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Navigating Digital Innovation for Climate Action

2023 STATE AND TRENDS

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The Climate Ledger Initiative (CLI) would like to thank the donors, authors, interview and other partners, and contributors who helped to create this sixth report on navigating digital innovation for climate action. This work also greatly benefited from discussions with and input from participants in the 80-plus workshops and presentations held since the Climate Ledger Initiative began in early 2017, as well as from experience shared from numerous use cases.

climateledger.org

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Foreword

JANINE KURIGER
Head of Division of the Global Programme Climate, Disaster Risk Reduction and Environment
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The World Bank estimates that between 32 and 132 million people risk falling back into extreme poverty by 2030 due to the effects of climate change. The international community is struggling to deliver climate action sufficiently fast to meet the goals of the Paris Agreement. Digital technologies present various opportunities to accelerate and scale climate action in this context. These include for example satellite data for insurance against crop damage, sensors to measure clean cookstove usage, the use of blockchain for financial services, and smart electricity networks. The Swiss International Development Strategy 2021-2024 acknowledged such developments and declared climate action and digitalisation as two of its priorities.

The Climate Ledger Initiative (CLI) combines these priorities by leveraging digital technologies to accelerate climate action in line with the Paris Agreement and the Sustainable Development Goals (SDGs). The SDC has supported the CLI over the past five years and gained valuable insights into current trends, specific opportunities and the challenges involved, applying digital tools and innovations on the ground through use cases. Since the current SDC-funded phase of the CLI is coming to an end, it is time to take stock.

It is inspiring to see that the SDC-funded use cases have been successful in testing digital solutions for climate action, even though they introduced novel and unproven digital innovations in the challenging context of developing countries struggling with multiple crises. They demonstrate that even moderate financial support enabled solutions to problems, the results indicating further improvements. For many of the projects, the successful implementation of the ‘minimum viable product’ (MVP) helped attract more funding for scaling up.

One of the latest CLI use cases addresses the challenge of post-harvest and income losses of smallholder farmers around the world, primarily caused by the absence of proper cold chains. Your Virtual Cold Chain Assistant (Your VCCA) combines cutting-edge research on measuring the quality and perishability

of food by sensors, cold rooms powered by solar power and equipped with sensors, and an app providing real-time information for the farmers as well as the cold room managers and operators. The use case also shows how digital solutions can enhance trust. Farmers benefit from the service, for example by storing their products in cold rooms and selling when the price is high, and cold room operators can more easily access loans to expand their business because they can show a track record of successful business on the app.

This year's CLI Navigating Report looks at the lessons learned from the various SDC-funded use cases. One key example is to keep it simple. Various digital technologies have been hyped up in recent years, such as blockchain technology, NFTs (non-fungible tokens), and artificial intelligence. It is essential to consider rationally whether and how a digital solution really offers additional benefits compared with simpler or conventional solutions. Digitalisation should not be an end in itself. Depending on the context, an Excel-based solution might provide a better and more versatile approach than introducing blockchain. Or using existing messenger apps on smartphones might provide the better communication channel than a new and customised online platform.

Based on the experience of the past years and the lessons that are also presented in this report, the CLI is working on a guidance document that will assist the SDC in making better use of digital technologies in its projects, to achieve their goals and address existing challenges. It will further support the implementation of the priorities in the Swiss International Development Strategy 2021-2024, to use the potential of digitalisation and take climate action.

Preface

The Climate Ledger Initiative and its mission

The mission of the Climate Ledger Initiative (CLI) is to accelerate climate action in line with the Paris Agreement and the Sustainable Development Goals (SDGs). It does this using digital innovations applicable to climate change mitigation, adaptation, and finance. The CLI was started in 2017 by Nick Beglinger of Cleantech21 and is operated jointly by INFRAS and the Gold Standard Foundation. It is supported financially by the Swiss federal government and maintains a platform of donors, partners, and collaborators. Over the past five years, the Initiative has been able to bring together an extensive network of key actors from climate action and tech development. In this rapidly developing field it has advanced key technical concepts and delivered sound knowledge on a range of issues, including the governance of digital tools in climate action.

Over the years, the CLI has developed a better understanding of how, what, and where blockchain and distributed ledger technologies work – and where they do not. The focus has therefore shifted slightly towards establishing a broader understanding of digital innovation. Examples include sensors, satellite imagery, the internet of things (IoT), and machine learning. The CLI addresses policy and research questions and identifies specific opportunities for innovation where climate and digitalisation meet. Our work has benefited greatly from the contributions of participants in various workshops and events, and from the support of partner use cases. The CLI itself selected and supported several use cases in an open call.

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INFRAS

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

The Climate Ledger Initiative's sixth edition of Navigating Report

This year's edition of the Navigating Report[1] looks back at important milestones since the initiation of the CLI in 2017, presents use cases and ten lessons learned from their implementation. It also provides an outlook on digital developments for climate action in the coming years.

We are grateful to the authors and interview partners who have contributed their vision and experience in the novel application of digital technologies. These technologies are developing fast, and innovative business models are emerging and being tested in real-life use cases. We hope that this edition of the Report helps practitioners and policymakers alike to navigate this rapidly evolving field, and to take inspiration from actors that are already using digital innovations for climate action and sustainable development.

| 1 Previously named 'Navigating Blockchain and Climate Action'. For earlier editions please refer to the CLI website.

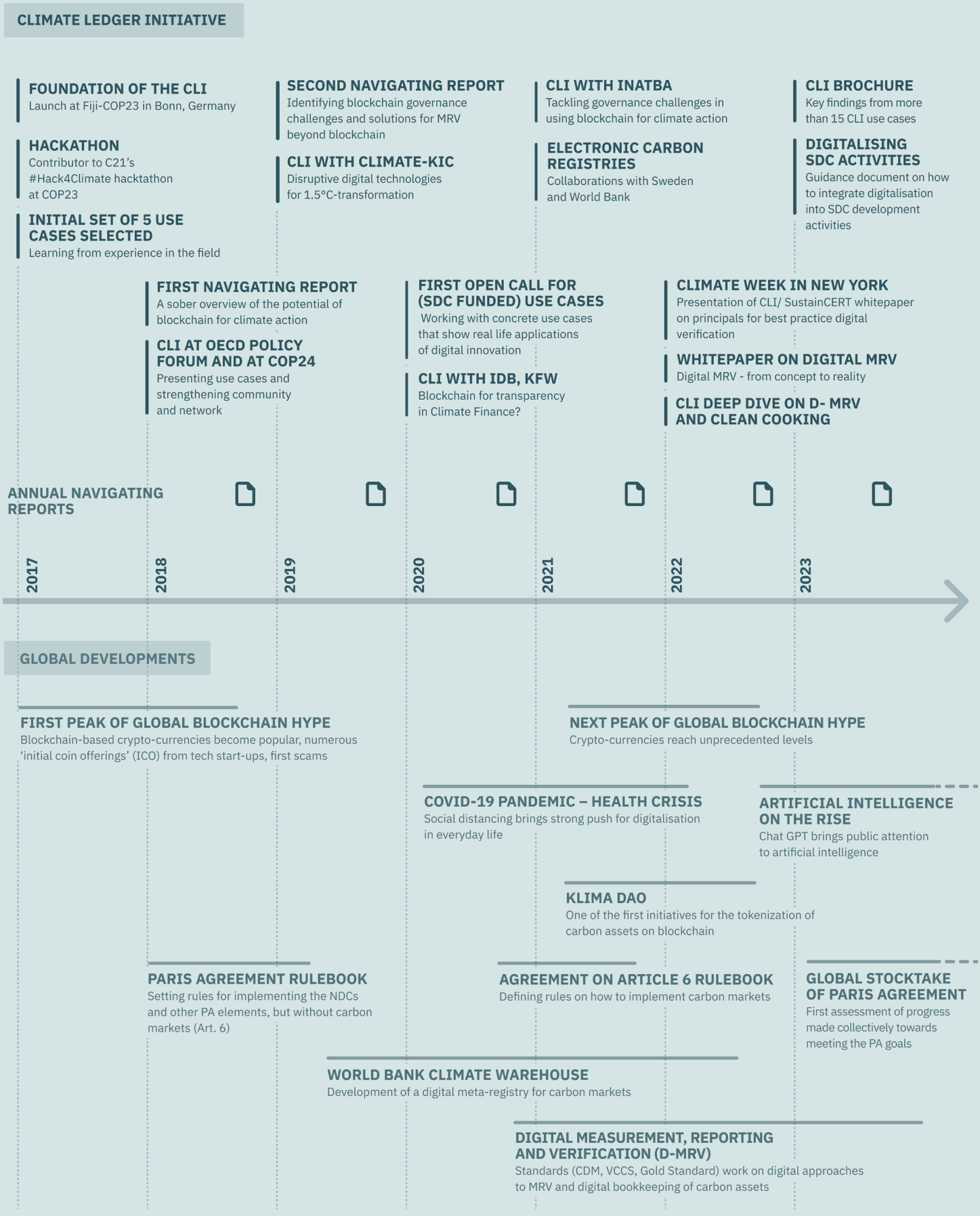
Summary and key findings

The Climate Ledger Initiative (CLI) was founded in 2017 to accelerate climate action in line with the Paris Climate Agreement and the Sustainable Development Goals (SDGs) using innovative digital solutions such as blockchain and distributed ledger technology, the internet of things (IoT), artificial intelligence (AI), and the use of sensors and remote sensing. The aim was to not simply follow the hype, but to take a critical approach, focusing on the potential benefits of technologies in real-life use cases with impact. A further principle was to build a network of the best (rather than the loudest) partners on the tech and climate sides. Since the current SDC-funded phase of the CLI is coming to an end, it is time to take stock.

Chapter 1 A bird's eye view of 6 years of digital climate action

Chapter 1 of this year's Navigating Report looks back at milestones from the initiation of the CLI in 2017 to today. The following figure provides some examples of CLI activities, including use cases, knowledge products and events. In addition, it shows a selection of major global trends and events that provided the context relevant in shaping CLI's numerous activities.
Digitalisation is one of the key priorities of the Swiss International Cooperation Strategy 2021-2024. The Climate Ledger Initiative provides important evidence-based inputs, animating international debate on the interfaces between climate action and digitalisation. At the SDC, the CLI knowledge products and use cases bring further awareness of the potential of digital innovations.

CLI milestones – from its launch to today



Chapter 2 Showcasing digital innovation and climate action in practice

Since the use cases have been core to gaining practical experience in using digital innovation for climate action, Chapter 2 provides various insights and lessons learned. The CLI is currently supporting two new use cases.

