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# Navigating Blockchain and Climate Action

## 2022 STATE AND TRENDS

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climateledger.org

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# Preface

## The Climate Ledger Initiative (CLI) 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. 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 also 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, 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 innovations. Examples include sensors, satellite imagery, the internet of things (IoT), and machine learning. CLI addresses policy and research questions and identifies specific opportunities for innovation where climate and digitalization meet. Our work has benefited greatly from the contributions of participants in various workshops and events, and from the support of partner use cases. CLI itself selected and supported several use cases in an open call.

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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 fifth edition of Navigating Blockchain and Climate Action

This year's edition of the Navigating Report[1] focuses on how digital solutions can help improve environmental integrity.

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.

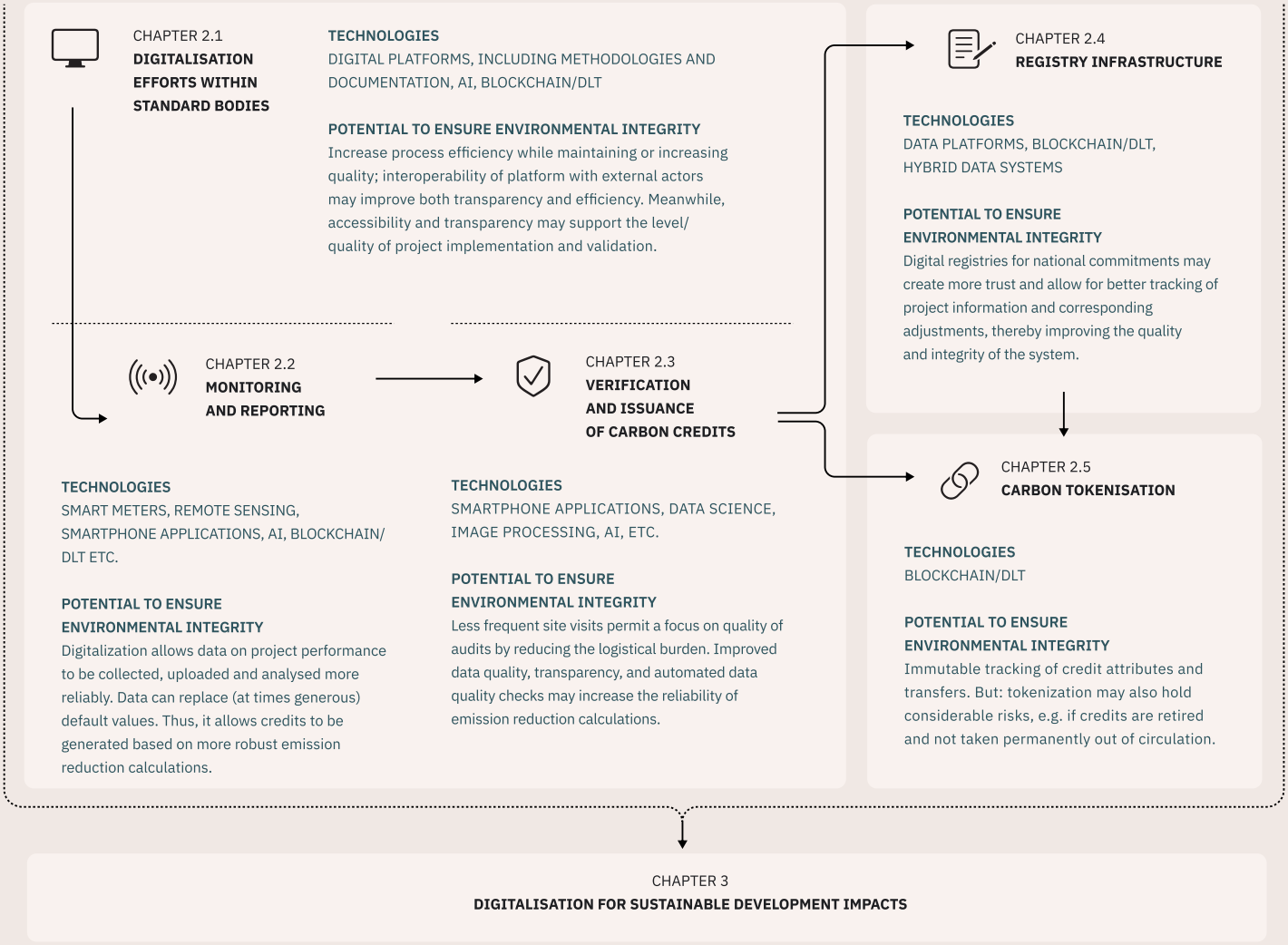
1. For previous editions please refer to the CLI website.

# Summary and key findings

Carbon markets are evolving rapidly. In the compliance markets under the rulebook for Article 6 of the Paris Agreement, their potential is being unlocked by the emerging institutional framework and the establishment of the supervisory body. Meanwhile, in the voluntary carbon markets, companies' increasing awareness of and interest in net zero and Paris-aligned corporate mitigation targets is fuelling demand for credits. However, high transaction costs and the lack of transparency and integrity of carbon market schemes remain major barriers to scaling (Taskforce on Scaling Voluntary Carbon Market 2021).

While CLI has been working on a broad range of use cases in climate change adaptation and mitigation, this year's Navigating Report focuses on the role of digital approaches to scaling carbon markets and improving their environmental integrity. Digitalization is still very much a work in progress. However, numerous use cases and outlines for the future use of digital tools in carbon markets are emerging.

After providing some of the context, the report offers reflections on digitalization efforts within standards bodies. Based on specific research projects and use cases, it also examines digital approaches to increasing environmental integrity in monitoring and reporting, verification and the issuance of carbon credits, as well as registry infrastructure and carbon tokenization, and the potential they offer. In addition, the Report discusses digitalization for tracking sustainable development impacts.




## Chapter 2.1

# Digitalization becoming a key topic for the carbon market and its standards bodies

**Digitalization is a key means of accelerating the implementation of the Paris Agreement**: To reach the Paris Agreement goals, we need results-based climate finance and carbon markets to develop fast and with a high degree of integrity.

**Digitalization may enhance trust in voluntary carbon markets**: Digital approaches may hold the key to the necessary scaling of results-based climate finance and carbon markets. If done correctly, they offer the opportunity to strengthen environmental integrity and increase credibility and trust. Greater trust would in turn be rewarded by higher prices, thus compensating for a potentially lower number of credits due to the more conservative approaches that are necessary for greater integrity.

**Digital approaches may lower barriers to entry**: Digital approaches offer a chance to lower barriers to gaining finance. For example, it may allow more actors access to carbon finance by receiving direct financial payments via mobile phones. On the other hand, care must be taken that digital approaches do not close out populations that have limited access to technology.

## Chapter 2.2

# Improving monitoring and reporting

**Digitalization may help to make monitoring and reporting more efficient and robust**: Many use cases already integrate digital technologies to monitor and report data. The number of technology suppliers is also increasing. The benefits of digital methods for monitoring and reporting data are clear. They improve not only efficiency, but also data reliability and credibility. This is an important condition for high quality credits.

**Wealth of data may improve quantification and methodologies**: The pervasive use of digital technologies in MRV at all stages of the project cycle can provide verifiers, standards bodies and researchers with a wealth of data. The possibility of having more measured data and replacing (at times very generous) default factors is particularly interesting. This would improve quantification and increase the quality of credits. New data should be made available via a common digital repository or platform.

## Chapter 2.3

# New approaches to the verification and issuance of carbon credits

**New blueprints for digital verification are emerging:** There are efficiency gains in the digitalization of verification processes, including automated data processing, streamlining documentation, and reducing site visits. Depending on the blueprint, the role of project participants and verifiers changes considerably. If an independent entity is quantifying as well as verifying emission reductions, this may boost the quality and credibility of credits. However, new forms of governance are necessary.

**Digital approaches may reduce the need for site visits:** Digitalization may allow data to be generated remotely. It may also permit remote project audits. Nevertheless, site visits will remain important, particularly at the beginning of a project.

**Specialist human expertise remains important:** Digitalization may help to automate many steps in verification. This reduces paperwork for verifiers and enables them to focus on auditing the quality of calculations and the correctness of emission reduction claims. While they might require more IT know-how, verification will still require specialist human expertise in the related carbon reduction or removal projects.

## Chapter 2.4

### Robust registry infrastructure for Article 6

**Digital registries may increase trust and environmental integrity:** Digital solutions can improve data collection procedures, MRV processes, and international transfers of carbon credits. They can also take care of all bookkeeping requirements. Additionally, Blockchain/DLT-based solutions provide immutable and trusted data storage that may be of particular interest to countries with weaker institutional capacities and governance settings.

**Blockchain/DLT allows a multitude of heterogenous carbon markets to be linked:** The bottom-up nature of the Article 6 mechanisms under the Paris Agreement requires a multitude of heterogenous carbon markets to be connected with each other. Blockchain/DLT may provide useful solutions to link different registry systems and ensure accurate accounting.

## Chapter 2.5

### The role of carbon tokenization

**Digital assets could increase access and transparency:** Tokens can help to increase access and to scale carbon markets. Transparency may also increase trust. Potential risks include tokens not being retired even though the related credits are. Principles are currently under development in order to ensure environmental integrity.

## Chapter 3

### Digitalization for sustainable development impacts

**Digitalization can support the achievement of the SDGs:** If done correctly, digitalization may help to measure sustainable development co-benefits. Additionally, current activities can be scaled, new market segments can be accessed, and new actors can enter the market. Finally, digitalization facilitates direct payments to low-income households, and particularly women.

