GSMA

Digitally Enabled Climate Finance

Access and delivery through mobile and digital technologies in low- and middle-income countries

GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing MNOs and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

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GSMA ClimateTech

The GSMA ClimateTech programme unlocks the power of digital technology in low- and middle-income countries to enable their transition towards a low-carbon and climate resilient future. We do this with the collective support of the mobile industry, as well as public and private actors. Through our research and in-market expertise, we catalyse strong partnerships, facilitating innovative digital solutions that address key challenges. Our work spans climate mitigation, adaptation and resilience strategies across the globe.

For more information about the ClimateTech programme, visit gsma.com/climatetech

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Acronyms and abbreviations

AF	Adaptation Fund
AI	Artificial Intelligence
API	Application Programming Interface
CCP	Core Carbon Principle
CIF	Climate Investment Fund
CoP	Conference of the Parties
DFS	Digital Financial Services
DLT	Distributed Ledger Technology
D-MRV	Digital Monitoring, Reporting and Verification
DPI	Digital Public Infrastructure
ESG	Environmental, Social and Governance
EV	Electric Vehicle
FSP	Financial Service Provider
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas

GIS	Geographic Information System
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
LMIC	Low- and Middle-Income Country
M2M	Machine to Machine
ML	Machine Learning
MNO	Mobile Network Operator
MRV	Monitoring, Reporting and Verification
NCCF	National Climate Change Fund
NDC	Nationally Determined Contribution
PAYG	Pay-As-You-Go
SCCF	Special Climate Change Fund
SDGs	Sustainable Development Goals
SME	Small and Medium-sized Enterprise
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market
WFP	World Food Programme

Foreword

Climate change is the most pressing challenge facing humanity and we continue to witness its impact. We have less than a decade to keep global warming under 1.5 degrees Celsius. Beyond that, the climate impacts which are already causing disruption will cause irreversible damage to our planet. By 2030, climate change and environmental degradation could push a further 100 million into poverty.

Finance is at the heart of tackling this crisis. The UK Government has committed to spend £11.6 billion between 2021/22 and 2025/26, establishing itself as a global leader in its commitment to climate action. But there is still much to be done.

One resounding message from COP27 in Sharm el-Sheikh was that significant global investment is needed for the world to transition to a low-carbon future. There is an urgent need for action from both public and private actors to mobilise and effectively channel capital.

Digital technology is uniquely placed to disrupt and accelerate climate finance. **This flagship report by the GSMA showcases models and best practices for how mobile and digital technologies can ensure vital funds reach the most vulnerable people and communities.** In doing so, it demonstrates the opportunities for transformative technologies to help counter the climate crisis.

Through the GSMA Mobile for Development (M4D) programme and other partners, the UK's Foreign, Commonwealth & Development Office (FCDO) has funded research, innovations and business models that use mobile and digital technologies to combat climate change, expanding the evidence base on how we can strengthen climate action. It is our hope that this timely report will catalyse further innovations and discussions in the climate finance space, shaping discussions at COP28 as we work towards realising the goals of the Paris Agreement.

David Woolnough
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Executive summary

Executive summary

Climate finance has increasingly taken centre stage in debates about the future of climate action. For low- and middle-income countries (LMICs) to reduce emissions, significant financial support is needed to transition to low-carbon economies and adapt to the impacts of climate change.

The importance of this issue was evident at COP27, where the financing of climate change adaptation and "loss and damage" funding was the focus of deliberations and commitments. However, there is still much to understand about climate finance, particularly who will pay for it and how to ensure the funds reach those living with the direct impacts of climate change in transparent, fair and effective ways.

With these questions in mind, the GSMA explored the role of mobile and digital technology in accelerating climate investment and financing in LMICs. Drawing from desk research and stakeholder consultations, this report presents the types of climate finance and models that are ready for digital innovation. Deep dives into different technologies and business models offer more in-depth analysis and considerations to strengthen future climate finance interventions.

At the outset of our research, it became clear that defining climate finance would not be straightforward. There is a sharp divergence between public and private sector perceptions of climate finance, with definitions influenced by the mandates of prominent institutions, existing institutional frameworks or entry points to climate investment (such as net-zero commitments). Gaining consensus in understanding is essential; how climate finance is defined will influence which financial mechanisms are used for climate action and the types of funding available.

The use of mobile and digital technologies in delivering climate finance to underserved communities shows excellent promise. Emerging solutions moving climate finance forward include frontier technologies, such as the Internet of Things (IoT) and blockchain, as well as the voluntary carbon market (VCM).

Stakeholders interviewed underlined the need for accurate data to plan and make decisions about climate finance interventions. This is especially important for the digital evolution of carbon markets, which aim to improve data quality, accessibility and resource mobilisation. VCMs can play a critical role in reducing the costs of emerging climate technologies and bringing them to market earlier. Digital monitoring, reporting and verification (D-MRV) platforms can offer more localised climate financing in LMICs, and underserved communities can receive immediate financial benefits from investment in climate-adaptive and mitigative methods through these platforms.

However, barriers still need to be overcome to integrate mobile and digital technology effectively. The research highlighted that the levels of adoption and cost of a technology, the broader climate finance ecosystem, the role of regulation and the availability of digital infrastructure and data, all influence practical application.

While climate finance is relatively new, the research shows that mobile and digital technology are uniquely positioned to provide tools that catalyse and strengthen how it is delivered. This report offers a preliminary assessment of digitally enabled climate finance to guide public and private sector actors, including financial institutions and mobile network operators (MNOs). In doing so, it seeks to support the delivery of innovative solutions and partnerships that serve communities most affected by climate change.

Background

The most climate-vulnerable countries require significant investment to help them be more prepared for climate shocks. Every country that is a signatory to the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) produces a Nationally Determined Contribution (NDC).[1] An unprecedented amount of climate finance needs to be mobilised for NDCs to be implemented effectively and achieve the goals of the Paris Agreement. This financing is delivered by the public and private sectors and detailed in Table 1.

1. A Nationally Determined Contribution (NDC) outlines national plans for mitigating and adapting to climate change.

Table 1
Sources of climate financing

Sources of financing		Description
Public sources	**Government and their agencies** 	These are resources that the government invests in climate change from their budget. Important aspects of this financing are the actual finance earmarked and provided to climate change initiatives, as well as the government's institutional capacity and level of interest in supporting projects. Funds come from national, regional, local and municipal governments.
	Development finance institutions (DFIs) 	— **Multilateral and regional institutions** have multiple shareholder countries and direct finance flows internationally — **Bilateral institutions** are owned by a single country and direct finance flows internationally — **National institutions** are owned by a single country and direct finance flows domestically
	National and multilateral climate funds 	National climate change funds are set up to receive funding from multiple high-income countries and to coordinate and align donor interests with national priorities. These funds include sources of climate financing from multilateral channels, such as: — **UNFCCC mechanisms and funds:** Global Environment Facility (GEF), Green Climate Fund (GCF), Adaptation Fund (AF), Special Climate Change Fund (SCCF) and Least Developed Countries Fund (LDCF) — **Other multilateral climate funds:** GCF Climate Readiness Programme, Climate Investment Fund (CIF), Clean Technology Fund (CTF), Forest Investment Program (FIP), Scaling Up Renewable Energy Program in Low Income Countries (SREP), Strategic Climate Fund (SCF) with the Pilot Program for Climate Resilience (PPCR), Adaptation Fund Climate Innovation Accelerator (AFCIA), Africa Adaptation Acceleration Program (AAAP), Global Ecosystem-based Adaptation Fund (EbA) and multilateral development banks (MDBs) — **Continental funds:** National Climate Change Funds (NCCFs) and Green Banks
Private sources		These include corporations, commercial financial institutions (including commercial and investment banks), institutional investors (including insurance companies, asset management firms, pension funds, foundations and endowments) private equity, venture capital and infrastructure.

Even with these financing vehicles in place, the International Institute for Environment and Development (IIED)[2] has found that less than 10% of funding committed under international climate funds actually reaches the local level, where climate impacts are most stark and preparedness and capacity to absorb climate shocks are limited. Localising climate finance in LMICs is therefore becoming increasingly urgent. When done well, localised climate investments are context-driven and innovations are tailored to local markets, where communities and local actors know how to best use the funds.

There are a variety of challenges to delivering adequate climate finance in LMICs. Our desk research and interviews with key stakeholders (see the Research approach section) revealed the following barriers:

- **Inconsistent and unreliable climate change data:** This can influence climate finance allocations and decisions about finance flows across various sectors
- **A lack of sustainable and efficient mechanisms for reaching vulnerable communities:** This impacts how effectively climate finance is delivered to the underserved
- **A lack of innovation to meet net-zero commitments and sustainability targets:** This is particularly an issue for the private sector, from which investment and commitments are crucial
- **A lack of tailored financial instruments:** These reflect the climate finance needs, contexts and diverse sectors in which financing is delivered

Various research has shown that **mobile and digital technology, if used well, can serve as a bridge between what is lacking and what could be**. This prompted the GSMA to embark on research that sought to understand the role of mobile and digital technology in the climate finance space.

2. IIED. (1 November 2019). Climate finance not reaching the local level.

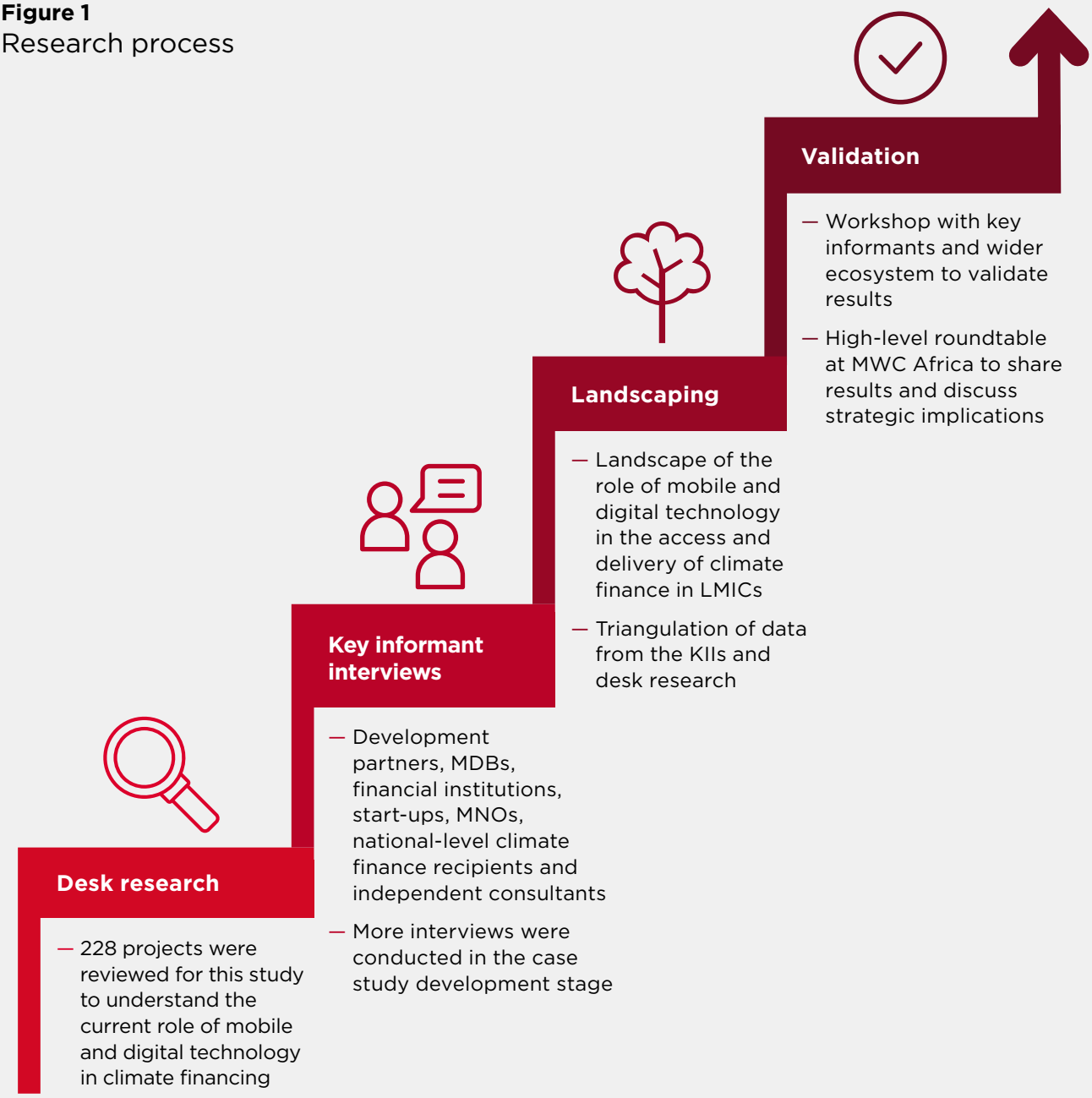
1. Research approach

1. Research approach

The objective of this research is to provide a global overview of the role of mobile and digital technology in accelerating climate adaptation investment and financing in LMICs. In addition to extensive desk research, we conducted key informant interviews (KIIs) to identify specific, localised climate finance mechanisms (e.g., NCCFs, VCMs), as well as the fiscal instruments (e.g., loans, grants, equity, insurance) used in climate finance delivery and access.

This research created a landscape of the role of digital and mobile technologies in enabling climate finance. We have delved into specific case studies to provide a clear picture of the business models, partnerships and benefits that projects currently (or might eventually) encounter when using digital technology. Our aim is to highlight use cases (albeit with different levels of adoption) that show a reasonable degree of promise for impact. The research identifies the barriers various actors face, including underserved communities, in applying digital and mobile technologies for adequate climate finance. We also offer considerations for existing and future opportunities for longer term collaboration in climate financing.

Figure 1
Research process



2. Emerging insights

Interviews with key stakeholders highlighted diverse, and sometimes contradictory, ideas about climate finance. This section of the report seeks to present a working definition of climate finance and an overview of the role of digital technology in strengthening the delivery of climate finance. This provides a snapshot of key issues, which are analysed in more depth in case studies in later chapters.