Yoma Ground Truthing 2.1.1

The Yoma Ground Truthing project aims to verify the combined use of remote sensing (incl. satellites and drones) and youth-based ground truthing to monitor biomass and related sustainability attributes in Malawi and Peru.

The Coldtivate app 2.1.2

The Coldtivate app is intended to reduce post-harvest losses for farmers and improve cold room management to store agricultural produce. A new Impact Dashboard for the app allows users to easily track and analyse the positive impact of their operations on their business, the farmers, and the environment.

The Navigating Report also provides updates on the following earlier CLI use cases:

This year's Report looks also at what has been learned from all previous use cases. For anyone who intends to use digital innovations for climate action, the following ten lessons can be drawn[2]:

TEN LESSONS LEARNED

1	Build on available local technologies and knowhow where possible
2	Low-cost and open-source options are key to upscaling
3	Find solutions to limited internet connectivity
4	Check for technical and non-technical interoperability
5	Keep it simple – digitalisation should not be an end in itself
6	Data protection and governance are key
7	Engage local and national authorities
8	Digital solutions can enhance data availability
9	Digital solutions can enhance trust
10	Seed funding allows digital innovation for climate action to be tested

Based on these findings and the experience of the past years, the CLI has developed a guidance document[3] for development projects to help them make better use of digital innovation. Using digital solutions and technologies in development cooperation may have numerous benefits:

BENEFITS OF DIGITAL SOLUTIONS AND TECHNOLOGIES

1	More efficient and effective projects, processes and services
2	Innovation and new business models
3	Enhanced participation and empowerment
4	Increased trust, reliability and accuracy in data and solutions

The guidance document leads through the process of recognising possibilities, assessing potential and selecting digital solutions for projects.

2 CLI 2023: Digitalisation for climate action, Experiences from use cases.
3 CLI 2023: How to digitalise your development cooperation projects and programmes - a guide for practitioners.

Chapter 3 Review and outlook on digitalisation trends

In Chapter 3, the Report provides an outlook on digital developments for climate action in the coming years by two representatives of the operating institutions of the CLI, Juerg Fuessler from INFRAS and Owen Hewlett from the Gold Standard Foundation. Digital technologies themselves have been rapidly evolving over the past six years. The CLI Navigating Reports[4] themselves represent a fascinating history of the evolving trends of recent years, of what was at the time hype, and is now an emerging, albeit very different reality. Three conclusions may be drawn:

CONCLUSIONS

1. Although reality rarely matches the technological hype, experience has been gained in how to short-circuit this learning curve and move straight to real collaboration between innovators and experts. The real use cases in this report prove that reality is often even more interesting than speculation.

2. However boring it may seem, good governance and consideration for ethics and moral hazards are essential to credibility. Technology solutions and applications simply cannot take off if they are encumbered by reputational and legal risk.

3. Collaboration is key. This is particularly true for technology enthusiasts and established experts and practitioners from the climate space.

What we have seen and learned in six years is incredibly exciting and has the potential, if combined with strong governance, ethics and collaboration, to change the way we do climate action. Technology cannot save the climate crisis, only we humans can do that. But human efforts can be enhanced, accelerated, unlocked and made fairer and more transparent with the efficacious use of technology.

From 2024 on, the CLI will continue in a somewhat adapted form, leaving the more general awareness-raising work behind and increasingly focusing on two broad areas. These are the practical implementation and scaling of digital approaches with our partners in specific areas of climate action, and increasingly seeking impact. Contexts may include work in development cooperation, the decarbonisation of private-sector value chains, or carbon markets including Article 6. In this sense, the journey is only starting, and we are looking forward to having you on board as we enter in 2024 this new and exciting phase.

4 See Navigating Reports on the CLI website

Abbreviations

AI	Artificial Intelligence
BASE	Swiss not-for-profit foundation
CLI	Climate Ledger Initiative
COP	Conference of the Parties
DLT	Distributed ledger technology
DTES	Digital Technologies for Ecosystem Services
EU ETS	EU Emissions Trading System
ESMAP	Energy Sector Management Assistance Program
FCF	FairClimateFund
GHG	Greenhouse gas emissions
GSIQ	Gold Standard Impact Quantification
HAP	Household air pollution
ICS	Improved cookstoves
IoT	Internet of things
IPCC	Intergovernmental Panel on Climate Change
ITMO	Internationally transferred mitigation outcomes
MRV	Measurement, reporting and verification
NDCs	Nationally determined contributions
OECD	Organisation for Economic Co-operation and Development
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goals
UNICEF	United Nations Children's Fund
VCCA	Virtual Cold Chain assistant
WHO	World Health Organization

1

A bird’s-eye view of six years of digital climate action, digital innovation, and the Climate Ledger Initiative

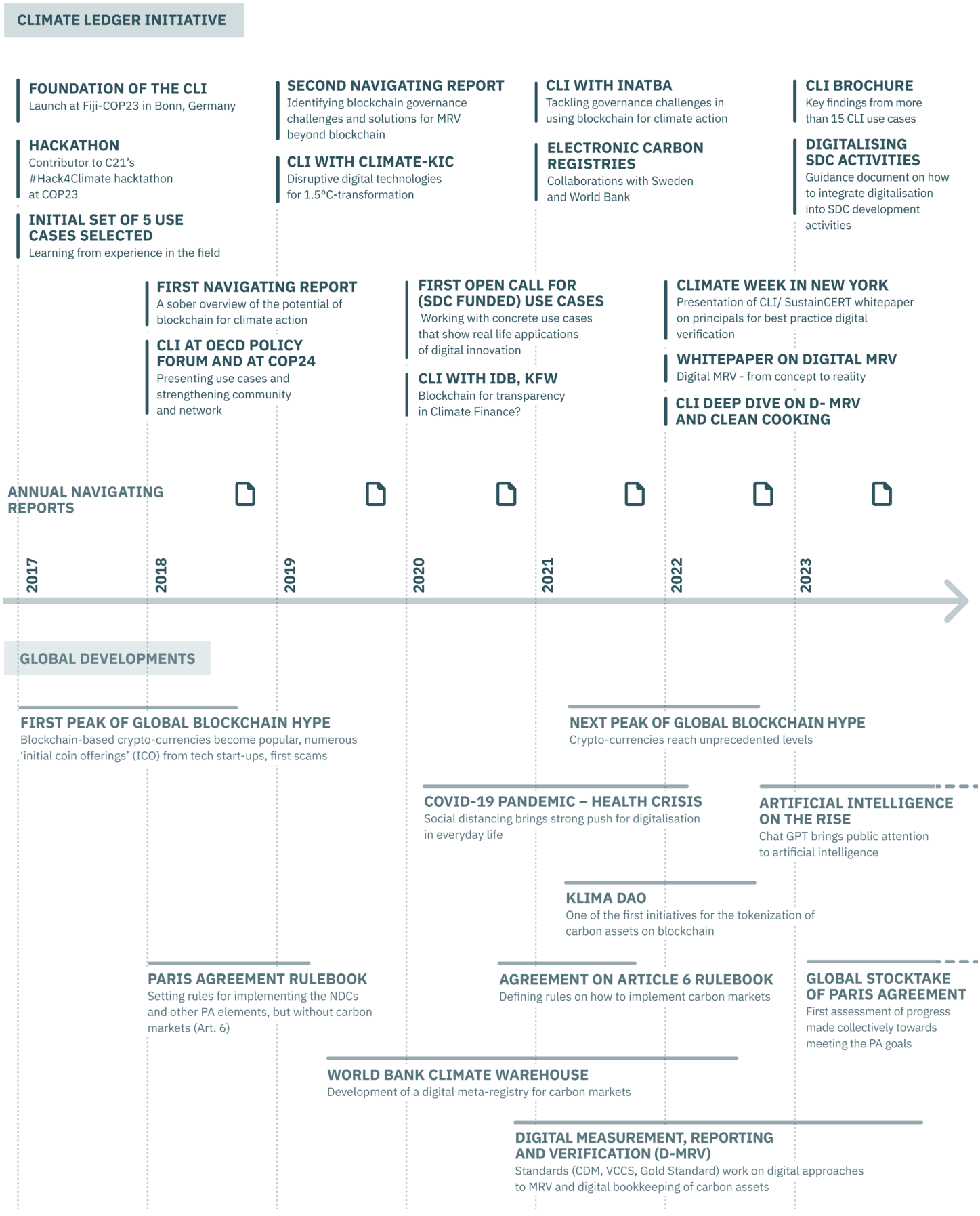
A bird's-eye view of six years of digital climate action, digital innovation, and the Climate Ledger Initiative

The Climate Ledger Initiative (CLI) was founded in 2017 to accelerate climate action in line with the Paris Climate Agreement and the Sustainable Development Goals (SDGs), using innovative digital solutions such as blockchain and distributed ledger technology, the internet of things (IoT), artificial intelligence (AI), and the use of sensors and remote sensing. The aim was to not simply follow the hype, but to take a critical approach, focusing on the potential benefits of technologies in real-life use cases with impact. A further principle was to build a network of the best (rather than the loudest) partners on the tech and climate sides. Since the current SDC-funded phase of the CLI is coming to an end, it is time to take stock.

Chapter 1 of this year's Navigating Report looks back at milestones from the initiation of the CLI in 2017 to today. Since the use cases have been core to gaining practical experience in using digital innovation for climate action, Chapter 2 provides various insights and lessons learned. The latest use cases are presented and updates on previous use cases provided. In addition, this year's Report looks at what has been learned as a whole from all previous use cases. It also provides some guidance on how development projects can make better use of digital innovation. In Chapter 3 it provides an outlook on digital developments for climate action in the coming years. The Navigating Report finishes with a concluding chapter.

Chapter 1.1

CLI milestones – from its launch to today



JUERG FUESSLER
Managing partner INFRAS
Co-founder CLI

Ahead of the COP in November 2016 I was approached by enthusiastic Swiss advocacy entrepreneur Nick Beglinger at Marrakesh airport baggage claim. He tried to convince me that blockchain has a huge potential to combat climate change, but I was more than sceptical to say the least. There was much buzz in the news and online about the wonders of distributed ledger technologies for everything from stock transactions to green behaviour. And crypto currencies like bitcoin seemed on their way to either obliterate national banks or turn out as monumental Ponzi schemes.

I was in Marrakesh to present research on the design of the new cooperative market mechanisms under Article 6, and more particularly how to get the bookkeeping for the international transfer of credits right. In the ensuing discussions in the COP corridors, I learned more about digital innovation, and asked myself: where in climate action could digital innovations act as a game changer?