# Abbreviations

| | |
|---|---|
| **AI** | Artificial Intelligence |
| **CDM** | Clean Development Mechanism |
| **CLI** | Climate Ledger Initiative |
| **COP** | Conference of the Parties |
| **DLT** | Distributed Ledger Technology |
| **D-MRV** | Digital Measurement, Reporting and Verification |
| **EU ETS** | EU Emissions Trading System |
| **FCF** | FairClimateFund |
| **GHG** | Greenhouse gas emissions |
| **GSIQ** | Gold Standard Impact Quantification |
| **HAP** | Household Air Pollution |
| **ICVCM** | Integrity Council for the Voluntary Carbon Market |
| **ICS** | Improved cookstoves |
| **IoT** | Internet of Things |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **I-Q&V** | Integrated Quantification and Verification |
| **ITMO** | Internationally Transferred Mitigation Outcomes |
| **LiDAR** | Light Detection and Ranging |
| **MRV** | Measurement, Reporting and Verification |
| **NDCs** | Nationally Determined Contributions |
| **PMI** | Partnership for Market Implementation |
| **SDC** | Swiss Agency for Development and Cooperation |
| **SEA** | Swedish Energy Agency |
| **SDG** | Sustainable Development Goals |
| **SBTi** | Science Based Targets initiative |
| **VCMI** | Voluntary Carbon Markets Integrity Initiative |

# 1

# Digitalization and the rapidly evolving carbon markets

# Digitalization and the rapidly evolving carbon markets

Carbon markets are evolving rapidly. In the compliance markets under the rulebook for Article 6 of the Paris Agreement, their potential is being unlocked by the emerging institutional framework and the establishment of the supervisory body. Meanwhile, in the voluntary carbon markets, companies' increasing awareness of and interest in net zero and Paris-aligned corporate mitigation targets is fuelling demand for credits. However, high transaction costs and the lack of transparency and integrity of carbon market schemes remain major barriers to scaling (Taskforce on Scaling Voluntary Carbon Markets 2021). What role can digitalization play in increasing both the effectiveness and the integrity of carbon markets?

This year's Navigating Report focuses on the role of digital approaches to scaling carbon markets and enhancing their environmental integrity. Digitalization is still very much a work in progress. However, numerous use cases and outlines for the future use of digital tools in carbon markets are emerging.

The following introduction provides some of the context. This is followed by findings from recent CLI research and use cases on specific contributions from digital tools to the carbon market project cycle (Chapter 2) and to measuring sustainable development impacts (Chapter 3). The final section summarizes the main findings (Chapter 4).

## Importance of transparency and integrity for carbon markets

'Environmental integrity' in the context of compliance markets under Article 6 means that the use of internationally transferred mitigation outcomes (ITMO) does not result in higher global greenhouse gas emissions (GHG) than if mitigation targets for nationally determined contributions (NDCs) had been achieved by domestic mitigation action alone (Schneider et al. 2017). Important factors influencing the global GHG impact of ITMOs include the quality of units and robust accounting for international transfers (Schneider, Kollmuss and La Hoz Theuer 2016).

Under the Paris Agreement, all parties are obliged to formulate national climate targets and track the GHG emission reductions achieved. Measurement, reporting and verification (MRV) requirements have increased considerably in comparison to the Kyoto Protocol era. The complexity and diversity of MRV have increased, in part because of national targets that may have different metrics and years. Additionally, countries participating in Paris Agreement carbon markets – be they buyers or sellers – need to report regularly on projects and programmes, as well as ITMOs. The post-2020 carbon markets may thus benefit particularly from digital measurement, reporting and verification (D-MRV) systems (World Bank 2022a).

The adoption of the Article 6 rulebook at COP26 in Glasgow at the end of 2021 laid a binding foundation for international carbon markets after years of discussion. Among other things, it was determined that corresponding adjustments needed to be applied under Articles 6.2 and 6.4. While important for environmental integrity, there are challenges in their implementation. Ensuring that an internationally transferred mitigation outcome is only accounted for by one country is difficult to monitor. Digital registers can be helpful in this regard (see Chapter 2.4). Another important element is that parties must show how the cooperative approaches in which they participate ensure environmental integrity. The latter can be improved by the use of digital solutions that can help to increase accuracy and achieve greater trust in data and calculated emission reductions or removals.

In the voluntary carbon markets, integrity consists of credit quality, robust accounting, and steps to ensure that the attributes of the credit used to make a voluntary claim are aligned with the claim being made[2]. Market activities have gained increasing attention over the past 18 months or so. Investing in decarbonizing their own operations and supply chains has rightly become a priority for many leading companies. There is also a strong interest in investing in voluntary carbon markets – including those in developing countries – as part of broader climate engagement strategies. For many companies, the voluntary carbon market is an important element in fulfilling net zero emission targets. The Science Based Target Initiative (SBTi), including its Net Zero Standard launched in October 2021, is supporting this trend. While the SBTi does not allow carbon credits to be applied to the achievement of near or long-term science-based targets[3], purchasing high-quality carbon credits in addition to reducing emissions along a science-based trajectory is considered to play a critical role in accelerating the transition to net-zero

2. In other words, it is not possible to make claims that imply that emissions have been compensated with anything other than a credit that has the attributes to support this claim.
3. Note that carbon removal credits may be used to achieve a Net Zero status once science-based long-term targets are achieved.

emissions at the global level (SBTi 2021). This is reported separately from the accounting required for the actual science-based target element.

Globally, the voluntary emissions market has developed very dynamically since 2020. Market volume rocketed by 190% between 2020 and 2021, and a further significant increase is expected in 2022 (Trove Research Limited 2021). This rapid development is set against a regulatory framework for all leading standards for the carbon market that is repeatedly criticized for not being sufficiently robust to assure credits of high integrity. The latest sign of this is a recent draft assessment framework from the Integrity Council for the Voluntary Carbon Market (ICVCM), which believes that no existing standard fulfils all of the newly defined criteria that are intended to promote integrity in voluntary offsetting[4]. Consequently, the voluntary carbon markets have a quality and thus environmental integrity problem with the continued proliferation of risky project types (Carbon Direct, 2022).

The need to improve the quality of voluntary carbon credits and the transparency of claims guidance is reflected in an array of new initiatives (see figure below).

4. Offsetting requires a binary understanding of credit attributes to support the efficacy of company claims, thus setting a high bar for integrity. It should be noted that key NGOs have moved to support markets for 'beyond value chain mitigation', but few support the concept of offsetting.

## EMERGING CARBON MARKET QUALITY AND INTEGRITY INITIATIVES[5]

| | |
|---|---|
| **Integrity Council for the Voluntary Carbon Market (ICVCM)**.<br>Visit↗ | An independent governance body established from the private sector-sponsored Taskforce for Scaling the Voluntary Carbon Markets. Focuses on the voluntary carbon market, and specifically the use case for voluntary offsetting, to ensure high-quality carbon credits for that purpose. Employs an independent expert working group to establish scheme-level governance and methodology/project type-level criteria intended to ensure the integrity of credits used for offsetting. |
| **Voluntary Carbon Markets Integrity Initiative (VCMI).**<br>Visit↗ | A multi-stakeholder platform to drive credible, net-zero-aligned participation in voluntary carbon markets. VCMI coalesces stakeholders around a shared vision for voluntary carbon markets to make a meaningful contribution to climate action and avoid the global temperature rising to 1.5˚C above pre-industrial levels. It also supports the achievement of the UN Sustainable Development Goals. Rather than offsetting, VCMI focuses on corporate responsibility beyond value chains as a contribution to global net zero efforts. |
| **Carbon Credit Quality Initiative (CCQI).**<br>Visit↗ | Seeks to provide transparent information on the quality of carbon credits. The initiative was founded by the **Environmental Defense Fund**, **World Wildlife Fund (WWF-US)** and **Oeko-Institut**. |
| **Calyx Global**<br>Visit↗ | Rating start-up providing independent quality and impact ratings for carbon credits. Calyx Global independently assesses the greenhouse gas integrity and Sustainable Development Goal impact of carbon credits. |
| **Sylvera**<br>Visit↗ | Rating company providing comprehensive carbon ratings with a focus on credits relating to agriculture, forestry and other land use (AFOLU). |

5. Disclosure: INFRAS supports ICVCM, CCQI and Calyx Global as an independent expert.

## Emerging experience with digital tools to measure impact

This year, digitalization in climate action took a major step forward. For example, leading program standards body Gold Standard announced an investment in a fully digitalized standards and assurance ecosystem. Both Gold Standard and Verra also announced their own working groups to bolster their expertise in topics such as digital MRV and the tokenization of credits (see also Chapter 2.1 and 2.5). In addition, other actors inside and outside of carbon markets have implemented various use cases and pilot projects in different regions of the world, covering a range of project types (Climate Ledger Initiative 2021, World Bank 2022b, CLI use case database).

Many of the projects are proving to be an important lever, helping efficiently to scale up and multiply the necessary climate action at the global level. Experience from our CLI-supported use cases has demonstrated that the immutable nature of blockchain applications can enhance transparency and trust among users. This has been observed in the Etherisc crop insurance use case in Kenya, where blockchain technologies automate the lifecycle of the insurance product and thus reduce costs and increase confidence in the database (Etherisc use case). Digitalization 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.

CLI-supported use cases have also shown how digitalization may help to generate reliable empirical data. This is often missing, even though it is a necessary basis for policy-making and for carbon markets with a high degree of environmental integrity. In Kenya, for example, low-cost sensors are helping to improve indoor air pollution data. This, in turn, influences policy-making (EED use case). In carbon markets, the CLI-supported FairClimateFund project in India is a case in point. It shows that more accurate monitoring data means emission reductions can be calculated more accurately, avoiding overestimations (FairClimateFund use case).

> "Solutions are needed in particular in the tracking and transparent disclosure of all aspects of corporate and national reporting, including their interplay with each other. Reporting must be aligned with science-based aspirations. Yet this complexity can only be managed with intelligently designed digital MRV approaches with compliance assurance and capture/tracking, all recorded in immutable and interoperable multi-layered registries."
>
> **Owen Hewlett,** The Gold Standard Foundation

## The Climate Ledger Initiative's engagement to enhance the environmental integrity of carbon markets

In 2022, CLI and INFRAS partnered with Sustain-CERT to produce two white papers on digital MRV in general and digital verification more specifically (Oberpriller et al. 2022 and Soini, Kohli and Fuessler 2022). As part of this shared venture, CLI conducted various interviews with experts from the Gold Standard Foundation and Verra, verifiers, technology providers and market specialists. The aim was to analyse digital options for MRV and their benefits for environmental integrity.