2.1 What is climate finance?

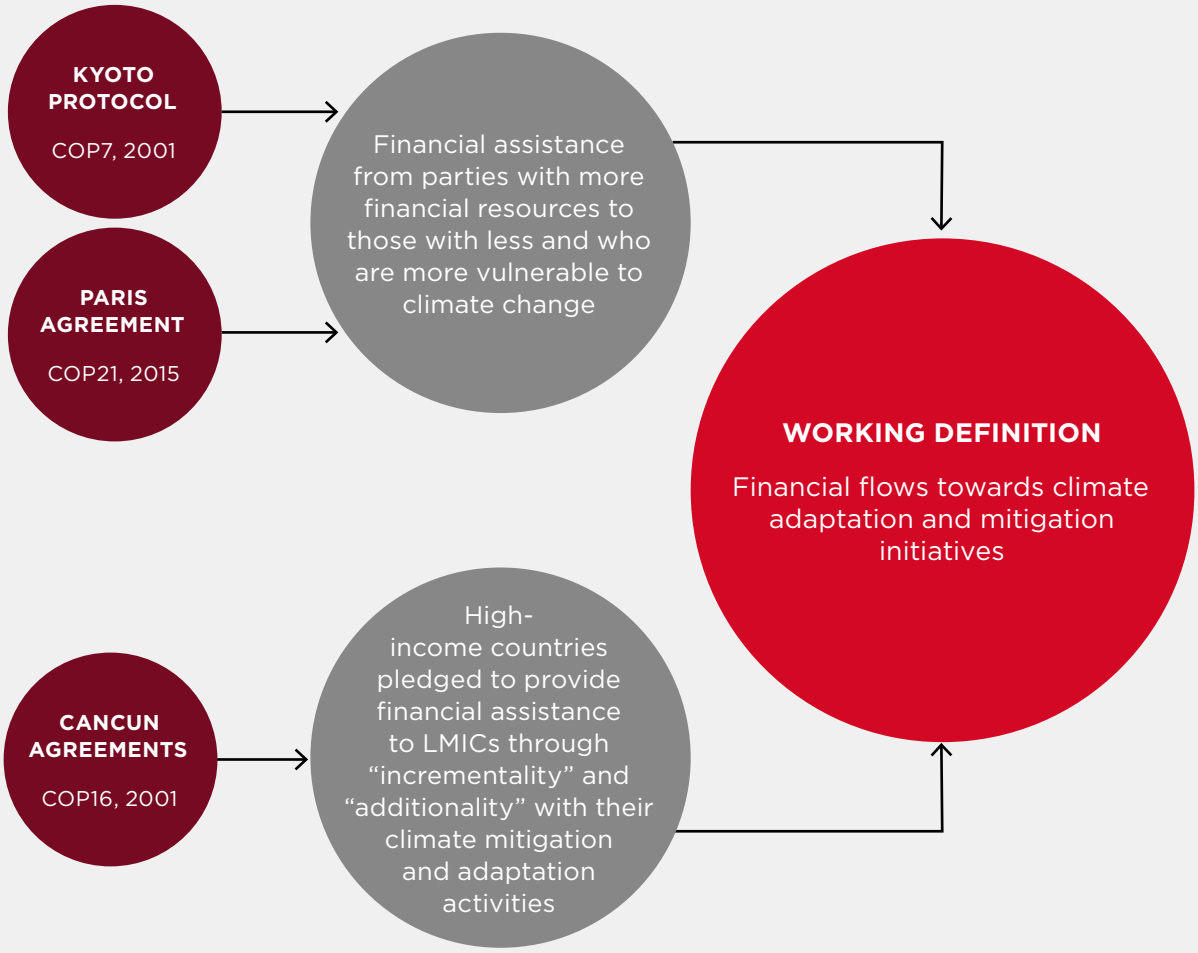
The research found divergent views on the types of funding that constitute climate finance, as well as how it should be delivered and how much funding LMICs will need to mitigate climate change and adapt to the impacts.

Public sector perspective on climate finance

Public sector definitions of climate finance seem to have emanated from various international agreements and conventions (see Figure 2).

In the context of this research, climate finance is defined as "financial flows towards climate adaptation and mitigation initiatives".

Figure 2
Public sector perspective on climate finance



Source: GSMA Mobile for Development

Climate financing can be further broken down into mitigation, adaptation and cross-cutting finance.

Figure 3
Uses of climate finance

Mitigation finance directs resources to activities that:

- Contribute to reducing or avoiding GHG emissions (low-carbon initiatives that encourage energy efficiency, renewable energy projects, etc.)
- Maintain or enhance GHG sinks and reservoirs (carbon capture, etc.)

Adaptation finance directs resources to activities that:

Reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks by maintaining or increasing adaptive capacity and resilience

Cross-cutting finance directs resources to activities that:

Contribute to both climate change mitigation and adaptation, and meet the respective criteria for each category (reforestation projects such as REDD+, etc.)*

* REDD+ is a framework created by the UNFCCC Conference of the Parties (CoP) to guide activities in the forestry sector that reduce emissions from deforestation and forest degradation, as well as the sustainable management of forests and the conservation and enhancement of forest carbon stocks in LMICs.

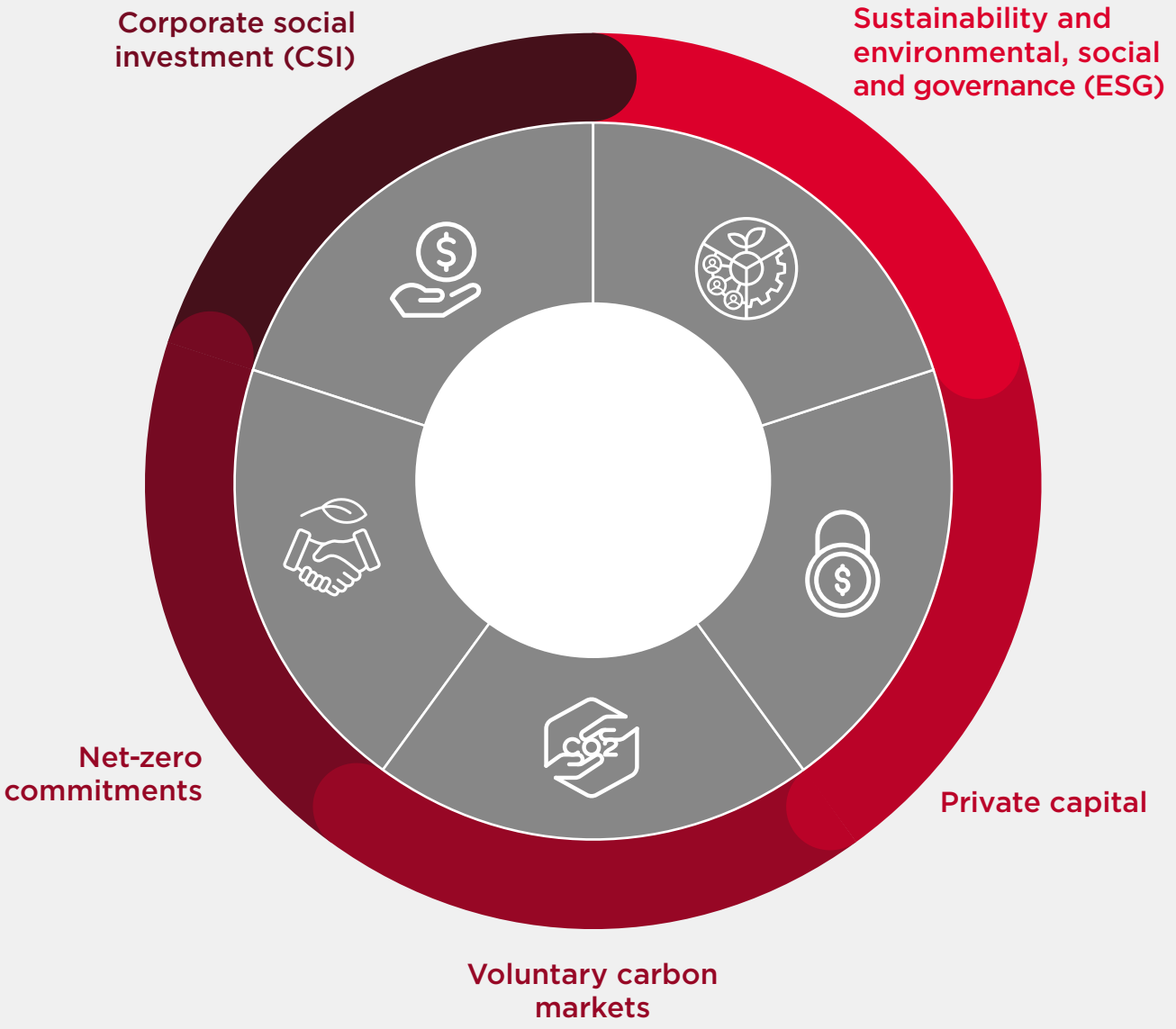
Source: OECD DAC Rio Markers for Climate[3]

3. OECD. (September 2011). OECD DAC Rio Markers for Climate: Handbook.

Private sector perspective on climate finance

The private sector includes a range of actors, from small and medium-sized enterprises (SMEs) to cooperatives, corporations, investors, financial institutions and philanthropies. Interviews with private sector players revealed that climate finance flows have been directed in a variety of ways (see Figure 4).

Figure 4
Private sector perspective on climate finance



2.2 How is digital technology linked to climate finance?

Various financial instruments are used in the delivery of climate adaptation and mitigation finance. The availability of specific financial instruments depends on i) market context; ii) existing financial mechanisms; and iii) a sector's adaptive frameworks for climate change. The continued digitalisation of the financial sector has also created preferences for certain financial instruments.

Table 2
Financial instruments

Financial instruments		Description
Grants		Transfers made in cash or goods or services for which no repayment is required
Debt		An obligation that requires one party, the debtor, to pay money or other agreed-upon value to another party, the creditor
Equity		The value given to a company's shareholders in terms of finance and accounting

There are clear opportunities for mobile and digital technology to accelerate access to climate finance and delivery, such as:

— **Credit modelling and lending:**
A lack of market information incurs costs for credit providers. Digital solutions can help credit providers:

- Understand their market and tailor products and services based on the needs of vulnerable populations
- Understand which vulnerable communities have been sidelined or excluded from economic and financial planning

— **Digital lending and insurance:**
Can be tailored to user needs and facilitated with machine learning (ML). ML can leverage alternative data, such as payments, e-commerce, social media or mobile phone activity, to make decisions about lending to climate-vulnerable customers.

— **Development of bankable projects:**
The risks associated with climate mitigation and adaptation projects tend to be highest in the early stages of implementation. Once projects start operations and deliver returns, they can be securitised and sold to institutional investors looking for stable, lower risk returns. Case studies have shown that digital technology can reduce uncertainty at the start of a project and reduce risks during implementation.

The following section details the types of digital and mobile technologies that facilitate these financial instruments.

2.3 Types of digital technology that can catalyse climate finance

Interviews with stakeholders delved into the potential of various digital and mobile technologies in LMICs. This section looks at:

- Low-tech solutions
- Mobile money
- Satellite imagery, remote sensing and geographic information systems (GIS)
- Big data, ML and artificial intelligence (AI)
- Internet of Things (IoT)/smart systems

Over the past 15 years, mobile and digital technologies have grown exponentially, increasing access to information, social networks and mobile money payments. The evolution of mobile and digital technologies such as IoT, AI, big data analysis, cloud computing, 5G mobile networks, robotics and autonomous electric vehicles (EVs), among others,[4] offer new opportunities in various sectors.

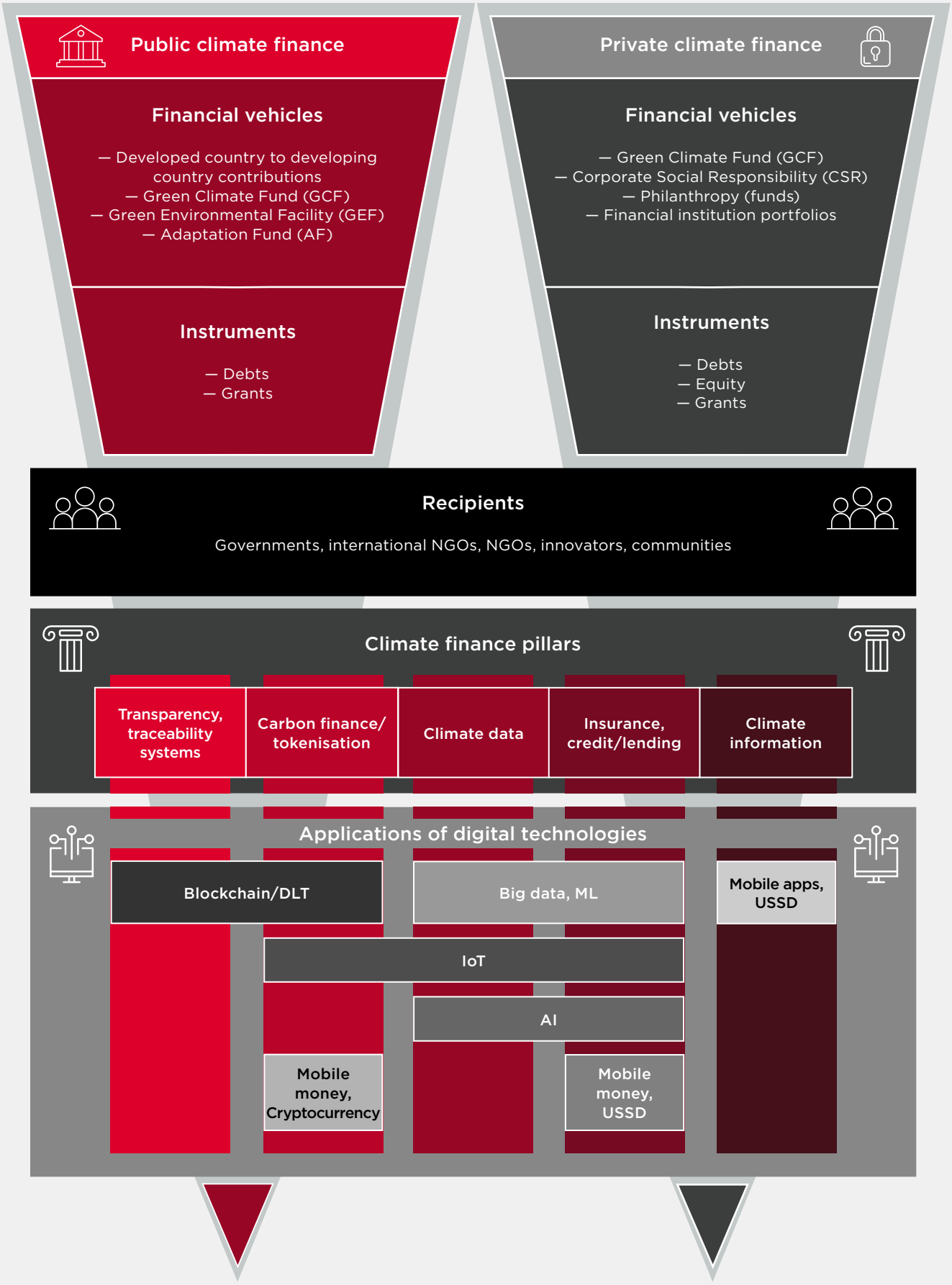
In LMICs, inadequate data, rigid financial instruments, underdeveloped financial and regulatory systems and a lack of climate information have all made it more difficult to access and deliver climate finance. Effective climate finance delivery and access are therefore anchored by:

- Climate data
- Adaptable financial instruments
- Traceable and transparent financial systems
- Climate information

Figure 5 provides an overview of public and private finance flows and financial instruments. This conceptual framework also illustrates how mobile and digital technology have supported climate finance constituents and catalysed its delivery in LMICs. Aligning these constituents will create an enabling environment in which to apply mobile and digital technologies.

4. United Nations ECLAC. (2022). Digital technologies for a new future.

Figure 5
Conceptual framework of digitally enabled climate finance



1. Low-tech solutions

What are they? Despite increasing smartphone penetration and the popularity of mobile apps, low-tech solutions continue to play a significant role in many emerging markets, with nine in 10 mobile money transactions in Sub-Saharan Africa still flowing through USSD.[5]

How do they enable climate finance? USSD has played a key role in supporting climate finance delivery, as it enables banks and other financial institutions to set up USSD services to offer financing to climate innovators. One example is providing a short code to farmers to access microloans. Off-grid renewable energy service providers can also adopt USSD to enable customers to make daily, weekly or monthly payments for the service.