To work on a thoughtful answer to this question, we joined Nick Beglinger in founding the CLI in 2017. We established a basic rhythm for our work with our annual Navigating Reports launched at the COPs – taking stock of the state of things and trends in the field and summarising the lessons learned from our practical work over the year. The intervening years have been marked by technological developments and the associated flurries of excitement, but also by (painfully slow) advances in rule-setting for the implementation of carbon markets under the Paris Agreement. A global pandemic brought immeasurable suffering and death, but also turned out to be a major driver of digital advancement in almost every aspect of how we work and live.
This context has also been relevant in shaping the numerous CLI use cases that have been implemented by our partners over these years. They illustrate that it is only by getting your hands dirty that complex technologies can actually be tested for their fitness for combating climate change. Not everything went smoothly in the use cases. For example, the AI/machine learning optical recognition of different plastic types in the green tracker project in Chile was found to be too challenging for the simple technology applied. That said, all use cases were successfully implemented, generated tangible results and demonstrated how digital innovation can further climate action in mitigation, adaptation and climate finance. The figure provides some examples of CLI activities, including use cases, knowledge products and events. Beyond the documents and presentations themselves (that you can download from climateledger.org), one of the main outcomes of this CLI phase is the CLI's weaving of a tight web of experts, tech partners and policymakers. This network will continue to work together and provide a basis for future activities.

In memoriam
Sven Braden
Co-Founder CLI

From the beginning, CLI Co-Founder and Programme Manager Sven Braden was a driving force behind the initiative. Without Sven, CLI would not exist in its current form. His enthusiasm for the use of new technologies in climate action, and his unflinching forays into the details of digitalisation and the related, intractable, governance issues made him the perfect ambassador for the CLI cause. Sven's huge international network connected climate policy-makers with start-up entrepreneurs and techies. Always combining the visionary with the down-to-earth, Sven initiated and helped implement several of the CLI use cases.

In the middle of his life and his work, Sven died unexpectedly in summer 2021 from COVID-19. He was taken far too early, leaving behind his young family, Rocío García with Camila and Guillermo. We are glad and grateful that Rocío has been stepping into Sven's shoes to continue his project management work for CLI. We dearly miss an outstanding colleague and a dear friend.

Chapter 1.2

Advancing digitalisation in development cooperation through the CLI–SDC partnership

INTERVIEW

Insight from
MATTHIAS BACHMANN
Project Manager
responsible for CLI
at SDC

The Climate Ledger Initiative was launched six years ago, in 2017. How has digitalisation in development cooperation evolved during this time?

Digitalisation has evolved a great deal, and artificial intelligence, blockchain, the internet of things, etc. have had major impacts on international cooperation. Technological development has accelerated in recent years. At the SDC we assess the availability of digital resources and how they can be used to reach our objectives. From education and agriculture to public administration, the SDC supports numerous projects that have a strong emphasis on digitalisation. So, a lot is happening, but sure, there is still considerable potential to harness such technologies more systematically.

What are the main challenges?

A key challenge is overcoming digital divides. According to 2021 figures from the OECD, almost three billion people worldwide are still offline. This shows that, when using digitalisation in development cooperation, access and digital skills must be considered. Otherwise there is a risk that we inadvertently further inequality or injustice, instead of contributing to their reduction. We must also consider other risks of digitalisation, such as the magnification of stereotypes through artificial intelligence. In turn, if employed wisely and brought to scale, digitalisation in development cooperation can contribute to systemic social, economic and environmental change. As a general approach, it makes sense to place people (and thus also planet!) first, and then think through how digital tools can help support their rights and well-being.

Digitalisation is one of the priorities of the Swiss International Cooperation Strategy 2021-2024. What would you say are the CLI's main contributions to this priority?

The Climate Ledger Initiative provided important evidence-based inputs, animating international debate on the interfaces between climate action and digitalisation. At the SDC, the CLI knowledge products and use cases created further awareness of the potential of innovation. Thanks to projects such as the Wood Tracking Protocol and OpenHAP, we have been able to gain a lot of valuable experience in specific technologies that can be harnessed in our work.

The CLI also helped us raise understanding on sensitive issues such as data protection and digital governance. I look forward to CLI's guidance document, which will allow us to think through digitalisation at the design stage of our projects.

Where do you see the main advantages of digitalisation in development cooperation?

Technologies will evolve rapidly over the next few years. While digital tools are not an end in themselves, they can help to implement our activities more efficiently. For example, the Digital Technologies for Ecosystem Services (DTES) use case in Peru shows how sensor technologies can help in collecting water data in the Andes, improving its accuracy and transparency, ultimately facilitating better and more participatory water management in the region.

We have summarised 10 key lessons from the CLI use cases (see Chapter 2.3). Are there any that you find particularly interesting?

All the key lessons listed are relevant. In my view, some of them are particularly interesting. Building on available local technologies and knowhow is key. And engaging local and national stakeholders and authorities is a no-brainer. In many places people can't rely on a well-developed infrastructure. Sometimes they are more at ease with other means, such as radio or with simpler digital tools such as Excel, rather than complex digital technologies. That does not mean that they cannot challenge the status quo, but they build on what works best and that can be a combination of a variety of technologies, new and not-so-new. Similarly, it is crucial to find solutions to limited internet connectivity.

How can the key lessons and the guidance document (see Chapter 2.3) help SDC projects to make better use of digital tools and applications?

There are at least three levels to consider. First, there are the basic considerations, namely the development problem or opportunity that is at stake, the stakeholders and their priorities, and the digital infrastructure and skills that are in place. Second, through the use cases the CLI provides insights into specific technologies and their advantages in a given context. Third, the CLI can provide guidance on complex issues – such as data protection or interoperability between different digital solutions. The guidance document will be very helpful here.

What is your conclusion on the Climate Ledger Initiative?

The CLI started at the right moment. It injected new ideas into the international debate on climate and digitalisation, and driving innovation. One thing is clear: we are still just at the start of digitalisation. In view of rapid technological developments, it will be crucial to keep pace. That is why the CLI's journey is just beginning.

2

Showcasing digital innovation and climate action in practice

Showcasing digital innovation and climate action in practice

Working with concrete use cases that demonstrate the real-world applications of digital innovation to drive climate action has always been one of the main pillars of the CLI. To learn from experience in the field, the CLI has selected and supported numerous use cases. In the following chapter, we highlight the impacts, lessons learned and challenges of six current and past use cases, two of which were just launched in 2023. Finally, we summarise ten key lessons from experience with all previous use cases[5].

Chapter 2.1

Two new CLI use cases applying digital innovation and climate action

In the following, the two CLI use cases launched in 2023 are presented. The first subchapter sheds light on the Your VCCA Impact Dashboard use case, the second focusses on the Yoma Ground Truthing use case.

| 5 See use case database on the CLI website

2.1.1 An innovative assistant for farmers to reduce food waste and secure higher prices for their produce

USE CASE: **YOUR VCCA IMPACT DASHBOARD**

Location	India Nigeria
Description	Integration of an Impact Dashboard in the Coldtivate app – a digital tool to improve cold room management and reduce post-harvest losses.
Sustainable Development Goals	SDG1 SDG2 SDG5 SDG7 SDG8 SDG9 SDG10 SDG12 SDG13
Sector	Agriculture, Supply Chain Optimisation
Technology	Remote Sensing, AI, Sensors, Digital twin modelling
Partners	BASE Foundation Swiss Federal Laboratories for Materials Science and Technology (Empa)
Project start within CLI	2023

"Customers buy the fresh products at good rates the next day without any complaints. Both customers and we, the farmers, are happy."

Savitri Mahato, farmer in Odisha, India

"I now know when to take my crops out of cold storage before they are damaged and sell them at the local market at a reasonable rate."

Brajkishore Prasad, small-scale fruit seller in Bihar, India

INTERVIEW

ROBERTA EVANGELISTA
Senior Digitalisation Specialist at BASE Foundation and Your VCCA Project Lead

SIMRAN SINGH
Sustainable Finance Specialist at BASE Foundation and Your VCCA Capacity Building Lead.

The Your VCCA Impact Dashboard aims to reduce post-harvest losses. What are the biggest challenges for farmers and market sellers?

Post-harvest losses due to the lack of a proper cold chain – the continuous system of refrigeration during storage and transportation between farmers and consumers – result in unnecessary food waste and income losses. In most low and middle-income countries, about 30-40% of produce is lost as a result of inadequate post-harvest infrastructure. Even when cold rooms are present, they are often subject to disruption or mismanagement. Some of the main challenges are inequitable access to cold rooms and a lack of trust in cooling solutions. In addition, food loss causes greenhouse gas emissions in two ways: from the energy and resources that were used to produce the agricultural products, and from of the disposal of spoiled produce.

How does Your VCCA work?

The objective is to enable smallholders to gain access to sustainable cooling and optimise their decisions on produce management. In addition, the project aims to support cooling companies in adopting cooling-as-a-service and improving cold room operations. In a nutshell, the project provides access to cooling facilities and access to data. By using the Your VCCA's Coldtivate app, cooling companies, cold room operators, farmers and minor traders can more efficiently access cold storage. They can digitally record and track the check-in and check-out of food crates, including information such as weight, crop type, and fees owed. This replaces manual registers that are error-prone and difficult to oversee. The app also includes digital twins that simulate the ageing of physical crops stored in cold rooms by using real-time temperature sensor data, thereby forecasting the ideal time window to sell them before they spoil.

How does this help farmers in practice?

Cooling fees are based on a pay-per-use-model. This means that farmers just pay for the fruit and vegetables that they cool per day, without the need for any upfront investment. Sensors in the cold storage facilities track the temperature in the cold rooms. This is used to forecast the quality of the food and translated into actionable information for the farmers, i.e. days left for the produce to be picked up and sold. By using the Coldtivate app, farmers receive real-time instructions to minimise food spoilage and to maximise the market value of their products. That is also thanks to machine-learning-based price prediction models embedded in the app. This helps them to

sell their products at good quality even several days after harvesting. And it also helps them to better negotiate the price for their products because they do not have to sell them immediately.

Research from Empa on food perishability and predictions with new sensors is crucial to your project. Can you elaborate?

With temperature and humidity sensors in nearly every container and cold room worldwide, lots of valuable data remains untapped. Empa's SymBioSys research team upcycles this data through meticulous mathematical analyses and physics-based modelling, enabling the real-time monitoring of crucial fruit attributes. This pioneering method allows quality deterioration and marketing challenges to be identified and predicted. Computer simulations of artificial fruit and vegetables can be used to forecast how external conditions, such as temperature and humidity levels, affect crop quality. Coldtivate recalculates the crate's shelf-life every six hours to account for temperature variations, and notifies farmers whose produce is about to expire. Currently, the app features digital twin models for 26 varieties of fruit and vegetable.

