energy production on one blockchain and converting the outcome into a carbon reduction on another blockchain, for example. One blockchain network will simply be unable to provide all the needs for any given transaction. Unleashing the full potential of the given attributes of blockchains will only be possible if multiple networks can evolve, each providing specific values and proper communication. In the end, data from private and public networks need to be routed directly to other relevant networks for transactions without having to establish one-to-one integration.

In April 2020, the World Economic Forum (WEF) published a report on blockchain Interoperability[2] in which several models, concepts, approaches and best practices for blockchain interoperability are discussed. The table below summarizes the approaches of blockchain interoperability as identified by the WEF.

The interoperability of blockchains will be crucial to the success not only for climate applications but for the entire DLT market. A mainstream solution to make blockchain interoperable has yet to be found. As more progress towards interoperability between blockchain protocols is expected in the coming years, interoperability is likely to become an important game changer for the blockchain industry.

TABLE 2: Summary of blockchain interoperability approaches

	DESCRIPTION	PROS/CONS
CROSS-AUTHENTICATION	Allows different blockchains to plug into a larger standardized ecosystem via hash locking – setting up operations on blockchain A and blockchain B with the same trigger – the most practical method for interoperability in cross-authentication but limited in functionality, supporting only digital asset exchange	+ Only approach that can enable blockchain interoperability without using a trusted central party — Limited practical experience – technology not yet widely adopted
ORACLE	Transfers external data to the blockchain platform for on-chain use; can be used to automate processes based on real world events, such as the automated in-demnification of climate risk crop insurance	+ Proven and easy to implement systems; provides data feeds about external events — Does not create actual blockchain-to-blockchain interoperability; makes blockchains interoperable with their (non-blockchain) environment
API GATEWAY	Governs the access point to a server and the rules that developers must follow to interact with a database, library, software tool or programming language; organizes several APIs	+ Tried and tested technology – easy to implement — May not guarantee data consistency across two blockchain platforms, i.e. may not guarantee that updates are made to a given data item; centralizes trust in API operators

2 World Economic Forum, Inclusive Deployment of Blockchain for Supply Chains: Part 6 – A Framework for Blockchain Interoperability, weforum.org

2.3

Open Data for climate action

To scale up the use of climate-relevant data in a way that impacts the world's GHG emissions at the necessary magnitude, the implementation of Open Data approaches needs to become mainstream. Open Data can foster transparency, promote greater participation and encourage sharing of ideas. The free use of data extends the scope of applications for data sets and supports collaboration and knowledge creation on a large scale – outcomes that are urgently needed if the goals and objectives of the Paris Agreement are to be met in time.

OPEN DATA PROVIDED TOP-DOWN

Open Data usually refers to the information collected, produced or paid for by public or private institutions and made freely available for reuse for any purpose. In the context of climate change, Open Data plays a particularly important role. For instance, the Intergovernmental Panel on Climate Change (IPCC) has achieved great success in putting climate change on the international political agenda. The data underpinning IPCC research builds on various open sources. The transformation of statistical climate data into easily digestible visuals through data visualization, such as maps and graphs, helped convey the importance of the issue to the public[1].
In recent years, several Open Data platforms have evolved to provide the basis for climate research and beyond. In many cases these platforms offer APIs to allow for the interaction with third party applications. The table 3 in the next page provides an overview of selected Open Data sources.
The data streams covered by these platforms are usually released by central governments. The top-down approach of climate-related Open Data has the advantage that it provides officially approved data on national GHG emissions and projections. It allows third parties (academia, business) to analyze results and to determine if they align with the goals of the Paris Agreement.

The scientific analysis of the Climate Action Tracker serves as a good example of how data from the UNFCCC data portal can be used to inform the international community about the climate-related progress of major economies. The NDC Explorer[2] is another example of an Open Data tool that helps countries access and compare their priorities and ambitions related to climate action plans. The explorer provides a database that contains all Nationally Determined Contributions (NDCs) of countries and opens it for comparison using interactive online features.

Open Data not only allows analysts to examine the impact of existing policies and to compare climate pledges but can also lay the groundwork for the implementation of new policies with higher ambitions. Such policymaking is the intended outcome of the recently launched initiative, showyourbudgets[3]. The project's website uses historical emissions and the overall temperature objectives of the Paris Agreement to project when every country has to become climate neutral. With this information the public and the media can easily evaluate whether any given country is making its fair contribution to the achievement of the Paris goals. The disadvantage of top-down data is that often this information is dated.

1 OD4D, State of Open Data - 7. Environment, od4d.net
2 Deutsches Institut fur Entwicklungspolitik (DIE), Klimalog, NDC Explorer, klimalog.die-gdi.de
3 showyourbudgets.org

TABLE 3: Selected climate-related Open Data platforms provided top-down

OPEN DATA PLATFORM	SCOPE
UNFCCC Data Portal[4]	Reported greenhouse gas emissions are registered by almost all countries in the world
IPCC Data Distribution Centre[5]	Provides historical climate, socioeconomic and environmental data, and projects scenarios
World Bank Climate Change Knowledge Portal[6]	Provides global data on climate, vulnerabilities and impacts; visualizations available at country, region and watershed levels
Southern African Science Service Centre for Climate Change and Adaptive Land Management[7]	Supports climate change adaptation by making data, information and knowledge openly available
European Union Copernicus Climate Data Store[8]	Provides authoritative information about the past, present and future climate, as well as tools to enable climate change mitigation and adaptation strategies by policymakers and businesses

Information in GHG inventories of Annex 1 countries, for example, is based on data that are at least two years old when published. In the case of Non-Annex 1 countries these delays are even longer.

OPEN DATA PROVIDED BOTTOM-UP

In contrast to the top-down approach, Open Data provided bottom-up is available much sooner, sometimes even in real time, and can therefore achieve other objectives. Moreover, bottom-up data often provide every level of granularity. Such data may be generated by governments, commercial data providers or non-governmental organizations that deploy networks of their own devices. The table 4 provides an overview of selected approaches that use Open Data sourced bottom-up.
A subcategory of bottom-up sourced data is crowdsourced data, which may become increasingly important in the future due to its potentially high level of credibility. Flightradar24, a web-based platform that offers a global flight tracking service, is a great example that illustrates the potential of crowdsourced Open Data. Flightradar24 offers real time information of thousands of aircraft around the world. The data come primarily from a proprietary, crowdsourced network of about 20,000 so-called Automated Dependent Surveillance Broadcast (ADS-B) receivers hosted by private individuals and companies all over the world.

Every time air-control radar hits a commercial aircraft, the ADS-B device on the aircraft sends back information on the aircraft's registration and real time GPS coordinates, altitude and speed. The platform tracks more than 150,000 flights per day. The website's flight map is updated every couple of seconds and allows the tracking of specific flights.

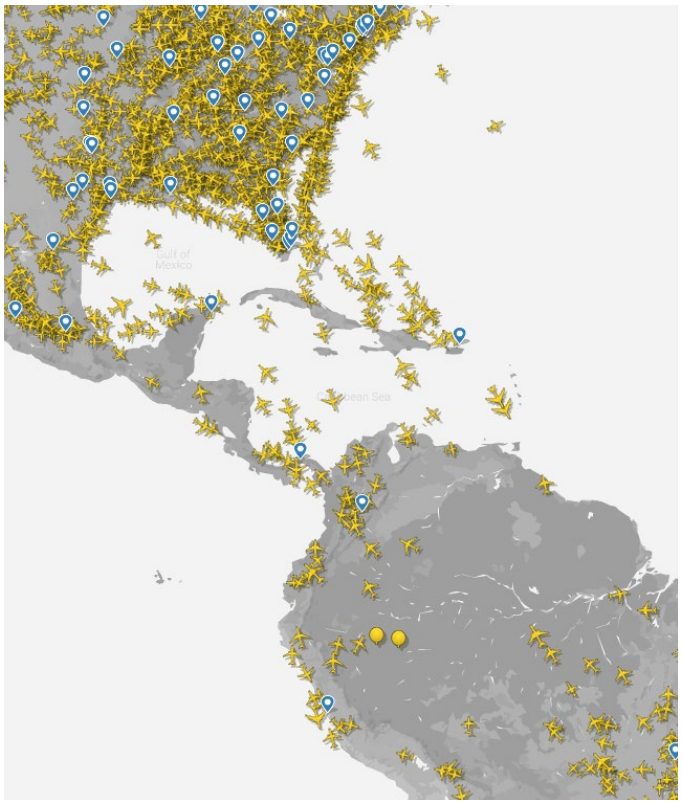
4 See for Non-Annex 1 Parties: UNFCC, Greenhouse Gas Inventory Data - Flexible Queries Non-Annex I Parties, di.unfccc.int and see for Annex 1 Parties: UNFCC, Time Series - Annex I, di.unfccc.int
5 ipcc-data.org
6 climateknowledgeportal.worldbank.org
7 SASSCAL, OADC (Open Access Data Center), sasscal.org
8 climate.copernicus.eu

TABLE 4: Selected climate-related Open Data provided bottom-up

APPROACH	DESCRIPTION
CDM Platform[9] , global	Offers a wealth of information on mitigation technologies, including methodologies and documentation of concrete projects
OpenSurface[10] , Chile	Digital MRV system that generates and uses real time Open Data to help prevent environmental harm such as illegal logging
InfoAmazonia[11], Colombia	A transparency tool to help Colombian officials reduce forest clearing; alerts citizens to new construction projects that may threaten the Amazon ecosystem; uses open data from satellites and crowdsourced data from journalists[12]

In the future the service of Flightradar24[13] could well support the work of the International Civil Aviation Organization and the implementation of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). Under CORSIA, all states that host aircraft operators are required to monitor, report and verify CO_2 emissions from these flights every year from 2019.

In addition to the monitoring of flight emissions, 88 states have volunteered to participate in offsetting a fraction of their CO_2 emissions starting in 2021[14], and are requiring aircraft operators to submit annual emission reports. These reports inform operators and governments whether the emissions of their fleet are in line with thresholds under CORSIA. In the future, a crowdsourced data platform like Flightradar24 could perform independent cross-checks and verification on the emission reports submitted by aircraft operators under CORSIA.



Real time air traffic over the American continent, November 2020. Source: Flightradar.24.

A similar MRV approach could be developed for the shipping sector to support the strategy of the International Maritime Organization to reduce GHG emissions from international shipping and phase them out as soon as possible. Similar to the data used by Flightradar24 in the aviation sector, organizations like Skytruth[15] could use satellite data com-

9 cdm.unfccc.int
10 opensurface.io
11 InfoAmazonia Colombia, colombia.infoamazonia.org
12 Calle Helena, Tres carreteras que amenazan al pulmón más grande del planeta, infoamazonia.org
13 flightradar24.com
14 ICAO, CORSIA Newsletter August 2020, icao.int
15 SkyTruth, Mapping Global Fishing: Global Fishing Watch, skytruth.org

bined with crowdsourced data from the Automatic Identification System (AIS) network. AIS is a GPS broadcast of a ship's location, like the ADS-B of airplanes, and was primarily designed to avoid collisions at sea. Information about a ship's behaviour can be derived by analysing the identity, speed and direction of broadcasting vessels. Tracking the open activity data of international shipping could also help analysts calculate the sea traffic contribution to global GHG emissions.

Open Data will be key for the development of climate-related applications. Both top-down and bottom-up Open Data are useful in enhancing transparency and improving efficiency of climate action.

2.4

DLT and Open Data

The promotion of transparency, the equal access to information and the reorganization of data exchange among participants are elements shared by DLT and Open Data. Indeed, combining DLT and Open Data can help manage organizational and technical boundaries between participants who want or need to automate the exchange of data.

- DLT allows users to share data while participants retain control over their own data. Each participant may choose what data to share in the decentralized system and what to withhold. A great advantage of this approach is that nobody needs to take full responsibility for the security and maintenance of the system, compared to the traditional approach where a centralized authority controls and administers the system and the data.

- By using cryptography, DLT increases trust in data – an important requirement for every open data platform. The immutability of ledger entries in DLT (every participant has a local copy of all ledger entries) increases data integrity.

- Privacy concerns related to DLT use cases such as the immutability of data (which may conflict with the right to be forgotten) or the transparency of ledger entries (visible to all network participants) should not be issues in the context of Open Data initiatives. The free access to and full availability of data are core principles of both DLT and Open Data.