SPOTLIGHT 1

DigiFarm – Kenya

About:

DigiFarm, a subsidiary of Kenyan MNO Safaricom, is an integrated mobile platform that supports the expansion of digital financial services (DFS) to agribusinesses and smallholder farmers.

How it works:

The platform offers farmers convenient, one-stop access to a suite of products, including financial and credit services, quality farm inputs at discounted prices, input loans, customised information on farming best practices, as well as access to markets. Other value-added services include insurance yield cover and extension services provided by remote agronomists from the DigiFarm call centre or on-the-ground DigiFarm Village Advisors.

Models:

- Primary platform is a USSD code (*944#). The DigiFarm app can also be downloaded from the Google Play Store.
- For contracted farmers, payments are made through e-vouchers issued by DigiFarm based on the loan awarded at the nearest DigiFarm Master Agent. For non-contracted farmers, payments are made through mobile money (i.e., Safaricom's M-PESA).

5. USSD is similar to a short message service (SMS) and uses codes made up of the characters available on a mobile phone.

2.Mobile money

What is it? Mobile money is a service that uses a mobile phone to access financial services.

How does it enable climate finance? Mobile money helps build resilience to climate change by enabling services such as savings, credit, insurance, remittances and government transfers.

For example, mobile money-enabled insurance services can address the lack of financial protection smallholder farmers have against unpredictable weather patterns. Innovative rainfall index insurance models offer low-cost premiums and payments via mobile money for crop damage or poor harvests caused by drought or excess rainfall. These services can also be linked to credit, enabling farmers to invest in agricultural inputs that enhance climate resilience and increase household and agricultural productivity, such as improved irrigation, fertiliser and pesticides.

3. Satellite imagery, remote sensing and GIS

What are they? Satellite data is generated via remote-sensing technologies, providing reliable and timely information about the earth's surface. Earth observation satellites rely on their attached payloads to collect and transmit images or other data on the earth's characteristics. The satellites are launched to relatively low altitudes, capturing images of indicators, or lack of indicators, of economic activities, urban areas and access to water, roads or electricity.[6]

How do they enable climate finance? Remote sensing and GIS can help finance providers (such as insurers and debt providers) locate large and low-income communities or groups most in need of climate finance. More specifically, this data can be useful in improving livelihoods connected to agriculture. Examples include crop monitoring and linked insurance mechanisms, forestry planning as payment for ecosystem services and disbursement of financial relief following disasters. Insurance companies and debt providers can then use GIS data to offer insurance and loans to communities based on existing agronomic boundaries and soil carbon estimation images.

SPOTLIGHT 2

Boomitra – India

Boomitra uses public and private satellites and AI algorithms to measure absolute levels of soil moisture, soil organic carbon and more. Boomitra couples these insights with carbon credit payment schemes, empowering farmers around the world with knowledge and financial tools to adopt regenerative land management practices. These practices increase soil health and agricultural yields while also offsetting significant GHG emissions. To date, Boomitra has established projects on more than five million acres of land globally with more than 100 partners.

6. Chebib, K. (15 October 2020). "Mapping poverty: Space and mobile technologies offer new perspective". GSMA Mobile for Development Blog.

4. Big data, machine learning and artificial intelligence

What are they? Big data is the availability of large data sets, which can be coupled with ML and AI technologies to make sense of the data. AI is the ability of a machine or computer to emulate human tasks through learning and automation. ML, a subset of AI, uses computer-based algorithms to find patterns across data sets.

How do they enable climate finance? Most companies focus heavily on environmental sustainability metrics in their ESG frameworks. This includes the reduction of electricity usage, changes in the fuel consumption of company vehicles, carbon emissions, gallons of water saved and increased waste diversion.

Big data has potential to generate useful insights that can support environmental sustainability and help companies improve their business performance by acting on the environmental impacts of their operations throughout the value chain. Big data enables companies to collect detailed information and share it with their consumers, suppliers, partners and competitors. As big data technology improves and companies use platforms to track and integrate qualitative data in their operations, businesses and investors alike will be better able to link big data analytics with sustainable business practices.

ML and AI can be employed to effectively and efficiently collect environmental-related data that will influence institutional policies. These technologies can help identify practices that expose companies to risks that violate ESG standards and measure a company's progress in implementing their ESG goals.

5. IoT/smart systems

What are they? The Internet of Things (IoT) is a network of internet-connected objects that can collect and exchange data using embedded sensor technologies. Data can allow devices in the network to "make decisions" autonomously based on real-time information.

How do they enable climate finance? One way of fighting climate change is through advances in machine-to-machine (M2M) communications or IoT. IoT is already offering unique opportunities to address many environmental issues, such as clean water, landfill waste, deforestation and air pollution, which will ultimately help to reduce the environmental effects of human activities.

IoT is relevant for farming communities, too. To feed a growing global population, farmers need to produce more food using sustainable methods. Current farming methods often use more irrigation water than necessary, resulting in wasted water, soil degradation and pollution from runoff. Integrating IoT technologies, such as sensors that collect data on soil moisture, weather and fertilisation levels, can help farmers optimise their irrigation and production. Autonomous tractors could take care of ploughing, seeding and spraying to reduce human labour.

IoT monitoring and automation systems could also help to scale carbon capture programmes, as outlined in Spotlight 3.

SPOTLIGHT 3

Carbon Value Exchange Platform – Global

The Carbon Value Exchange Platform (CaVEx) is a cloud-based digital marketplace that facilitates the accurate collection, verification and monitoring of data on positive climate actions from small projects, while also facilitating trade through a transparent trading model.

IoT and M2M connectivity have been used to remotely monitor activity levels through connected devices and calculate their impact on carbon emissions. By pooling and aggregating this data, the platform centralises the verification of emission reductions, significantly cutting the costs of issuing high-quality carbon credits. The exchange also enables micropayments from the sale of carbon credits to be digitally transferred directly to the individuals involved in the projects. This increases the flow of capital to locally led initiatives that combat the climate crisis and support livelihoods in LMICs.

6. Blockchain and distributed ledger technology

What are they? Blockchain is the underlying technology that supports bitcoin and other cryptocurrencies. Distributed ledger technology (DLT) includes blockchain and decentralises the process of accounting for, and verifying changes in, information across a network.

How do they enable climate finance?
Although still in its infancy, blockchain has been used to enhance the accountability and traceability of climate finance flows. It has been tested to provide solutions to two challenges:

1. **Trust:** Since many climate finance actors do not have access to data on the climate investments of other actors, there is an increased risk of double counting and spending. Blockchain can mitigate this risk and enhance trust in carbon finance data and reporting.

2. **Decentralisation:** For financing to reach the most vulnerable communities, governance and financial systems need to be decentralised. However, while national governments may see the value of decentralising the implementation of climate finance to reach the most vulnerable, they would not want to devolve functions like reporting and spending on climate flows. Blockchain can ensure that all players have a standard reporting database for easy reporting and accountability to donors and NDCs.

SPOTLIGHT 4

Climate Action Data Trust – Global

The Climate Action Data (CAD) Trust offers a decentralised meta data platform that links, aggregates and harmonises all major carbon registry data to facilitate transparent accounting in line with Article 6 of the Paris Agreement. The CAD Trust's open-source system uses DLT to create a decentralised record of carbon market activity to avoid double counting, enhance trust in carbon credit data and build confidence in carbon markets.

2.4 Adoption of mobile and digital technologies in climate finance

The ability of mobile and digital technology to provide access to and deliver climate finance will depend on the extent to which it has been adopted. Based on interview responses, we found that adoption depends on two main factors:

- **Return on investment (RoI):** integrating technologies in climate finance can be expensive, so the technology needs to advance a company's goal, financial or otherwise (such as impact)
- **Tangible applications of mobile and digital technology in climate finance:** this refers to the frequency of use of the technology in climate finance

The adoption of mobile and digital technology in the context of climate finance is summarised in Table 3.

Table 3
Adoption of mobile and digital technologies in climate finance

Mobile/digital technology	Level of adoption for climate finance in LMICs	ROI	Tangible applications	Relevance
Mobile technologies (including mobile money and USSD)	Adopted	✓	✓	There are numerous examples of the use of advanced mobile technologies, such as M-KOPA and electricity meters.
Blockchain and DLT	Infancy stage		✓	Most applications are between nations in the registry but not at the community level.
AI	Infancy stage		✓	AI has been used to interpret and triangulate satellite data. For example, AI has been instrumental in the forestry and agricultural sectors. More technical expertise is needed to apply AI to climate financing.
Satellite data	Medium stage of adoption		✓	Satellite data has been used mainly in the aggregation of smallholder farms and in forestry to implement nature-based solutions (NbS).
IoT	Medium stage of adoption		✓	IoT has been integrated mainly in agricultural systems and the delivery of utilities, such as electricity and water. The appetite for more precise data in climate financing underscores the importance of IoT.

3. Deep dives into digital climate finance models

In the stakeholder interviews, some common themes emerged around mobile and digital technologies that were either being used to access and deliver climate finance or had tremendous potential. This section features examples of digitally enabled climate finance models that are relevant to underserved communities and have a great deal of promise, but have not yet been fully explored through research or tangible applications. These include:

— Deep dive 1: **Voluntary carbon markets**
— Deep dive 2: **IoT and PAYG**
— Deep dive 3: **Fintech**
— Deep dive 4: **Digital monitoring, reporting and verification in the public sector**
— Deep dive 5: **The gender dimension of climate finance**

Deep dive 1: **Voluntary carbon markets**

Voluntary carbon markets, or VCMs, are markets in which individuals, organisations or companies buy or sell carbon credits voluntarily to offset their carbon emissions. Digital innovations play an essential role in facilitating market-based platforms like VCMs by digitising and automating data capture and verification, triangulating the data collected and making it more transparent and traceable. While VCMs are still in their infancy, they hold significant promise to deliver climate financing at the community level in LMICs and generate revenue for climate mitigation projects.

Context

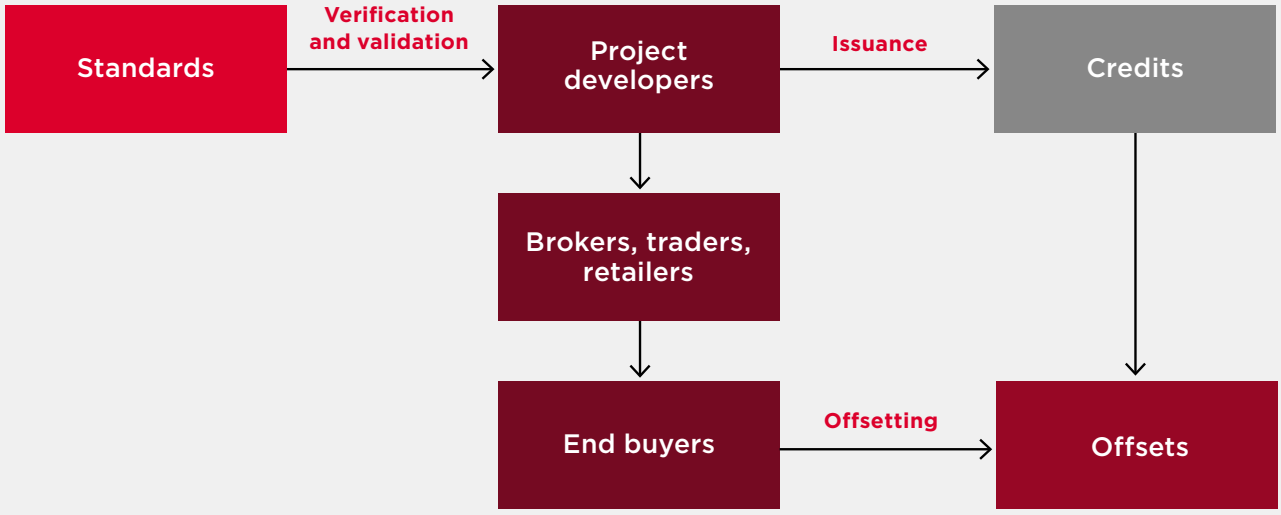
Article 6 of the Paris Agreement establishes a mechanism for governments and the private sector to engage in cooperative approaches to address GHG emissions and develop more cost-effective reductions.[7] This includes carbon markets.

To meet the 1.5°C climate change goal, companies, individuals and institutions are now participating in the VCM to offset their carbon emissions. By definition, VCMs are markets in which carbon credits[8] are purchased voluntarily rather than to comply with legally binding emission reduction obligations.[9]

Traditional carbon credits differ from premium carbon credits. Traditional carbon credits compensate individuals and companies for sequestering CO2 and other GHG emissions. Premium carbon credits are characterised by more ambitious climate action and are subject to more rigorous standards. They go beyond reducing carbon emissions to integrate social and environmental considerations in their project design and implementation that reflect the United Nations Sustainable Development Goals (SDGs), such as gender, health and livelihoods. An example of premium credits is clean cookstove projects, which promote cleaner and more efficient cooking to reduce harmful pollutants[10] and quantify additional outcomes, such as health benefits (reflecting SDG 3: Good Health and Well-being), that other climate projects may not have.[11] As a result, premium credits have a higher monetary value and provide a way to finance adaptative strategies at the local level, rather than just climate mitigation activities.

Typically, five types of carbon market players must be present for carbon credits to be issued and purchased: standards setters, project developers, brokers/traders/retailers, end buyers and offset projects. This is outlined in Figure 6.