Are the target groups already benefiting from the app?

Yes, some initial results are already visible in our pilot projects in India, Nigeria and the Philippines. To date, we have been partnering with six cooling companies and piloting the solution in 19 cold rooms. Around 400 farmers have used the app to store more than 10,000 crates of produce (approximately 230 tonnes). Cooling users report a reduction in post-harvest loss of around 20% and an increase in revenue of around 20%. Women make up 30% of users, and we are working to increase this to 50% with the help of the gender-sensitive capacity-building material that has been developed as part of the project. Thanks to the use of solar-powered technologies and to the reduction in food loss, approximately 700 tonnes of CO2 are avoided per room per year.

Why are cooling services in general and solutions like the Coldtivate app not already common practice?

Traditionally, farmers and cooperatives faced high upfront costs and ongoing expenses in establishing and maintaining cold rooms, resulting in disrepair over time. The Your VCCA project uses a servitisation business model to ensure that smallholder farmers do not have to bear the cost of the equipment, and to incentivise cooling companies to use the most efficient technologies to run and operate cold rooms. To build trust in cold storage and encourage farmers to use the cold rooms, Coldtivate keeps them updated on their crop's condition and on room temperature and occupancy, which can be monitored remotely in real time. We have built on the expertise of Empa to advise cooling users on how to optimise storage conditions inside cold rooms to minimise crop spoilage, and we have recently published an open-access operators’ manual that summarises state-of-the-art best practices in post-harvest handling. Together with the capacity-building material developed for cooling users, these resources ensure that smallholder farmers are informed about the benefit of cooling and trust the solution as a valid alternative to distress-selling right after harvest.

What exactly is the function of the Climate Ledger Initiative in this context?

With support from the CLI, Your VCCA is now working on integrating a new Impact Dashboard into its Coldtivate app. With this innovative tool, cooling companies can easily track and analyse the effects of their operations on their business, the users, and the environment. This helps them not only to better monitor the performance of the different rooms they operate, but also to provide information about the viability of their solution to external stakeholders, to more easily access additional loans to expand their business.

Could you tell us more about the functionalities of the Impact Dashboard?

The Impact Dashboard has a user-centred design and has been co-developed with cooling companies. It incorporates aggregated data on cold room utilisation rates, revenue, post-harvest loss reduction, and the increase in income for farmers associated with each room and over various time periods. The Dashboard also calculates greenhouse gas emissions savings from using renewable energy in the solar-powered cold rooms and reducing post-harvest losses through the Coldtivate app. Furthermore, it allows data to be exported to demonstrate creditworthiness for companies, and provides guidance to entrepreneurs on crafting impact reports for potential investors that are aligned with the Sustainable Development Goals.

Your project is implemented primarily in India and Nigeria. Are there any differences in how cold room services and the Coldtivate app have been received in the two countries? And do you see potential for implementing the app in other countries?

The initial user statements are promising. There are shared challenges in India and Nigeria, much like other low and low-middle-income countries. Both countries rely on agriculture for employment, with smallholder farmers struggling to make a sufficient living, particularly women. In India, the focus has been on employing members of farmer-producer organisations or women's self-help groups to operate the rooms. In contrast, in Nigeria, the emphasis has been on identifying individual women and youth in the community who need employment opportunities because of their socioeconomic situation, and then training them to run the rooms. The adoption and deployment of Coldtivate required similar efforts in both countries, involving training operators on how to use the app, and awareness-raising campaigns to increase its use among farmers. We have also incorporated digital twins in the app to accommodate crops available specifically in these regions. The positive reception in India and Nigeria bodes well for the project's potential in countries facing similar agricultural and economic challenges. In fact, Coldtivate is available worldwide, and its adaptability for use in decentralised, multi-commodity cold rooms enhances its broader applicability.

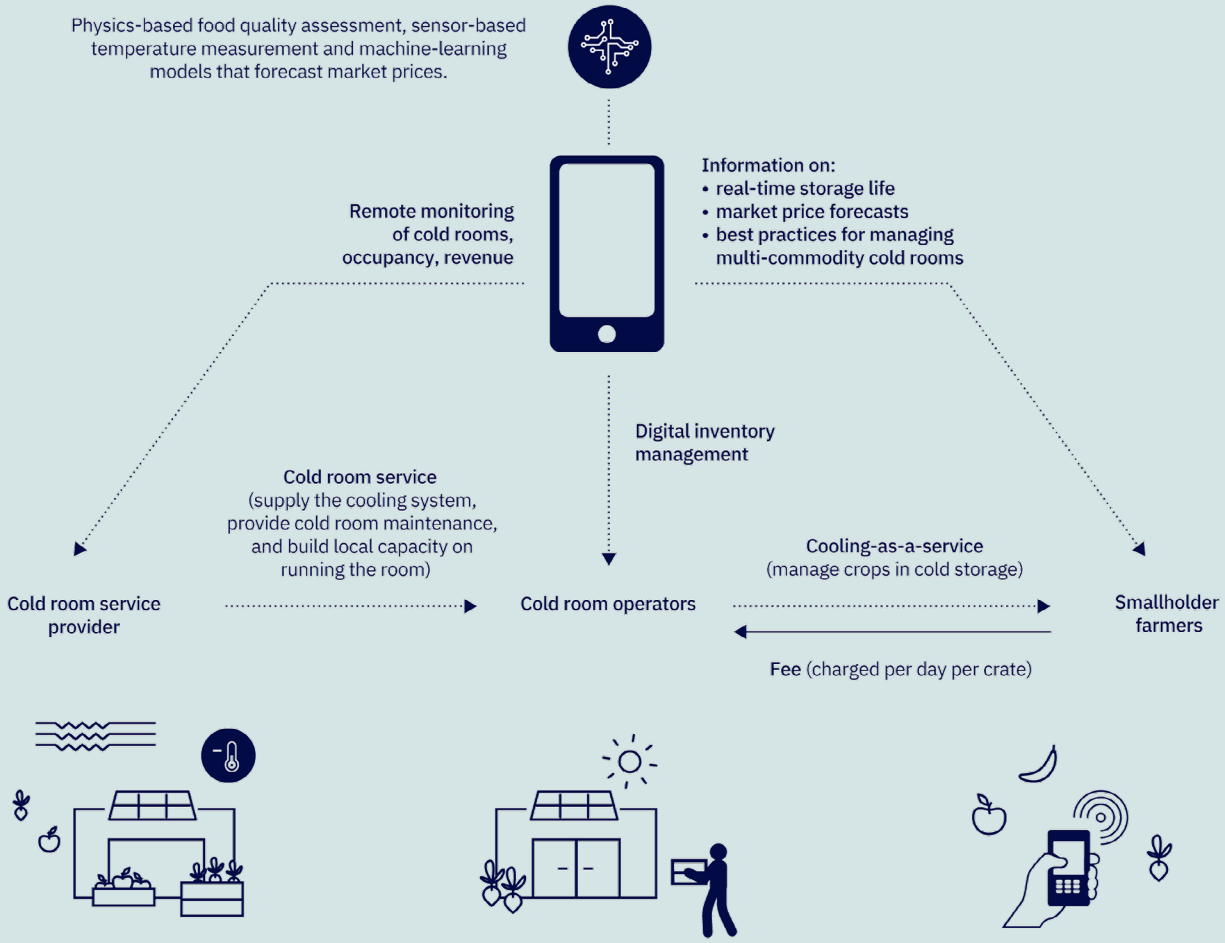


FIG.2 How the Coldtivate app benefits cold room operators and farmers. Source: Your VCCA and Zoï Environment Network.

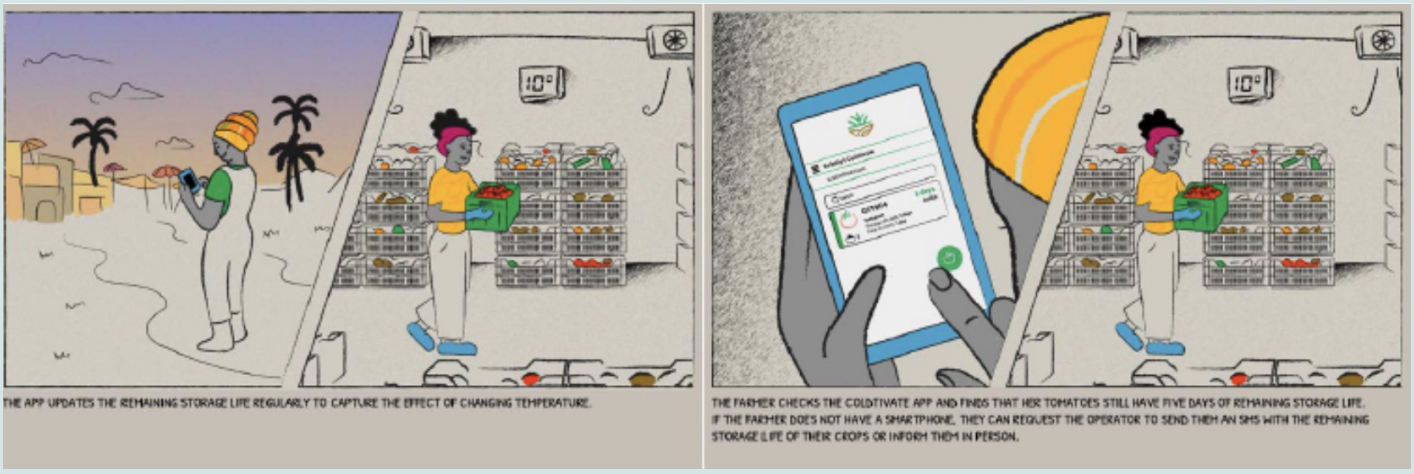


FIG.3 Extract from a brochure training farmers to use the Coldtivate app. Source: Your VCCA

2.1.2 Combining satellite pictures with youth-based ground truthing to track carbon stored in forests

USE CASE: **YOMA GROUND TRUTHING**

Location	Malawi Peru
Description	The Yoma Ground Truthing project aims to verify the combined use of remote sensing (incl. satellites and drones) and youth-based ground truthing to monitor biomass and related sustainability attributes such as carbon sequestration as a result of reforestation.
Sustainable Development Goals	SDG1 SDG4 SDG8 SDG9 SDG13 SDG15
Sector	Forestry, Agriculture
Technology	Remote Sensing, App
Partners	UNICEF Yoma (Youth Marketplace Agency) Wyss Academy for Nature Bioverse Labs European Space Agency Wells for Zoë INFRAS Geoville Hatfield CLS
Project start within CLI	2023

"Estimating biomass from satellite data is technically challenging and often inaccurate. Ground truth is a crucial complementary element and component that is often lacking"

"This project also has great added value for young people. By collecting data, they make an important contribution to climate action and at the same time gain important experience"

Michael Scheibenreif

INTERVIEW

MICHAEL SCHEIBENREIF
UNICEF

What is the idea behind Yoma Ground Truthing?