Climate use cases that combine DLT and Open Data are still rare. In 2019, DLT developer IOTA and others launched the Industry Marketplace[1], a vendor- and industry-neutral platform that automates the trading of physical and digital goods and services. Instead of trusting a central authority, the platform provides trust via cryptographic proof. This enables automatic trading between devices with digital contracts. Joerg Nagel, from Neoception and a founding partner of the Industry Marketplace, provides an example on how the commercial exchange of data between businesses takes place:
"Imagine that a provider of temperature data captured from sensors all over the globe puts its information on the decentralized market. A weather forecast provider could then request specific data for a specified period in order to optimize its services. Both sides can agree on the price for the year for the data, the weather forecast provider subscribes to the data and uses the data to compute a

| 1 industrymarketplace.net

new weather model with the optimized forecast." Even though IOTA's Industry Marketplace is not meant to be an Open Data platform in the classical sense it provides a first important step in that direction. The platform enables the automated exchange of data from different devices for various business models, including those that follow Open Data principles. In the example given above, the weather forecast provider could team up with insurance companies and offer its optimized forecasts to Open Data platforms for regions that face specific climate adaptation challenges – droughts, floods or hurricanes.

VOICES FROM THE PRACTICE

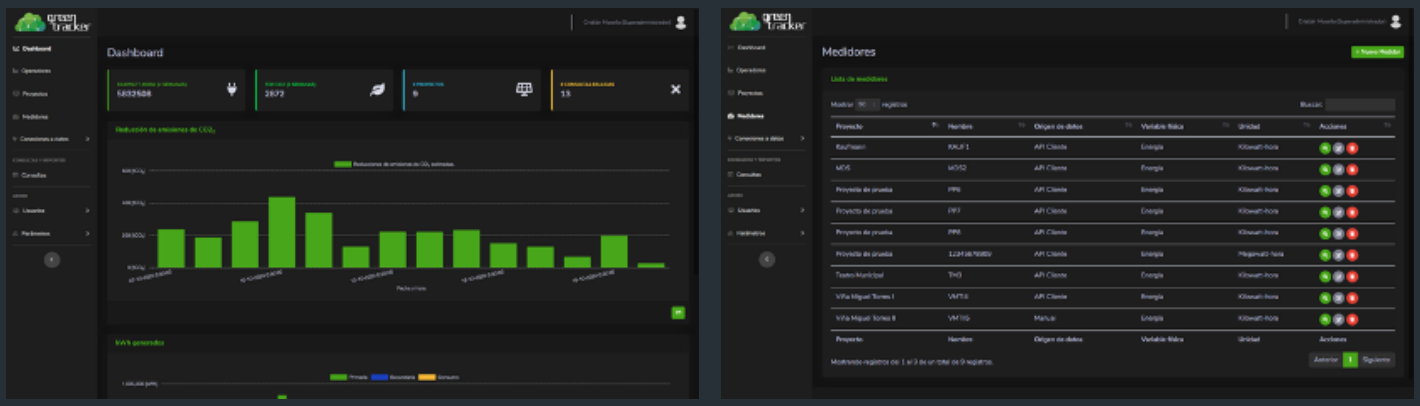
Insight from
CRISTIAN MOSELLA
ENERGYLAB

Cristián Mosella is an Engineer from Chile and co-founder and managing director of EnergyLab, a Latin-American start-up based in Chile. EnergyLab is currently piloting Green Tracker – a cloud-based hybrid blockchain system, where green actions such as green power, electromobility and materials recycling are set with their corresponding MRV, so the primary and secondary data are collected through a background service connected to the corresponding monitoring sources – IoTs preferably and AI-assisted image recognition systems. The application is expected to become fully productive by mid-2021.

Q: What is the role of Open Data in your current work with the establishment of a blockchain-based MRV System? Do you use and generate open data?

A: That is a very interesting topic, where some tensions are reflected. On the one hand you want as much transparency as possible, in order to show traceability and build confidence and trust in the systems, while on the other hand you get the natural reluctance of companies in opening their data sets. Everybody knows that huge business opportunities will be around managing large volumes of data, but since this trend is still new and is evolving very fast, it gets difficult to assess what the trade-offs will be in the short term. Whether Open Data is the best way to add or create value from a specific data set seems hard to tell.

In our Green Tracker project, which is a blockchain-based MRV system, the issue tends to become highly relevant. We are working with great granularity, which in most of the cases goes beyond of what is publicly available. In this case it is left to the companies to create different profiles on the system, where they can administer the level of openness for different types of users.



Screenshot of digital MRV system Green Tracker: CO_2 Reductions achieved and List of Mitigation Measures. Source: Green Tracker.

Did you experience challenges of interoperability during the set-up of Green Tracker? What are your key findings?

Any application that aims to be widely used needs to think deeply about interoperability. Otherwise, this will certainly become a relevant barrier when scaling-up the application. Green Tracker deals with raw data coming from different type of meters, IoTs and data lakes, where everything may follow different conventions, structures, and protocols. It seems important that once the common ground has been identified, we set up the required codes and intermediary infrastructure which lets the system homogenize the wide diversity of system and connections that the application will be dealing with. So, data collection and the adequation and homogenization are very relevant. But apart from that, especially for projects like the Green Tracker, it is very relevant to deal with several types of monitoring devices. The same occurs with DLTs, where interoperability may potentiate the power, scope and scaling capacity of the climate impact.

How do you address challenges around interoperability? Do you know of best practice approaches?

We see that flexibility from the developer's perspective and standardization from the data generator's perspective are required for the most relevant systems' features and sources of data. These are the attributes that should be kept in mind from the early stages of the development of any solution.

Is interoperability also relevant to your work on the blockchain level? For example, do you plan to work with two or more DLT systems in the future?

It is certainly relevant. The DLT solutions we are working with make sense only when they deal with good quality data, which in our cases are directly obtained from the physical world. So, having an "oracle" that allows us to bring data from a wide range of devices, physical variables and types of technologies is a great challenge. At the same time, it increases our chances for adoption and scaling up. Another challenge that may soon become relevant will be the integration of different types of payment services and potential token-exchange functionalities from different blockchain ecosystems.

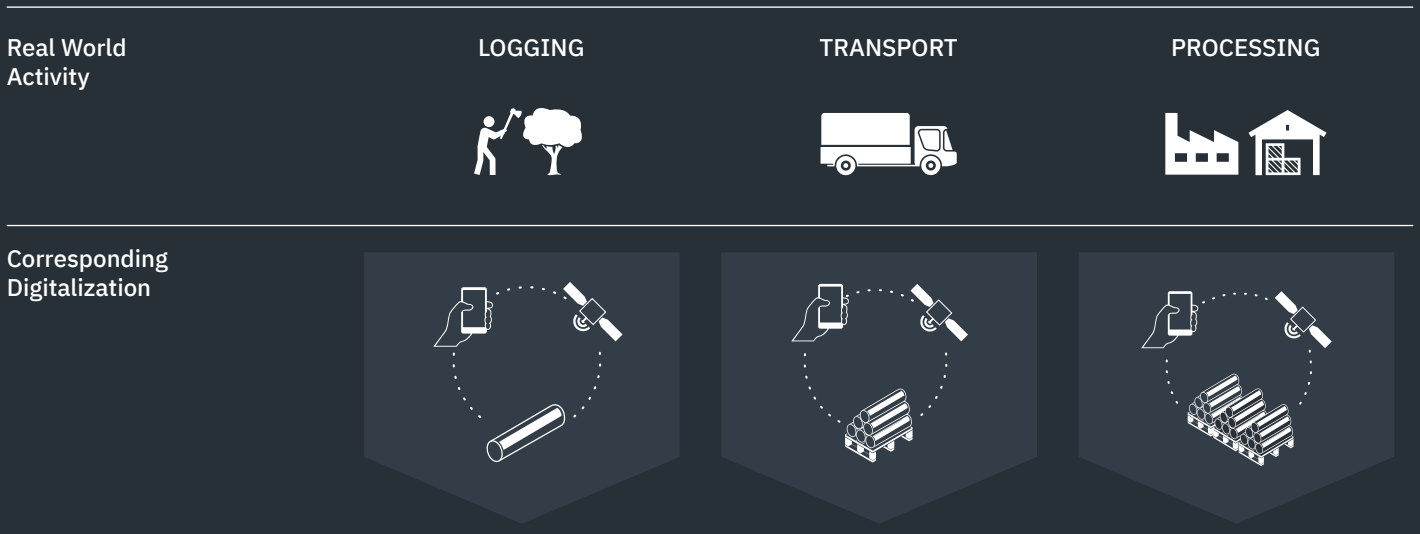
Insight from
MICHAEL FABING
IT Lead, Wood Tracking Protocol

Michael Fabing is a computer scientist living in Lima, Peru. Since 2018 he has led the technical development of the Wood Tracking Protocol (WTP). WTP provides a tool to document the work of participants of the wood processing chain in the Amazon region of Peru. The project combines a smartphone application with a digital platform that includes a gateway to a blockchain network. The tool is currently being tested in the field. It is the aim of the WTP team to collaborate with similar initiatives that try to increase traceability and transparency in the Peruvian forest industry. In that context interoperability of the WTP may play a crucial role in the future. WTP is a CLI use case supported by the Swiss Agency for Development and Cooperation.

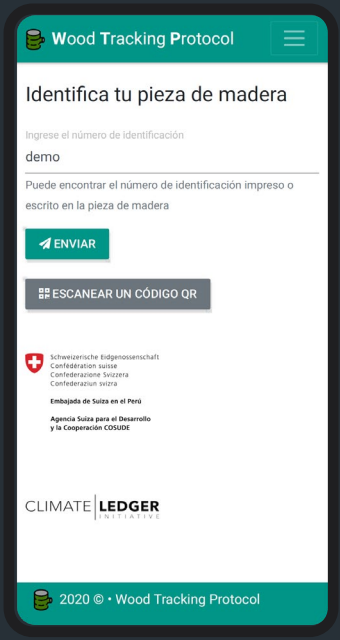
Q: How is interoperability relevant within the work of WTP? What are the challenges in your view?

A: Interoperability is truly relevant for us since we rely on third party – mostly governmental – data. An objective of our application is to fight illegal logging. Therefore, we work closely with the government data that determines who may and who may not access our platform. Moreover, our platform should also be notified once forest authorities, or the police flag a convoy of wood as illegal. And, when forest authorities decide that a certain section of the forest should be protected, and any wood cutting should be strictly forbidden, our app should not only prevent the storage of any related data of the protected trees, but inform the wood cutter that this area has to be preserved at all cost, and even alert the local authorities to inform them about potential illegal logging. Interoperability with all stakeholders in the wood industry in Peru is particularly important to us.

Concept of the WTP. Source: Wood Tracking Protocol



Can you tell us something about the technical setup of WTP? And how do you address challenges around interoperability?



WTP smartphone application

The WTP applies two different DLT approaches.
We work with Ethereum to store simple data and to programme smart contracts which will automate the payment once the work by a predetermined woodworker was done and validated.
We consider InterPlanetary File Systems [IPFS] to store photos and more complex data. IPFS would be used for most of the data storage to lower the costs compared to the public network of Ethereum. To protect user privacy, some information is not stored on any blockchain or DLT network.
Private information such as telephone numbers, profile photos, personnel addresses are stored on a local database, to respect privacy law, and avoid problems such as doxing.
To enable interoperability with third parties, WTP uses a combination of Rest-ful API and GraphQL API. One of the issues that we encountered here in Peru is that the adoption of APIs is still limited. Many of the institutions that deploy IT approaches in order to improve the traceability of Amazon wood simply don't have an API and rather work with Excel, or CSV files to download, or use SOAP, an XML-based protocol. The use of newer versions of modern Restful API that are standard for all mobile applications remains the exception. We partially support GraphQL API, but the requirements for a GraphQL server in Peru are still limited.

What is the current status of WTP? What is planned for 2021?

We have built the smart phone application and an associated platform with a blockchain gateway. We are currently testing the app in various pilots in the field in the region of Madre de Dios, close to the Peruvian border with Brazil. Our goal is to have WTP officially recognized as a tool to meet the goals of forest laws, namely, to determine the origin of wood. We also see potential for engagement with non-state actors such as the FSC standard. From a technical point of view, we plan to take the next step in 2021. Now, information is added to our platform manually via an app. In the future we would like to automate the process using IoT sensors such as RFID Technology to manage the entire flow of information.

WTP is focused on the Peruvian forest industry. Does this mean WTP will remain a domestic solution or do you see a potential for WTP to be applied beyond the borders of Peru?