Figure 6
Leading players in carbon markets

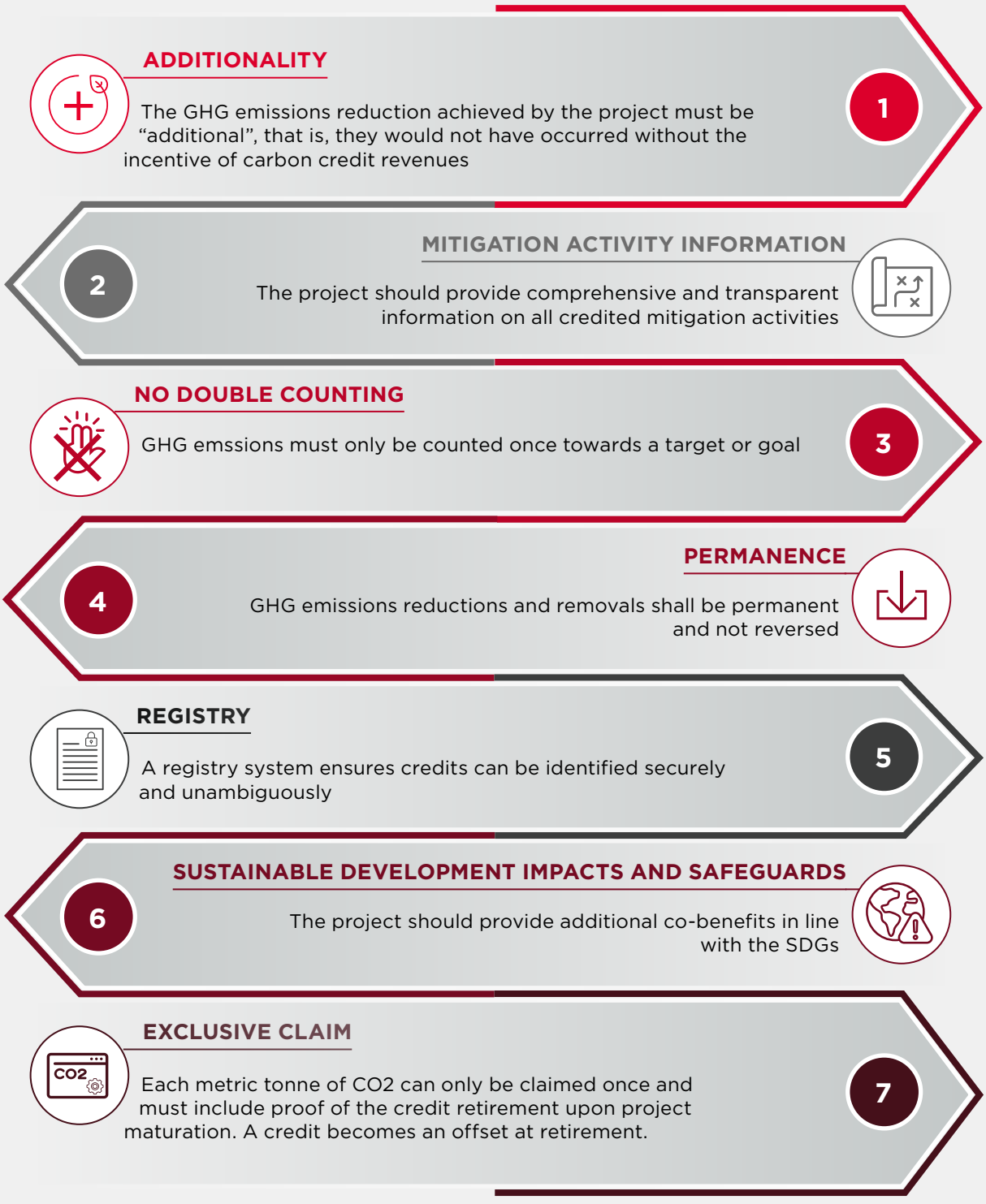


Source: S&P Global Platts

7. UNFCCC. (12 December 2015). Cooperative Implementation: Article 6 of the Paris Agreement.
8. Typically, one carbon credit in a VCM represents the removal or reduction of one metric tonne of CO2e emissions. However, the amount of CO2 emissions that must be offset to earn one credit can vary depending on factors such as the type of project (renewable energy, forestry, etc.), the location of the project and the methodologies used to measure and verify emission reductions.
9. Climate Change Committee. (October 2022). Voluntary Carbon Markets and Offsetting.
10. "Methodologies" refers to a standard set of parameters, criteria and operations required for the calculation of emission reductions or removals from a carbon project during its lifetime.
11. Streck, C. et al. (11 October 2022). "Beyond carbon – evaluating the sustainable development co-benefits of carbon projects". Ecosystem Marketplace.

These key players must adhere to core carbon principles (CCPs),[12] which ensure the integrity of the carbon credits. These requirements are determined by standards certifications offered by four primary carbon standards: Verified Carbon Standards, the Gold Standard, the American Carbon Registry and the Climate Action Reserve. There are seven CCPs to which digitally enabled platforms must adhere (see Figure 7).[13]

Figure 7
The seven core carbon principles



Source: GSMA Mobile for Development, based on the Integrity Council for Voluntary Carbon Markets

12. CCPs are used to inform and guide the assessment of carbon credit programmes and different types of carbon credits.
13. The Integrity Council for the Voluntary Carbon Market. (2022). Part 2: Core Carbon Principles.

How do VCMs support climate finance?

Climate finance facilitates the participation of projects in the VCM by providing financial and investment support and supporting the monitoring, reporting and verification (MRV) (see Deep dive 4) of innovations in the climate space.[14]

The carbon market has two entry points: the voluntary market[15] and the compliance market.[16] The VCM is, however, preferred over the compliance market since it is more fluid. It allows companies and individuals to freely register their projects and sell and buy carbon credits regardless of their geographical location or sector. This provides an incentive for companies to take more responsibility for their carbon emissions, to make progress on meeting their science-based targets and to achieve net-zero emissions by 2050.

Climate projects in the carbon market can benefit from early investment in green technologies, especially those that are more challenging to commercialise.[17] Corporations inject financing for unconventional climate projects that are designed to include the community in sequestering CO2 and other GHG emissions. For example, Safaricom, in collaboration with the Kenya Forest Service, is working on a carbon offset reforestation programme that they hope will participate in the VCM.[18]

At the national level, governments in LMICs are setting up carbon regulations to unify VCMs and make trading more stable and trustworthy. Regulations would mitigate the risk of double counting and develop a split-share formula to ensure that money from the credits goes to the key contributors, including the community. In line with this, the Africa Carbon Markets Initiative (ACMI) was launched at COP27 in Egypt to expand Climate Africa's participation in the VCM.[19]

In summary, VCMs facilitate climate finance (specifically for mitigation projects) in LMICs by helping to:

- **Drive early investment in green technologies**, especially those that are difficult to commercialise.
- **Provide an additional revenue stream for low-carbon projects**. Existing projects can participate in carbon markets if they adhere to the CPPs. The sale of credits from the projects should also compensate communities for embracing low-carbon technology.
- **Enable innovations and corporations to meet net-zero targets**. Different strategies have been embraced, including, but not limited to, financing innovations and projects that mitigate and adapt to climate change.
- **Set regulations that can organise the market**. The development of the CCPs has provided a standard for projects and innovations willing to participate in the VCM. This has enhanced the integrity of the credits and set up suitable structures for key players to participate. Various countries, such as Kenya, are also considering regulating interactions in the VCM to avoid conflict around double counting and ensure the vulnerable communities that play a key role in driving the projects are compensated fairly.

14. Strand, J. (June 2019). Climate Finance, Carbon Market Mechanisms and Finance "Blending" as Instruments to Support NDC Achievement under the Paris Agreement. World Bank Group.
15. A VCM allows carbon emitters to offset their emissions by purchasing carbon credits for projects aimed at removing or reducing GHGs from the atmosphere.
16. A compliance market is a market for carbon offsets created by the need to comply with a regulatory act.
17. Taskforce on Scaling Voluntary Carbon Markets: https://www.iif.com/tsvcm
18. Safaricom. (2020). Resilience through Transition: 2020 Sustainable Business Report.
19. Africa Carbon Markets Initiative: https://www.seforall.org/ACMI

Role of digital technology

According to the Taskforce on Scaling Voluntary Carbon Markets,[20] there have been concerns with the implementation of past carbon finance projects (see Table 4). Mobile and digital technologies can be employed to help address these challenges.

Table 4
Common challenges of carbon finance projects

Market concerns	— Markets can be difficult to navigate for new buyers (e.g., purchasing carbon credits requires technical and market know-how, understanding of independent standards and trusted references for pricing) — Buyers cannot always trust that the project is free of quality or reputational risks (e.g., some large companies have teams that conduct independent checks on projects to ensure quality) — Risk management tools are limited (e.g., limited use of forward contracts in secondary markets to manage price risk) — Limited financing and resources are available for suppliers (e.g., lack of structured finance, burdensome administrative and project development costs, limited capacity for local auditors)
Integrity and quality concerns	— Low prices can lead to concerns over the quality of credits or to a perception among buyers that there is a lack of confidence in the market — Specific methodologies require updating (e.g., some projects may no longer be additional, have flawed baseline calculations or do not include adequate safeguards) — Double counting and double claiming concerns arise from having multiple unconnected registries and a lack of guidelines for member states from the Article 6 negotiations — Worry that the use of offsets leads to greenwashing or indicates a lack of real or ambitious climate action (e.g., limited alignment on what constitutes a valid corporate claim) — Lack of transparency and concerns about credibility with the corporate use of offsetting and with point-of-sale products

20. Taskforce on Scaling Voluntary Carbon Markets: https://www.iif.com/tsvcm

In response to these concerns, which could limit the scaling of VCMs, digital market-based platforms and tools have been developed to make the generation and trading of carbon credits easier and more reliable. These are highly dependent on digital technology and have advantages over traditional platforms, which are detailed below.

1. **Market-based platforms can digitise and automate end-to-end data capture and verification.** Data quality is an important principle that all participants in voluntary and compliance carbon markets must adhere to. This is a challenge with traditional data collection approaches, which are tedious. Employing technologies to capture the data automatically minimises errors.

   Figure 8 illustrates how different technologies can facilitate the participation of smallholder farmers in the carbon market and verify their carbon credits. IoT automates data collection while satellites aggregate data and blockchain enables transparency and traceability by third-party validators. Farmers receive a pay-out for participating in the carbon market that is sent to their mobile money account.

2. **Digital technology can facilitate quick onboarding of microprojects** to platforms to participate in the VCM. Microprojects benefit from technical assistance when they align with carbon market CCPs and methodologies.

3. **Digital technology plays a key role in data triangulation, verification and accountability**. For example, satellite imagery data can be used to verify and account for data collected from agricultural or natural resource management projects.

4. **Digital market-based platforms facilitate microproject aggregation**, mainly in energy and agricultural projects. Individual participation in the carbon market is investment heavy for microprojects, but aggregating them opens access to out-of-reach markets, pre-financing and technical assistance. Pre-financing and technical assistance ensure that the microprojects meet relevant standards and use alternative climate mechanisms.

5. **Digital market-based platforms improve market visibility for buyers and sellers**. Some market-based platforms have a marketplace plug-in that lets buyers and sellers negotiate fair pricing of carbon credits. This has significantly improved the visibility of data and financial flows to buyers.

Figure 8
Example of a carbon collection and verification sequence

Carbon markets for smallholder farmers

Mobile and digital technologies enable farmers to:

— Participate in the carbon market
— Monitor, report and verify carbon credits

IoT	Satellite data	Blockchain	Mobile money pay-outs
IoT can be leveraged to collect data through sensors deployed on smallholder farms.	Satellite data is key for aggregating farmers by agronomic climate conditions and during pay-outs.	Blockchain enables verification of carbon data from smallholder farmers.	If carbon credits can be traded as digital currency, farmers can convert them to their digital currency of choice and withdraw them as cash through mobile money.

Source: GSMA Mobile for Development

6. **Market-based platforms bear the accreditation burden for microprojects**. These platforms have prior knowledge of the carbon space and direct linkages with carbon market standards.

7. **Market-based platforms have an opportunity to drive a fair share of payments** to underserved communities.

8. **Market-based platforms can help proponents of carbon credits to finance adaptation at the community level**. Carbon projects not only reduce emissions, but also help communities adapt to climate impacts, such as improving livelihoods, healthy soils and biodiversity, among other actions.

Conclusion

Article 6 of the Paris Agreement highlights how countries can "pursue voluntary cooperation" to reach their climate targets. Deliberations on the creation of a global carbon market are only just beginning. Consequently, there is still a great deal of uncertainty about how the carbon market will be applied to benefit communities and contribute to various institutional targets.

While mobile and digital technology have helped to transform VCMs, their potential and importance have not been fully recognised. Integrating digital technology in climate action can direct more financing to impactful climate resilience activities while also lowering the cost of the technology.

Looking ahead to COP28, it is hoped that deliberations will include the regulation of carbon markets. Discussions could also underline the valuable role of mobile and digital technology in supporting the integrity of the market and the communities that benefit from it.

Deep dive 2: **IoT and PAYG**

The Internet of Things and pay-as-you-go model have been applied in various climate resilience contexts. However, the intersection of these models in strengthening climate finance is relatively new, piloted primarily in the energy, agriculture and natural resource management sectors. These projects show promise as IoT technologies have helped to collect precise carbon data that has incentivised participation in the carbon market. Moreover, financial service providers (FSPs) can leverage this data to provide performance-based loans to farmers, increasing their access to credit. However, questions remain over how the IoT and PAYG model can help vulnerable communities adapt to climate change, particularly whether IoT infrastructure could be extended to both urban and rural areas and how the information gathered can be best used to manage and provide financing to safeguard against climate risks.

Context

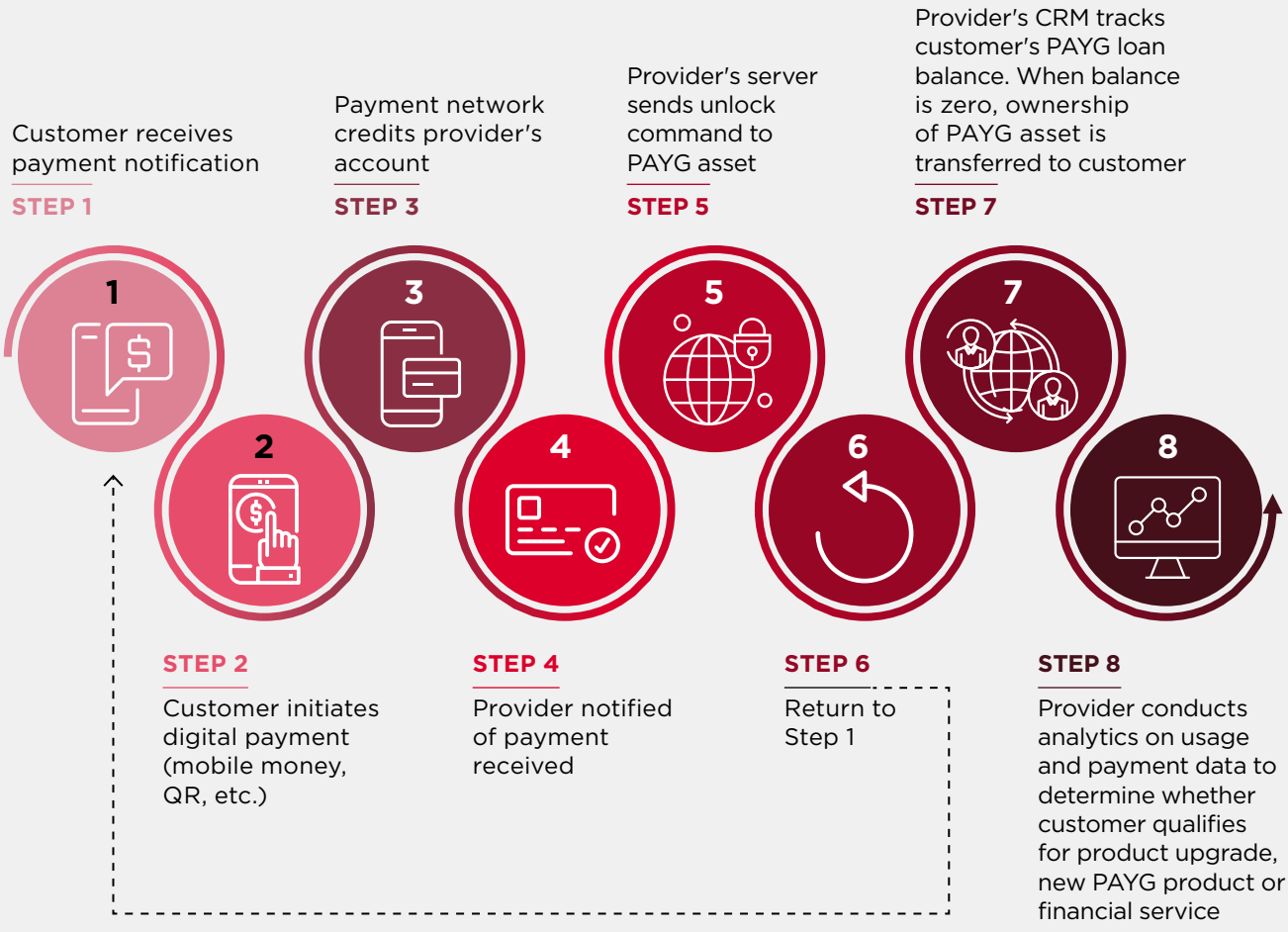
IoT and PAYG models

In climate-focused activities, the PAYG business model allows a consumer to pay for an asset (e.g., a clean cookstove or agricultural equipment) to a provider in instalments. Payments are usually made through the consumer's prepaid mobile payments account. The asset is returned to the provider if the consumer can no longer pay for the product.