Furthermore, CLI is represented in Gold Standard's working group on digital assets for climate impact. The group's discussions focus on the creation of digital assets to represent mitigation outcomes, in particular credits issued ex-post for verified emission reductions/removals. It is part of an initiative supported by Google Charitable Giving, led by Gold Standard with core partners ClimateCHECK and the IOTA Foundation. The objective is to develop open, global collaboration on next-generation digital solutions for carbon market standards and measurement, reporting and verification.

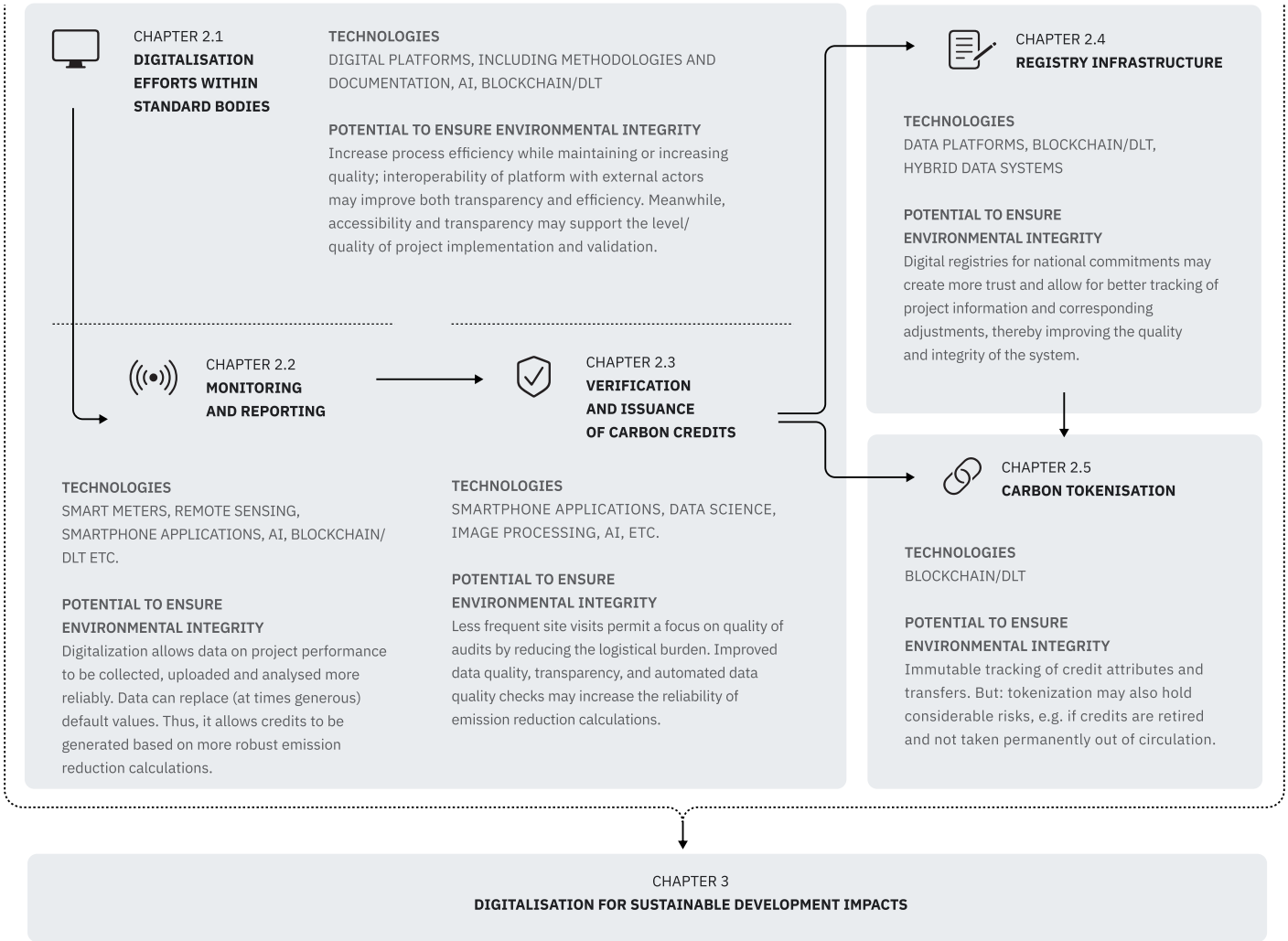
# 2

# Digitalization ensuring the integrity of carbon markets

# Digitalization ensuring the integrity of carbon markets

As shown in Chapter 1, ensuring the quality and integrity of all carbon credits is a huge challenge. Here, digitalization is of benefit in terms of efficiency gains and scalability, which can help to reduce the overall costs of project implementation. Digitalization also has the potential to improve the environmental integrity of carbon markets.

The following overview outlines the functioning and benefits of novel digital approaches with regard to accuracy, credibility and trust. Starting with more general reflections on digitalization efforts within standards bodies, in the following chapters we then go into key areas of the carbon project cycle to identify the principal opportunities and challenges when implementing digital tools.



# Chapter 2.1

## Reflections on digitalization efforts within standards bodies

Several carbon program standards, certification bodies, and registry operators are currently looking into adapting their standards and procedures to facilitate and make best use of digital approaches. Standards bodies such as CDM, Gold Standard and Verra are beginning to provide guidelines for project implementation and the associated MRV requirements. They play a directional role in the future digitalization process. Many standards are working on digitalizing their requirements and methodologies. Some are also pursuing the use of technology to automate processes, reduce errors, and facilitate interaction between the relevant actors.

Technology is always seen as only a means to an end, rather than an end in itself. In the context of the present climate and environmental emergencies, that end is to avert and mitigate climate change, and make all value chains, ecosystems and communities resilient to further change. To achieve this finance must flow at scale to high quality, impactful, community-engaged action via mechanisms with integrity.

It is in this sense that emerging technologies such as AI and blockchain can supplement existing technologies, such as standards platforms and quality assurance, to achieve greater credibility and trust, efficiency and practicability in action, and financial flows.

With any new digital tool or idea, we should ask 'how does this help move towards quality, impact and scale?' It is easy to be sceptical about some emerging technologies, such as tokenization, whilst with others it can be tempting to embrace the new for its own sake. Neither of these standpoints offers the discernment needed to achieve what needs to be done.

Trust and practicability are the main challenges that standards face in the context of scaling finance and action. For example, some of the most important activities that need finance, such as helping vulnerable communities to access clean energy and services, are complex to implement and monitor. This can impede trust and certainly increase both cost and time to financial transaction, as previous Navigating Reports have covered (Climate Ledger Initiative).

Technology can help on both counts. IoT (technology-mounted monitors) and AI (portfolio-level analytics) can combine to make monitoring less manual and assurance easier to deliver. In both cases trust can also be enhanced through transparent, tamper-proof data collection that mitigates the risks associated with human handling and checking.

The other area of challenge is the myriad ways in which carbon data is valued. Take the following example from agriculture: the program works with farmers across a sourcing region to improve farm health and yield whilst reducing emissions and sequestering carbon in the soil. The data that it generates might be eligible for the issuance of carbon credits for use in various forms of carbon markets, ranging from voluntary offsetting and impact contributions to compliance schemes such as domestic taxation. It could also be used to transfer mitigation outcomes between countries. In parallel, the emissions associated with production represent a liability for the companies for whom these farmers are value chain participants, as well as the local authority and national accounting regimes.

What is clear is that some of these uses of emissions data can be operated in parallel, double-reported but still accurate and credible. This would be the

case, for example, with the overlay of national and corporate inventory reporting, where a hierarchy of targets exists. Others, such as voluntary offsetting use cases, cannot be double-counted or double-claimed and still make sense. In reality this is complex, with many actors involved and many uses of data. The risk associated with getting this allocation wrong is that finance becomes inefficient and key actors are no longer certain how much action is needed to mitigate their liabilities and ultimately the climate emergency. In the worst case, it may lead to a net increase in GHG emissions. Digital and fully interoperable platforms for carbon standards can ensure robust accounting even in situations in which emission reduction sources, project types and attributes, and claims (offsetting, contribution claim) make bookkeeping more complex.

We do not need technology to establish the rules of the game. What can and cannot be double-counted or double-claimed is clear. Technology can help with practical administration, however. Blockchain especially can assist with the complexity of allocation, particularly where multiple and often competing interests are involved. It is in this context that the trust and accuracy afforded by technology can help take credibility principles to scale.

## INTERVIEW

Insight from

**CHARLES WILSON**
COO, The Gold Standard Foundation, UK

**OWEN HEWLETT**
CTO, The Gold Standard Foundation, UK

**Why is digitalization so important to Gold Standard?**

CW: The Paris Agreement target of limiting global warming to 1.5° C requires carbon markets that are ten times easier in terms of user efficiency, utility and benefits. They also need to be ten times faster in standards development, access and deployment. We believe that they also need to be ten times better at mobilizing resources for climate action. So, the market will continue to mushroom. It must become faster and bigger. At the same time, we need to be able to provide data credibility and assurance, and especially environmental integrity. This can only happen through the digital transformation.

**What digitalization efforts is Gold Standard focusing on?**

OH: Gold Standard is working on digitalizing our standards and assurance work to enable easier, faster MRV. Additionally, we are working with civil society to establish clear accounting and allocation principles and tools to ensure that benefits and liabilities are properly assigned. In this sense I would advocate for an ‘A’ to be added to ‘MRV’, to take into account ‘allocation’ in

an ever-more complex environment. You can learn more about our work via the Gold Standard website.