Illegal logging represents a major burden for building a sustainable forest industry in Peru. That is why we decided to start with WTP in Peru. However, the approach we apply can easily be adopted to other jurisdictions as well.
However, first we conclude the piloting phase and synthesize the relevant experiences for the further development of WTP.

Only then we will discuss the next steps which will surely involve the possibility of expanding our scope beyond Peru.

Analyzing paper trails during the WTP Piloting Phase in Madre de Dios, Peru. Source: Wood Tracking Protocol.

SUMMARY AND OUTLOOK

Encouraging open access to climate-relevant data empowers public and private sector stakeholders to develop low-carbon development plans, to better inform investment decisions and to allow civil society to participate more effectively in climate policymaking. The future management of these data will be based on a combination of DLT, IoT and AI, and will open the door for new business models and digital applications. Interoperability is key to the success of such digital applications. From the technical side, interoperability often is the main requirement enabling applications to perform their basic functions. Without the technical linkages based on common data exchange standards, applications will have a hard time working properly and scaling up operations. Interoperability is not, however, limited to the technical side. Non-technical interoperability on the human or organizational and institutional layers is also important. Enabling interoperability on the human layer can serve to identify potential

data providers ahead of project implementation, and interoperability on the organizational and institutional layer is crucial for sharing and integrating data assets on GHG emissions among public organizations, private sector participants and across national borders.

The interoperability of blockchain networks is a relatively new development, and discussions on the interoperability of blockchains are still in the early stages. Because blockchain networks are operating according to their own mechanisms and protocols, new ways have to be found to enable the direct link of the networks without the need for a centralized operator.

Open Data can foster transparency, promote greater participation and encourage sharing of ideas, and Open Data approaches to climate activities can be top-down or bottom-up. Challenges may arise regarding the openness and the right to make full use of data. Crowdsourced data offer an interesting potential for a credible verification of emission data, especially in the international aviation and shipping sectors. DLT allows users to share data, while retaining control. Open Data and DLT are both based on free access to and full availability of data, making them a natural fit.

Tracking logged wood in Madre de Dios, Peru. Source: Wood Tracking Protocol.

3

Digital MRV in carbon markets post-2020: next generation quality, integrity and flexibility

Digital MRV in carbon markets post-2020: next generation quality, integrity and flexibility

OWEN HEWLETT
CTO
THE GOLD STANDARD FOUNDATION

Interest in carbon markets is growing, and further growth is predicted[1]. The past year saw the integration of markets for corporate climate finance beyond science-based targets[2] and the formation of a taskforce on scaling voluntary carbon markets[3]. With 1 January 2021 generally considered the date from which Paris Agreement accounting provisions should be implemented, major updates to the setting of baselines, additionality and double counting will likely be necessary.

This chapter reviews the emerging role of digital monitoring, reporting and verification in navigating the complexity of post-2020 carbon markets, explores how digital MRV can support the flexible application of different market-based credit and finance mechanisms in support of climate action, and considers how to move to a standardized way of applying MRV to maximize efficiency and flexibility.

The concept of digital MRV can be summarized as the enhancement and automation of MRV to improve trust, efficiency and value, and implies disruption by different technological solutions to the predominantly manual processes of data collection, emission calculations, reporting and verification.

A number of technology-based solutions that aim to improve efficiency, credibility and value are emerging:

- Implementation of IoT and remote sensing technology in data collection – the use of smart meters for renewable energy activities, usage sensors for efficient cook stoves or remote sensing and radar for the collection of land-use data, for example.

- Automated model-based approaches for calculating and reporting impacts in combination with remote sensing data collection – the use of validated data and coefficients to convert remote sensing information into carbon stocks, for example – and the use of AI to glean data from other sources for further validation, comparison and calibration in real time.

- Smart verification approaches that can be put in place ex ante and calibrated to allow real time, remote verification of information as received, enhanced with AI to compare real time against expected results.

1 Environmental Finance, Strong Growth Predicted for Voluntary Carbon Market, environmental-finance.com
2 Science Based Targets, Foundations for Science-based Net-zero Target Setting in the Corporate Sector - Version 1.0 (2020), sciencebasedtargets.org
3 TSVCM, Taskforce on Scaling Voluntary Carbon Markets - Consultation Document (2020), iif.com

Different technologies may influence and improve different parts of MRV, and while the original digital MRV benefits still stand, two further benefits are now envisioned – the potential to navigate fragmented markets more flexibly and the mitigation of risk associated with COVID-19 and other future extraordinary events.

3.1

Digitized MRV for the European Bank for Reconstruction and Development

Insights from
DMITRY HALUBOUSKI
Climate Finance Associate
at the Energy Efficiency and
Climate Change Department
of the European Bank
for Reconstruction and
Development (EBRD)

With large and varied portfolio, EBRD is facing challenges in applying consistent approaches to monitoring, reporting and verification. As a major multilateral development bank (MDB), EBRD must meet a wide range of reporting and transparency standards. Mr. Halubouski discusses the relevance of digitized MRV in the context of the D-MRV programme – a pilot to demonstrate the feasibility of automating and digitizing some of the key MRV processes.

Q: The EBRD has a large and varied portfolio of finance and investments. What are the key challenges you face in applying a consistent approach to MRV and how important is robust MRV to your operations? As a major multilateral development bank, the EBRD must have to meet a wide range of reporting and transparency standards. How much of a challenge is it to align an MRV system to deliver on them as they inevitably grow and change? Does a digital approach offer an opportunity to rationalize this?

A: Robust MRV frameworks are a cornerstone underpinning and facilitating impactful climate mitigation and adaptation action across the globe. Such systems encourage transparency, accountability and trust between parties and provide a high degree of assurance to the international community that efforts to combat climate change are yielding the expected results. Strong MRV systems that credibly link investments to measurable results on the ground are also instrumental in facilitating access to climate finance and carbon markets. Both international climate donors and carbon credit buyers increasingly demand higher levels of stringency in climate impact assessments and reporting.

The EBRD, alongside other partner MDBs, has been at the forefront of climate finance action driven by commitments to substantially increase climate investments and also to align its investments and operations with the goals of the Paris Agreement, having also signed up to the recommendations of the Task Force on Climate-Related Financial Disclosures. This increases requirements for more accurate, robust and up-to-date data on the performance of the portfolio of projects EBRD invests in.

To date, impacts of these investments have been largely assessed and reported on an ex ante basis following common MDB methodologies. However, there is a growing understanding of, and demand for, broader adoption of ex post approaches to report verified results from climate investments to support disclosure and to better inform climate-aligned investment decisions. It is in this context that enhanced MRV approaches have been identified as an essential element of the innovation pillar prioritized in the recently approved EBRD Green Economy Transition approach 2021–2025, which targets green finance ratios of more than 50 per cent by 2025 and cumulative GHG emission reductions of 25–40 million tCO_2 from the Bank's supported investments over the strategy timeframe. Thus, advanced digital MRV solutions will support the Bank's green economy agenda aiming for an accelerated green low-carbon transition in our countries of operation.

You're developing various digital approaches to MRV. What do you see as some of the most promising technological advances at the investment level that could help your work?

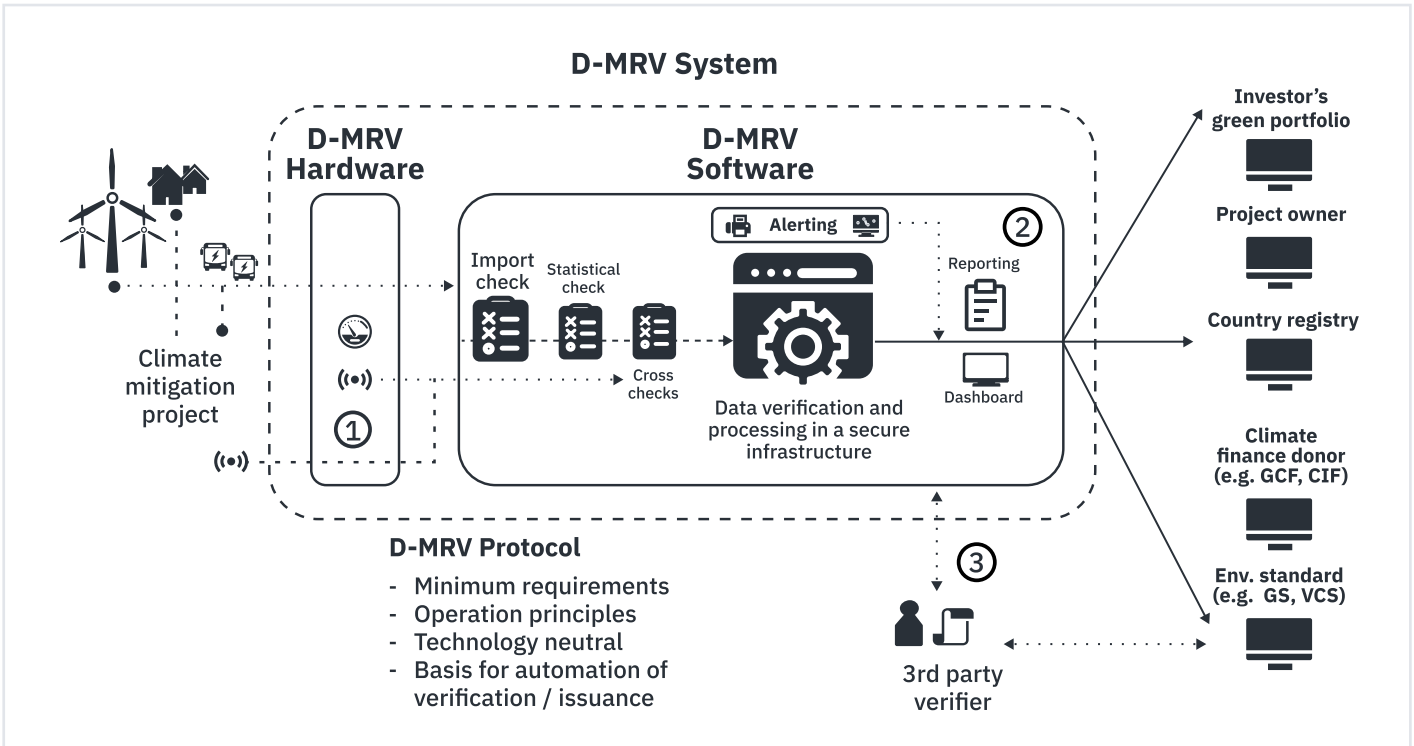
Conventional MRV systems rely substantially on manual data entry and management, making them quite cumbersome, error-prone and costly to implement with a sufficiently high degree of accuracy, reliability and timeliness. In fact, the experience of CDM under the Kyoto Protocol clearly demonstrated that MRV requirements mandated by international standards often create additional barriers to implementation of impactful mitigation interventions – particularly small-scale, spatially and/or temporally distributed ones – due to the prohibitive cost of MRV, disruptions and delays, and generally, long lead times for bringing certified mitigation assets to the market.

At the same time, the latest advances in digital and IT technologies – such as smart meters, digital sensors, distributed ledgers – hold the potential of generating significant gains in terms of cost, time, accuracy, transparency and reliability throughout the MRV process. Reduction of MRV costs can help open up additional revenue opportunities through carbon markets for a range of climate projects previously prevented by the high MRV transaction costs, as, for example, would be the case for small-scale distributed renewable energy projects.

Driven by the shared ambition of staying ahead of the curve in climate finance, EBRD, supported by the Spanish Climate Change Office, piloted in 2019 the development of a prototype advanced digitalized MRV system – what we've dubbed "D-MRV" – with the primary objective of demonstrating the feasibility of automating

and digitizing some of the key MRV processes, all in a secure platform. The pilot was also intended to provide insights into the scale of potential MRV transaction cost and time savings that D-MRV system could help unleash.

The D-MRV solution has been successfully tested on a renewable energy project that forms part of EBRD's portfolio – the Khalladi wind farm in Morocco. The project has been connected to the prototype D-MRV system, enabling direct data acquisition, transfer, plausibility and integrity cross-checks, and yielding system pre-verified carbon emission reduction calculations in an automated way. The pilot results were presented at a side event organized by EBRD as part of COP 25 in Madrid in December 2019, while the overall concept of the system design and potential rule changes were also opined upon – largely in a supportive way – by Gold Standard and an independent verifier.