IoT is a network of internet-connected objects that can collect and exchange data using embedded sensor technologies. Data can allow devices in the network to "make decisions" autonomously based on real-time information.

The integration of IoT in the PAYG model has given service providers the ability to remotely lock and unlock assets and, most importantly, access financing from FSPs.

Figure 9
How PAYG works



Source: Mastercard

How do IoT and PAYG models support climate finance?

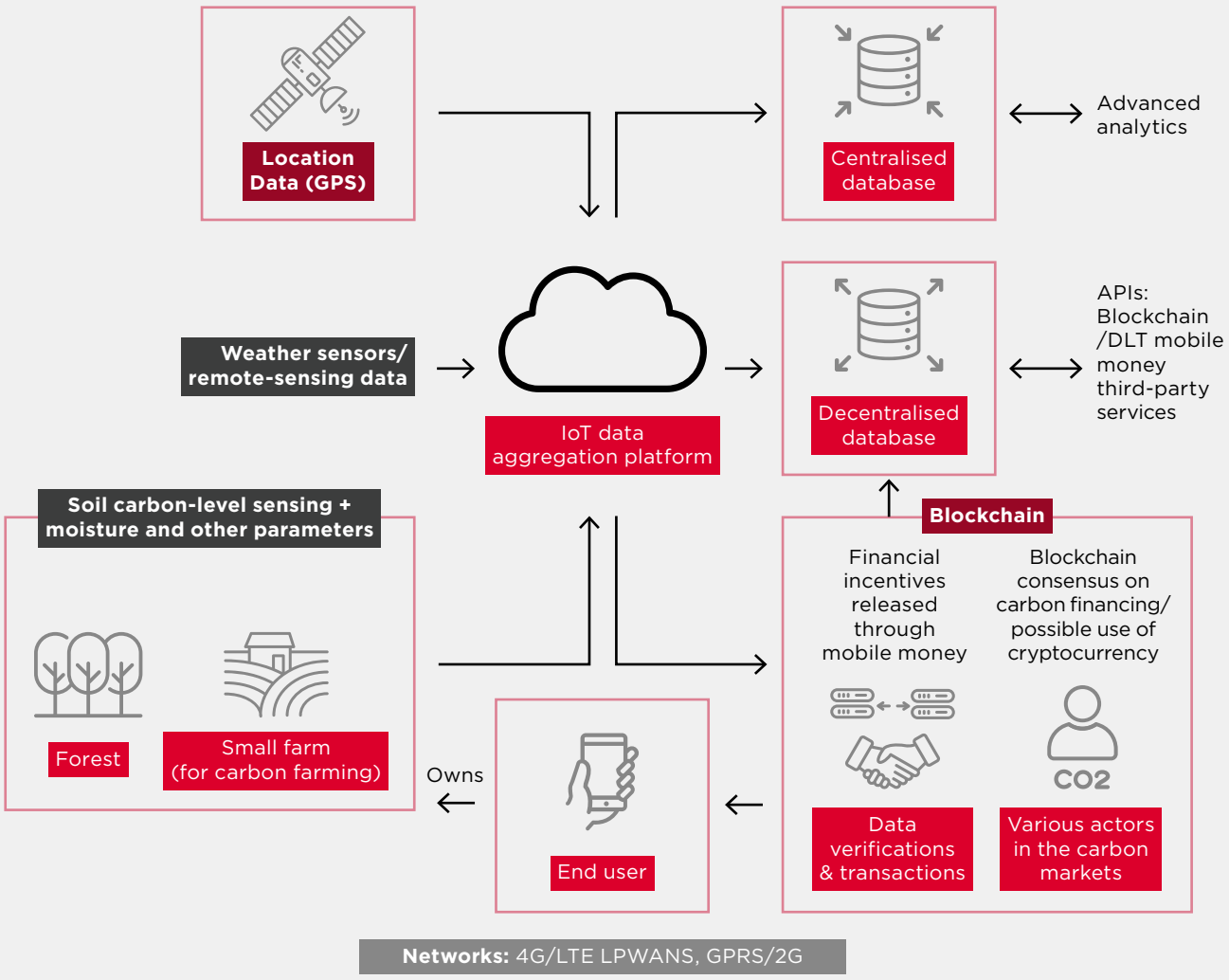
The combination of IoT and PAYG models to enhance climate finance is a relatively new concept, tested primarily in the agriculture, energy and natural resource management sectors. Two examples of how the models have been used in climate finance are detailed below.

Example 1: Climate financing in agriculture

One IoT and PAYG scenario in agriculture is the use of solar-based irrigation systems. These systems are built on IoT to manage water efficiently and to help farmers adapt to the effects of climate change. A PAYG model allows farmers to eventually own the irrigation system or return it to the manufacturer at the end of the usage period. Meanwhile, the IoT data provides precise information on the farmers' activities (see Figure 10) – data that FSPs need to accurately estimate how much climate finance to provide a farmer, either in the form of insurance or a loan.

This model is particularly effective when key stakeholders work in partnership. An ideal ecosystem would be a collaboration between an MNO, a financial institution, an IoT and a PAYG service provider.

Figure 10
IoT, PAYG and climate financing in agriculture and natural resource management



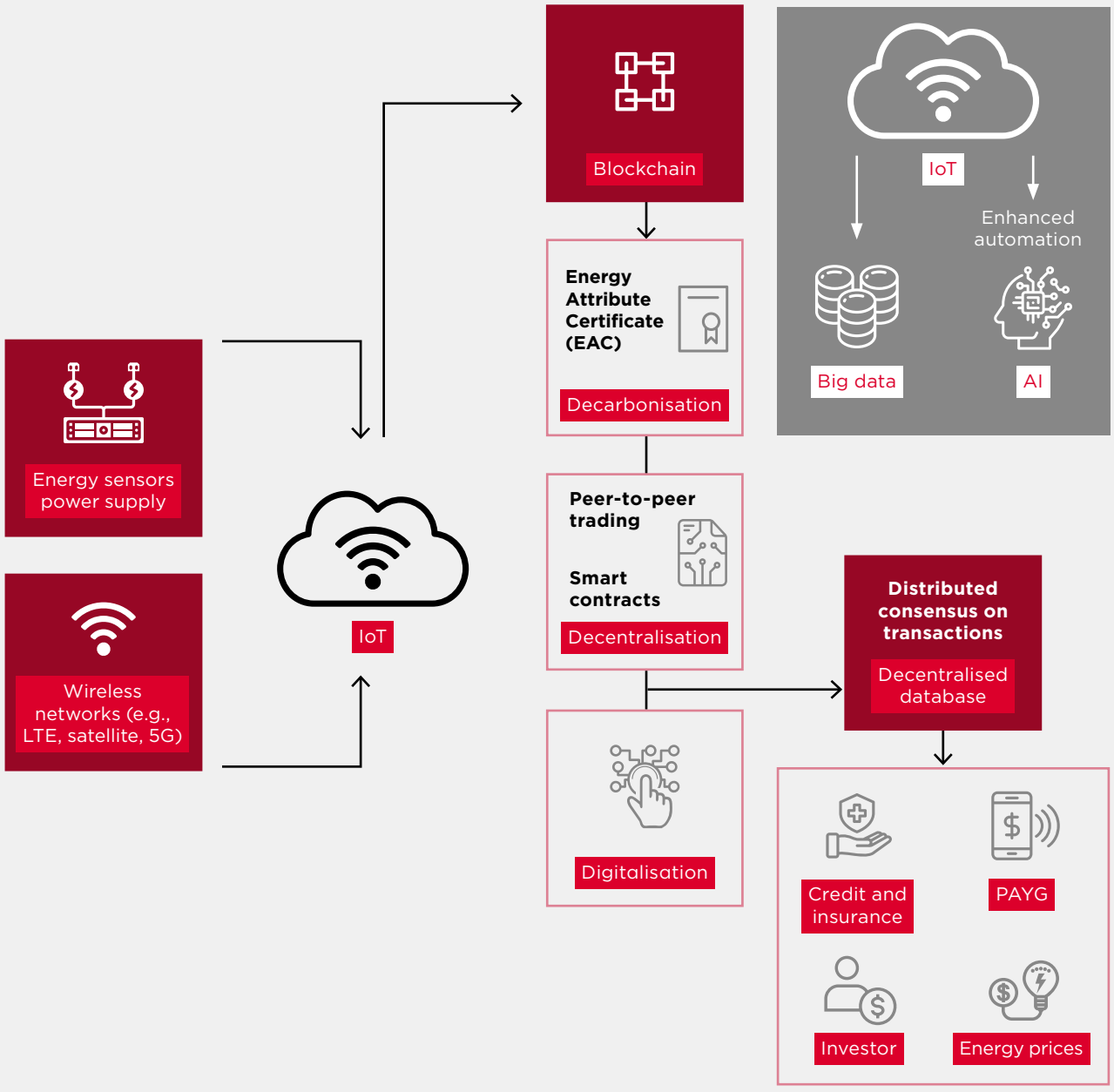
Source: GSMA Mobile for Development, based on research interview responses

Example 2: Climate finance in the energy sector

The energy sector can harness two financing options from IoT and PAYG models: traditional financing supported by data and carbon financing.

Traditional financing supported by data can facilitate access to credit and insurance from financial institutions. Figure 11 illustrates how data sets from IoT technology (customer usage, payment behaviours and asset health), combined with AI, can better tailor products and services to customer needs. Such data can also help PAYG service providers secure more climate financing to scale their services or accurately determine the cost of service packages based on the customer's location and income level. This is exemplified in Spotlight 5: M-KOPA.

Figure 11
IoT, PAYG and carbon financing in energy



Source: GSMA Mobile for Development, based on research interview responses

SPOTLIGHT 5

M-KOPA – Kenya, Nigeria and Uganda

M-KOPA, an African company founded in 2012, is one of the largest PAYG solar providers on the continent. Operating in Kenya, Nigeria and Uganda, M-KOPA has connected more than a million customers and provided more than $600 million in credit. M-KOPA has always believed in the value of digital payments and IoT technology for their customers and their business. The company has invested in connected PAYG assets and continues to use the data they generate to improve business operations, strengthen customer relationships and bring customers into the financial system.

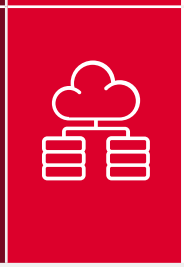
Based on the success of their PAYG solar business, M-KOPA has extended their financing to new product offerings, such as smartphones, cookstoves and water tanks. M-KOPA has also sold more than 120,000 PAYG TVs, with most of these customers upgrading from a basic solar home lighting system. In Kenya, M-KOPA transfers customer credit reports to the central credit bureau. By extending additional financial services to their customers and helping them create first-time relationships with formal financial institutions, M-KOPA is helping to place their customers on a path to financial inclusion.

Carbon financing can accelerate the scaling up of clean technologies that use the PAYG model for energy access. Projections show that carbon credits (see Deep dive 1) can help subsidise the cost of clean energy alternatives and make products more affordable for low-income households. For companies that have successfully embraced this business model, the carbon credits provide additional revenue streams to serve lower tier markets without compressing margins. IoT provides critical and precise data, and using blockchain can ensure that the carbon data is not altered. This is important for transparency and traceability, which are key for just pay-outs to households that have invested in this alternative approach.

Role of mobile and digital technology

The IoT and PAYG model is a digital-driven model that enables efficient data collection and can facilitate performance-based financing and carbon financing. IoT technology has played a key role in collecting data sets on customer usage, payment behaviours and asset health. This new development is due to the various functions that IoT introduces to the PAYG model,[21] as outlined in Table 5.

Table 5
The function of IoT in the PAYG model

Remote control		PAYG products, with embedded IoT technology and strong connectivity, enable the PAYG model to work. PAYG providers can remotely turn devices on and off based on customer payment behaviour, which reduces their overall risk. **Impact:** Enables better finance and risk controls
Data collection		Data aggregation supports many analytical use cases, including credit scoring and market intelligence on product and service offerings. **Impact:** Enables new product and service offerings

Source: Mastercard

Conclusion

The combination of IoT and PAYG is being used by innovators in the energy, agriculture and natural resource management sectors, and could have an impact on climate finance. The business models outlined in the energy and agriculture sectors are uniquely positioned to provide quality data that can inform decisions about access to performance-based loans and participation in carbon markets.

With growing evidence of its potential application, the IoT and PAYG model could expand to other sectors impacted by climate change in LMICs.

21. Mastercard. (May 2018). Pay-As-You-Go and the Internet of Things: Driving a New Wave of Financial Inclusion in the Developing World.

Deep dive 3: **Fintech**

Fintech is the integration of technology in financial services to improve customer usage and delivery.[22] From a climate finance perspective, fintech contributes to the financial inclusion of vulnerable communities by providing products and services (such as loans and insurance) tailored to their specific climate-related needs. This is enabled by the rapid development of DFS, inclusive financial innovations and mobile phone ownership in LMICs. Despite the potential of climate fintech to improve access to and deliver climate finance, there are numerous regulatory challenges that need to be addressed for it to achieve full impact.

Context

Fintech is reshaping the future of finance. Fintech innovations are anchored on two key pillars – reach and speed – with commercial models designed to reach as many people as possible, including vulnerable communities, in real time. The fintech industry requires an efficient, frictionless ecosystem to thrive, and the cooperation of key players, such as regulators, banks, FSPs, product service providers and digital credit providers. Favourable regulations and sectoral collaboration can increase participation and support for fintech innovations to ensure they meet their commercial goals.

Several enabling conditions are necessary for fintech to help vulnerable communities gain access to financing. These include, but are not limited to:

1. **The availability of mobile and digital payments**. Fintech innovations depend heavily on mobile and digital technology for data and enabling instant payments.

2. **The ability to facilitate end-to-end digital payments**, regardless of location. This was tested during the COVID-19 pandemic when mobility was restricted and there was a greater need for remote solutions. Fintech innovations enable key parties (e.g., buyers and sellers) to send funds instantly.

3. **Increased competition with the banking sector**. As fintech has challenged traditional banking systems, innovations have reshaped products and services, market players and structures and provided alternative forms of money (e.g., mobile money, cryptocurrency). This is driven by changes created by competition in the broader financial sector.

4. **The ability to manage personal finances**, primarily for vulnerable communities. Mobile wallets enable end users to better plan their personal finances, which can also become collateral for loans from fintech innovations.

These enabling conditions depend on a country's financial regulations and the ability of innovations in the industry to upscale. For example, when developing M-PESA (mobile money fintech) and M-KOPA (lending) services, the Central Bank of Kenya accepted a "sandbox" regulation for innovation. While both were designed as commercial businesses, the services have facilitated access to debt and asset financing for climate-related activities, such as improved access to solar-powered devices.