**You have launched the Gold Standard Impact Quantification program (GSIQ). Tell me more about it.**

CW: Yes, we decided to digitalize all aspects of the Gold Standard for the Global Goals scheme so that it is intuitive, accessible, practical, efficient, robust, compelling, overseen and transparent. Furthermore, we think it is crucial to align our activities with key emerging third-party platforms, going beyond them where we don't feel they're strong enough, to ensure Gold Standard projects can fully participate. Through our GSIQ program we want to do nothing less than influence the wider conversation on digital technology in climate, through thought and action leadership.

**But what does digitalization mean in practical terms for Gold Standard?**

OH: Gold Standard manages a standards and assurance scheme for high-quality climate mitigation, adaptation and sustainable development activities and finance. As we cover a wide range of activities, impacts and data usage, our standards documents are extensive and complex. This can make it challenging for proponents to know what is relevant to their activity, and how to reflect these requirements in design and implementation. As with many standards, monitoring, reporting and verification (the process of collecting and reporting data to meet standards requirements), and assurance (the process of auditing and assessing conformity with requirements) are largely manual at present. This will be remedied in the new Gold Standard Impact Registry and data platform, which itself will be designed to be interoperable with whichever systems Gold Standard ultimately works. This combined programme is called 'GSIQ', which stands for Gold Standard Impact Quantification.

**In early 2022 Gold Standard published a document entitled Site Visit and Remote Audit Requirements and Procedures. What is the story behind this guidance?**

OH: It all started during the COVID-19 pandemic, when everyone had difficulties visiting project sites in person. So, we started to discuss when you really need someone on site and when, given the unique circumstances, audits can be done remotely or in a hybrid way, and what the applicable rules should be. Remote assessments provide a chance to optimize the assessment's effectiveness and efficiency while maintaining the integrity of the audit process. Digital tools may reduce travel time and costs while offering the opportunity to assess more locations. Furthermore, they allow auditors to focus on the quality of the audit by reducing the logistical burden of site visits. This hopefully leads to improvements in the reliability and effectiveness of the assurance process. Remote audit techniques can be used as a complement to existing site visit obligations, to offer flexibility to projects without infringing on existing Gold Standard

for the Global Goals (GS4GG) rules and requirements. Although the circumstances were far from ideal of course, it has been useful to test how remote and hybrid audits can work.

**How can your work have an impact on other market participants?**

CW: For GS it is vital to act in a networked environment. We must work in close collaboration with certifiers, developers, governments and platforms, but also with finance and the tech community. A networked standard allows Gold Standard to connect proactively with various systems and partners in an ecosystem aligned with GS-defined requirements and principles. If we interact with other market participants in terms of digitalization, we can scale the market, especially the voluntary market. We're delighted to see that quality is becoming an important issue. Rapid scaling holds the risk of poor quality. Digitalization can help prevent this. Through its digitalization effort, Gold Standard –as the leading quality standard – has the potential to influence the community. Through the early mover advantage, the Gold Standard Foundation has an opportunity to define quality in digital solutions and its ecosystems for environmental markets and sustainable finance. It is in Gold Standard's DNA to share our work and our learnings, and so we hope that both our good ideas and our mistakes can inform and inspire quality and integrity in other organizations taking up the same challenge. We simply cannot imagine continued growth and alignment between approaches without dealing with the inevitable complexity that follows.

**What have you already learned from initial digitalization work?**

OH: Having decided to invest in this effort, we quickly engaged with the scale and complexity of the endeavour. One major learning is the need for a distinct goal for what we want to achieve. That goal must also be based on solid scientific data and a clear vision of what we want to use that data for. We also discovered that, while we have a high degree of internal literacy about these topics, it is inevitable that we will need to bring in new talent and that the organization will also look to build a group of experienced, independent experts to support our work.
With a clear vision, a detailed roadmap and the right resources supporting implementation, we are highly optimistic that we can obtain impact data more efficiently, while increasing accessibility and interoperability. We also need to focus on the allocation of attributes to different participants in climate and sustainable development finance. As the various finance mechanisms expand, both voluntary and compliance, there will be more and more potential for conflicting or double-counted claims. To avoid inefficient finance, and proponents becoming embroiled in dispute, it will be important to be clear on who gets to use what data for

what purpose, and who then does not. This is both rulebook and infrastructure, both of which we will be taking forward.

**Why are digitalized standards not yet common practice?**

CW: The main reason that our solution has not yet become common practice is the complexity surrounding interoperability and the emerging alignment of different reference frameworks, which is only a recent phenomenon. If systems cannot yet work together, and the points of reference have not been settled, it can be difficult to determine the right time to get to work. This is particularly true of many organizations like ours, which are not necessarily able to reallocate internal expertise at short notice.

Insight from
**BENKTESH SHARMA**
Senior Director for Technology Solutions, Verra, US

**Verra, a global standards body for the voluntary market, has also recognized the sign of the times and is planning to digitalize its methodologies. Like other standards bodies, Verra must collect data from various libraries in order to check it, which is neither efficient nor error-proof. Benktesh Sharma sees the following developments and hurdles for his organization:**

**What is Verra doing in terms of digitalization?**

Verra aims to use digital approaches to speed up the project development and verification process. It plans to develop a 'Digital Projects and Methodologies' platform that allows project developers better access to templates and guidance documents. Furthermore, Verra plans to allow project developers to use a fully digitized verification process based on a project-specific D-MRV platform. This platform would be designed by the project developer or third parties, in accordance with the Verra guidelines we are currently working on. Once an auditor certifies the platform, it could be used fully automated within a certain time period, without the need for additional verification. It must be noted that human intervention is still needed if the system detects a problem or parameters cross pre-defined thresholds.

**Where do you start from, and where do you see hurdles?**

D-MRV would start with simple project types like renewable energy for limited geographic regions, some agriculture land management (ALM) projects, and afforestation, reforestation and revegetation (ARR) projects, where measurements can be done by remote sensors. For other project types building a fully automated D-MRV platform will be more challenging. Also, D-MRV may not be able to do all of the verification work, so on-site visits will still be necessary for certain projects, for example.

# Chapter 2.2

## Monitoring and reporting

The measurement, reporting and verification (MRV) of climate change mitigation activities' impacts is an essential part of the project cycle under all relevant carbon standards. It is particularly important to assure the accuracy and credibility of carbon credits. However, the costs and complexity of conventional MRV constitute a significant barrier to upscaling and accelerating climate action and access to certified carbon markets (Soini, Kohli and Fuessler 2022).

Digitalization has increased in various areas in the past couple of years. However, at present in carbon markets MRV often still involves sending around reports, checklists or spreadsheets by email, and requires comprehensive on-site visits where project implementation and meter readings are checked in situ.

This traditional approach relies on manual interventions for data collection and verification, and tends to be error-prone and expensive. Manual data entry also reduces the credibility of results. With the recent rapid growth of the climate tech sector, a wide range of digital tools have become available, such as enterprise-level GHG accounting software and remote sensing monitoring platforms. Such platforms can be used for data collection and processing, and also facilitate verification. These fully integrated digital systems may provide much-needed credibility and independence to the new generation of climate solutions providers (Soini, Kohli and Fuessler 2022).

In a conventional project cycle, credits are verified and issued every pre-defined monitoring period, typically on an annual basis. D-MRV solutions allow for an integrated system of digital monitoring, quantification and verification that enable continuous certification and issuance (Soini, Kohli and Fuessler 2022).

Apart from efficiency, digitalization can also make data-gathering more robust. More reliable data on emissions savings can be reported, thereby improving the environmental integrity of project impacts. Compared with conventional approaches with a focus on manual, often spreadsheet-based data handling, digital systems are perceived to enable (Soini, Kohli and Fuessler 2022):

- **Streamlined collection and quality checks of relevant parameters in line with standards' requirements.**
- **Aggregation on a centralized platform for easy access, traceability, and transparency.**
- **Harmonized treatment of different project types to maximize synergies in the software's application.**
- **Removal of failure points in the monitoring process (e.g. due to manual data transfer and reliance on spreadsheets).**

## INTERVIEW

Insight from
**MARTIN SOINI**
Scientific Advisor,
INFRAS and CLI,
Switzerland

**Martin Soini, on behalf of SustainCERT, has been assessing digital MRV applications for different sectors, such as decentralized energy, forestry and agriculture.**

**Martin, how far has the market for digital measurement and reporting developed?**

Digital MRV is still a nascent field. We have conducted a series of interviews with commercial actors currently working on digital monitoring for carbon credit generation, and have seen that maturity in the digital technologies under consideration ranges from early pilots to established operations, depending on sector.

**Your analysis focuses on two different sectors. Where does the transition stand for digital measurement and reporting in decentralized renewable energy production, such as photovoltaic?**

Regarding PV, some companies are already well advanced in the use of digital tools for MRV. For example, for decentralized PV the spread of pay-as-you-go systems has brought about the general advancement of digital systems for measuring and billing energy services. These existing systems for MRV for carbon markets can be used at relatively low cost. They reduce the need for site visits, increase credibility because meter readings do not need to be transferred manually, work well with current methodologies and standards, and are generally very mature and scalable. This is the easiest way for many actors to enter digital MRV.

**And what about digital monitoring for clean cookstoves projects?**

The cost benefits may be less obvious with clean cookstoves, where digital temperature sensors or power meters are used to track usage time, for example. We assume that only the economies of scale associated with the mass production of clean cookstoves with integrated sensors could bring down costs sufficiently for large-scale sensor use. Cost reductions might also be achieved by equipping only a (random) sub-sample of stoves with sensors. These savings may be limited, however, because determining the baseline (fuel type and quantity, efficiency, usage time) still requires a costly household survey in most cases.

**Where do you see the advantages in terms of improving carbon markets?**

Digitalized MRV for clean cookstoves may bring considerable benefits with regard to credibility. The preliminary data indicates sensor-based measurement of usage times and frequency to be more reliable than conventional survey-based data. In addition, having key performance data available on a digital dashboard for an individual stove makes the cookstoves attractive for (retail) consumers of carbon credits, as they can track the performance of their projects transparently over time. Also, the approach allows for direct payments to households, and particularly to women, and therefore strengthens SDG co-benefits.