D-MRV System. Source: EBRD

Building on this prototype system experience, EBRD proceeded in 2020 to develop a fully functional D-MRV system that would automate and digitize the entire project MRV workstream – directly acquiring project monitoring data and processing it through to output of system pre-verified mitigation results; reporting on project performance and environmental results achieved to different groups of stakeholders using predefined templates; and enabling independent verification of climate results claimed and of the entire MRV value chain to ascertain accuracy, complete-

ness and integrity of data flows and compliance with applicable rules and requirements.

Quite importantly, the system will also provide additional functionality to support avoidance of double counting of environmental outcomes under different standards or programmes such as carbon credits and renewable energy certificates. Establishment of direct communication links with country or organization registries for data exchange will also be explored.

During the first half of 2021, the full-scale D-MRV system is going to be developed and deployed to a number of EBRD projects to support both monetization of carbon credits generated by a distributed portfolio of renewable energy projects in Jordan, as well as utilization of concessional climate finance for renewable energy projects, and associated reporting obligations, under a Clean Technology Fund programme managed by EBRD across several countries in our region of operation. The experience of this extended piloting of the D-MRV system will provide valuable insights into its further improvement and expansion to other sectors beyond renewable energy, potentially informing further digitalization of MRV in the post-2020 carbon markets. Obviously, the regulations of environmental standards need to be adapted to allow for full digitalization of MRV, and this is the area where joint efforts by the international climate community are required and where EBRD has been engaging with carbon governance bodies, such as Gold Standard, and independent verification entities to seek buy-in on potential enhancements. There seems to be a general consensus in the market that the benefits of MRV digitalization on improving the quality and value of mitigation outcome data, though carrying potential risks such as data security and integrity and verifier liability, need to be carefully analysed and reflected in the updated regulations.

You've been working on a Digital MRV Protocol applied to some exciting use cases, could you describe the Protocol and how it is targeting some of those challenges and opportunities in MRV? How does the Paris rulebook affect the thinking behind the Protocol, if at all? Would it be helpful to be able to refer to common digital principles? And if so, what do you think they would need to cover and who should own them?

Yes, indeed, EBRD has been spearheading the development of a Protocol for Digitalized MRV, or D-MRV Protocol, which in our view could be an instrument for instilling trust in D-MRV approaches within the climate community. The D-MRV Protocol, which is due to be released shortly, aims at establishing basic requirements for and principles of operation of a D-MRV system with the objective of ensuring accuracy, consistency, traceability and integrity of mitigation outcome data from on-site raw data measurement through to output of mitigation results calculation. By establishing these minimum requirements – or we can call

them digital principles – both at the hardware and the software level of the D-MRV system, covering the areas addressed by the above objective, the protocol would provide a basis for certification or validation of such systems by independent entities, facilitating their integration into the project design.
Digitalization would enable significant improvement in the efficiency of MRV processes, most importantly at verification and issuance, effectively reducing MRV transaction costs and time to market for mitigation assets and facilitating faster payment terms.

Robust digitalized MRV systems will clearly become instrumental in unlocking the full potential of scaled-up carbon markets under the new paradigm of Article 6 activities under the Paris Agreement. And we clearly see the benefit of the protocol in setting minimum standards and providing further guidance on application of digitalized MRV approaches across the whole spectrum of heterogeneous actions under Article 6. Converging on a comprehensive set of requirements applicable to different types of mitigation activities and having these eventually endorsed by the climate market regulatory bodies and assurance providers and embraced by the market would take time and concerted efforts of the climate community.
The extended piloting of the D-MRV system in a range of renewable energy projects, as described above, will provide EBRD with additional insights to inform further enhancements of the D-MRV Protocol.

As much as we like pioneering such initiatives, EBRD appreciates the value of an international body – D-MRV platform – that would convene the key stakeholders, including environmental standards, independent verifiers, national climate authorities, MDBs, to facilitate consensus building on common approaches to digital MRV. Such a body could host and support further updates of the D-MRV Protocol, promoting its wider adoption in the market.

We hope the path that EBRD is laying out with the protocol will help lead to application of more robust and efficient digitalized MRV approaches in the market, facilitating transparency, integrity and impact of climate action around the globe!

3.2

The role of digital MRV in fragmented markets

The use of market mechanisms in climate action is a means to an end, a set of tools to be used to influence behaviour, generate finance and raise ambition. The market is not homogeneous, but in fact points to a wide range of possible applications that serve different parts of the solution to the climate emergency, for example transfers of mitigation outcomes between countries for reporting at the country level, transfers to companies for sectoral compliance (such as CORSIA) or voluntary offsetting.

A carbon mitigation project could be financed through carbon markets under several market applications that could be suitable. The selection of the most appropriate application is a function of the project attributes, which can determine which markets it may be eligible for. A host country, for example, may wish to drive change in its forestry sector and support the project by initially seeking funding through Article 6 release (i.e. a second country purchases removal units from the host country, as related to the afforestation project). The project may also be able to access voluntary carbon market finance, where its units are used in the context of voluntary offsetting, wherein the purchasing company may wish to purchase credits from the project to offset its emissions while also making narrative claims about the biodiversity benefits.

Further options in compliance markets exist – for example an airline could purchase credits from the project to report against its CORSIA targets, or a domestic company may purchase them as allowances against a domestic carbon tax. Underlying each of these options, the afforestation project and its core MRV provisions remain the same, the main difference being the variable provisions to gain access to each option.

Underlying these choices therefore is a need to conduct the appropriate level of MRV to unlock finance. In the context of carbon markets, the expectation for MRV accuracy and rigor applied to projects may be higher than, for example what is expected of countries in the context of their general reporting under the Paris Agreement.
When designing an ambitious climate action, carbon market proponents are also likely to want to maximize flexibility to attract finance from whichever mechanism best supports their work.

Previous CLI Navigating Reports have explored how disrupting MRV with innovative technology can increase credibility and trust by removing error in manual handling of information and inadvertent or fraudulent misreporting. Similarly, an automated process through direct data capture together with remote verification through calibration can significantly increase efficiency and reduce cost. Finally, shifting to an automated process can bring us closer to issuance of assets in real or near-real time, ensuring that only the highest value assets are available to markets.

We can now add to this the value of flexibility – that MRV can be designed in such a way to maintain maximum flexibility as to which source(s) of finance can be sought by an action and how this can evolve over time. While in some cases this has been possible, for example some renewable energy devices have been able to choose between the issuance of Renewable Energy Certificates and carbon credits, this has tended to be limited to those that are simplest to break down into binary choices and where MRV is less complex. As state and non-state mechanisms grow and overlap with each other, all activities will need to overcome this complexity to minimize risk and maximize opportunity.

3.3

Scaling the voluntary carbon markets: an emerging discourse on scale enabled by automating MRV

In September 2020 taskforce on scaling voluntary carbon markets was launched, headed by former Governor of the Bank of England, Mark Carney. The taskforce seeks to enable the scaling of the voluntary market by between 15 and 160 times its current issuance, by unpacking and driving the market provisions and infrastructure needed to support that growth. The taskforce determined in its initial consultation that credibility, efficiency, resilience and value are all enhanced by a digital approach to MRV, with a view to full automation, which it supports. At the same time the group acknowledged that stakeholders could be left behind if the market insists on these approaches and discards more traditional MRV.

This recommendation could produce a number of benefits. It has the potential to reduce issuance costs, especially for small projects and for programmes related to infrastructure or involving multiple parties. It could reduce payment terms from 15 months to about 6 weeks, and ultimately become the foundation for interoperable carbon markets. It could improve claim credibility, data traceability and integrity; allow interoperability; accelerate credit issuance and cash flow for project developers, partially resolving the financing gaps that exist now; and reduce costs. Transparency will bolster trust in voluntary credits.

Excerpt from ‘Taskforce on Scaling Voluntary Carbon Markets’

November 2020

Recommended action 11: Institute efficient and accelerated verification.

The Taskforce proposes a digitized project cycle with two features: a shared data protocol that captures necessary project data digitally and protects its integrity during processing and transfer, and an integrated process that allows verification entities to continuously monitor and validate integrity as projects are developed, rather than at the end of the process. The Taskforce acknowledges that monitoring, reporting, and verification involves a global community of assurance providers with overlaps between the compliance and voluntary markets. The verification process should be consistent across the markets for all carbon credits issued. Furthermore, technology is rapidly evolving. The Taskforce recommends that the share data protocol explore the inclusive use of satellite imaging, digital sensors, and distributed-ledger technologies, to further improve speed, accuracy and integrity.

Source: TSVCM, Taskforce on Scaling Voluntary Carbon Markets - Consultation Document (2020), iif.com, p. 16

VOICES FROM THE PRACTICE

Insight from
INGO PUHL
Co-Founder of South Pole

As a member of the Taskforce and a leading proponent of the shift to a digital MRV modality, Mr. Puhl sees the following benefits for market practitioners like project develo-pers and retailers: Digital MRV begins with data capture and the possibility to tag for what purpose an input data item has been used already. Think of it as a reverse data supply chain transparency application. By tagging for what purpose input data – like activity data – has been used already, we can use digital processes to ensure that input data are not used to double claim an environmental credential across governance standards. This solves a lot of the issues downstream about facilitating decentralized interoperability across carbon market system boundaries, double claiming or counting, integrity, issu-ance and cash flow acceleration. To implement this, we would need agreement on digital data protocols across carbon standards and beyond. In addition, digital processes replace and supplement related human resources capacity shortcomings related to data collection, management and verification, thus reducing data integrity uncertainty and market access barriers.

Q: As a member of the Mark Carney Taskforce thinking about vastly scaling carbon markets, how do you see a shift towards digital approaches contributing?

A: Digital approaches can contribute to the scaling of carbon markets if they are adopted across carbon standards and facilitate interoperability. My hope is that the Taskforce can drive the formation of such a consensus-based approach via recommendations on the use of digital data protocols for adoption by all those who endorse its recommendations. Digital approaches create the basis for the use of carbon credits across different carbon markets, transparency, reduce the costs of carbon credit origination and accelerate the revenue origination process for carbon credit sales. All of these factors combined will increase the attractiveness of carbon assets for users and producers tremendously. The net effect of this is a hopefully massive crowding-in of new users and producers.

What do you see as the main barriers right now and how can we move the agenda forward quickly?

The most sensible thing to do would be to include criteria for the use of a harmonized digital data protocol into the Taskforce recommendations related to the core carbon principles. In a next step, it would be great to continue working on the imple-mentation of such recommendation with the participation of the main carbon standards.

How can we make sure no one is left behind by the transition, for example those for whom capacity may be low?

I am convinced that a digital approach always works in favour of those whose capacity is low. Every experience shows that digitalization improves access – the costs of international phone calls, East Africa's solar home revolution, for example.

Carbon is quantifiable and market maturity is relatively high. How do you see the equivalent digitization agenda in the context of sustainable development and the less easily quantified matters such as safeguards?

My hope is that we can leapfrog into the use of digital processes in relation to other Sustainable Development Goals and safeguards. In relation to socially focused SDGs, I believe that the agenda around digital identity could be a useful starting point. In relation to economically and environmentally driven SDGs, I believe that supply chain transparency is a useful starting point.

How do you see this change affecting the verifier community?

The verifier community has an important role to play but requires an adjustment of their standard business process which requires a build-up of their own digital competence. I observe that at least some members of that community already have fully committed to their own digital transformation. Having said this, digitization is a process that will happen over time and will occur gradually.

How can standard bodies help operationalize the change?

There is a need to establish harmonized digital data processing and management procedures that are implemented and adhered to across standards. This could be achieved through a working group that seeks to implement related recommendations that come out of the Taskforce. In parallel, standard bodies should encourage the piloting of digital processes, initially in parallel to existing procedures.

Can you give us some examples of your work? And where can people find out more?

One of my current key initiatives is to design and operate SHIFT Asia, South Pole's platform to accelerate electric mobility in South East Asia, as the first digital carbon programme in cooperation with the Thailand GHG Organization under the T-VER Standard. Thailand GHG Organization is embracing the digitization of the T-VER Standard and is a great partner to drive this agenda forward.

Electric mobility – due to its distributed nature and its convergence at the intersection with renewable energy generation and grid flexibility, which drives the capacity of the power grid to manage variable loads typically associated with renewable energy – makes SHIFT Asia an ideal candidate for a digital approach.

SHIFT Asia has very recently been recognized by the Partnership for the Four Global Goals as a State-of-the-Art Partnership of the year in recognition of this innovation. We are very interested in partnering with other members of CLI to fully implement this concept and scale it up to other areas.