22. Kagan, J. (30 June 2022). "Financial Technology (Fintech): Its Uses and Impact on Our Lives". Investopedia.

How does fintech support climate finance?

There are two important ways that fintech supports climate finance access and delivery: through greater financial inclusion and the development of climate fintech.

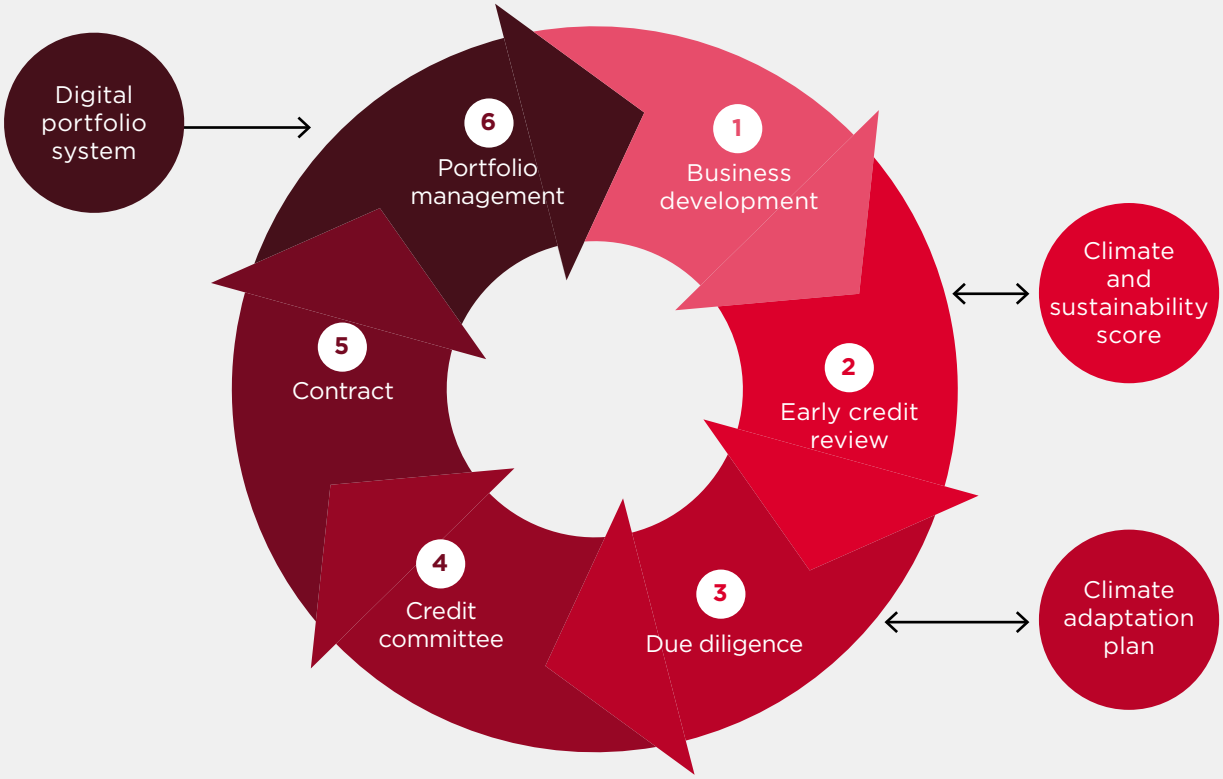
Financial inclusion

The fintech industry can provide innovative products and services that finance climate adaptation and mitigation actions. For example, climate change research shows that many small enterprises and smallholder farmers lack the financial muscle to invest in climate-smart agriculture, given the challenges in securing credit from traditional FSPs.[23] Such financing is more likely to be offered by fintech innovations, which can provide more tailored products that better absorb the risks associated with these consumers. Spotlight 6 features ADAPTA, a climate adaptation fintech in the agriculture sector that offers products designed around climate-specific risks and considerations.

SPOTLIGHT 6

ADAPTA – Kenya

Figure 12
ADAPTA's Climate Smart System



ADAPTA is an innovative climate adaptation and sustainability fintech serving the agriculture sector. This US- and Kenyan-based company seeks to strengthen the climate resilience and biodiversity practices of farmers and agricultural SMEs while also supporting their expansion plans. ADAPTA uses data and climate technologies to facilitate lending decisions and improve agricultural risk management. For example, their Climate Smart System (CSS), as highlighted in Figure 12, finances smallholder farmers and pastoralists through farmer cooperatives, savings and credit cooperatives (SACCOs) and aggregators. ADAPTA plans to offer this climate sustainability tool to lenders and investors to facilitate greater access to finance.

23. Liu, D. et al. (2022). "Financial inclusion and its influence on economic-environmental performance: demand and supply perspectives". Environmental Science and Pollution Research, 29, 58212–58221.

Climate fintech

At the intersection of the climate and fintech industry, the climate fintech sector combines digital innovations, applications and platforms as crucial financial intermediaries and mediums between all stakeholders pursuing decarbonisation. Climate fintech is inherently green and supports sustainable development[24] in the following ways:

- **By guaranteeing green finance:**[25] Green finance is a financial innovation aimed at solving environmental problems. Climate fintech remits green finance to support environmentally friendly business models focused on water, air quality and clean energy, among other areas.
- **Fostering efficiency:** Climate fintech has reduced the transaction costs of business models in sectors impacted by climate change. For example, FSPs can use data on growing conditions, such as temperature and humidity, to provide loans and insurance to smallholder farmers. This information can help them recognise and manage risk, which accelerates financial decision-making.
- **Lowering costs and information asymmetry:** Data derived from climate fintech business models can help FSPs recognise and reduce risk.
- **Valuing nature's assets:** Blockchain has played a key role in tokenising[26] natural resources. For actors that are carbon neutral, blockchain offers traceability and assurance that these assets are not double spent, while tokenised assets can be collateralised for use in lending or insurance.
- **Offering a solution for sustainable finance:** In contrast to traditional financing sources, climate fintech innovations have provided affordable finance to vulnerable communities to propel a green transformation.

Role of digital technology

Digital technology underpins the fintech industry, particularly through the provision of data management and sharing, end-to-end digital payments and unified payment systems.

Data management and sharing

Fintech innovations thrive on data management and sharing. For example, AI and ML can play a major role in providing personalised advisory services to end consumers (such as farmers). End users can also access information on the amount of loans they can borrow from a financial institution. In addition, blockchain is used to ensure that systems are transparent and traceable, although this application is still in the exploratory stage.

End-to-end digital payments

Mobile technology, as highlighted earlier, is a key factor in fintech operations. Mobile technology has facilitated mobile wallets that, in turn, enable end-to-end digital payments. These payments can facilitate the traceability of climate finance to vulnerable communities, including those who have traditionally been excluded from financial services. Access is influenced by mobile ownership and usage, which are still barriers among certain demographics in LMICs. However, the increased access and use of mobile money and wallets have allowed traditionally excluded groups to access financing and other DFS.

Unified payment systems

Various country-level regulators in LMICs have established public infrastructure to support private innovations in the fintech industry. For example, the National Payments Corporation of India (NPCI)[27] has developed a unified payments interface (UPI)[28] that enables users to transfer money directly from one bank account to another in real time. This could be from a customer to a business or between individuals.[29] From a climate finance perspective, fintechs are expected to benefit from unified payment systems by facilitating transparent and traceable climate finance flows that national governments can use for climate decision-making and planning. The data on climate finance flows also captures climate investment at the national level to meet NDCs.

24. Cen, T. and He, R. (2018). Fintech, Green Finance and Sustainable Development. Proceedings of the 2018 International Conference on Management, Economics, Education, Arts and Humanities (MEEAH 2018).
25. Green financing is financial flows (from banking, microcredit, insurance and investment) from the public, private and not-for-profit sectors to sustainable development priorities.
26. "Tokenisation" refers to the process of issuing a blockchain token (specifically a security token) that digitally represents a real tradeable asset.
27. NPCI: https://www.npci.org.in/
28. Das, N. (4 June 2022). "What Makes India's Unified Payments Interface (UPI) A Global Test Case?" Outlook India.
29. Ibid.

Conclusion

Disruptive technologies emerging from the fintech industry have immense potential. However, to harness their full capacity in the access and delivery of climate finance, key stakeholders must work together to address the following challenges:

- **Data protection, privacy and empowerment:** Improved data-sharing agreements in the fintech industry would reduce information asymmetry and reduce the costs associated with tailoring services and products. This would also increase the number of financial services and products designed to adapt to and mitigate climate change.
- **Regulations:** For the fintech industry to support climate action efficiently, financial regulations must be streamlined, non-prescriptive and reviewed periodically. This will not only allow for cutting-edge innovations, but also help them to scale. For example, M-PESA and M-KOPA host financial products and services that provide financing for climate-related actions, such as loans to vulnerable groups. National regulators need to allow for "sandbox" regulations to pilot such innovations.
- **Investment heavy:** Fintech innovations are an alternative way to finance risky development solutions, including for climate adaptation. This is because many of these innovations require significant upfront investment and are considered high risk, making it difficult for them to secure traditional financing. For example, climate-smart agriculture often requires substantial initial investment that many traditional financiers are unwilling to provide. This is where fintech can have a particularly strong impact.

Deep dive 4: **Digital monitoring, reporting and verification in the public sector**

Monitoring, reporting and verification (MRV) to support climate finance first emerged in the UNFCCC process for the 2007 Bali Action Plan, which directed Parties to ensure their mitigation actions were measurable, reportable and verifiable. Since then, momentum for establishing robust MRV systems that cover all climate finance flows has grown. Despite its importance, designing MRV in climate finance systems has encountered challenges relating to institutional factors, definitional issues and reporting systems. Digitising the MRV process has helped combat the costly, error-prone and time-consuming processes associated with reporting NDCs.

Context

MRV provides a system for quantifying and tracking progress on climate actions towards emissions reduction targets and verifying that these targets have been met. MRV is defined in Table 6.

Table 6
Definition of monitoring, reporting and verification

Monitoring	Monitoring and estimation of funds that have been secured/ allocated and mobilised to finance climate actions.
Reporting	Periodic reporting of climate finance information in a transparent, straightforward and disaggregated way that allows data to be compared over time.
Verification	Verifying and validating information to ensure it is correct and accurate. Verified information is useful for assessing whether resources are being used effectively.

Source: GSMA Mobile for Development desk research

Under the UNFCCC, countries are required to use MRV processes to ensure their GHG inventories and progress on NDCs are reported accurately. This is facilitated by a transparent framework for action and support, which is designed to be flexible and consider the different capacities of the parties involved. It builds on the collective experience from the MRV process.[30] However, reporting is undermined by inadequate data collection, management analysis tools and structure. This inhibits the development of a digitalised, bottom-up national tracking exercise that could streamline routine reporting processes.

The public sector would benefit from a digitalised MRV process because it:

- Enables national and international policymakers and actors to make informed decisions about climate change adaptation, mitigation and resilience
- Serves as a planning tool for national governments, which can use the data to project their country's future climate needs
- Provides data on impact and evidence of suitable coordination mechanisms for various climate actors
- Unlocks new financing for national climate action and provides data to help countries identify their financial and technical needs

Application

As highlighted above, traditional MRV frameworks play an important role in public climate finance. Traditional MRVs call for country baselines of climate change adaptation and mitigation activities, against which progress is measured over time. The baselines are also established on national standards that outline the importance of partnerships and community participation across priority sectors. Once countries have established baselines and adhere to standards, they can focus financing on key climate adaptation and mitigation actions. However, this requires data to be collected on the priority climate activities.

To ease this burden of data collection, countries have developed an open-source MRV system that enables data to be captured at the individual project level, as well as sector and national levels. However, data is still subject to third-party verification. Verification bodies are expected to sift through large volumes of data to double-check accuracy, transparency and compliance. This is a tedious and lengthy process for countries.

The role of digital technology in monitoring, reporting and verification

Challenges in the traditional MRV process have prompted the use of digital technology to streamline data collection, processing and quality control. This has created digital monitoring, reporting and verification systems (D-MRV), which integrate mobile and digital technologies in a comprehensive data collection approach, using standardised data exchange and application programming interfaces (APIs).[31] Examples of such technologies include smart sensors, satellites and drones, cloud computing, AI, IoT and blockchain encryption.

The interconnectedness of these technologies in a D-MRV system helps projects to communicate outcomes in real time, which has made reporting faster, more consistent and accurate. D-MRVs have enabled projects to connect to other sectoral, national and international registries,[32] which helps to streamline MRV processes for national climate action plans and activities.

An example of a D-MRV is the United Nations Development Programme (UNDP) climate-focused digital public infrastructure (DPI), which is detailed in the following section.

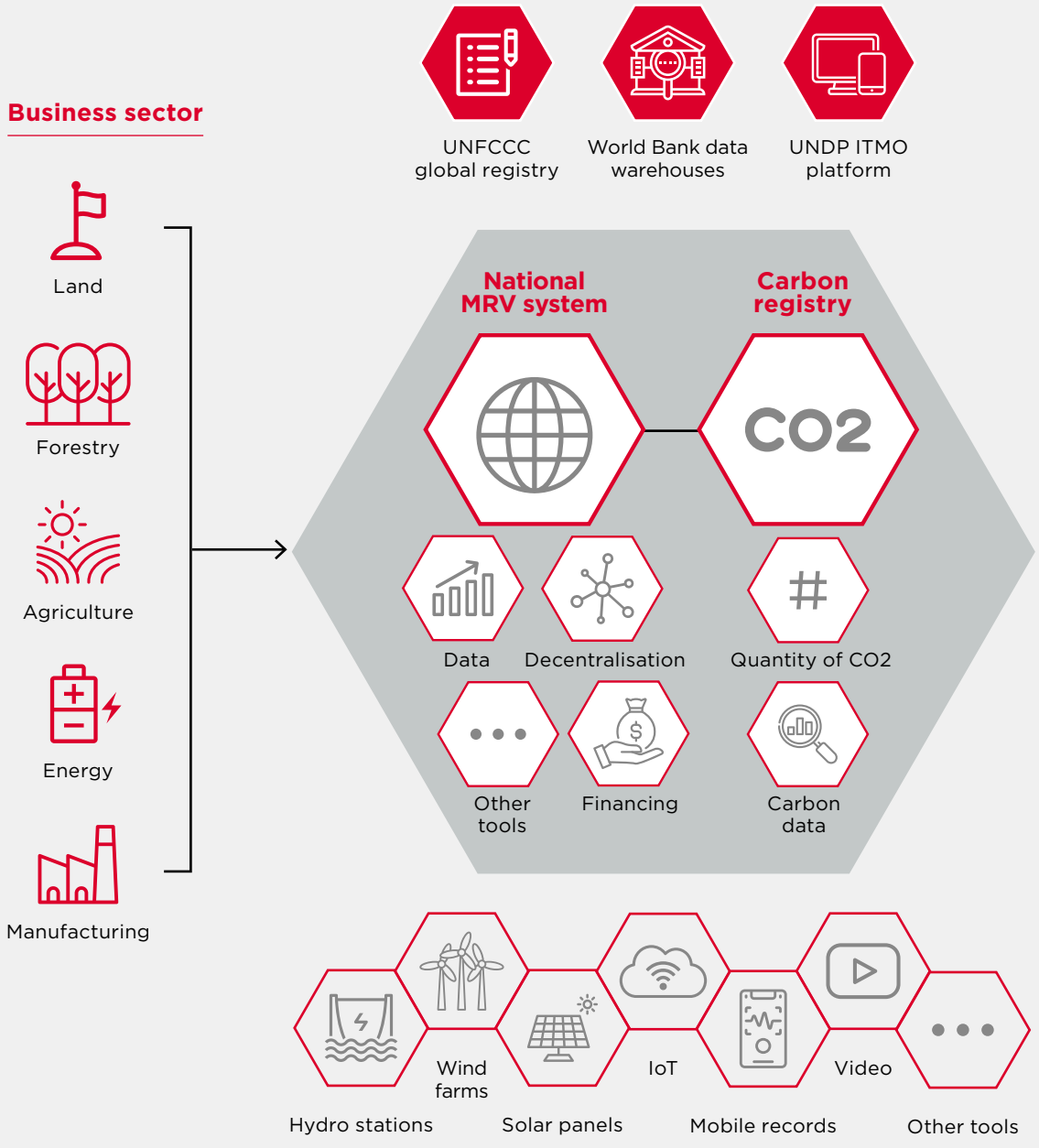
Example: UNDP's digital public infrastructure

Effective climate financing requires accurate data on national climate goals and progress. DPI that is climate-focused, interoperable and open source is important to enable transparent MRV processes and aggregate NDCs across countries. Accurate climate reporting requires a unified data connectivity system that provides universal visibility and communication and the ability to act. This system should also align with evolving UNFCCC guidance.