**Carbon removal in forestry and agriculture represents another important project type for carbon markets. What are the advantages of digital MRV here?**

Compared with technical energy systems, MRV in natural systems tends to be more complex and challenging. Conventional monitoring approaches in these areas are primarily based on extensive field data collection and approximate assumptions, such as land use and tillage factors, to determine carbon stock changes as a result of project activities. More advanced models are increasingly relevant for monitoring, and the field is developing rapidly.

**What does that mean exactly? What approaches are there?**

You can model ecosystems for forestry biomass and soil organic carbon. Many actors supporting or implementing nature-based carbon projects rely on comprehensive process-based and/or empirical modelling and machine learning approaches to obtain estimates of above and/or below-ground carbon stocks. Furthermore, comprehensive data platforms aggregate a broad range of model input data from various sources, including field measurements, satellite imagery, LiDAR, and weather information. Meanwhile, our paper looked at the in-situ measurement of soil carbon. One of the actors we interviewed commercializes recent research work on an in-situ soil carbon measurement device using inelastic neutron scattering and gamma spectroscopy to measure total soil carbon levels. A soil volume of 0.75 m3 within the 30 cm topsoil layer is measured at once. Commercial rollout is scheduled for the near future.
Finally, in one of the use cases considered in the paper, the biomass of trees is measured in-situ using RFID tag identification and efficient data entry with a dedicated app. Smallholder farmers enter the monitoring data on their mobiles and receive carbon credit payments for this. Data is automatically uploaded to a dedicated digital platform.

**And what are the benefits of these digital approaches?**

Both digital approaches allow for cost savings through high-volume sampling and the extensive use of model-based and data processing approaches, including machine learning and artificial intelligence. This reduces the need for expensive, manual in-situ field measurements. The up-front investment in modelling, technology, software, equipment and skilled labour is usually considerable, however. Thus, it is helpful that in some cases there are other drivers of intervention. For example, in agriculture, the provision of soil organic carbon data is often used to optimize farm management.

**You talked about cost savings, but what about other advantages?**

In general, the use of digital tools in forestry may provide higher levels of accuracy in determining the amount of carbon removed, for example. Digital approaches rely on broader data sources to calculate biomass volumes and emission reductions. However, in the case of soil organic carbon and woody biomass, approaches are more indirect when compared with conventional approaches, which are typically laboratory testing and field measurement. Some actors claim the accuracy and precision of their results to be superior to conventional approaches. These claims do not seem to have been independently validated at this stage. Additionally, the limited accuracy of remote sensing for carbon estimation is reported to be a barrier to adoption among certain potential customer groups. Some solutions rely on proprietary approaches and machine learning, which reduces transparency compared with conventional methodologies. Many credibility claims from tech developers and innovative start-ups are difficult to assess today, as there seems to little independent validation of many of the new approaches for a wide range of species and conditions.

**What does that mean for standards?**

Major standards bodies are planning to provide guidelines and digital tools that promote D-MRV in all sectors. However, it remains to be seen how fast they can develop the related technical and human capacity to fulfil their rule-setting role in these novel technological areas.

## A range of possible technologies and experiences

A number of technology-based solutions that aim to improve efficiency, credibility and value are emerging for measurement and reporting. Examples include the use of IoT and remote sensing technology in data collection, i.e. smart meters for renewable energy activities, usage sensors for efficient cookstoves, and remote sensing and radar to collect land use data. There are also automated model-based approaches that calculate and report 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 AI can be used to glean data from other sources for further validation, comparison and calibration in real time (CLI 2020).

Various types of actors are working on D-MRV, covering different ranges in the MRV chain. Some limit themselves to operating digital platforms and providing data, while others are envisioning or have already implemented processes along the whole chain from monitoring to issuance. Most establish partnerships to complete the link between project realization and carbon credit issuance. For example, an operator of distributed energy hardware partners with another actor to establish the digital link to certification (Soini, Kohli and Fuessler 2022).

Interesting technology options and experience from digital monitoring and reporting use cases are given below.

# Radicle

radiclebalance.com

Radicle provides a flexible and mature data management system for carbon projects, streamlining the MRV process from efficient monitoring data acquisition through to verification. The system was designed for carbon projects in the agricultural sector. It was subsequently expanded to other industries and project types, from clean cookstoves to mitigation measures in the gas industry. Thanks to high efficiency and streamlined processes, the system can substantially reduce verification costs and increase carbon credit supply. The automated digital approach removes the points of failure inherent in conventional manual monitoring steps, and therefore boosts credibility.

Built to facilitate parameter collection to the greatest possible extent, the Radicle system handles data in an integrated, centralized, and traceable manner. For example, a monitoring data point representing the display of a heat or gas meter may be saved as a numerical value backed by the corresponding photo for easy verification. Thanks to a high degree of automation, verification can shift to verifying the digital MRV platform system, including underlying data processing, calculations, etc., rather than the data itself. The system's flexibility allows for broad applicability, beyond conventional projects. Since data is stored in a machine-readable form, the system is easily compatible with various compliance markets and standards.

# FLINTPro

flintpro.com

Afforestation and reforestation monitoring is experiencing a strong push towards broad data utilization and sophisticated modelling. FLINTpro emerged from the need to provide support for the application of complex modelling frameworks. FLINTpro aims to assess carbon flows in forestry and agriculture in as much detail as possible, while remaining neutral with respect to carbon markets and standards. Clients' needs in this regard are translated into tailored models, and access to results is provided to via a SaaS application. At the core of these activities is the FLINT ("Full Lands Integration Tool") open-source software, a modular platform for land use carbon MRV. Projects are built from many consistent layers of space and time data, including satellite imagery. This is complemented by client-provided data and process-based models. With such a focus on broad data input, links to other systems through appropriate APIs are seen as paramount. The stated goal of the company – to facilitate access to ecosystem modelling for carbon monitoring – potentially translates into greater credit volumes on carbon markets.

Aerial Photography of Green Field. Source: Pexels

# FairClimateFund

fairclimatefund.nl

The development of digital clean cookstove monitoring has become an active area in recent years. However, the corresponding projects have so far been limited to a relatively small scale. FairClimateFund is a social enterprise, one of whose programs is to implement large-scale clean cooking projects for carbon credit generation. As part of a pilot project in India supported by CLI, 100 cookstoves were equipped with temperature sensors to directly digitalize activity data. The pilot phase showed that the IoT-measured usage rate of the stoves in the use case is around 66%. By comparison, other Gold Standard projects in which monitoring is done on a sampling basis report a usage rate in the range of 90% to 95% for the first year of the project. This demonstrates how conventional monitoring overestimates the impacts of cookstove projects, and the better accuracy of IoT-based monitoring. The latter thus help to generate more reliable data regarding the emission reductions achieved, and hence improves environmental integrity (see also the interview in Chapter 3).

Digital cookstoves in India. Source: FairClimateFund

# OpenHAP Project

OpenHAP

EED Advisory (OpenHAP project) is not directly involved in carbon credit generation. However, a recent research project for CLI on indoor air pollution measurement and activity tracking for cookstoves touches on many of the topics that are also relevant for MRV in the carbon credit context. EED developed OpenHAP, which is a low-cost IoT-enabled household air pollution (HAP) monitoring system. The aim was to design and evaluate the performance of a low-cost integrated HAP, proximity, and stove use sensor, and to demonstrate its utility by measuring HAP in Kenyan homes. The pilot project showed that the OpenHAP device is a reliable, low-cost option for measuring and tracking HAP. The results from the measurement campaign in low-income areas around Nairobi show that cooking with firewood as a fuel leads to HAP concentrations that are four to five times those of cooking with a kerosene or LPG cookstove. Also, it was found that cooking in a multi-room house allows pollutants to dissipate faster than cooking in a single-room house, indicating that people living in the latter households are more exposed to high HAP levels. Talks are currently ongoing with the Kenyan government on upscaling OpenHAP.

Source: EED

# Chapter 2.3

## Verification and issuance of carbon credits

Core to the supply of accurate and high-quality carbon credits is verification. This is a thorough and independent assessment of a project activities' implementation and claimed GHG emission reductions or removals. It is an element of the MRV of the impact of climate change mitigation activities, and an integral part of project cycles under the relevant carbon standards. In the same way as data collection and measurement, at present the verification process is often characterized by sending around pdf reports, checklists, and spreadsheets, and by personal on-site visits. Verifying data manually tends to be error-prone and reduces the credibility of results.

The verification process can be digitalized at different levels. At a lower level, selected digital tools are used wherever useful in the current verification process, e.g. for data checking, information management, or reporting. At the higher level, the complete verification process is fully digitalized, including automated quantification and checks. A continuous chain of automated verification would allow for the real-time issuance of credits (Oberpriller et al. 2022).

At present, verification typically includes the following elements:

- **Verification of the compliance of project implementation with documentation and standards requirements**: On-site visits and desk reviews are done to ensure that the project meets the requirements as defined in the registration phase, and to detect material deviations from project documentation and standards requirements.

- **Verification of data capture, sampling approaches, surveys, and quality control**: The aim is to evaluate and reduce the uncertainty of inputs, and to ensure robust quantification. This is done through on-site visits and desk reviews. Data is provided mainly as Excel, Word or pdf documents and shapefiles. Based on newly released guidelines, Gold Standard started to use remote site visits in early 2022 for a renewable energy project (see the interview in Chapter 2.1).

- **Verification of quantification**: The quantification approach is assessed during validation in the registration phase of a project. During verification, the focus is on the correct application of the quantification approach. The verifier manually compares the monitoring plan and monitoring report in order to verify the calculation of emission reductions.