3.4

COVID-19: further evidence of the value of automating MRV

The COVID-19 pandemic had directly impacted various fields of climate action, and so too the viability of MRV. COVID-19 restrictions on travel and social distancing has meant that many climate actions have been forced to consider how monitoring and reporting of data takes place, and for assurance providers how audit teams can get to sites and assess evidence. In the carbon markets there are good examples of how standards have reacted, affording projects and assurance providers with flexibility to act without putting colleagues at risk and minimizing disruption.

While these short term measures are essential and urgent, they also point to a further advantage to a more digital approach – resilience. While the core benefits of credibility, efficiency, value and flexibility remain central to the mission of digital MRV, resilience to shocks is a key component that can now be added. The afforestation project is again a good example.

Traditional MRV of these activities involves on-site measurement and census of biomass and soil, on a manual sample basis perhaps supplemented by growth models and other techniques. The audit involves a site visit that physically assesses the evidence submitted and perhaps in some cases repeats measurements to check. All of these actions involve travel and teamwork that is either prevented or limited by COVID-19 restrictions, and that will last for an unknown period. The implication of this shock to projects is that monitoring and on-site assurance becomes impractical, expensive or impossible to cover from a human resources liability perspective. In turn this may lead to non-conformity with the issuing standard and a failure to realize carbon assets required to generate finance.

An automated, largely remote monitoring approach, like those outlined in earlier reports (for example drone-based radar survey or remote sensing) could help to minimize onsite exposure and thus increase resilience to shocks such as COVID-19. This is in addition to other benefits such as allowing real time observation and remote assurance through calibration of techniques.

3.5

The role of assurance providers in the changing environment

The emergence of digital MRV implies a change to the business and operating models of assurance providers. This is particular important in markets, where assets are realized only through assurance provided by independent and accredited third parties. Previous Navigating Reports have highlighted that indeed these themes do not point to the end of assurance providers, but rather to an evolution and an enhancement of the value they can provide, while reducing the transactional, manual data handling element that is often duplicated.

Insights of
WERNER BETZENBICHLER
Executive Chairman of Verico SCE and General Manager at the Designated Operational Entities and Independent Entities Association (DIA)

Although my personal views will most likely not overlap one hundred percent with those of all management staff of validation and verification bodies [VVBs] active in the carbon market, I believe that there is common understanding that the technological development needs to be reflected by the way independent third parties render their services in future. There are new competence requirements for members of validation and verification teams ensuring that they have the capability to track raw data and aggregated results stored and transferred by new technologies. Auditors, being familiar with encryption software and data security concepts, will spend more time in front of their own computers instead in interviews and inspections at the project site.

However, even when trading of environmental commodities is based on more or less online available measurement results, it is the verifier's attestation which is still needed to create trust of buyers that these results are real. Hence, the process of data processing and transmission from a functioning measurement device to a commodity registry at the speed of light will become a key objective of investigation for third party services. And it is more a kind of validation – with need for revalidation at a defined frequency once the system is installed – than an ex post verification as applied by most schemes nowadays.

Nonetheless, the current competence requirements on VVBs will remain valid, while new ones will be added. Not all kinds of mitigation actions will be eligible for new MRV technology. Furthermore, validation also covers compliance checks and the evaluation of features which are different from MRV approaches. The DIA for example, has recently started working on the development of a rating concept for mitigating actions in carbon mar-

kets especially under Art 6.2 of the Paris Agreement. Out of almost 100 indicators in a scoring approach, only a handful directly correlated to MRV activities and MRV results. While some stakeholders have the opinion that innovative technology will reduce the burden of verification, I rather expect that it moves workload from regular verification audits to an earlier stage. Innovative technologies will not displace verification. They offer benefits in data security and speed and reduce the risk of human error. And they require new skills and competences at VVBs, hence making their team compositions more colourful, interdisciplinary and interesting.

SUMMARY AND OUTLOOK

One of the key emerging themes of the post Paris Agreement era is a trend towards an understanding how the different levers of change – such as climate finance, carbon markets and corporate action – available to state and non state actors will need to work together. At the state level, the Paris Agreement effectively represents a suite of mechanisms to realize shared goals, including direct action and reporting – Nationally Determined Contributions, for example – flexibility to transfer mitigation outcomes (i.e. Article 6), and allows for countries to support others in achieving their targets (climate finance). In reality, an individual action or activity can touch on a number of those options. For example, climate finance may invest in nature based solutions to the benefit of the host country NDCs and achievements of targets. That same activity, however, could be financed by carbon markets and used in the context of, for example, a CORSIA commitment.
In conclusion, we find that:

- Carbon markets will fragment along a wider variety of use case lines than previously experienced, and will need to deal with policy externalities and emerging updates to core provisions.

- Proponents navigating these fragmented markets will need to understand both core provisions of markets and the variable provisions for eligibility, and recognize that both risk and opportunities may arise.

- Standards systems and assurance providers will need to be consistent in their understanding, application and assessment of core and variable provisions.

- Digital MRV approaches can help track the provisions and attributes needed to access certain markets, linking to interoperable registries to create seamless and immutable tracking of assets and ensure their correct usage, and can create consistency in approach.

- Digital MRV can also help reduce exposure to risks such as COVID-19 by designing and implementing MRV systems that are less reliant on direct, manual collection and assessment of data.

In the coming twelve months we expect this discourse to link further to the MRV recommendations put forward in the Voluntary Carbon Market Taskforce.

4

Governance challenges in implementing digital technologies for climate action

Governance challenges in implementing digital technologies for climate action

MADELEINE GUYER, ANIK KOHLI
Project Managers
INFRAS

Blockchain technology allows large groups of people and organizations to reach agreement on and permanently record information without a central authority, but not having a central authority does not mean an absence of governance. This chapter explores the relevance and meaning of governance in implementing digital technologies for climate action, and offers the insights of experts in blockchain governance.

4.1

Blockchain governance and why it matters

Climate action blockchain projects and use cases all deal with a similar set of questions related to governance. Is blockchain the right technology to solve the problem at hand? Who can validate a transaction? Who decides how the blockchain will change over time? How are disputes resolved? How and to what extent are assets on the blockchain covered by national legislation? How does the project relate to the rules of the Paris Agreement? Governance means different things in different contexts, comes in different forms and operates on different levels – the international, the national and the blockchain.

GOVERNANCE ON THE INTERNATIONAL LEVEL

The Paris Agreement sets out rules for climate action and provides details for implementation. The rules specify the climate-related information countries must provide, as well as the format and frequency of submissions. They also specify reporting procedures for national inventories, Nationally Determined Contributions and the international transfer of mitigation outcomes in carbon markets. If blockchain technology is to accelerate the implementation of the Paris Agreement, the use cases need to consider these international rules.

GOVERNANCE ON THE NATIONAL LEVEL

Blockchain is a technology that is disrupting existing economic, social and political structures. Fundamental characteristics of blockchains such as decentralization, anonymity, immutability and automation lead to difficult legal and regulatory questions. Governance issues at the national level

include data privacy, the right to be forgotten, digital identification of participants (humans and machines), "signatures" for smart legal contracts and enforcement of smart contracts. Using blockchain for climate action may raise additional regulatory and legal issues–many countries have energy laws that do not provide for peer-to-peer electricity markets, for example.

GOVERNANCE ON THE BLOCKCHAIN LEVEL

Blockchain governance issues revolve around protocols. Who can use the network? Who can validate a transaction? What is the consensus mechanism? How are protocol changes implemented? How is interoperability with non-blockchain parts of the network ensured? Many aspects of blockchain governance are of a technical nature and relate to underlying operational processes. Three different blockchain architectures have emerged – public and permissionless blockchains, federated or consortium blockchains and private or permissioned blockchains.

The rules and governance of blockchains define who can access information, change protocol rules or data, mine tokens or coins and set transparency requirements. Building confidence and maintaining trust in blockchain calls for an understanding of the three levels of governance. The CLI has conducted a series of interviews with experts to discuss governance issues and learn from their experiences and practical solutions.

TABLE 5: Blockchain governance systems. Source: CLI Navigating Report 2018.

BLOCKCHAIN TYPE[1]	DESCRIPTION AND EXAMPLES
Public (permissionless) ledgers	Anyone can download code and start running a public node, validate transactions in the network and contribute to the consensus process for adding blocks to the chain and defining the current state. Most of the current consensus mechanisms in public blockchains contain the proof-of-work algorithm, which typically leads to high electricity consumption and is slower and more difficult to scale. Examples: Bitcoin, Ethereum, Litecoin
Federated or consortium blockchains	Operating under the leadership of a group, these blockchains allow only specific nodes to participate in the verification process. They are faster, allow for higher scalability and provide more transaction privacy than public blockchains. The consensus process is controlled by a preselected set of nodes. Examples: Energy Web Foundation, R3/Corda
Private or permissioned blockchain	Permission to write (and read) are kept by one organization. Examples: Internal company blockchains for database management

| 1 Fuessler in "Governance of Blockchain and Climate Action", p. 87, CLI Navigating Report_2018

VOICES FROM THE PRACTICE

Insight from
FLORIAN DOEBLER
Social Impact and Public Sector Development Lead at IOTA

IOTA is a secure data communication protocol and zero-fee microtransaction system utilizing distributed ledger technology. IOTA's key innovation is the Tangle, a system of nodes that confirms transactions and allows participants to transfer immutable data and value and achieve consensus on the data and value transactions in the network.

Q: What's IOTA and how does it work?

A: The Tangle provides a single source of truth and trust in data, with a goal of being the backbone of the Internet of (every) thing in a highly networked world. It can be used to generate machine-to-machine micropayments and share data across the ecosystem of devices, generating data, producing results and co-creating new business models. IOTA is developed open source with the full benefits of transparency and visibility into the code base, better reliability, security and freedom from becoming locked in by vendor or technology. IOTA is a protocol that is based on a Directed Acyclic Graph [DAG] and works without miners. It therefore does not introduce any hierarchies into the network. The network is permissionless and can be used by everyone without requiring the IOTA Token – everyone can access the IOTA protocol without having to worry about the regulatory implications of owning digital assets. This allows IOTA to be utilized in a range of industries and use cases, spanning mobility and automotive, global trade and supply chains, industrial IoT, smart cities, sustainability management and digital identity.

As of the latest development, IOTA has launched Pollen, the first test network that is completely decentralized and works without the so called coordinator that was previously needed to achieve finality in the DAG-based network. Furthermore, distributed ledger systems such as IOTA function without miners to confirm the transaction. With IOTA, anyone who wants to make a transaction on the network must confirm two previous transactions. Every node is repeatedly asked if they consider a transaction to be true. Since no monetary incentives are introduced to keep the network safe, other mathematical solutions were developed, most notably a voting scheme that is designed after extraordinary behaviour seen in nature. Bees "synchronize" their movement to defend themselves against predators.

They do this without any centralized entity, and only know when to “change their state” by observing the behaviour of their peers. Individual autonomous agents that act according to some predefined rules can be found in many systems in nature, such as bees, ants, schools of fish and even in some areas of physics. Very simple rules can create incredibly complex features that, over time, manifest as emergent properties of a system. IOTA ´s consensus mechanism works in the same way. Instead of trying to reconstruct the opinion of every other node, it cares only about the opinions of a very small subset of nodes and lets consensus be formed organically as an emergent property of the network. While the development of a DAG-based network is much more complex than linear blockchain architectures, the advantages with regard to scalability, predictability, power consumption and governance become apparent as IOTA approaches production readiness in the coming months.

How does governance matter in your work at IOTA?

Governance is central to the development of the IOTA protocol from several perspectives. The research and engineering of the core protocol is led by the IOTA Foundation, with little predefined on-chain governance regarding the features of the protocol. This ensures a reliable and predictable development process that is in line with the expectations of established industry leaders and international regulation. It is the mission of the Foundation to balance the needs of public and private actors as well as a big open-source community and to make sure the protocol is fit for purpose across sectors and applications. The network and technology are openly accessible and can be used by anyone in order to shape the general purpose protocol to specific needs.

In our co-innovation activities with partners, we are always faced with governance as a central topic to successfully complement or replace legacy systems with decentralized ones. Questions of liability, accountability and privacy need to be solved in line with existing legislation. Furthermore, the IOTA Foundation believes in and fosters the potential of decentralized technology to improve governance processes in a wide range of applications such as environmental accounting, taxation or supply chain provenance to name a few.

Distributed Ledger Technology offers new tools for governments and policymakers to deliver public and government services, and the IOTA Foundation ´s Regulatory Affairs team is engaging

actively with thought leaders from academia, civil society, business and government to inform dialogue and legislation as prerequisites for the real world adoption of permissionless distributed ledgers.