30. UNFCCC. Article 13.1 of the Paris Agreement.
31. dhis2: "The world's largest health information management system – developed through global cooperation led by UiO".
32. Diam-Valla, C. et al. (26 October 2022). "Why the world needs a common infrastructure for reporting climate targets". World Economic Forum.

A DPI approach

Figure 13
Digital public good ecosystem and functionalities



Source: UNDP

The DPI approach, as illustrated by the UNDP example, differs from other emerging tech platforms that collect emissions and other NDC data. An MRV-DPI is characterised by:

- **An open-source system:** Similar to DHIS,[33] the world's largest health information management system platform, a DPI has common standards for data collection and exchange. A DPI system can provide data connectivity and interoperability to ensure what is being measured across countries is consistent, while also respecting national contexts.[34]
- **Open APIs:** An API enables other tech systems to plug into it. This could enable smooth data aggregation across countries and the integration of other project-level MRV tools and platforms in the system. It could also spur more innovations, such as tools that enable advanced analytics.[35]
- **Safeguards:** The system should reinforce transparency so that data is not at risk of being compromised, misused or double counted.
- **Agility:** The system should support additional features that can be easily plugged into the system.
- **Intelligence:** The system should be able to rapidly analyse climate finance data, flows and reports.
- **Future readiness:** The system should support the integration of emerging technologies, which could enable faster and more efficient data collection, analysis, reporting and decision-making.

Conclusion

D-MRV holds promise for NDC accounting as it can provide more accessible and reliable monitoring, automated reporting and streamlined verification. However, LMICs still face several challenges with digitalising MRV processes, including:

- **Technical knowledge** of the design and implementation of D-MRV systems and familiarity with the mobile and digital technologies proposed at various stages of implementation.
- **Availability of certain technologies** based on the jurisdiction. Various countries have regulations guiding the use of certain technologies.
- **Data protection regulations** in various LMICs. The derived operations data should be secure and used for the intended purpose. This is usually highlighted in various data agreements.
- **Cost of realising the full potential of D-MRV systems**. D-MRVs are investment heavy compared to traditional MRV systems.

For countries to embrace D-MRV models, such as the climate-focused DPI models discussed in this section, accessible learning materials need to be developed to build the capacity of public sector actors and help them understand both the potential of these models as well as the challenges.

33. dhis2: "The world's largest health information management system – developed through global cooperation led by UiO".
34. Diam-Valla, C. et al. (26 October 2022). "Why the world needs a common infrastructure for reporting climate targets". World Economic Forum.
35. Ibid.

Deep dive 5:
The gender dimension of climate finance

The human perspective on climate change is as important as the science. Women in LMICs are more likely to experience the adverse impacts of climate change due to gender inequalities, social norms and economic disparities that can limit their access to resources, education and decision-making power. However, women are influential stakeholders in implementing low-carbon pathways as farmers, entrepreneurs, producers, consumers and household managers. This makes women important agents of change in the fight against climate change.[36]

Digital technology has provided a pathway to financial inclusion for women in LMICs, enabling them to access financing and better adapt to climate change. For example, digital technology can facilitate the collection of gender-specific data in climate-related projects, which informs planning and decision-making about financing at project and country levels.

Context

Women in LMICs are disproportionately impacted by climate change, in part because of their reliance on land and natural resources for their livelihoods. In climate-dependent sectors such as agriculture, women make up 43% of the labour force.[37]

To help women manage the impacts of climate change, access to finance is crucial. However, women represent 55% of the world's unbanked population[38] and are more likely to face barriers accessing climate-related financial services. This limits their ability to purchase agricultural inputs such as fertilisers and production-enhancing equipment.

Application

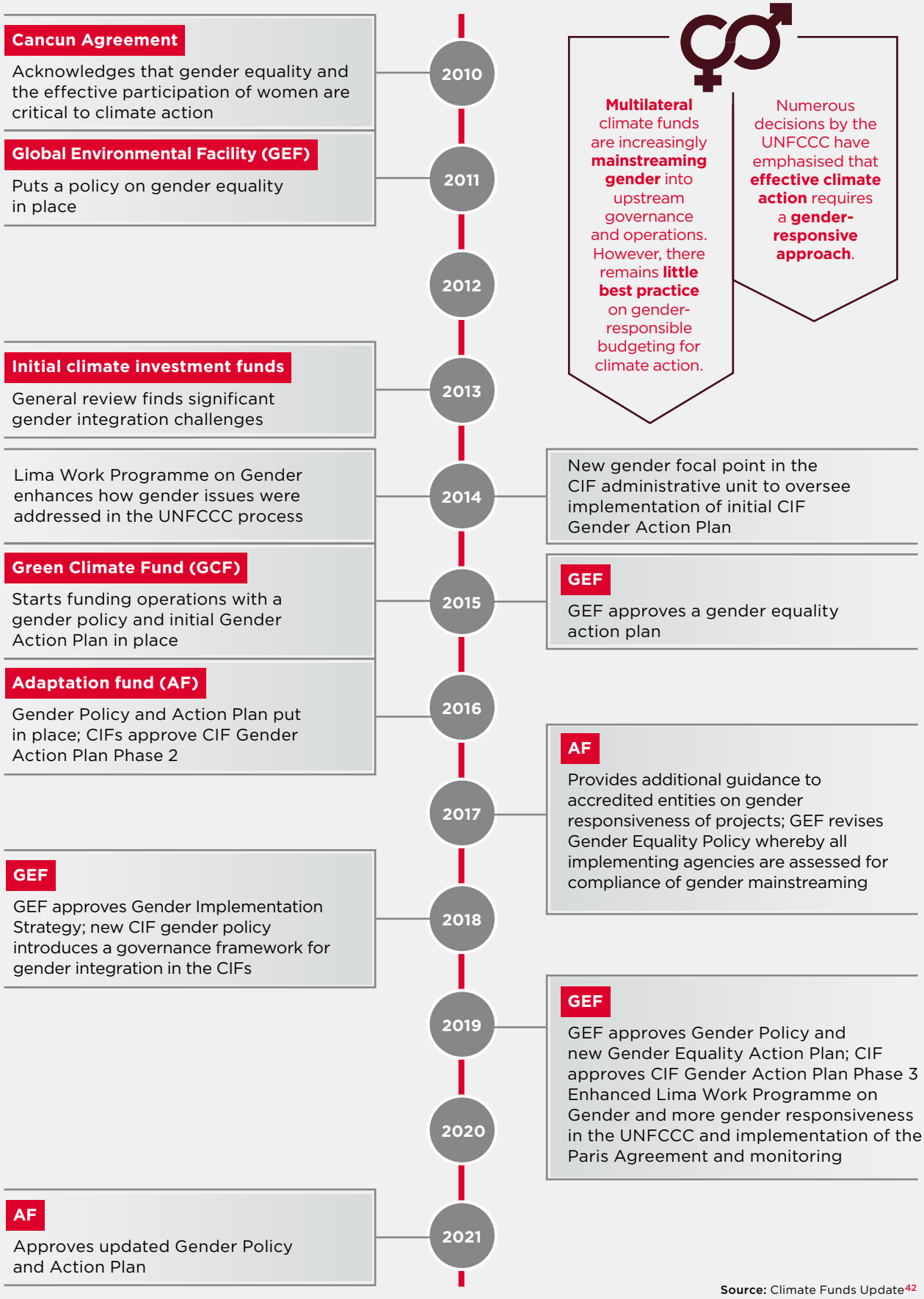
There are two distinct gender dimensions of climate finance: gender-specific data and financial inclusion.

Gender-specific data

Disaggregated data on gender is a challenge for most countries. The OECD points out that only 33% of the SDGs' 104 gender-related indicators have gender data.[39] In the context of climate finance, it is vital that a gender lens is applied to all climate-related activities and climate-related development finance. Without it, there is a risk that gender inequalities could increase, and that vulnerable groups and communities could be further marginalised.[40] In their Fifth Assessment Report,[41] the IPCC emphasised the need for gender integration and has taken steps to ensure gender is integrated in various climate finance modalities. These are detailed in Figure 14.

36. Schalatek, L. (February 2022). "Gender and Climate Finance". Climate Funds Update. Heinrich Böll Stiftung.
37. Food and Agriculture Organization (FAO) of the United Nations. (2022). Women in Agriculture.
38. World Economic Forum. (2021). "Tech can reach the world's unbanked women – but only if they tell us how it should work".
39. OECD. (2020). OECD Economic Outlook 2020.
40. Alston, M. (28 May 2013). "Women and adaptation". WIREs Climate Change, 4(5), 351–358.
41. IPCC. (2014). AR5 Synthesis Report: Climate Change 2014.

Figure 14
The gender responsiveness of climate finance



Source: Climate Funds Update[42]

42. Schalatek, L. (February 2022). "Gender and Climate Finance". Climate Funds Update. Heinrich Böll Stiftung.

Financial inclusion

Through fintech (see Deep dive 3) and other innovations, women have experienced better access to climate financing. This has been facilitated by tailored financial products designed to meet specific gender needs. For example, women who invest or participate in sectors vulnerable to climate change (such as agriculture) can better adapt to climate impacts (such as drought).

Role of digital technology

Climate finance should be able to reach populations most vulnerable to climate change through a variety of channels, including mobile and digital technology. However, this is made more difficult by women's lower levels of mobile phone ownership and access.[43] Case studies[44] have highlighted the potential of mobile and digital technology to accelerate access to climate finance for women. For example:

- Mobile technology can provide alternative financial products and services to alleviate some of the social and cultural barriers women in LMICs face. For example, big data from mobile money subscribers and users can enable women to build credit profiles based on their account and activity history.
- AI and ML can swiftly capture the gender-disaggregated data needed to tailor financial products and services to women's needs in specific contexts.
- Digital technology can generate credit ratings for loans, bypassing the need for borrowers to have traditional forms of collateral, such as property. Mobile money has made responsible lending easily accessible and, in some instances, more affordable for women given that loans are granted based on the borrower's limits and ability to pay them back.

  Mobile money providers (MMPs) have also enabled customers to access adjacent financial services, such as insurance, savings and investment products. However, women are less likely than men to use these services as they have less access to mobile phones and connectivity, less information, limited participation in the workforce and lower socio-economic status.[45] Innovators are exploring better and more efficient ways to provide climate finance to women living with the negative effects of climate change.

SPOTLIGHT 7

World Food Programme cash programmes – Global

World Food Programme (WFP) cash programmes, whether delivered through their direct operations or in support of government social protection systems, can be a starting point for digital financial inclusion. Cash programmes can provide first-time access to accounts (mobile money) and financial services for unbanked and underserved populations and their businesses, which have traditionally been left out of formal financial channels. Having greater economic autonomy can ease the burden of survival, build agency and activate women's decision-making power. In line with the WFP's Gender Policy, the transformative potential of digital financial inclusion lies in the belief that women's economic empowerment is one step towards more substantive and influential participation and leadership in society.

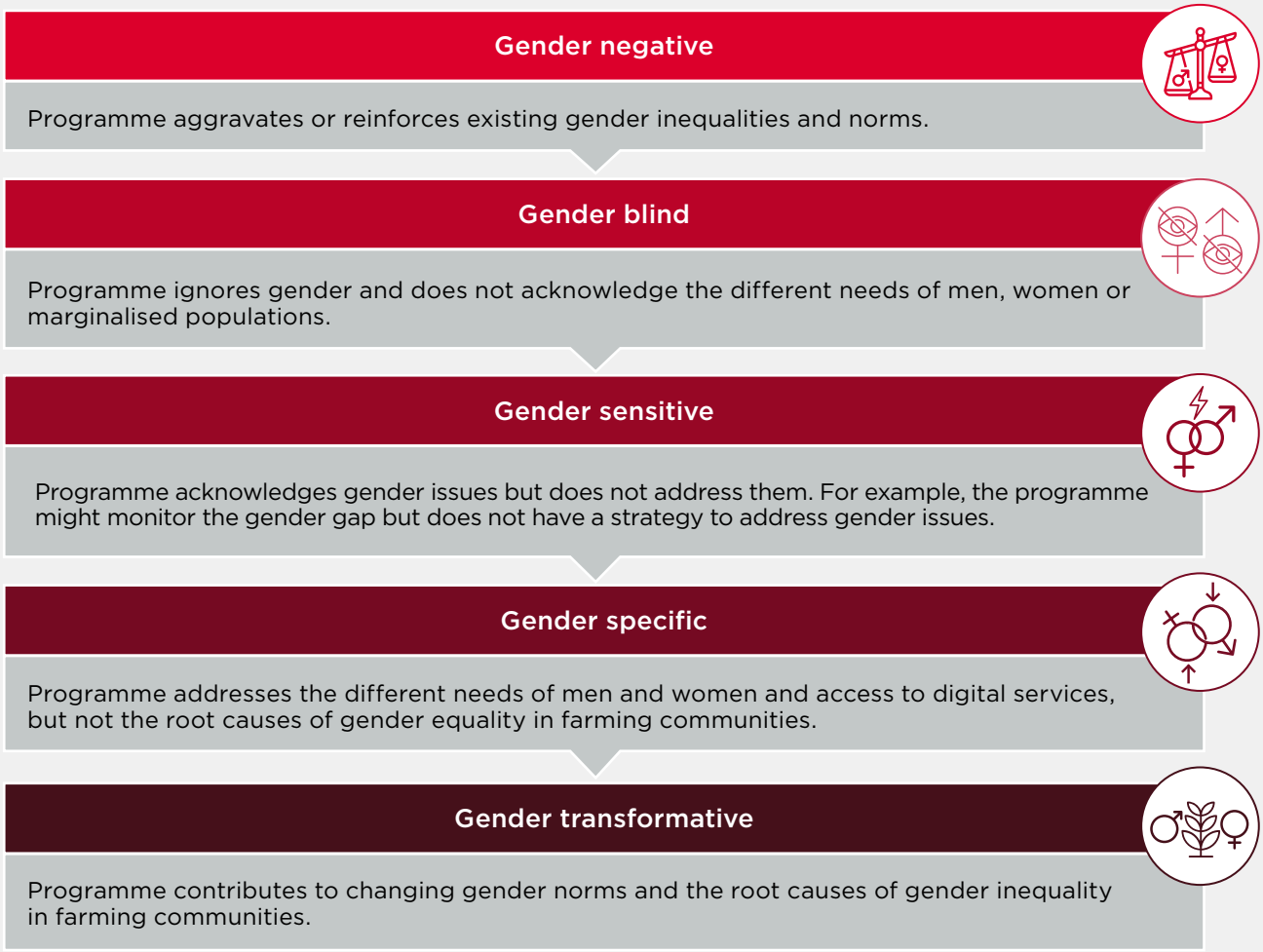
43. GSMA. (2022). The Mobile Gender Gap Report 2022.
44. Peralta, A. (2019). "Gender and climate change finance". Case study from the Phillipines. Heinrich Böll Stiftung.
45. Mastercard and IFC/World Bank Group. (December 2018). Women and Digital Financial Services in Sub-Saharan Africa: Understanding the Challenges and Harnessing the Opportunities. Field Note 10.