## INTERVIEW

Insights from
**ANIK KOHLI**
Project Manager
INFRAS and CLI,
Switzerland

**On behalf of SustainCert, INFRAS has analysed the implications that digitalisation has on verification and what this could mean for the role of a verifier. For that work, INFRAS has conducted interviews with different verification and standard bodies such as the Gold Standard Foundation and Verra (Oberpriller et al. 2022):**

**INFRAS has developed two blueprints for using digital approaches in the verification process of carbon market projects. Both blueprints feature a high level of digitalization, assuming for each project type the best available and economically deployable technology is applied. Could you briefly explain the two blueprints?**

The first blueprint we call «D-VER» blueprint. The project participant develops a project specific digital verification platform or uses a third-party provider's solution. There is digital data capturing and automated data quality checks as well as quantification and reporting on the platform. The roles of stakeholders remain the same as in current verification approaches. The verifier has comprehensive access to the platform to assess all relevant project data and calculations.
The second blueprint proposes an integrated quantification and verification (I-Q&V) platform. It is hosted by an independent third-party that we call «I-Q&V entity». They provide for integrated services combining the former verification tasks with quantification and reporting of reduction claims. The role of the project participant is thus limited to loading the necessary raw data through digital interfaces on the I-Q&V platform in a fully automated way.

**The second option would significantly change the role of the verifier, wouldn't it?**

Yes, that's correct. This is clearly a paradigm shift. Currently, project participants are responsible for measuring, quantifying and reporting and there is a third-party audit for all those steps. Under the I-Q&V blueprint, data handling and quantification would be as much as possible automated and handled by an I-Q&V entity.

**How can the quality of the I-Q&V platform be assured?**

On the one hand, having an independent entity providing I-Q&V services has the potential to provide more accurate and conservative quantification. It may facilitate overcoming the problem of information asymmetry: Project participants usually have the highest level of information about their specific project and have an incentive to maximize the number of credits, which is possible navigating the gray area almost every method exhibits (options, assumptions, samples, control groups, modelling approach

etc.). On the other hands, there needs to be a new governance set-up: The I-Q&V platform's underlying processes and models, i.e. all code that is used for automatization would need to be pre-certified by a third party. The standards would publish a list of requirements all platforms have to fulfil. Where manual input is allowed, this shall be earmarked for potential spot checks by the standard.

**A labor intensive and costly part of verification are on-site visits. Will they still be needed?**

On site visits will still be required but may be made more efficient and less frequent by digital means. This is true for both blueprints.

**What impact would digitalization have on the issuance of credits?**

Generally, it remains in the hands of standards to issue credits. For both verification blueprints, there exists the option that credits are issued in real-time. This is only possible if there is an unbroken chain of automated measurement, reporting and verification. For example, this could be possible for grid connected renewable electricity generation. This implies that the code used for the automatization is pre-certified by a third party. Additionally, a certain number of credits is withheld from real-time issuance to create a buffer that allows for unforeseen problems. Another prerequisite would be the possibility for fully automized verification of sustainable development co-benefits that certain standards certify.

**Are these blueprints applicable to all different kind of project types?**

Digitalization is easier to implement for project types where digital measurement systems are already available or used and where methodologies are less complex. For renewable energy, for example, electricity production is often already metered continuously, such that few technical barriers exist to implement both types of blueprints.
For afforestation/reforestation, digitalization is more complex, but various solutions are already applied in practice.
There are, however, project types like soil organic carbon where automatization is challenging and the measurement devices and accompanying models for quantification are still under development and require significant project related expertise and manual interventions. This is particularly a challenge for the I-Q&V blueprint, as quantification would be done by the I-Q&V entity which would need to have relevant expertise. If modelling approaches require considerable amounts of "manual" work, this is both a problem of human resources and also regarding governance.

**How would you summarize the main difference between the two blueprints?**

A crucial difference between the two blueprints is the involvement of the project participant. For the D-VER blueprint, he or she

has to set up a digital D-VER platform, which entail considerable know-how and up-front costs. This will increase the barriers to enter carbon markets, especially for project participants with little experience and financial means. This is a considerable disadvantage, as those are an important target group of carbon money. This may be eased by the emergence of third-party D-VER platform service providers supporting project participants for a fee. The I-Q&V blueprint, on the other hand, has lower barriers for entrance, as the project participant's task would be reduced to implementing the project and providing raw data, which is usually her or his main know-how.

**Digital approaches may hold the key for necessary scaling of the voluntary carbon markets. Apart from efficiency gains, what are other benefits of digital verification processes?**

If done correctly, they offer the opportunity to strengthen environmental integrity and increase trust into carbon markets. Credibility of results can be increased if less manual interventions are necessary. Higher trust would in turn be rewarded by higher prices, thus, compensating potentially lower credit numbers due to more conservative approaches. Digital approaches offer a chance to lower the barriers of entry, allowing more actors access to carbon finance and the accompanying sustainability benefits.

**How can environmental integrity be improved through digitalization?**

Generally, to achieve high environmental integrity, quantification should be carried out in a conservative way such that there is a low likelihood of overestimating emission reductions or removals. Improving the quantification approach is not directly part of an individual verification, because approach and default values are usually fixed during validation, based on standards' methodologies. However, digitalization may lower the costs of measurement and data processing and thus improve availability of data to replace at times very generous default factors. Having the data on a platform allows to transparently and automatically measure uncertainties and decide if default factors should be replaced.

Insights from
**WERNER BETZENBICHLER**
Executive Chairman Verico SCE, CEO BeCe Carbon Experts GmbH, Germany

**What is the current status of digitalization in verification processes?**

Within the EU ETS, reporting and verification can be done on a digital platform. The input fields for the monitoring report are frozen so that the verifier can then check the content. The plat-

form used is an adaptation of a data management system for tax purposes, which is well experienced. The CDM has templates for monitoring reports for projects with less complex methodologies. However, they are not digitalized at a similar level yet.

**What would be the implications for verifiers if MRV processes are further digitalized?**

Building up the necessary IT expertise will be a challenge for some verifiers. Many monitoring and reporting process appear eligible for further digitization. However, there will also be the need for human expertise in the verification for digitized data, and best for also even complete digitized verification process. For projects with more complex methods, sectoral and technical expertise of the verifiers will always be required. Thus, site visits will remain necessary for many project types. Like for the traditional MRV concept a time gap between reporting and final attributing the label of verified data will remain in a digitized MRV approach, but it might be shortened significantly. The skill to assess data processing and data security will become more important for future verification teams.

**Why are site visits so crucial?**

Site visits at the beginning of a project are necessary to make sure a project is set-up according to project plan. Additionally, the technical equipment for measurement needs to be checked in order to know that data is reliable. Currently, there are still many mistakes happening at the stage of data monitoring. Additionally, there are many missing data points. While digitalization may help to reduce site visits at a later stage in the process, it will remain important at the beginning of a project cycle.

**Where do you see the biggest potential for fully digitalized processes?**

Renewable energy projects have certainly the possibility for fully automized MRV processes. However, renewables will soon be considered as non-additional, i.e. part of the baseline, so that these project types will not exist anymore for carbon markets. Projects where you e.g. measure methane are more error prone and human expertise will be required also in the future. I see potential to digitalize MRV of afforestation projects.

# Chapter 2.4

## Registry infrastructure for Article 6 actions

The Paris Agreement's Article 6 mechanisms for carbon markets require countries to 'ensure environmental integrity and transparency' and to 'apply robust accounting to ensure, inter alia, the avoidance of double counting' (Article 6 of the Paris Agreement). Any such cooperative approach under Article 6 requires the establishment of strong institutional settings, regulatory frameworks, and reliable and trusted information systems in the form of a registry. Being more bottom-up in its architecture that the earlier Kyoto Protocol, the Paris Agreement lacks the centralized institutional and registry infrastructure setting that the earlier flexible Joint Implementation (JI) and Clean Development Mechanisms (CDM) offered. Such registry infrastructure is nonetheless key to functioning accounting. These registry systems must track mitigation outcomes throughout the process cycle for ITMO transfers, including authorization, MRV, issuance, transfer, the corresponding adjustments, and cancellation, etc. (Fuessler, Guyer, and Broekhoff 2021).

More than two-thirds of countries are planning to use carbon markets to meet their nationally determined contributions (NDCs) to the Paris Agreement. Countries such as Chile, Ghana, Jordan, Singapore and Vanuatu are already building end-to-end, state-of-the-art digital infrastructures to support their participation in international carbon markets. These innovative digital solutions are rapidly evolving as a new international carbon market nears reality (World Bank 2022b). Jordan, for instance, was the first developing country to build MRV and GHG registry systems to international standards that are the key building blocks for future emissions trading. It is working with the World Bank's Climate Warehouse program (World Bank 2022c) and Partnership for Market Implementation (PMI) to develop and test this digital infrastructure (World Bank 2022b).

Sweden is another country with experience of digitalizing registries. On behalf of the Swedish Energy Agency (SEA), CLI and INFRAS analysed the potential of blockchain based technologies, and developed a demo registry system together with its IT partner, Cosmos. The study (Fuessler, Guyer, and Broekhoff 2021) focused on the potential of blockchain-based technologies and analysed options for building a registry infrastructure for Article 6 transactions. The study highlights that digital solutions can improve data collection procedures and digitalize the MRV process for international transactions. 'Blockchain, DLT and other digital innovations for electronic registry systems and MRV may provide numerous benefits compared with the use of a conventional centralized database', Jürg Fuessler, managing partner at INFRAS, explains. 'Blockchain/DLT entries are immutable. This increases security especially in the context of countries with weaker institutional capacities and governance settings. Additionally, blockchain/DLT systems may also be better suited to connect different registry systems. This allows for the linking of a multitude of heterogenous carbon markets'.

Generally speaking, if Sweden wants to implement a registry system focusing purely on its domestic needs, then a conventional database may be a better solution. Such a system may be more performant and, as a domestic system, public trust in the Swedish government and public databases is high enough that there is no need for an extra technological trust layer from blockchain/DLT. However, it will be important for Sweden to

cooperate with other partners from the Article 6 community, as collaboration is the very essence of the new market mechanisms. As an internationally well respected and neutral country, Sweden may join forces with like-minded countries to form the nucleus of an international Article 6 registry and transaction infrastructure. Based on its usefulness, trusted technology and high environmental integrity, it could attract many other host and acquiring countries with similar mindsets.