Ground truthing refers to the process of verifying or confirming information by directly observing and collecting data on the ground, in the actual locations where a project or initiative is planned. It involves validating the accuracy of data, assessing local conditions, and ensuring that existing data aligns with the reality on the field.
For monitoring biomass and related sustainability attributes, high-resolution satellite imagery alone is not enough. Satellite images provide a comprehensive overview of the landscapes, but with remote sensing, it is possible to monitor the latest developments over large areas, such as monitoring progress and impact of reforestation initiaties. However, even high-resolution images are not, in themselves, sufficient for precise monitoring. For example, they allow certain changes to be detected in the biomass such as trees and shrubs, but monitoring tree growth accurately is particularly challenging in the early stages. Yoma Ground Truthing aims to validate remotely sensed data with ground truth data collected by young people. UNICEF contributed to the conceptual design of the overall study and directly contributed to the project activities on the Malawi site with its resources and network.

What are the main challenges you want to address with Yoma Ground Truthing in Malawi?

In Malawi reforestation and ecosystem restoration projects lack systemic and verified monitoring data during the initial years of the project. High-resolution satellite imagery alone is not sufficient for monitoring tree growth. The Yoma Ground Truthing project aims to validate remotely sensed hotspots of either low or high tree growth with ground truth data.

How does Yoma Ground Truthing work?

By using an app – which the project partners Bioverse and Wells for Zoë developed for this use case – young people can validate the remotely-sensed biomass estimates on the ground. The app specifies locations that should be visited and allows users to upload geo-located photos, relevant biomass parameters, and complementary information such as tree species or land use types. The data collected on the ground is complemented with data from drones. Together, they help to complement and validate the data from satellites. In the long run, this should improve data on biomass based on satellite data and thus increase the efficiency and accuracy of measuring such relevant monitoring data.

Why are young people such important partners in the project?

Many young people are out of work, lack training and opportunities to earn a living. The project allows them to broaden their horizons while being supported on their learning to earning journey. The involvement of young people strengthens community ownership of the project and also help to protect the environment. In addition, the participants in this workshop can be trained to measure DBH, a metric expressing the diameter of the tree trunk approximately 1.3m above ground. The project even involves young graduates from the UNICEF Drone and Data Academy in Malawi, who are collecting drone imagery, and support the triangulation of the different geo-referenced data sets.

How do the various stakeholders work together?

The Yoma Ground Truthing project is implemented by various organisations from all over the world. UNICEF is contributing experience in integrating young people in Malawi, the Wyss Academy has broad knowledge and is responsible for local implementation in Peru, and Bioverse and Wells for Zoë contribute to citizen science tools and reforestation. The African Drone and Data Academy is responsible for capacity-building and drone use, and ESA and its sub-contractors are in charge of remote sensing, data analysis, modelling, and combining data from satellites, drones and youth-based ground truthing.

What impact can the project achieve – beyond the findings on the ground?

In this project, partners from four continents are working together. This means that many actors can benefit from the learnings, not only the specific results but also in terms of the broader implications of remote sensing applications interacting with youth-based activities on the ground. Furthermore, the apps could be used in other regions. Therefore, the project aims to identify best practice approaches, demonstrate feasibility, analyse outcomes and feed the knowledge gained into the further development of such integrated systems.

Do you see potential for implementing the project in other countries?

The project has the potential to be extended to other countries where Yoma currently operates, such as South Africa, Kenya, Tanzania, and the Philippines, as well as future scaling countries.

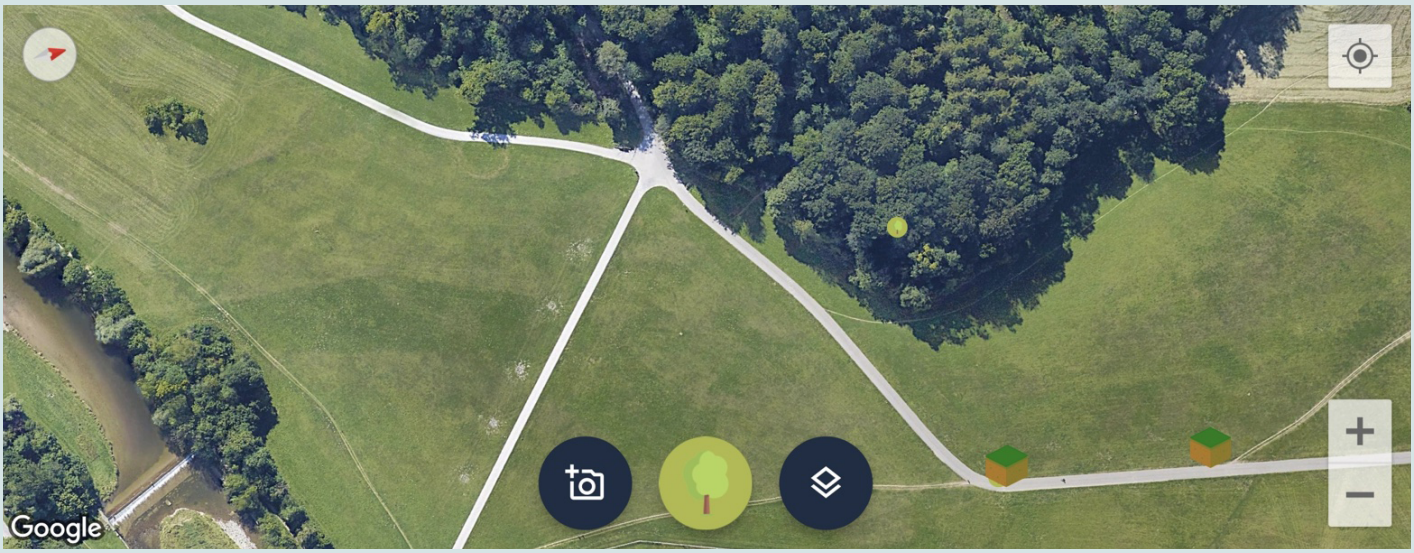


FIG.4 Screenshot of the mobile application developed for the ground truthing activities of the Yoma Ground Truthing project. Users can navigate to pre-defined locations, take geo-tagged photos and collect additional information such as tree species or land use types. Source: Yoma Ground Truthing

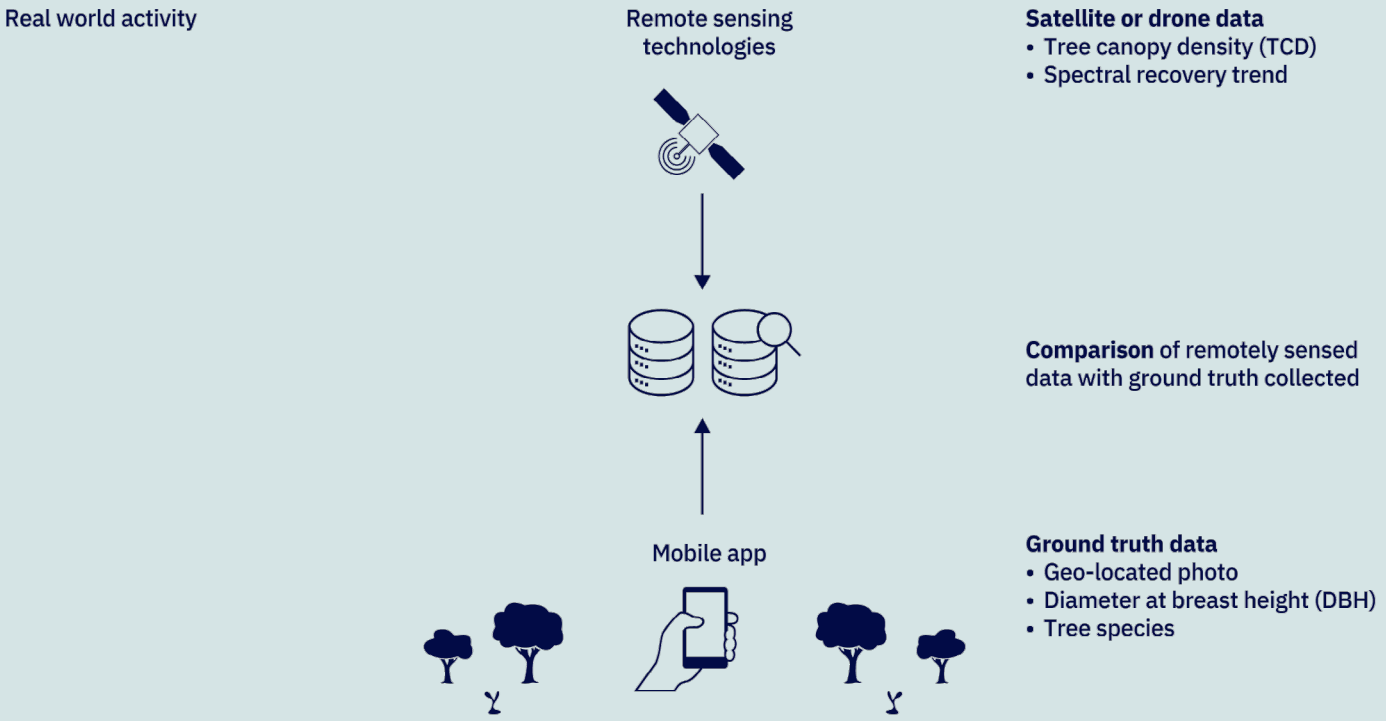


FIG.5 The concept behind the Yoma Ground Truthing Monitoring use case to validate reforestation in Malawi. Source: Yoma Ground Truthing and Zoï Environment Network.

Chapter 2.2

Updates on previous CLI use cases

The fourth edition of the Navigating Report presented various CLI-funded use cases all over the world and their contribution to climate action and the UN Sustainable Development Goals. Updates on a selection of these usea cases are presented below.