Conclusion

The gender analysis criteria highlighted in Figure 15 creates a level playing field to integrate gender in climate programmes and initiatives, and the same should be done when designing and implementing climate financing instruments and funding modalities. Despite the promise of digital technology to digitalise climate finance, women face persistent barriers:

- **Gender gap in mobile phone ownership:** Women's mobile phone ownership, including internet-enabled handsets, should be supported and accelerated, as it affects access to financing instruments, digital tools and platforms.
- **Gender expertise:** The public and private sector actors financing and deploying mobile and digital technology in the climate space need to ensure they purposefully consider women as well as men.
- **Lack of gender-responsive guidelines and criteria in climate finance:** Public and private climate finance funding modalities, such as the Global Environment Facility, Green Climate Fund and others, should have gender-responsive guidelines, allocation criteria and financial instruments.

Figure 15
Gender analysis criteria for climate finance programmes and initiatives



Source: GSMA Mobile for Development adapted from the Gender Continuum framework[46]

46. Pederson, A., Greaves, L. and Poole, N. (March 2015). "Gender-transformative health promotion for women: a framework for action". Health Promotion International, 30(1), 140–150.

4. Looking ahead

This report has provided an overview of how mobile and digital technology can be used to facilitate and accelerate climate finance. While disruptive technologies offer great promise, they require an enabling ecosystem and robust financing to be successful. The deep dives illustrate how these technologies can be used in LMICs to ensure that climate finance reaches those most affected by climate change in a transparent, fair and cost-effective way. More research is needed to explore how they are being applied in specific sectors, regions and administrative units.

The main conclusions of the study are outlined in this section, alongside considerations to strengthen the delivery of digitally enabled climate finance mechanisms.

Defining climate finance

The research highlighted that the public and private sectors define climate finance differently. This has an impact on the level, quality and priority of investment in climate change. Understanding the various definitions of climate finance is also key to creating an inclusive ecosystem in which all actors can execute their mandates, including the mobile and digital technology community. The knowledge and technical expertise required for climate finance can be enhanced based on agreed definitions, and will help to develop tailored products, services and capacity building tools.

Considerations

- **Public and private stakeholder consultations and dialogues are needed** to foster understanding of the divergent climate finance definitions that capture the interests and concerns of all stakeholders. This will help to enhance the understanding and participation of diverse actors working to solve the complex challenges of climate change.

- It is essential to **enhance knowledge and technical expertise** by providing tailored capacity building tools and training programmes in climate finance. This will help to build the skills and expertise needed to effectively mobilise and manage climate finance investments in LMICs.

- Climate finance and investment has traditionally focused on mitigation, but as the global tide of climate action swings towards adapting to the impacts of climate change, it is also critical to **view climate finance through the lens of capacity and solutions and advocate for adaptation funding.**

Building knowledge and technical expertise in digitally enabled climate finance

Climate finance is a new, complex and contested field. Digitally enabled climate finance has added a layer of complexity because it incorporates technology in both climate action and climate financing. As a result, there is a gap in knowledge and technical expertise, which are key to developing solutions and accelerating climate finance for those most impacted by climate change.

Considerations

- **More tailored and country-specific research** on digitally enabled climate finance is needed to understand the roles of various players in the climate space, their potential future roles and their impact on access to, and delivery of, climate finance. This will help to develop context-specific mobile or digital solutions tailored to the needs of different target groups and the ecosystems in which they operate.

- **Develop training programmes to provide technical assistance and improve knowledge and expertise** in digitally enabled climate finance. This capacity building is needed across a range of sectors and stakeholders. It is important to note that climate finance is a new space and the use of digital technologies is still an underexplored component. Tailored training and technical assistance can help stakeholders understand the potential of digital technologies and how to use them to accelerate and deliver climate finance for those most impacted by climate change.

- **Foster partnerships between key stakeholders to create innovative solutions** that address the complex challenges of climate finance. Bringing together different areas of expertise will help to create comprehensive and effective solutions. One example was offered in Deep dive 3 with India's Unified Payment System, through which the public sector provides the infrastructure for private innovations in the fintech industry. Such partnerships can help to accelerate climate fintech innovations in LMICs.

- There is scope to **create knowledge-sharing platforms through national and regional innovation hubs** or exchange programmes for peer-to-peer learning, knowledge and technology transfers. This will provide opportunities to learn from the successes and challenges of others and ultimately improve understanding and best practices of digitally enabled climate finance.

Developing digital infrastructure and ecosystems in LMICs

The deployment and delivery of climate finance via mobile and digital technologies depends on strong digital infrastructure. However, there are numerous barriers to the development of this infrastructure, including:

- Connectivity challenges, especially in rural or remote areas where investments are high and revenue is low, and there are few products and services for climate finance access and delivery.
- Embracing mobile and digital technologies is expensive for both consumers and innovators. This is due to the high costs of acquiring the necessary devices to accelerate climate finance access and delivery.
- As the effects of climate change continue to be felt in LMICs, digital infrastructure is susceptible to climate change-related damage, which subsequently affects the delivery of mobile and digital solutions that support and accelerate climate finance.
- A lack of coordination runs the risk of fragmenting technologies with other parts of the ecosystem.

Considerations

- **Governments and private sector players should prioritise investment in digital infrastructure**, including expanding mobile broadband coverage to rural or remote areas. This will help to provide wider and more cost-effective access to mobile and digital technologies that can deliver climate financing.
- **Governments should consider flexible policies and regulations that allow for experimentation**. In Kenya (see Deep dive 3), this approach fostered cutting-edge innovations that have facilitated climate finance.
- **Match MNOs with innovators through national and regional hubs** to find ways to address technology gaps and support climate finance. One example is the development of IoT SIM cards to connect the use of clean cookstoves to carbon credits (see Deep dive 2).
- **Collaborate and build partnerships among MNOs** to i) create climate finance solutions on shared mobile and digital infrastructure; ii) expand the scale and reach of existing climate finance solutions; iii) pursue purchase agreements that allow innovators to access finance for climate change solutions; and iv) explore integrating technology to make mobile and digital solutions for climate finance more cost effective.

Improving access to quality data

Digital technology needs to be integrated in climate finance to ensure quality data. However, in LMICs, there are data-related barriers that make it difficult to attract investment and compete for access to climate financing. These barriers and limitations include:

- Lack of sufficient meaningful climate data on finance flows. Reliable data provides the flexibility to manage and price risk and base financing and investment.
- Lack of aggregated and/or centralised data for local, national or regional climate financing and investment.
- Lack of historical, current and predicted weather and climate data and analysis.
- Lack of confidence in data sharing, which inhibits access to i) consumer data; ii) financial data; iii) credit data; iv) impact assessment data; and v) population data on people affected by climate change.
- Limited capacity to analyse and interpret climate data that would justify appropriate climate finance solutions. This hinders the development of a bankable proposal for climate-related solutions.
- Regulatory requirements and constraints on data usage.
- Transparency and traceability of the data collected.

Considerations

- To facilitate the flow of data needed to deliver climate finance, **data-sharing protocols should be established**. This could include supporting country initiatives that develop unified systems to accelerate climate finance, such as the Unified Payments System in India (see Deep dive 3) and the MRV-DPI (see Deep dive 4). The unified systems have not only facilitated data sharing, but also have the potential to support transparent and traceable climate finance flows.

- **Data collection techniques that use established frameworks are needed to ensure data is credible and consistent**. For example, developing a set of common data standards and protocols can help ensure that data is collected in a consistent and comparable way across different projects and initiatives. This can facilitate data sharing and analysis and help stakeholders to understand how climate finance is being used and to evaluate the impact of different initiatives.

- It is important to **enhance data collection, analysis and technical expertise at national and institutional levels**. This could be achieved by digitalising the MRV process at project and national levels, as highlighted in Deep dives 1 and 4.

- **MNOs can play a key role as custodians of digital consumer data**. Having MNOs more closely embedded in digital climate finance solutions can facilitate the collection, storage and analysis of consumer data in a secure and responsible manner.

Reaching underserved populations

Underserved groups in LMICs, especially women, are the least likely to access and use mobile technology. This is due to a variety of reasons, including the affordability of handsets and data, a lack of digital skills and social norms. Since these groups tend to be the most vulnerable to the impacts of climate change, solutions need to be tailored specifically to their needs and access to technology.

Considerations

- As highlighted in Deep dives 3 and 5, mobile technology can help to promote financial inclusion by **enabling communities to access financial services and products through their mobile phones**. MNOs have access to a wealth of data on consumer behaviour, which can be leveraged to tailor solutions to the needs of consumers and designed to maximise impact. This was illustrated in Spotlight 5 with the example of an MNO (Safaricom) partnering with a financial institution (Commercial Bank of Africa, CBA) to offer financial products tailored to underserved populations.

- It is also important to **address the gender gap in mobile phone ownership**, as outlined in Deep dive 5. Women's mobile phone ownership should be supported and accelerated, as it has an impact on access to financing instruments and the effectiveness of digital tools and platforms.

- **Private and public actor consultations are needed that analyse digital climate finance through a gender lens** (see Figure 15). This will help to ensure the specific barriers and needs of women are considered and solutions are designed to be more inclusive. Supporting public and private sector-driven advocacy can also propel the development of gender-responsive guidelines and criteria for climate finance generally and for digital climate finance in LMICs.

- When designing mobile or digital solutions for underserved communities, it is important to **consider initiatives that are tailored specifically for users who are not literate or have limited access to technology**. Co-designing solutions will ensure high uptake and impact. Digital literacy gaps can be addressed by providing skills training and education to empower underserved communities and facilitate uptake of the solutions.

The development of carbon markets

As illustrated in Deep dive 1, the adoption of Article 6 and Article 6.4 of the Paris Agreement, which outline the development of a VCM, has sparked interest in this innovative climate financing mechanism. However, there are persistent implementation challenges, largely due to complex and immature markets. Barriers include:

- **Resource requirements:** High transaction costs stem from the need to evaluate, register, validate and monitor, report and verify VCM projects. Issuance of carbon credits is a time-consuming and resource-intensive process.

- **Multiple MRV frameworks:** Requirements for monitoring and reporting are complex and inconsistent across geographies, markets and project types. In addition, there are not shelf-ready methodologies tailored for LMICs.

- **Regulatory questions:** Governments are trying to understand how to fit carbon credits into existing regulatory systems.
- **Considerations for underserved communities:** Concerns about inclusivity could stem from being excluded from the design of past programmes and innovations. A failure to include communities in the design process disenfranchises the underserved, undermines local livelihoods and produces weak economic incentives.
- **Credibility concerns:** A lack of precise data in the MRV process and concerns over double counting are both potential barriers to uptake.

Considerations

- **Lower the cost of issuing carbon credits by aggregating solutions providers** (e.g., smallholder farmers, SMEs, innovators) on market-based carbon platforms. These platforms can provide the necessary infrastructure for the MRV of carbon credits, technologies that can otherwise be expensive for individual service providers and technical assistance providers. They also bear the accreditation burden for service providers, among other benefits (see Deep dive 1).
- **Use smarter, cheaper and more programmatic data collection mechanisms and platforms** to provide easy access to data and analytics tools, and to build an evidence base for climate project financing and investments. As illustrated through examples in the report, this could include the use of mobile data collection tools, remote-sensing technologies and ML algorithms to collect, process and analyse data in a more cost-effective and scalable way.
- **Offer standardised solutions that resolve end-to-end D-MRV, reduce costs and enhance transparency and traceability**. For example, verification needs to embrace triangulation methods, such as the use of satellite data. Developing a standardised set of tools and protocols for monitoring, reporting and verifying carbon credits helps to reduce the administrative burden and cost of compliance for carbon credit providers.
- **Use local rather than global accreditation platforms** that would embrace local D-MRV solutions providers and their participation in carbon markets. Local accreditation platforms can provide a more accessible and affordable pathway for small-scale solutions providers to access carbon markets and benefit from carbon finance. This was exemplified in Spotlight 3 with the Carbon Value Exchange Platform.
- **Advocate for voluntary and compliance markets to allow underserved communities to sell their carbon credits before the designated maturity period** through the Futures Market.[47] These mechanisms can provide a buffer for vulnerable communities to manage market shocks and ensure a steadier and more reliable stream of revenue from carbon finance.
- **Support the issuance of carbon credits with gender, health and livelihood co-benefits through market-based platforms**, as this would enable communities to sell their carbon credits at a premium. Carbon market platforms can create specialised carbon credit categories that reward providers for achieving additional social and environmental co-benefits alongside carbon reductions. These credits can provide a premium price for carbon credit providers and ensure that carbon finance benefits the most vulnerable communities.

The GSMA ClimateTech programme welcomes practitioners to join ongoing efforts to explore how mobile and digital technology can strengthen the delivery of climate finance to underserved communities. If this work interests you and your organisation, please get in touch.

47. Futures Market is an auction market in which participants buy and sell commodity and futures contracts for delivery on a specified future date.

Appendix

Stakeholders engaged

The GSMA would like to acknowledge the contributions of the stakeholders interviewed and those that provided feedback during the course of this research. The organisations that took part in this study are listed below.

Type	Name	Region
Development partners	United Nations Capital Development Fund (UNCDF)	Africa
	African Development Bank (AfDB)	Africa
	Alliance for a Green Revolution (AGRA)	Africa
	International Union for Conservation of Nature (IUCN)	Africa
	GIZ	Global
		Asia
	CGAP, World Bank	MENA
	Plan International	Africa
	Care International	Africa
	2XCollaborative	Global
	UNDP	Global
Mobile Network Operators (MNOs)	Airtel Africa	Africa
	Safaricom	Africa
	Telenor Group	Europe
		Asia
	Jazz.com.pk	Asia
Financial and investment institutions	Cooperative Rural Development Bank (CRDB) Tanzania	Africa
	Kenya Bankers Association (KBA)	Africa
	Financial Sector Deepening (FSD) Kenya	Africa
	Kenya Commercial Bank (KCB)	Africa
	Adapt Earth	Africa
	Finnfund	Global
	Rabo Bank	Europe
Solutions providers	Sanergy	Africa
	Sinan Energy	Asia
	SunExchange	Africa
	ATEC	Asia
	Afropavo Analytics	Africa
	myAgro	Africa

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