What regulatory and legal challenges have you faced for IOTA in general and in different use cases?

For the IOTA Foundation, it is important to bring the technology to the attention of the regulators in an open and honest dialogue. Especially the question on how to apply the European General Data Protection Regulation [GDPR] must be clarified with regard to the right to be forgotten. GDPR is a regulation of the European Union, which harmonizes the rules for processing personal data by most data processors, both private and public, throughout the EU. The implementation of our decentralized identity framework has taken great care in being GDPR-compliant. Any clear Personal Identifiable Information [PII] is never stored on the immutable ledger so as to adhere to the right to be forgotten. According to the standards for decentralized identity, public keys and an identifier must be stored on the ledger. We have added layers of protection for those, as these can be considered PII under specific circumstances. So are public keys hashed with a salt before they are put on the ledger and are the identifiers exposed in a very limited manner, preventing a correlation attack.
Governance issues vary largely depending on the sectoral application and specific national regulations. Our work strongly relies on the regulatory framework and requires as much legal certainty as possible. We sense, however, that there is a lot of support, both from the European Union as well as national governments for solving these questions collaboratively, and movement at the regulatory level is seen in almost all areas and sectors based on the evident potential of Distributed Ledger Technologies to support societal shifts towards transparency and sustainability.

Why did you register IOTA as a foundation in Germany?

It was a deliberate decision that the IOTA Foundation was registered as a not-for-profit foundation in Germany. We are the first foundation with a cryptocurrency endowment that was registered in the European Union. Although there were many regulatory challenges in the beginning, the choice for a strongly regulated jurisdiction such as Germany helps to create trust in the IOTA Foundation and is a prerequisite to interacting with governments, industry and standardization bodies across the globe. Widespread adoption of DLT will depend on credible, strongly regulated organizations and we strive for maximum transparency towards our regulators partners and community.

Insight from
MARIANNA BELOTTI
and **MONIQUE BACHNER**

Co-chairs of the
Governance Working
Group of INATBA

The International Association for Trusted Blockchain Applications (INATBA) offers developers and users of DLT a global forum to interact with regulators and policymakers and bring blockchain technology to the next stage. Initiated by the European Commission and launched in April 2019, the association already has a membership base of more than 150 organizations, from start-ups to key industry players in various sectors. The association is additionally supported by an Advisory Board including organizations such as the Organisation for Economic Cooperation and Development, the World Food Programme, the World Bank and the United Nations. The core objectives of INATBA are to:

- Establish a permanent dialogue with public authorities and regulators
- Promote open, transparent and inclusive global governance models for blockchain and DLT
- Support the development and adoption of interoperability guidelines and global standards
- Develop sector-specific guidelines and specifications

INATBA works along 14 different working groups including one on Climate Action and one on Governance.

Q: What are the current crunch issues being discussed at INATBA's Governance Working Group?

A: The current focus of our discussion is on frictions that can arise when adopting global blockchain solutions and how to overcome these frictions. It's highly important to discuss these with stakeholders from all over the world in order to reflect the different situations in various countries. Furthermore, the topics of the roles of governance, interoperability and standard-setting are particularly present on our agenda as we see these as keys to enabling wider deployment of blockchain ecosystems.

One of the main lessons learned in our latest work was the realization that global standards are needed in order to overcome different frictions due to the current lack of trust and lack of commonality across platforms. In our Governance Working Group, we discuss not only technical interoperability, but also legal interoperability, that is, how to deal with the reality of having very different laws and regulations in different countries – each with its own legal sovereignty. It is important to push for greater coherence in order to overcome these differences to collaborate smoothly as so much ultimately depends on the underlaying legal systems, yet blockchain platforms are being deployed across regions and even across the world.

As standardization of laws across all countries is not realistic – even famous treaties such as the UN Declaration of Human

Rights is not universally adopted – we have focused on developing soft instruments such as guidelines and codes of conduct that can be applied in any country.
This is especially relevant while working with governments. Whether hard or soft instruments are needed to overcome frictions also depends on whether you talk about "on-chain governance", meaning governance issues concerning blockchain-specific technical matters or "off-chain governance" which is closer to traditional corporate governance. For the latter especially it seems more fitting to have soft instruments as these are already dominant in traditional governance mechanisms to allow for a flexibility while setting common expected standards.

In addition, we have been looking at how to move forward with an inclusive and efficient taxonomy focusing on trade-offs between blockchain features and current business and tokenless aspects. INABTA itself will not provide a taxonomy, as we are not a standard-setting organization. However, we can provide examples of best practices with taxonomies as we have access to a great pool of different actors from various blockchain ecosystems. For instance, we are keen to ensure all efforts in this area also promote and ensure inclusiveness, as all these ecosystems are being designed to govern our futures.

Your Working Group is promoting a transparent and inclusive model of governance for blockchain and other distributed ledger technology infrastructure and applications. How do you define governance?

There's no single definition of governance as there are so many different aspects within blockchain ecosystems. Governance for blockchain applications can appear on different levels. You may talk about legal aspects such as privacy or data issues, or about technical blockchain governance, et cetera. Only once you have defined the aspects you talk about can you start to say what you understand under governance. It is important to stress that governance means different things in different contexts.

Governance is about organizing power, risks and responsibilities. Blockchain ecosystems are complex and multi-layered, which is also due to the fact that blockchains involve decentralization – we are not only decentralizing power, but also trust in many of those layers. We need to avoid governance crises if we are to build and maintain trust in these ecosystems and in the technology, and to avoid governance crises we need much more inclusive and sustainable design of these new technologies and each layer of the infrastructure, and with proper – and ongoing – governance, oversight and adaption over the long term.
While blockchains are generally transparent, they also well

INATBA established a COVID Task Force. In your view, what influence has COVID-19 had on the future of blockchain and digital technology development and use?

placed for securing and sharing data and for various types of verification which are helping to enable interesting new possibilities. Novel methods for sharing aspects of research while being able to maintain secrecy over other proprietary rights have been used. Digital identifiers and so called self sovereign identities that allow for sharing limited yet pertinent information for detection of new infection clusters and for contact tracing could be useful. Authentication of identities and origin is also important for supply chains and use of funding and donations. Being able to gather the right data and then share it quickly and efficiently through open data platforms is key in a pandemic like COVID-19.

Insights from
SUSAN DAVID CAREVIC
and **RACHEL CHI KIU MOK**
World Bank

Q: Would you explain the Climate Warehouse?[2]

A: The World Bank's Carbon Markets and Innovation team is exploring a Climate Warehouse ecosystem to demonstrate a decentralized information technology approach to connect climate market systems. This meta information system connects country, regional and institutional databases and registries from both private and public entities such as governments, as well as carbon standards such as Verra or the Gold Standard, to surface publicly available information on mitigation outcomes from activities reducing greenhouse gas emissions and record status changes to provide information on how mitigation outcomes are used. For instance, the warehouse could provide information on a new photovoltaic roof project in Chile that reduces greenhouse gas emissions and is used to offset flight emissions in the US. The objective is to enhance transparency and trust among market participants and enable tracking of mitigation outcomes across jurisdictions and test blockchain technology for this purpose[3].

2 World Bank Group, Summary Report: Simulation on Connecting Climate Market Systems (English) (2019), openknowledge.worldbank.org
3 Refer also to the article on the Climate Warehouse in Navigating Blockchain and Climate Action - 2019 State and Trends, climateledger.org

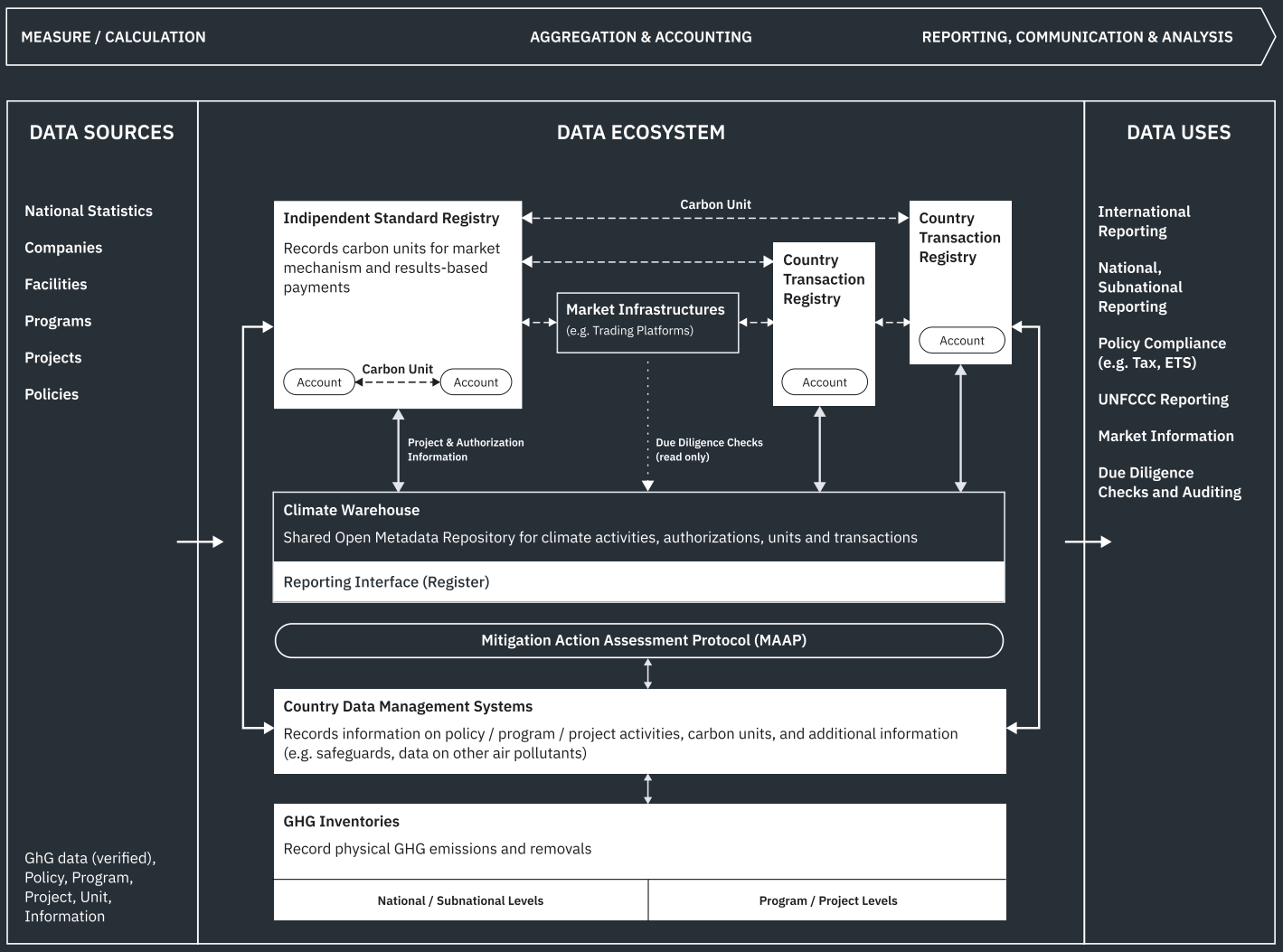
What architecture did you use?[4]

The Climate Warehouse is an umbrella platform for countries and institutions to surface information on their mitigation activities and assets, referred to as mitigation outcomes [see figure p.55]. The Climate Warehouse is a hybrid solution, comprised of a decentralized blockchain-based data storage system and a responsive user interface that supports participants with centralized services such as the ability for participants to upload and download data related to mitigation outcomes. During the first phase, participants shared data to the Climate Warehouse either by hosting their own node of the blockchain, through application programming interface, or by uploading data through spreadsheets or manual entry. Once data were shared by a partner, the Warehouse stored the data on the blockchain for full transparency. For the next simulation phase, the architecture was changed in order to make it simpler for partners to connect. That means that they're making use of an auxiliary application that brings together data from partner registry systems with new fields established in the Climate Warehouse so that partners don't have to update their own registry systems for the purpose of simulation testing. The auxiliary app provides the ability for partners to connect, and partners can view their uploads and edit data. This app is stored in a docker container in the partner's environment and connects to the blockchain either through a shared node or a node that the partner establishes. For this phase of the simulation, we are also using a blockchain as a service provider.

"Creating confidence in the technology is key! When you're prototyping, you need to make sure not to overburden your partners and not to overload the system with too many functions."