2.2.1 Foster legal, sustainable logging through the Wood Tracking Protocol

USE CASE: **WOOD TRACKING PROTOCOL**

Illegal activities such as mining, logging, and drug production are important drivers of deforestation in Peru. The Wood Tracking Protocol (WTP) brings transparency and traceability to the timber industry in Peru by introducing a blockchain-based platform[6]. Information is collected via smartphones at each of the key steps in wood logging, transportation and processing.

| 6 The Wood Tracking Protocol website

INTERVIEW

MICHAEL FABING
Novusteck

IVÁN ALCANTARA
MDA

How has the Wood Tracking Protocol developed? What results have you been able to achieve in the past few months?

Our smartphone app and platform were tested in the field during previous pilot phases supported by the CLI in 2020 and 2021. Based on experience and a range of feedback, we learned how important it is to private companies for the app to be recognised by public institutions, to avoid double data entry.

We therefore resumed dialogue with national and local forest authorities (SERFOR and OSINFOR) and with six local governments. Together, we want to explore the institutional and technical options for integrating digital WTP processes into existing governmental wood tracking procedures, which are currently operated predominantly manually and only meet the individual needs of each institution. This requires more time and expense to align or share information.

WTP offers a smartphone app that connects to a central database with a gateway to a blockchain. What were the success factors?

More than 80% of Peruvian territory does not have any internet access. On a technical level it was therefore key to develop a WTP app solution that works also offline. It is possible to register with a connected mobile phone and to upload the data collected in the field to the platform at a later stage.
On an institutional level, involving local authorities is key. To implement the Wood Tracking Protocol we engaged early on with national and local authorities. We explained the blockchain-based approach and briefed them on this and other new technological approaches, and how to integrate them efficiently into a public system. It should be noted that the Amazon Regional Commonwealth has on its agenda the issue of sustainable Amazon connectivity. The use of this level of database technology and the intelligent devices that have been developed would be the first experiences that would generate a lot of interest in new applications of this technology.

What were the main challenges?

A major challenge is the technical and organisational interoperability of different information systems. For example, it was necessary to check and develop the interoperability of the blockchain-based WTP approach with the existing IT systems used by the companies. Allowing for local storage of data on the phone required additional clarifications with regard to governance and legal interoperability. Compatibility with the existing systems used by the authorities and readiness among the national and local authorities integrate the WTP remains a challenge. Another challenge was that project manager Sven Braden died unexpectedly in Summer 2021 due to COVID-19. After this difficult time, we needed to resume work with national institutions, private companies and partners.

What are your plans and next steps with the Wood Tracking Protocol?

The next WTP phase includes the WTP app and functionality being integrated and working seamlessly within the relevant wood tracking processes applied by the national authorities. These are Osinfor (agency for the supervision of forest resources and wildlife), Serfor (national forest and wildlife service, under the Ministry of Agriculture and Irrigation) and the Mancomunidad Regional Amazónica. The idea is that any user can use the WTP project app and that the information that is collected will automatically be available to the local authorities to prove the sustainable origin of the legally logged wood. With this, the WTP may facilitate wood companies' access to international markets that require certificates of legal origin.

2.2.2 Crop insurance for smallholder farmers to protect their livelihoods and increase resilience to climate change

USE CASE: **CLIMATE RISK INSURANCE**

Crop insurance is crucial for smallholder farmers to protect their livelihoods and increase resilience to climate change. However, traditional insurance is often unaffordable, or cannot provide sufficient coverage. Etherisc and ACRE Africa provide a mobile phone and blockchain-based insurance model. Direct payments are triggered by satellite weather data, such as drought conditions.

INTERVIEW

JAN STOCKHAUSEN
Etherisc

How has Climate Risk Insurance developed since the CLI use case ended? What results have you been able to achieve in the past few months?

Based on our success we are continuing our journey with our partner ACRE Africa and are currently in our fifth season. We have integrated soil moisture data and risk pools in stablecoin (cryptographic currencies that are pegged to value of fiat currencies like the US Dollar). Etherisc continues to scale. As part of the Lemonade Crypto Climate Coalition, led by the Lemonade Foundation, we are delighted to have provided a further 7,000 Kenyan farmers with parametric crop protection powered by Chainlink on the Avalanche blockchain during the recent growing season. We are expecting to close the year with about 60,000 farmers onboarded and an overall 90,000 policies processed on our platform. We are also working on a use case with World Food Programme (WFP), African Risk Capacity Limited (ARC Ltd) and the local insurer Yelen Assurance to insure about 4,000 farmers in Burkina Faso. In addition, at COP27 in Egypt in December 2022 we were invited to present our work during a panel at the IFAD pavilion.

The purpose of your project is to make this type of insurance cheaper, faster and more transparent, based on blockchain technology. What were the success factors?

Having the right partners and supporters is key. The support of CLI provided funding at a critical stage in the tech development and enabled us to build and execute the pilot. As a licensed operator ACRE Africa provided us with boots on the ground, insurance products and capacity and access to farmers at scale. Regarding the technology we were able to tackle the problems of delayed payouts and lack of transparency. Mercy Corp Ventures, who supported Acre Africa in the project, reported that we managed to reduce operational costs by 80% and reduced claims cycles to as little as 24h from the trigger event allowing for mid-season payouts[7].

What were the main challenges?

Despite the cost reductions thanks to digitalisation, insurance is still expensive. We think that this is why market penetration is still relatively low, at about 3%. In addition, as a result of climate change the weather is becoming increasingly volatile. The net cost of risk is rising while the size of the farmer's field remains the same. Therefore, we started to think differently about revenue models. Maybe the cost of insurance is not too high? Maybe it is just the farmers' income that is too low?

What are your plans and next steps with Climate Risk Insurance?

We want to focus on developing additional sources of income to enable smallholder farmers to pay for insurance. We are currently working with Solidaridad, ARC, Agro Consortium and Rabobank's Acorn team to initiate a pilot in Uganda. Smallholder farmers are trained to pursue simple carbon farming activities, such as agroforestry and the use of biochar. The sequestered CO2 can be quantified and certified as carbon credits. By selling these certificates farmers receive revenue, from which a part will be deducted to cover insurance. Our tech platform will automate and execute these transactions in a seamless way for the farmers.

7 Pilot Insights | Driving Climate Resilience for Smallholder Farmers in Kenya Through Smart Contract Weather Index Insurance | by Mercy Corps Ventures | Mercy Corps Ventures | Medium

2.2.3 Low-cost indoor air pollution sensors to foster policies for clean air in healthy homes

USE CASE: **OPENHAP**

Household air pollution (HAP) poses high health risks. The use of traditional forms of cooking fuel, such as wood, crop waste and charcoal, is a main contributor. According to the World Health Organization, HAP was responsible for about 3.2 million deaths in 2020[8]. To better monitor air pollution in households, EED Advisory and its partners developed OpenHAP, a low-cost IoT-enabled household air pollution monitoring system.

| 8 WHO 2022: Household air pollution.

INTERVIEW

MARTIN KITETU
EED Advisory

How has OpenHAP developed since the CLI use case ended? What results have you been able to achieve in the past few months?

The CLI use case is currently being used as the basis for various monitoring activities and engagement with different national and international actors. For example, thanks to our efforts under OpenHAP our team was invited to contribute to the Kenya National Air Pollution Strategy. We recently also applied our expertise to assess the impact of households in Kenya adopting electric cooking, resulting in an official Energy Sector Management Assistance Program (ESMAP) report on this subject. In addition, we were able to provide expertise for development organisations such as GIZ and present our tools at the Clean Cooking Forum in Ghana. Finally, we also contributed to the work of the Clean Cooking & Climate Consortium (4C), which is a group of partners convened by the Clean Cooking Alliance (CCA). 4C is developing a new methodology for crediting emissions reductions from cooking projects, which is a critical step in strengthening carbon markets for these projects.

What were the success factors for the CLI use case?

The financial and technical support from CLI and Michael Johnson from the Berkeley Air Monitoring Group were pivotal to the success of OpenHAP. In general, one of the main challenges with sensors is their costs. Our field-calibrated low-cost sensors with local tools have proven to provide important information, particularly as they can be applied on a broad scale, at several locations and over long time periods. It was also crucial that we could publish a pollution study across 100 households with our air pollution monitors in two low-income areas in Nairobi, Kenya, and present the findings in CLI and other webinars.

What are your plans and next steps with OpenHAP?

Based on the experiences with OpenHAP we plan to continue working on indoor air pollution. Our aim is to continuously implement digital monitoring, reporting and verification tools in energy, air pollution and clean cooking activities.

2.2.4 Clean cooking as a business empowering women

USE CASE: **CLEAN COOKING AS A BUSINESS**

Cooking on a traditional open fire causes health problems, deforestation, and climate change. The CLI supported a pilot project by FairClimateFund (FCF) that supplied vulnerable households in Raichur, India, with clean cookstoves. The stoves were equipped with sensors to monitor cooking practices and to calculate and validate climate impacts and carbon emission reductions.

INTERVIEW

NEERA VAN DER GEEST
FairClimateFund

How has Cooking as a business developed since the CLI use case ended? What results have you been able to achieve in the past few months?

We have continued to operate the DLT/blockchain-based platform to which data from the sensors measuring and monitoring the time the women spend cooking is automatically transferred. Thus, the platform continues to offer carbon credits for direct purchase. We have also successfully sought new funding for a second phase based on the initial CLI phase. This funding will be made available in the coming months. However, the project will be transferred to another FCF project in Rwanda.

Your main aim was to provide access to clean cooking and to measure its climate impacts. What were the key success factors?

The main success factor for Cooking as a business is that sensor-based stove monitoring has been able to measure and calculate the carbon emission reductions of households in the Raichur area. In total we provided clean cookstoves to 100 vulnerable households. The use case revealed that, compared with the manual field surveys, cooking time was 30% lower when using the IoT sensors. The sensors therefore help establish cooking time more accurately, which is reflected in the calculation of carbon emission reductions.

What were the main challenges?

The scalability and cost of the sensors is the most challenging part. The sensors are relatively expensive compared to the cookstoves. In addition, the cookstoves used in India do not have the best emissions reduction performance and associated health impacts. In general, scaling depends highly on the framework conditions. In some countries, the regulation of data exchange may impede the operation of blockchain and hinder cross-border carbon trading and direct payments to cookstove users.

What are your plans and next steps with Cooking as a business?

We have submitted the second phase of this platform to another donor in Rwanda, where we will implement cleaner stoves. We will integrate a financial module to pay households a cashback directly, based on their carbon emission reduction while cooking.