## Chapter 2.5

## Carbon Tokenisation

Digital assets related to carbon markets can be created in the form of a token using blockchain, or distributed ledger technology (DLT). This could generate greater trust and transparency within carbon accounting and carbon markets. It might also result in greater market access for carbon credits because such tokens can be more easily traded, for example. This is important for the evolution of the market. However, there are also potential risks and new factors to consider when tokenizing carbon assets. For example, steps must be taken to ensure that tokens are retired where the related credits are themselves used as offsets and retired. The re-use of such tokens for other purposes must be rendered impossible. Another hot topic is the need to limit the carbon footprint of the blockchain/DLT used to create the token.

**INTERVIEW**

Insights from
**HUGH SALWAY**
Head of Markets,
The Gold Standard
Foundation, UK

**We've heard a lot about carbon tokenization, what does it mean exactly?**

Carbon credits, which are assets that represent a verified tonne of CO2e reduced or removed, are typically issued in the form of unique serial numbers into a public registry, such as the Gold Standard Impact Registry.
In the context of carbon markets tokenization typically refers to the representation of carbon credits on a blockchain. In theory this could be done directly by either the carbon market stan-

dard that issued the carbon credit (sometimes called 'native tokenization'), or by a third party on a separate platform, as has been done for instance by the Toucan Protocol or Air Carbon Exchange. When transacted on third party platforms, it is essential that the blockchain-based representation stays connected to the original carbon credit in the issuing standard's registry. This avoids the credit being used twice, for example.
At the time of writing, the main standards serving the carbon market – including Gold Standard and Verra – had prohibited tokenization without their explicit consent. This is to ensure that, where permitted, tokenization is a cooperative process and the potential environmental, legal and reputational risks are properly managed.

**Who might benefit from tokenization?**

Proponents of tokenization point to significant potential benefits for end users of carbon credits. It is argued that it can open up access to carbon credits to a wider set of actors, including individuals. It is also argued that digital assets represented 'on-chain' can create greater trust among corporate buyers.
But will tokenization bring tangible additional benefits for those delivering the impact – the local implementing partners and communities? The potential is there, for instance if tokenization could be applied to channel upfront financing to projects to help to get them off the ground. This is still to be demonstrated at scale, however.

**What do you need to consider in terms of governance?**

A standard-setting body like Gold Standard is a trusted entity that allows finance to flow to verified impacts. That trust comes from safeguards and control mechanisms like additionality tests, and buffer pools to protect against impermanence risks. You could characterize some of the examples of tokenization over the past year as financial flows without certain essential safeguards, and there were challenges as a result.
That said, there are a number of organizations in the web3 community that are looking to build sustainable, collaborative models to apply blockchain technology to the carbon market. In addition, in March 2022 the International Emissions Trading Association developed a set of guiding recommendations for the application of digital innovation to the carbon market. These provide a good starting point for the governance and safeguards that could underpin responsible tokenization in the future. This includes principles focused, for example, on due diligence procedures, the avoidance of double-counting and false claims, as well as the sustainability of the blockchain itself. As a standard-setting body, we are now looking at how we might put these principles into operation.

**How do you assess the current rapid development in this area?**

There is a lot that can be learned from activity over the past year. Looking at the positives, it seems clear that the web3 space has the potential to leverage significant finance for carbon credits and carbon market activities, which could play a role in the market's growth.

There have been challenges, however. The original practice of tokenizing carbon credits followed a model in which credits were retired in the registry of the issuing standard, which was predominantly Verra, before a blockchain-based token was created to represent that credit. This violates the general principle that when a credit is retired, it is taken permanently out of circulation. This matters, as it otherwise becomes much more challenging to control double-counting and the claims made against carbon credits, or representations of them.

Like many innovations, we have seen a flurry of initial action. Key actors from both the carbon market and web3 community are now considering and developing safeguards and norms to underpin applications of blockchain technology and tokenization for the future in a way that incentivizes high-impact, high-integrity climate action.

**What is the Gold Standard Foundation's position on carbon tokenization?**

Gold Standard has worked for a number of years to bring the benefits of distributed ledger technology to the carbon market. We have done this through both the Climate Ledger Initiative and our involvement in the development of the Climate Warehouse, a new platform established by the World Bank to bring together data from all major registries within a central repository that uses blockchain technology.

In response to recent developments in tokenization, Gold Standard updated its registry terms of use in May 2022 to prohibit Gold Standard units being tokenized without our express consent. We are now developing the criteria that will determine when this consent is provided. This step – which is similar to action by other standards – is seen as important to make sure that tokenization moves forward in a way that is credible, sustainable, and coordinated with the issuing registry.

At the same time, we have recently established a working group focused on 'Digital Assets for Climate Impact'. It brings together project developers, web3 companies and other international experts to look at the opportunities presented by tokenization. We believe that this type of engagement is an important foundation. From it, we can collectively build a positive vision for how to realise the benefits of new and innovative solutions, while managing the potential risks.

# 3

# Digitalization for sustainable development impacts

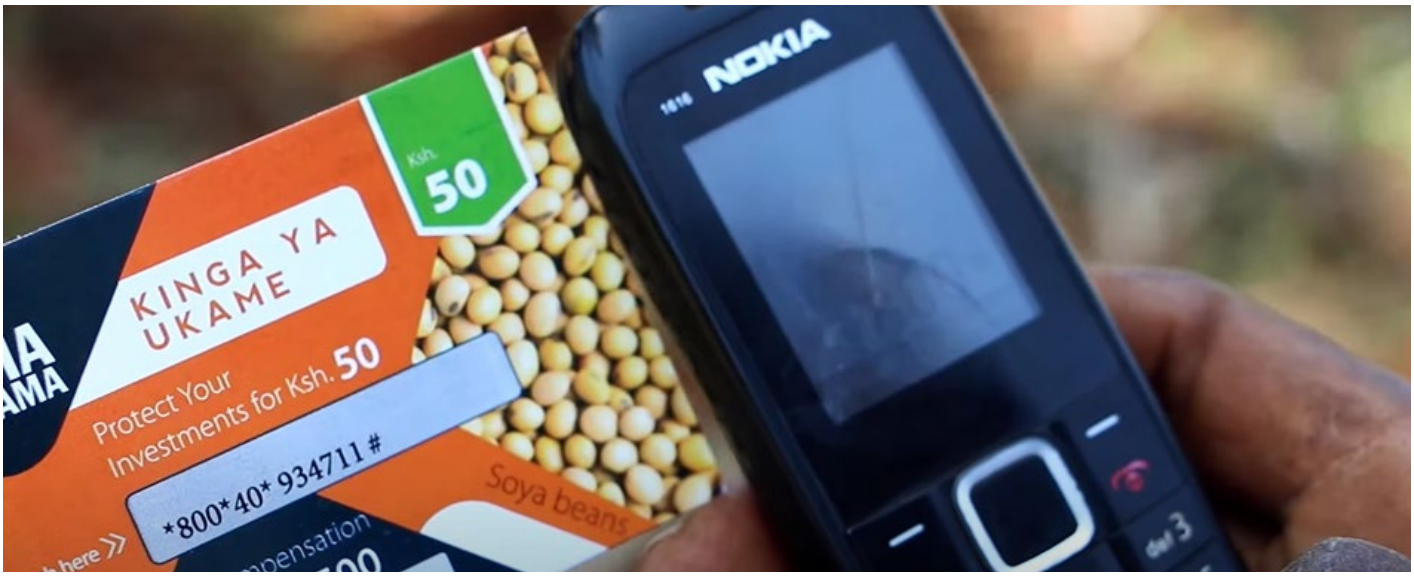
# Digitalization for sustainable development impacts

As we have seen in the previous chapters, the effectiveness and environmental integrity of climate measures that reduce greenhouse gas emissions can be improved through digitalization. However, in addition to GHG emission reductions or removals, such measures are often designed to address various other Sustainable Development Goals (SDGs). Here, too, digitalization can have a positive impact. The development and use of smart systems, AI and the internet of things can generate unique opportunities to tackle SDG-related challenges to ensure an equitable, environmentally sustainable, and healthy society (Mondejar et al. 2021). CLI-supported use cases also demonstrate the sustainable development opportunities that digitalization can provide going forward. CLI use cases show that digitalization promotes the following aspects:

- Impacts of sustainable development co-benefits become measurable, thus more reliable and visible.
- Current activities can be scaled, new market segments can be accessed, and new actors can enter the market.
- Direct payments to low-income households, and particularly women, are made possible to improve their living conditions; websites providing finance for clean cooking are one example here.

Specifically, we have been able to identify the following SDG benefits in the CLI-supported use cases:

In the Etherisc use case, Kenyan farmers are provided with accessible and transparent crop insurance that runs on blockchain. Farmers buy the 'Bima Pima' microinsurance offered by ACRE Africa in the form of a scratchcard that comes with a bag of seeds or fertilizer at the beginning of the crop season. They register and activate their insurance with their phone by sending a simple text message with the activation code from the purchased scratchcard. Once a farmer registers, the weather conditions of




Farmer using the USSD code from a scratchcard to activate his policy. Source: Etherisc

Chulika stove with sensor installed in the field. Source: FairClimateFund

the farm are monitored using open-source weather data from the ARC2 satellite. Should the farmer suffer adverse weather conditions such as excess rainfall or drought, the blockchain-based smart insurance contract can immediately issue a payout through a mobile payment network. In addition to SDG 13 Climate action, this digital crop insurance addresses many different SDGs simultaneously: SDG 1 No poverty, since it avoids farmers falling below the poverty line and SDG 2 Zero hunger, as insurance payments replace the food that subsistence farmers grow themselves. Other Sustainable Development Goals that the use case touches upon are: SDG 5 Gender equality, because 60% of smallholder farmers are women; SDG 8 Decent work and economic growth; SDG 10 Reduced inequalities; SDG 11 Sustainable cities and communities; SDG 15 Life on land; and SDG 17 Partnerships for the Goals.