Susan David Carevic, World Bank

4 World Bank Group, Simulation on Connecting Climate Market Systems (2019), documents.worldbank.org



Climate Warehouse long-term vision. Source: Adapted from World Bank.

In 2019 four participants agreed to collaborate in the first phase of simulation – the Government of Chile, Ministry of Energy; the Government of Japan, Ministry of the Environment; the Gold Standard Foundation; and Verra. The lessons learned in the first simulation round will be taken up by the teams for the second phase of simulations scheduled towards the end of 2020.

Q: Could you explain how the first round unfolded and how it relates to the second round?

A: We had to provide the participants with sufficient time for their preparation and internal coordination. This is true for any prototyping work, but it is especially relevant when prototyping in a technology-based environment with partners not normally working with such technologies. Options for participation in the Climate Warehouse should ensure that we meet partners where they are and the we can maximize participation. In the first phase, participants were able to choose between uploading a simple Excel spreadsheet with predefined columns and values for projects and unit-related data, using a defined application programming interface to establish their own node.

Most used the Excel option because it needed less work and time as well as fewer resources for adapting their existing data systems. Furthermore, it is important to focus on participants' needs early on. We're trying to keep our data dictionary flexible to account for different scenarios. We are creating a data model for processes that are yet to be defined, so we are trying to balance consistency with the need to be flexible.

The second phase of simulation will focus more on real time simulations and we will try to get more governmental entities as well as standard-setting organizations to participate. In our next simulation we want to show what it would be like if registry systems are connected to the Climate Warehouse Information System, so that when changes to metadata occur in registries, these are reflected in the Climate Warehouse. The Climate Warehouse will also benefit from other Article 6 work such as the Climate Market Club or the Bank's Partnership for Market Readiness work. Actors from the Climate Warehouse and those working on Article 6 are engaged to share lessons learned from their activities.

In your view, why does governance matter and how does it matter in your work?

Governance sets the rules of play. It defines what the system is allowed to do, what data is needed and who is setting the rules for decision-making. For the prototyping phase, governance aspects were kept as simple as possible. We focus on the quality of data, showing the benefits and providing a learning experience. The intention is to encourage participation and not make it an exclusionary system. Therefore, the World Bank is the administrator and will remain so for the coming second simulation phase. However, the World Bank does not intend to launch an operational warehouse system. The purpose of prototyping and co-creating with partners is to define the data structures and functions that would be needed from an operational system and to share the lessons learned with the partners and the public. Also, the current limitation to storing only publicly available information simplifies potential privacy issues. The prototype warehouse stores data on a blockchain implemented as a private permissioned Ethereum network which uses a proof-of-authority consensus algorithm. This will remain for the second simulation phase. The private approach simplifies governance issues but also limits the benefits from the decentralized blockchain.

As soon as the Climate Warehouse goes live, there will be a need to have a governance body to answer questions like how long data can stay in the system. Who can participate? Who needs to pay and what? However, the membership and organization of this governance body still need to be discussed with our partners. Experience shows that you can have the best solution in the world, but if partners do not accept the solution, it will not work. Hence, an open communication with the partners is key at this stage as they help the World Bank see what governance model would work for the partners. The intention is not to dictate rules, but to learn from partners what is needed.

“From a blockchain perspective, governance is from the many and it should benefit them.”

Susan David Carevic, World Bank

What are the main challenges regarding governance for DLT solutions in general and particularly for climate action?

With regard to the national level, we have not faced any difficulties with national laws in the pilot. Nevertheless, there are national laws that make participation in international projects and storing data outside national boundaries difficult. On the national level, it is also important to raise awareness about what blockchain is and what it can be used for.

With regard to the international level, the Climate Warehouse is not carrying out transactions, but only surfaces data on transactions. Therefore, the main asset is to see whether information is missing, or duplications may have happened. The Warehouse can show double counting but will not do anything about it. The Warehouse will not have a police function but can provide the information for another body to act accordingly.

Insights from
THOMAS NÄGELE
Managing Partner at
NÄGELE Attorneys
at Law LLC

The Nägele law firm specializes in commercial law issues in private and public law, in particular in blockchain, DLT and IT. As a Liechtenstein lawyer with experience as a software developer, Thomas Nägele deals with Internet and IT law as well as civil and corporate law. He was a member of the of the Liechtenstein Government work group that drafted the novel Liechtenstein Blockchain Act (Token and VT Service Provider Act – TVTG).

Q: You deal with blockchain technologies and the associated legal issues. What are typical legal questions in connection with DLT and blockchain that your clients have?

A: At the beginning of 2016, many companies tried to finance themselves through blockchain solutions – initial coin offerings. These were projects from all over the world, which also looked at the possibilities in Liechtenstein and Switzerland. The main question was always the demarcation to the applicable financial market law. Questions of legal certainty for corporate financing were at the forefront.

A little later in 2017, questions arose as to how to transfer tokens representing rights in the real economy. These were mainly tax law issues such as questions about value added tax.

In principle, legal security is key for companies. In most cases, reasonable solutions can be provided within the framework of existing rights. However, with the new TVTG law, Liechtenstein has been able to create additional legal security.

Since the Liechtenstein law has been in existence, new questions have arisen, for example regarding the transfer of property rights. What stays the same over the years is the fact that DLTs and blockchains should enable transactions between parties who do not trust each other without the need for an intermediary. This is what we are supporting with our legal advice.

What role does a legal framework like the TVTG play?

The TVTG mainly helps companies to plan blockchain and DLT based activities in Liechtenstein. However, it is also conceivable that a company applies the TVTG, for example in Germany, if this is possible. The TVTG is mainly useful because it provides answers to the most relevant legal challenges arising from the transition to a fully digital economy, aka token economy. The hope for a similar approach on an EU level was fulfilled in September 2020 with a draft Market in Crypto-assets Regulation and a pilot regime for DLT markets from the European Commission. In the end, a harmonized approach is needed. However, the TVTG is also intended to be a means of communication and

marketing. It should show that Liechtenstein is an innovative financial centre showing first mover advantages. This also helps to jointly identify what works and what doesn't. Luxembourg, for example, is not only attractive for funds because of its law – mostly harmonized within the European Union – but also because they have been able to build on a great deal of experience and expertise in this area. The TVTG was a courageous step by the Liechtenstein Parliament and the Government – especially considering that at that time it was less clear in which direction DLT and blockchain would develop and that there was nowhere to write off.

What are the main challenges regarding governance for DLT solutions?

On the technical level, questions arise mainly in terms of scalability. In other words, how many transactions can be handled per second? Are there corresponding technologies? There are also legal questions, for example in which jurisdiction can I offer the service? But also data protection issues, compliance and due diligence play important roles. For a long time, the EU's basic data protection regulation [GDPR] was forgotten. It was not visible that there were problems between blockchain solutions and the GDPR. After the EU had written a position paper on the issue more people became aware of the problem. In the meantime, many blockchains have made it their goal to meet the requirements of the GDPR. However, the main problem – that data cannot be deleted – remains. The aim should be to minimize the data and the blockchain technology would be suitable to retrieve only the most necessary data. For example, if you want to buy cigarettes, it is actually not necessary to enter the whole date of birth. Only the information whether one is old enough to buy cigarettes would be necessary. I am not aware of any company in the EU that is 100 per cent compliant with the GDPR regulation; that is simply not possible. Therefore, GDPR is a big challenge for digitalization, not only with blockchain solutions. Remember, if data is deleted, it could usually be restored somehow as long as the data medium is not physically destroyed.

Furthermore, there is a challenge with respect to the secondary market for security tokens and the central securities depositories regulation – EU law stipulates that from 2023 onwards, all newly issued securities must be accounted for by a central securities depository [CSD]. With blockchain systems, the question arises whether the CSDs are still needed and even if they can fulfil their role. The tokenization of securities on a blockchain basis is

very promising since tokens representing company shares can be exchanged directly peer to peer. However, if a CSD has to be involved, the question arises whether blockchain-based solutions still make sense at all. However, once this hurdle has been overcome – and the European Commission's pilot regime addresses this issue – such applications can take off.

SUMMARY AND OUTLOOK

The interviews show how important governance is to blockchain applications for climate action. This section summarizes some of the initial findings on blockchain governance, and suggests some lessons that blockchain proponents may incorporate into their advocacy.

RAISING AWARENESS OF GOVERNANCE ISSUES

Governance sets the rules of the game, and while experts recognize that dealing with governance issues is crucial, the often separate communities of blockchain tech experts on one side and policymakers and governance experts on the other side limit the exchange of information. In a recent CLI webinar for the Hyperledger Climate Action and Accounting Special Interest Group, participants mostly from the tech side identified the need to engage much more strongly with governance issues in their work. Creating confidence and trust in technologies in general, and in DLT specifically, is key. Sound governance is the way to establish and maintain that confidence.

STARTING SIMPLE

The World Bank's warehouse prototype intentionally simplifies the system. At present, only publicly available information is available in the system, so issues of confidentiality and data security do not arise. Because participants can work with simple spreadsheets and do not need to run their own blockchain node, the barriers to participation are low. As participants gain more experience, the approaches can become more complex.

PILOTING IN SPECIFIC GOVERNMENTAL CONTEXTS

IOTA chose a specific German and European Union legal context (GDPR) for its pilots, and is developing best practice solutions in this context. Similarly, Nägele Attorneys work in the context of Liechtenstein's novel law and solve the specific issues of their clients in that context. Time will tell which legal settings and governmental frameworks are more suitable and provide the better balance between trust and flexibility to serve the needs of international blockchain applications for climate action.

ENGAGING WITH POLICYMAKERS, USERS AND OTHER STAKEHOLDERS

As a new technology, blockchain needs to attract the attention of policymakers, potential users and other stakeholders. Blockchain applications need to be user-friendly, and the prototyping of the World Bank's warehouse has shown the importance of

providing participating entities with ample time to get familiar with the blockchain technology and to develop internal coordination. Active engagement with governments and policymakers is crucial in informing the public dialogue and legislative process on blockchain applications. The INATBA offers DLT developers and users a global forum for interacting with regulators and policymakers as part of the effort to bring blockchain technology to the next stage. The CLI will continue to bring together practitioners, technology proponents, government officials and researchers to overcome hurdles and allow full utilization of the potential of blockchain and related innovative technologies for urgently needed acceleration of climate action.

PROVIDING GUIDANCE ON TECHNICAL AND LEGAL INTEROPERABILITY

Technical interoperability – the ability to exchange data with other platforms and the off-chain world – is crucial for blockchain applications, and legal interoperability has to consider various laws and regulations that differ from country to country. The development of standards to improve technical interoperability beyond individual use cases could be helpful, and because uniform laws across countries are not possible, the development of soft instruments such as guidelines and codes of conducts could also be useful.

As the importance of governance in blockchain applications for climate action gains recognition, the CLI is deepening its work on governance through dedicated workshops and knowledge products. INATBA and CLI plan a joint report on governance for spring 2021[1]. In addition, the CLI continues to support use cases that allow practitioners to gain further experience with solutions to governance questions. The CLI looks forward to collaborating with a broad group of partners in this quest.

| 1 To be published on our website www.climateledger.org

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Outlook and CLI's use case programme

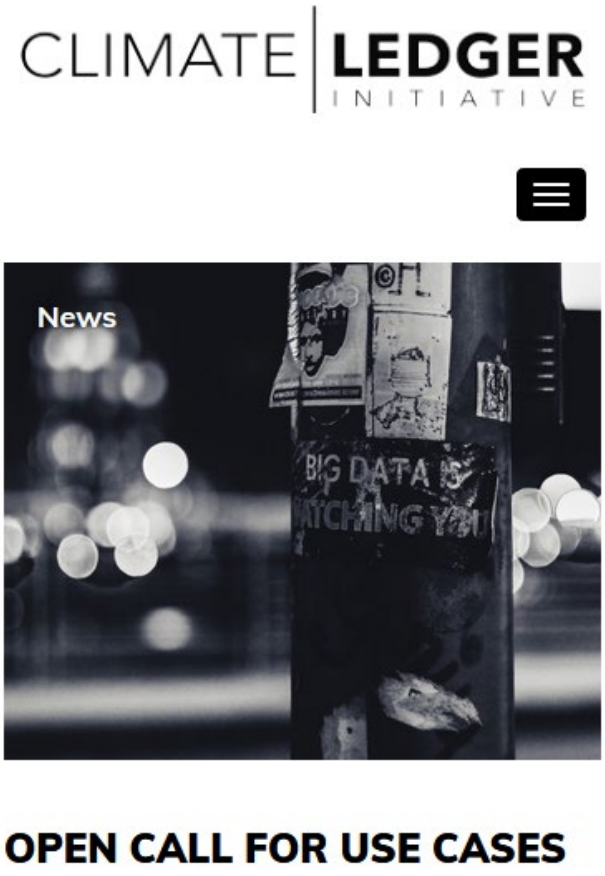
Outlook and CLI's use case programme

The current COVID-19 pandemic led to a boost in digital technology applications in 2020. Start-ups and companies of all sizes as well as governments are eager to benefit from the emerging opportunities from digitization. Especially in climate action there is great potential to translate blockchain and other digital innovations into tangible solutions.
As the blockchain hype is diminishing, the focus is moving in the direction of considering what can and cannot be digitized. Furthermore, focusing on standardized protocols in order to foster the exchange between systems will remain key. Success with the digitalization of climate data calls for support for the cooperation and exchange between technical, scientific and regulatory stakeholders. Trusted and effective governance frameworks on all levels will be indispensable in future developments.