Chapter 2.3

Ten lessons learned from CLI use cases

The work of the CLI and its partners since 2017 has demonstrated that digital technologies can drive climate action. A brochure showcasing eight CLI use cases provides an overview of thematically different projects, individual challenges, and the digital solutions chosen[9]. Key lessons from our work and CLI-supported use cases can be summarised as follows:

1 BUILD ON AVAILABLE LOCAL TECHNOLOGIES AND KNOWHOW WHERE POSSIBLE

Depending on the local circumstances, many different technological solutions may already be available. Profiting from local technological knowhow leads to more sustainable and long-term solutions. Merely relying on popular technologies and international expertise adds additional risks. For example, the CLI OpenHAP use case developed a low-cost sensor to measure indoor air pollution locally. This was then tested and calibrated for broader use. Similarly, the CLI Green Tracker use case developed their own platform based on blockchain and the recognition of waste composition based on AI.

2 LOW-COST AND OPEN-SOURCE OPTIONS ARE KEY TO UPSCALING

When it comes to environmental monitoring, bringing down the costs of remote data capture is key. High sensor costs are an obstacle to upscaling data monitoring. In some instances, low-cost technologies may be used, if their potential lack of accuracy is offset by better statistical approaches, such as a much greater number of data points, to generate reproducible results of sufficient quality. Low-cost options are supporting the upscaling of technical solutions for climate action. Open-source data and code enable collaboration, profit from existing solutions and improvements in verifiability, and support scaling and sustainability. For example, the CLI OpenHAP use case demonstrated that low-cost measurement devices can provide a good option to assess indoor air pollution and therefore impacts on health. In addition, the data collected facilitates studies on a larger scale.

| 9 CLI 2023: Digitalisation for climate action, Experiences from use cases.

3 FIND SOLUTIONS FOR LIMITED INTERNET CONNECTIVITY

Many pilot projects rely on mobile phones or the internet. Over the past decade, networks have expanded rapidly, providing access to an increasing proportion of the world's population. However, connectivity is often still poor, especially in more remote rural regions. Therefore, solutions that also work independently of internet connectivity and allow data transfer and updates at a later stage when connectivity is available again are important. The CLI wood Tracking Protocol use case, for instance, allows wood to be registered with a mobile phone and data to be uploaded to the platform at a later stage.

4 CHECK FOR TECHNICAL AND NON-TECHNICAL INTEROPERABILITY

Interoperability between different digital systems is essential for solutions to work. This is particularly important for technical aspects, so that proposed solutions can talk to each other and be connected to relevant existing digital systems. The lack of interoperability and wide range of standards, often in the context of proprietary digital systems, are a major obstacle to the seamless implementation of different technologies in different sectors, and the related scaling. In addition, interoperability extends beyond the technical aspects and is also required for institutional or legal aspects, for example. The CLI Wood Tracking Protocol use case showed the importance of checking the interoperability of the blockchain-based approach with timber companies' IT systems, as well as the local authorities' current approach to wood tracking.

5 KEEP IT SIMPLE

Digital solutions have been hyped up on various occasions in recent years. It is essential to consider rationally whether a digital solution really offers additional benefits compared to simpler or even analogue solutions. Digitalisation should not be an end in itself. Depending on the project, an Excel-based solution might provide a better and more versatile solution than introducing a blockchain, for example. Or using existing apps that most users have on their smartphones might provide a better communication channel than a new and customised online platform.

6 DATA PROTECTION AND GOVERNANCE ARE KEY

Data protection refers not only to traditional data protection such as backups and archives, but also to data security and data privacy. Protecting data from corruption, compromise or loss is also key to digital solutions for climate action. What data is collected, used and shared must be clarified thoroughly. Particular attention is needed to provide solutions that comply with current laws on data protection, such as the European Union (EU) general data protection regulation (GDPR), that also affect organisations outside the EU that collect and process the personal data of EU citizens and residents. While data protection and governance were relevant in most use cases, the issue was addressed in depth in a report on governance and blockchain produced jointly by the CLI and the International Association for Trusted Blockchain Applications (INATBA).

7 ENGAGE LOCAL AND NATIONAL AUTHORITIES

For new digital tools to succeed in practice, a particular effort is needed to inform relevant national and local authorities to get them on board. Sufficient time for collaboration with the relevant authorities is perceived as a key element in understanding local circumstances and regulations with regard to digital approaches. In this way, government actors can be helped to understand the potential and limits of innovative digital technologies. They are also empowered to assess how use cases can support government efforts and design tools that complement governmental work. The CLI Wood Tracking Protocol, for example, use case shows how important it is to engage early on with local authorities to explain the blockchain-based approach and possibly integrate the digital solution into a public system.

8 DIGITAL SOLUTIONS CAN ENHANCE DATA AVAILABILITY

Low-cost sensors and other remote sensing options can enhance data availability and accuracy. There is often a lack of reliable empirical data as a sound basis for policymaking, carbon credits with a high degree of environmental integrity, or other measures for climate action. In addition to more available and more accurate data, digital solutions also allow data for enhanced climate action to be analysed and presented in good time. In the CLI use case from FairClimateFund, for example, accurate, automated monitoring of cooking data in India ensured that emission reductions are calculated correctly, without overestimation. Similarly, the CLI Green Tracker use case showed how AI-based data analysis can provide

timely information on, say, waste. Finally, the Yoma ground truthing project improves the availability and accuracy of data on biomass by combining satellite data and data collected on the ground by youths on their smartphones.

9 DIGITAL SOLUTIONS CAN ENHANCE TRUST

Trust can be increased in various ways by digital solutions. Digital applications allow for a direct flow of data from the sensor or IoT device and lower the need for manual data entry, significantly reducing errors. This improves the credibility of the available data. In addition, the immutable nature of blockchain applications can generate increased transparency and trust for its users. Finally, digital solutions allow transaction costs to be avoided and prompt direct transfers of information or money without any intermediary. The CLI use case by Etherisc for crop insurance in Kenya used blockchain technologies to automate an insurance product for farmers. They could reduce costs and increase confidence in the product. Digitalisation and the use of mobile phones increases transaction speed, allowing payments to farmers in near-real time, in contrast to the weeks or months of delay with conventional systems. The CLI Your VCCA use case, that provides an app for cold room operators and the farmers using them increases trust. Farmers have up to date information on food quality and their stored products. Cold room operators can make their management of cold rooms visible, and more easily access loans for new cold rooms.

10 SEED FUNDING ALLOWS DIGITAL INNOVATIONS FOR CLIMATE ACTION TO BE TESTED

The minimum viable product approach also works in the context of digital innovation for climate action in developing countries. The CLI use cases have shown that even very moderate financial support enabled key ideas to be tested, the core functions in solving a problem to be identified, and the results fed into improvements in the approach. Successful minimum viable products are a key vehicle to attract more funding for scaling up. The careful selection of projects and their teams were key to supporting projects that could be further developed beyond CLI funding.

DIGITAL APPROACHES AND INNOVATION IN DEVELOPMENT COOPERATION

Based on the findings and experience gained since 2017, the CLI has developed a guidance document for development cooperation practitioners to explore the potential of digitalisation in their projects[10]. Using digital technologies in development cooperation may have numerous benefits:

BENEFITS OF DIGITAL TECHNOLOGIES

1	More efficient and effective projects, processes and services
2	Innovation and new business models
3	Enhanced participation and empowerment
4	Increased trust, reliability and accuracy in data and solutions

The guidance document leads through the process of recognising possibilities, assessing potential and selecting digital solutions for projects. It aims to explore digital solutions and kick-start digital transformation. The guidance document takes the practitioner through a process that will take several weeks or months and has the following seven steps:

SEVEN STEPS

1	Know your project, goals and challenges
2	Assess local circumstances and capabilities
3	Identify existing digital solutions and connect with experts
4	Explore possible digital solutions (inspiration can be found in the CLI use case brochure[11])
5	Consolidate ideas in a stakeholder workshop
6	Draft a proposal for the integration of digital solutions
7	Evaluate implementation and training to make necessary adjustments

10 CLI 2023: How to digitalise your development cooperation projects and programmes - a guide for practitioners
11 CLI 2023: Digitalisation for climate action, Experiences from use cases.

3

Review and outlook on digitalisation trends

Review and outlook on digitalisation trends

OWEN HEWLETT, The Gold Standard Foundation
and **JUERG FUESSLER,** INFRAS

If six years is a long time in terms of the climate, it is an eon in technology. The Climate Ledger Initiative was founded in 2017 at the Marrakesh COP. Now, its Navigating Reports[12] themselves represent a fascinating history of the evolving trends of recent years, of what was at the time hype, and is now an emerging, albeit very different reality.

Reflecting on the past six years a number of conclusions emerge. First, none of the innovative, ground-shaking technologies have changed the world in terms of its response to the climate emergency. There was never really any chance of a silver bullet and none has or is likely to emerge. But this does not mean that digital innovations such as DLT and machine learning have not made gains or shown promise, or that the promise of IoT is entirely unfulfilled, as evidenced by the use cases explored throughout this year's report.

A calm look at the relative successes and scaling of these technologies tells us that blockchain/DLT and tokenisation both have a foothold in carbon markets and development finance, even if not yet fully realised. Their greatest potential may lie in settings where governmental capacity would most benefit from support, such as in a developing country context. However, the use of DLT/blockchain needs to be justified in each individual case and is not self-evident. In digital measurement, reporting and validation (D-MRV) for carbon market projects we have seen interesting use cases and innovation, but universal truths and good governance remain elusive, although this is certainly an area of huge potential. Major programme standards such as CDM, VCS, and Gold Standard, as well as verifiers such as SustainCert are working on integrating D-MRV, digital methodologies and accounting into comprehensive digital platforms that seek to cover the entire carbon project cycle to a greater or lesser extent. Later in the period, we saw artificial intelligence and machine learning applications emerge at astonishing speed, to great excitement and much greater attention from the public and media.

The emergence of all these technology types has certainly been messy. This is partly for cultural reasons, with many technology innovators with limited knowledge of climate action perhaps buying into the euphoria too much, while underestimating the complexity of the subject matter. In some areas there has been the attitude that we must entirely get rid of what went before and replace it with new digital approaches, only to find that the old guard were perhaps a great source of ideas and expertise all along.

| 12 See Navigating Reports on the CLI website

Equally, it is certainly fair to say that incumbents working in the climate and development space felt somewhat lost in the flood of news on digital innovation, and were afraid of the perceived risks of the new technologies. They have not always been welcoming or helpful to those innovators. What is clear is that the most exciting work emerges when each side lets its guard down and collaborates in good faith. The work in this nexus between tech communities and climate practitioners is exactly what makes our work in the CLI network so exciting.