Similar findings can be derived from the FairClimateFund use case (see Chapter 2.2). In this program, the Dutch-based social enterprise deployed 110 clean cookstoves, fitted with sensors, in two villages in the Raichur district of India – Ramanhal and Chickhonkuni. These households typically cook using firewood on traditional mud stoves. The system calculates cookstove impacts automatically using the international GS methodology for estimating emission reductions. In addition to supporting SDG 13 Climate action it also furthers SDG 3 Good health and wellbeing, because indoor air pollution is reduced substantially, and SDG 5 Gender equality, as less time is spent cooking, especially by women. FairClimateFund is now working on plans for the next phase, in which more technologies and geographies will be added to the platform to increase scope and scale. Most importantly, however, FairClimateFund wants to include additional features on the platform that would facilitate direct financial transfers to the cookstove users. In this way, the households using the clean cookstove would receive money directly, which would have the potential to transform their socio-economic status. The scheme generates revenue for low-income households, and particularly women, so that they can purchase or replace a cookstove. The use case thus also contributes to SDG 1 No poverty.

## INTERVIEW

Insights from
**JASMEET SINGH**
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India

**What is the FairClimateFund, and how does it address shortcomings in the way that renewable energies are applied at the household level?**

The technological innovation in this use case is defined within the framework of 'cooking as a business'. FCF has installed improved cookstoves (ICS) in rural households that presently cook using firewood. These stoves are fitted with heat sensors that can detect when someone is cooking and therefore track stove use in real time. The data is stored temporarily in a cache attached to the sensor. From there, it is extracted and uploaded to a backend server in the cloud. Cooking data received from the IoT platform is written into a blockchain, providing a real-time carbon inventory. Blockchain thus makes the entire process accountable. Impact buyers can trust the data source, and also make sure that the money is transferred directly to the impact generator. The process shortens the payment period compared with the traditional approach to climate financing. Monitoring cookstove use remotely also eliminates the costs and biases involved in conventional data collection.

**You mentioned redirecting money directly to the users. This would simplify the issuance process considerably and bring funds directly to the households, wouldn't it?**

That's correct. We are working on plans for the next phase, in which more technologies and geographies will be added to the platform to increase scope and scale. But most importantly, we would like to include additional features on the platform that would facilitate direct financial transfers to the cookstove user's account. With the increased demand in the carbon market for quality impacts and transparency, the concept – cooking as a business – will thus help to address earlier problems, such as accountability and integrity. Thus, the digital monitoring system could help to tackle climate change and make the carbon market ecosystem more fair, inclusive and transparent.

# 4

# Findings

# Findings

This year's edition of the Navigating Report has focused on digitalization and its benefits in terms of the environmental integrity of carbon markets. Based on various interviews and use case findings, we come to the following conclusions:

**Digitalization is a key means of accelerating the implementation of the Paris Agreement:** To reach the Paris Agreement goals, we need results-based climate finance and carbon markets to develop fast and with a high degree of integrity.

**Digitalization may enhance trust in voluntary carbon markets:** Digital approaches may hold the key to the necessary scaling of results-based climate finance and carbon markets. If done correctly, they offer the opportunity to strengthen environmental integrity and increase credibility and trust. Greater trust would in turn be rewarded by higher prices, thus compensating for a potentially lower number of credits due to the more conservative approaches that are necessary for greater integrity.

**Digital approaches may lower barriers of entry:** Digital approaches offer a chance to lower barriers to gaining finance. For example, it may allow more actors access to carbon finance by receiving direct financial payments via mobile phones. On the other hand, care must be taken that digital approaches do not close out populations that have limited access to technology.

**Digitalization may help to make monitoring and reporting more efficient and robust:** Many use cases already integrate digital technologies to monitor and report data. The number of technology suppliers is also increasing. The benefits of digital methods for monitoring and reporting data are clear. They improve not only efficiency, but also data reliability and credibility. This is an important condition for high quality credits.

**Wealth of data may improve quantification and methodologies:** The pervasive use of digital technologies in MRV at all levels of the project cycle can provide verifiers, standards bodies and researchers with a wealth of data. The possibility of having more measured data and replacing (at times very generous) default factors is particularly interesting. This would improve quantification and increase the quality of credits. New data should be made available via a common digital repository or platform.

**New blueprints for digital verification are emerging:** There are efficiency gains in the digitalization of verification processes, including automated data processing, streamlining documentation, and reducing site visits. Depending on the blueprint, the role of project participants and verifiers changes considerably. If an independent entity is quantifying as well as verifying emission reductions, this may boost the quality and credibility of credits. However, new forms of governance are necessary.

**Digital approaches may reduce the need for site visits:** Digitalization may allow data to be generated remotely. It may also permit remote audits. Nevertheless, site visits will remain important, particularly at the beginning of a project.

**Specialist human expertise remains important:** Digitalization may help to automate many steps in verification. This reduces paperwork for verifiers and enables them to focus on auditing the quality of calculations and the correctness of emission reduction claims. While they might require more IT

know-how, verification will still require specialist human expertise in the related carbon reduction or removal projects.

**Digital registries may increase trust and environmental integrity:** Digital solutions can improve data collection procedures, MRV processes, and international transfers of carbon credits. They can also take care of all bookkeeping requirements, such as corresponding adjustments to avoid double-counting. Additionally, Blockchain/DLT-based solutions provide immutable and trusted data storage that may be of particular interest to countries with weaker institutional capacities and governance settings.

**Blockchain/DLT allows a multitude of heterogenous carbon markets to be linked:** The bottom-up nature of the Article 6 mechanisms under the Paris Agreement requires a multitude of heterogenous carbon markets to be connected with each other. Blockchain/DLT may provide useful solutions to link different registry systems and ensure accurate accounting.

**Digital assets could increase access and transparency:** Tokens can help to increase access and to scale carbon markets. Transparency may also increase trust. Potential risks include tokens not being retired even though the related credits are. Principles are currently under development in order to ensure environmental integrity.

**Digitalization can support the achievement of the SDGs:** If done correctly, digitalization may help to measure sustainable development co-benefits. Additionally, current activities can be scaled, new market segments can be accessed, and new actors can enter the market. Finally, digitalization facilitates direct payments to low-income households, and particularly women.

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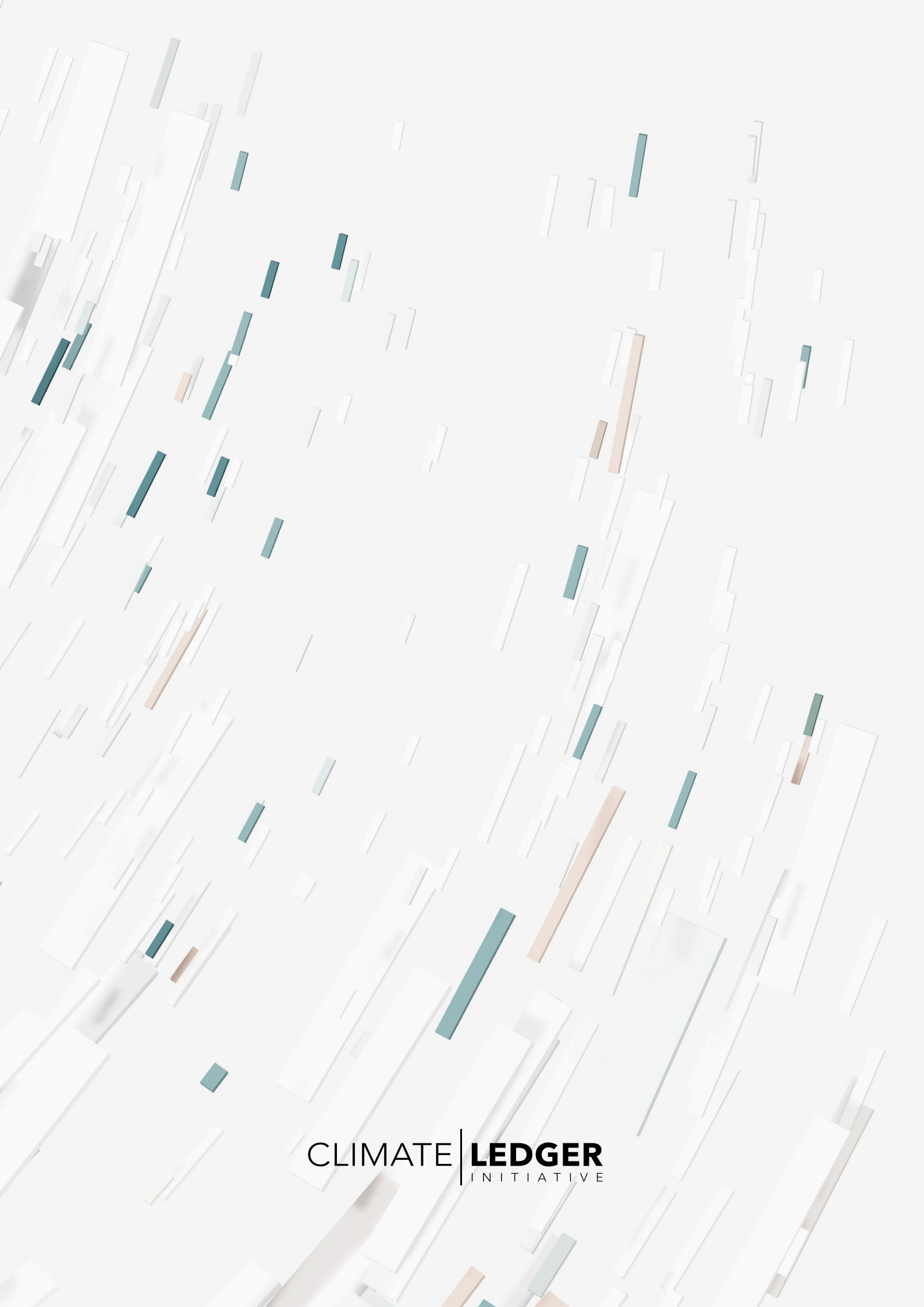
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