The Climate Ledger Initiative will continue to engage in this regard and to bring together practitioners, technology proponents, government officials and researchers to overcome hurdles and unleash the full potential of blockchain and related innovative information technologies for urgently needed acceleration of climate action.
That's why in the summer of 2020 CLI launched an open call for use cases that demonstrate real life applications of digital innovations to drive climate action. The CLI received numerous use cases that were based on strong concepts and robust partnerships. After an in-depth review, the CLI in cooperation with the Swiss Agency for Development and Cooperation shortlisted five use cases for further consideration.

The proposals range from an automated MRV framework for cookstove projects to the development of smart contracts to testing an automated MRV cycle for power generation projects.

The shortlisted partners are currently submitting full proposals for implementation in 2021. Brief summaries of current use cases follow.

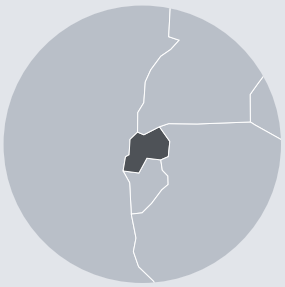


Indoor air quality, OpenHAP (2020), Kenya

Partners
EED Advisory (Nairobi), INFRAS (Zurich), Berkeley Air Monitoring Group (Berkeley)

Supporter
Swiss Agency for Development and Cooperation through CLI

The OpenHAP is a low-cost IoT-enabled household air pollution monitoring system. The goals are to measure indoor air pollution levels based on stove type and fuel and to assess the exposure of the household members. The project started with a pre-study to evaluate and calibrate the low-cost indoor air quality sensors and to work on the data transfer in the field. Planning for a larger household study is underway.



Distributed Renewable Energy Certificates, D-REC (2020), Rwanda

Partners
South Pole (Zurich),
Blockchain Buro (Ruggell),
INFRAS (Zurich),
Office for Foreign Affairs
Liechtenstein (Vaduz),
Shell Foundation (London)

Supporter
Office for Foreign Affairs
Liechtenstein (Vaduz)
through CLI,
Shell Foundation (London)

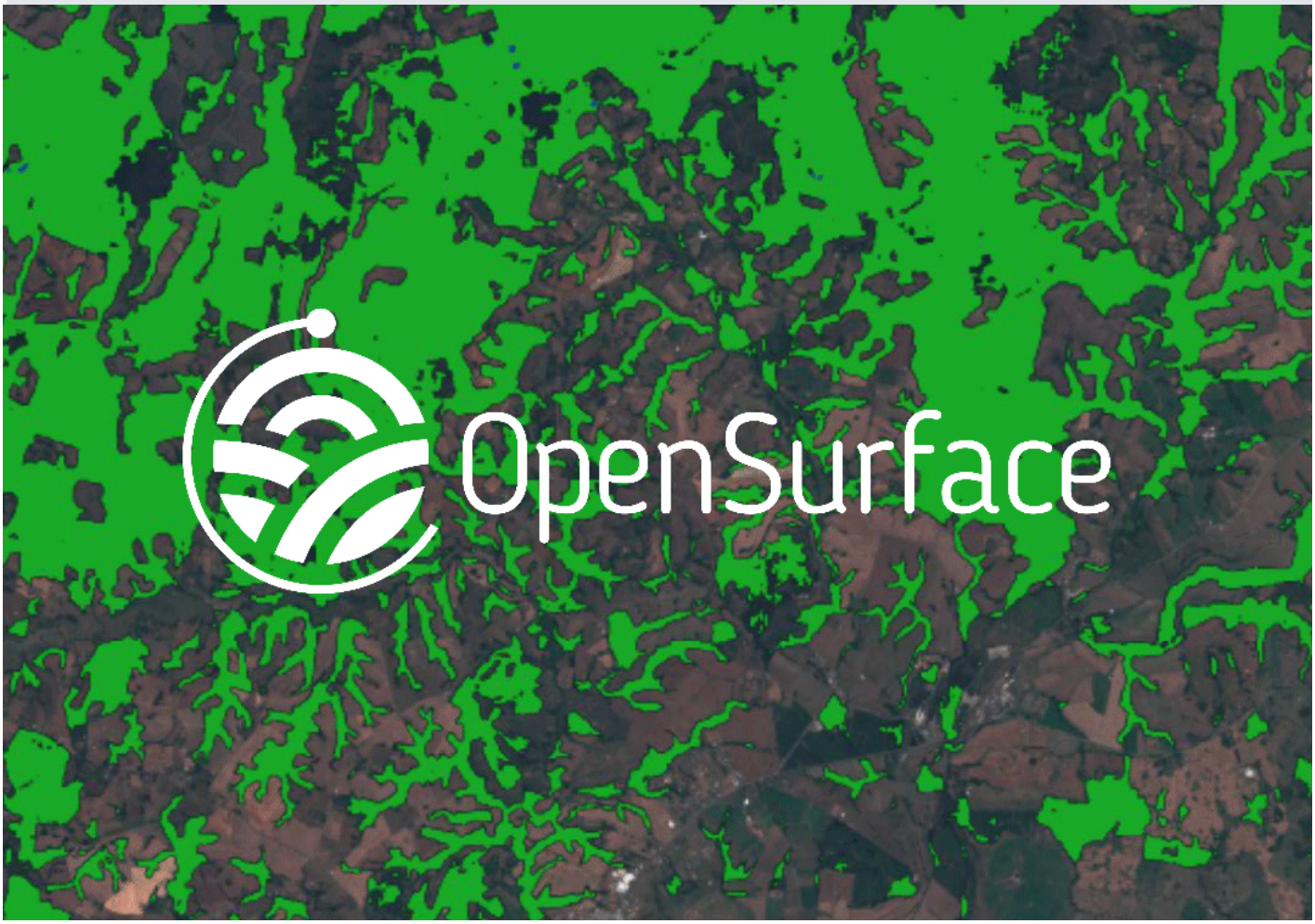
The generation of clean power from solar devices deployed in rural off-grid areas, on small and midsized buildings in a pilot phase is picked up by IoT metering devices. The resulting data streams are stored and tokenized using blockchain technology. The pilot explores how the generation and distribution of D-REC tokens can take place under the regulated framework of the Liechtenstein Law on Tokens and Trusted Technology Service Providers (Blockchain Act).

OpenSurface (2018), Chile

Partners
CONAF (Santiago), IDB Lab (Washington, DC), South Pole (Zurich), Cleantech21 (Zurich), Gold Standard (Geneva), ETH (Zurich)

Supporter
EIT Climate-KIC

OpenSurface uses AI and satellite imagery to constantly monitor land-use change anywhere in the world – alerting the right people to recent events on the ground, and triggering digital workflows that drive more effective climate action faster, and at greater scale. This could mean sending targeted deforestation alerts to the government team at CONAF (Corporación Nacional Forestal) who are using OpenSurface to monitor the Valdivia region of Chile, or automatically approving results-based payments when the system verifies sustainable land-use plans have been completed.



Wood Tracking Protocol (2018), Peru

Partners
Mecanismos de Desarrollo Alternos (Lima), SDC (Lima and Berne), INFRAS (Zurich)

Supporter
Swiss Agency for Development and Cooperation, SDC

The Wood Tracking Protocol is a digital approach to fighting illegal logging in the forests of the Amazon region of Peru. WTP allows wood companies and authorities to document their work using photos, GPS data and other features on a mobile device, and to store this information in a sequenced and tamper-proof way on a blockchain. In 2020 WTP concluded the development of a native application that allows the WTP smartphone app to work offline. In addition, pilot testing has started on logging sites and control posts of the regional forest authorities in Madre de Dios, Peru. WTP aims to conclude further pilot testing by the end of 2020.

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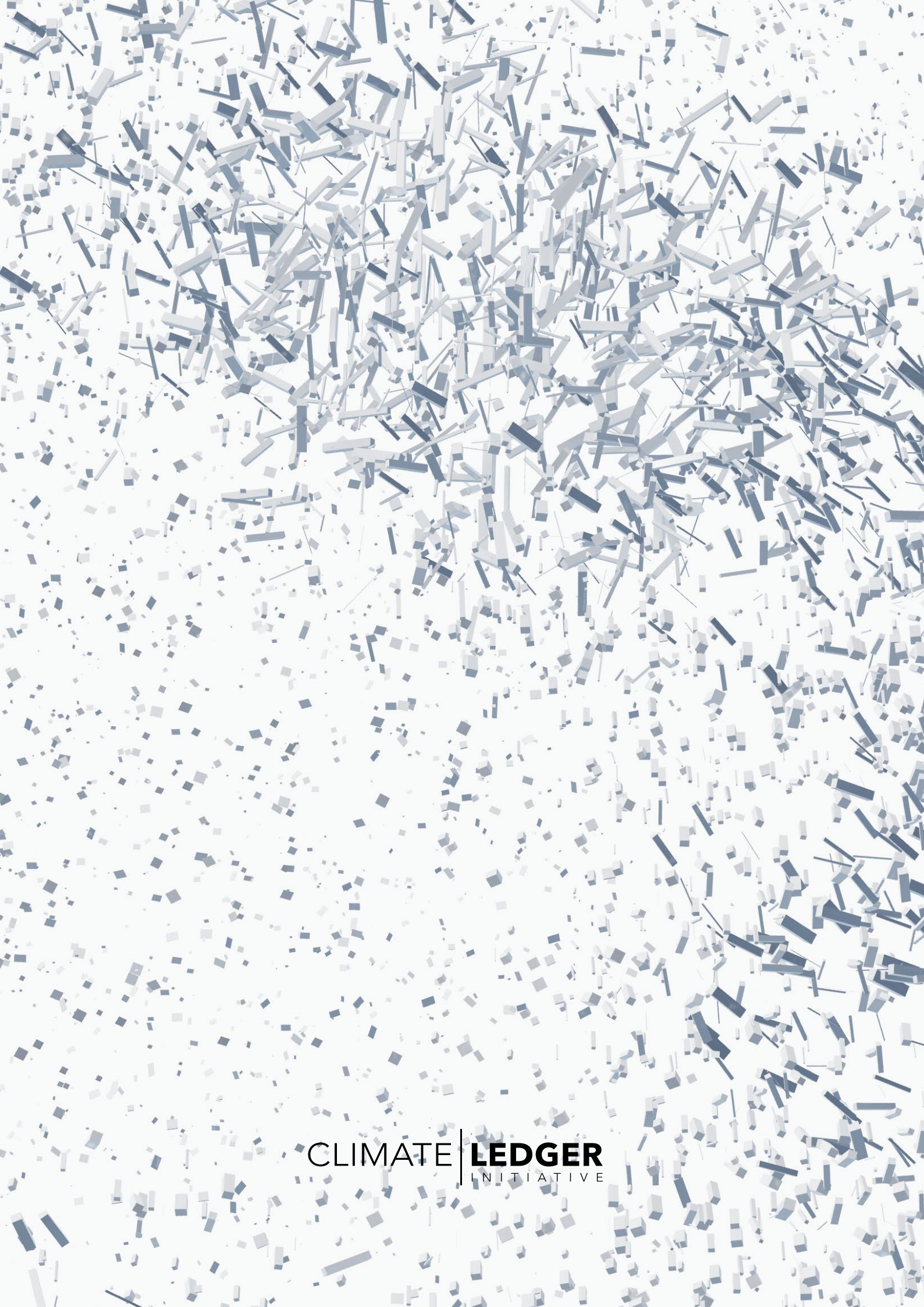
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