A good example of this was the emergence of tokenisation in carbon markets. Here it was clear that the tokenisation community expected to blow away the old systems and revolutionise the space with new finance, transparency and automation. The challenges identified as key fixes, such as the avoidance of double counting, greater transparency and security, were not the key problems the market faced, however. Further experiments, such as Klima DAO, proved that not speaking to experts can lead to expensive and often perverse outcomes. But good can emerge, as some of those innovators that were watching and participating began to collaborate with established players, such as Gold Standard, to further the useful application of DLT and tokenisation.

MARION VERLES
CEO SustainCERT

What added value have digital tools for carbon markets?
The solution to scaling carbon markets is clear: we need to increase integrity and transparency at greater pace. Today, I am pleased to see a growing consensus on the crucial role digital innovations in measurement, reporting, and verification (MRV) systems can play in improving the accuracy and credibility of carbon credits. Conversations on the need to transition from conventional to digital MRV (D-MRV) have quickly shifted from why to when, and highlighted that technology is now waiting for the ecosystem to catch up.

Where will we be in 3-5 years in the digitalisation of climate action and D-MRV?
We have enough knowledge and technology today to accelerate the roll out of D-MRV. In our current state of climate emergency – the science is unequivocal on this point – we need a new operating model. One with shorter release cycles, leaner development approaches and a focus on rapid, iterative improvements. This new model requires stronger collaboration, and I hope for a simpler future, where the technical decision-makers for leading standards formally engage with each other and the wider ecosystem to ensure D-MRV becomes the new norm for monitoring, reporting and verification.

One recurring question of our time is whether and how technology will replace human employment. Perhaps the most cited would be its impact on validation and verification bodies (VVBs) where automation, the use of validated data, digital MRV and remote monitoring are all spoken of potential replacements. This has not happened and indeed will not happen. A more measured prediction might be that they will help to move VVBs towards greater efficiency and a focus on the issues that really matter. In many ways technologies such as those that have emerged in the past six years are often at their best when considered as co-pilots, lifting complexity and reducing the risk of error for human experts.

WHAT MIGHT THE NEXT FIVE YEARS HOLD?

Certainly it is true that technologies emerge faster and more chaotically than the hyperbole suggests, before bedding down into a more mature understanding of their uses. That will continue to be true. The coming period is likely to be one of consolidation and further uptake and testing, rather than one of revolution, though in some areas (such as AI) we may see more rapid changes to our day-to-day working lives.

Carbon markets: If we were to predict the future of digitalisation in carbon markets, we would expect standard setting bodies to increasingly venture into digitalised approaches to project cycles. This would include certification workflows and methodologies, as well as a greater use of validated third-party data and algorithms. D-MRV and the related digital approaches may also support the current drive in the market towards high-integrity credits. That said, tech alone will not rectify the fundamental lack of environmental integrity of the majority of the current market.

A great challenge in this area will be the transparency of open vs. proprietary approaches, quality of governance, and access afforded by technology platforms, which remains a very underregulated area. Similarly, privacy and security will likely become of greater legal and ethical concern, and we would predict issues for some applications with unforeseen or simply unmitigated risks in these areas. In that regard we would certainly encourage and expect to promote a greater discourse on governance, ethics, privacy and security. These are all topics which can feel like an anathema to the free-thinking innovation technology communities, but they are the inevitable ceilings on their growth and must be properly addressed.

Financing and tracking of climate action and sustainable development: A further growth area will likely be found in the management and administration of the liabilities and beneficial outcomes of climate finance and action in sustainable development. Historically, the main financing mechanisms, such as carbon markets and donor grant money, have been kept separate from host country and corporate value chain targets. We expect this to change significantly in the coming years, with nearly all outcomes potentially appearing in different ways as different actors report progress towards their targets. These actors are host and acquiring countries' NDCs, donor country ODA and climate finance pledges, private sector net-zero pathways. Their reporting covers sustainability claims along entire value chains. There are times that this variation will be acceptable, and times when it damages ambition. This is a good thing, overall, given that the overlap represents the multiple interests of the entities concerned, but it can impact on the efficiency and efficacy of reporting and claims. Technology solutions, transparent and open data, and governance of data and allocation, will be essential to solving these issues.

As we look to the next five years, we may draw three conclusions. First, that although reality rarely matches the hype, experience has been gained in how to short-circuit this learning curve and move straight to real collaboration between innovators and experts. The real use cases in this report prove that reality is often even more interesting than speculation. Giv-

en how little opportunity is left to avert climate and nature emergencies, we will not have time to spend inefficiently fawning over the tech.

Second, however boring it may seem, good governance and consideration for ethics and moral hazards are essential to credibility. Technology solutions and applications simply cannot take off if they are encumbered by reputational and legal risk. This does not mean there is not room for rapid prototyping, but it does mean that the move to scale needs to be properly thought through. Similar issues exist with privacy and security, where the use of complex data can be fraught with legal risk.

Finally, collaboration is key. The moonshot mentality that exists within technology communities is exciting and energising, but can lead to a dismissive attitude towards established experts and practitioners. This is particularly true of the climate space, where the very harsh realities and complexities are already well known and cannot be fixed by any technological magic bullet. But this cuts both ways and the defensiveness of incumbents is equally unhelpful.

To end on a positive note, what we have seen and learned in six years is incredibly exciting and has the potential, if combined with strong governance, ethics and collaboration, to change the way we do climate action. Technology cannot save the climate crisis, only we humans can do that. But human efforts can be enhanced, accelerated, unlocked and made fairer and more transparent with the efficacious use of technology.

CLOSE OF THIS PHASE AND OUTLOOK FOR THE INITIATIVE

With this Navigating Report, the current SDC-funded CLI phase comes to an end in 2023. More than 15 use cases successfully implemented by CLI partners, over 80 presentations, workshop and webinars held, 12 knowledge products, fact sheets and whitepapers developed with more than 10 partners - and all summarised in 6 Navigating Reports - remain a sound basis for future endeavours in digital climate action to build on past experiences and best practice. The most important outcome of the phase is found in the numerous partners, practitioners, policymakers and experts with whom we have had the privilege to discuss and work on digital solutions to climate action in recent years. They will continue their work, building on the established network of actors and experience. From 2024 on, the CLI will continue in a somewhat adapted form, leaving the more general awareness-raising work behind and increasingly focusing on two areas. These are the practical implementation and scaling of digital approaches with our partners in specific areas of climate action, and seeking impact. Contexts may include work in development cooperation, the decarbonisation of private-sector value chains, or carbon markets including Article 6. In this sense, the journey is only starting, and we are looking forward to having you on board as we enter this new and exciting phase.

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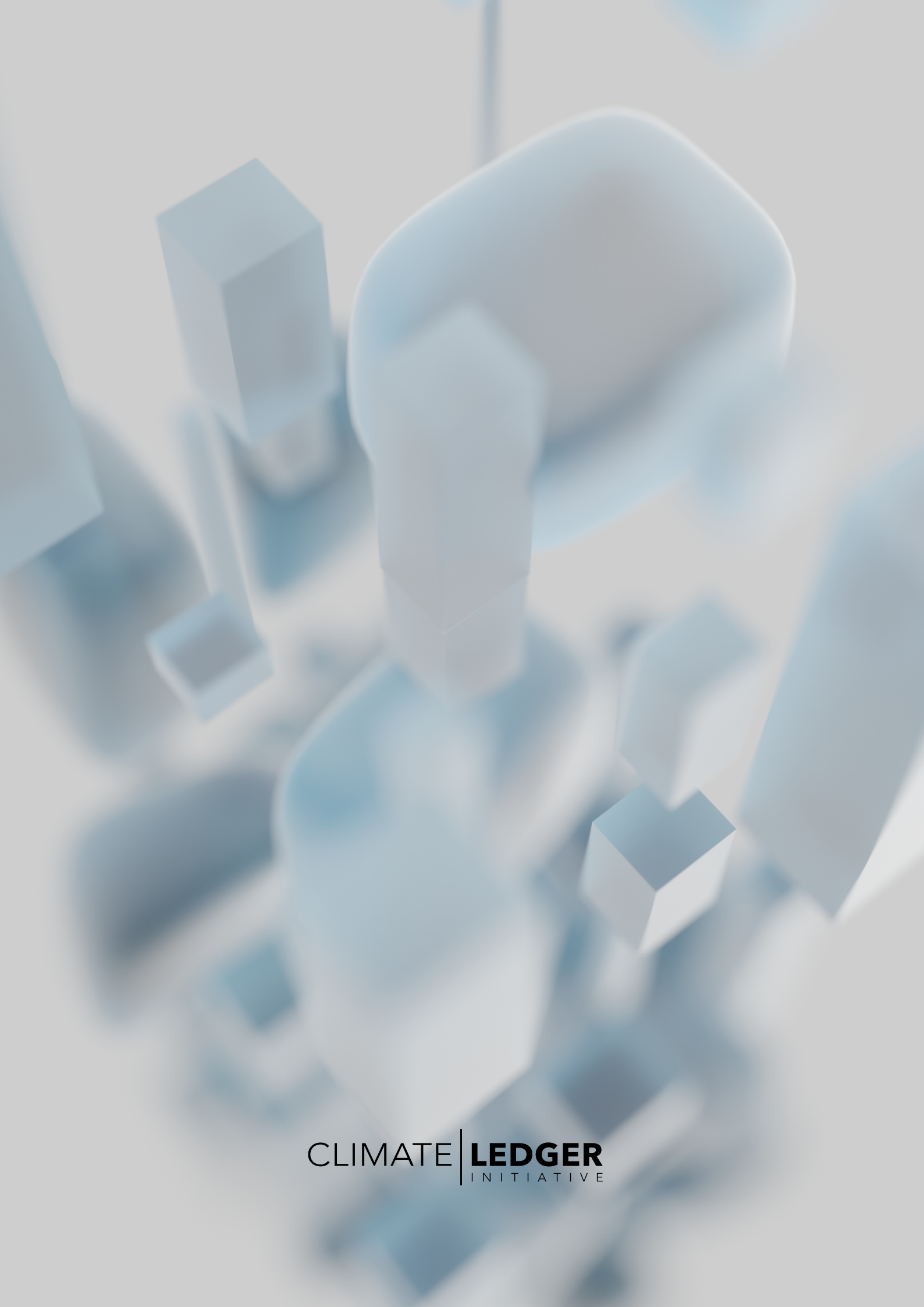
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