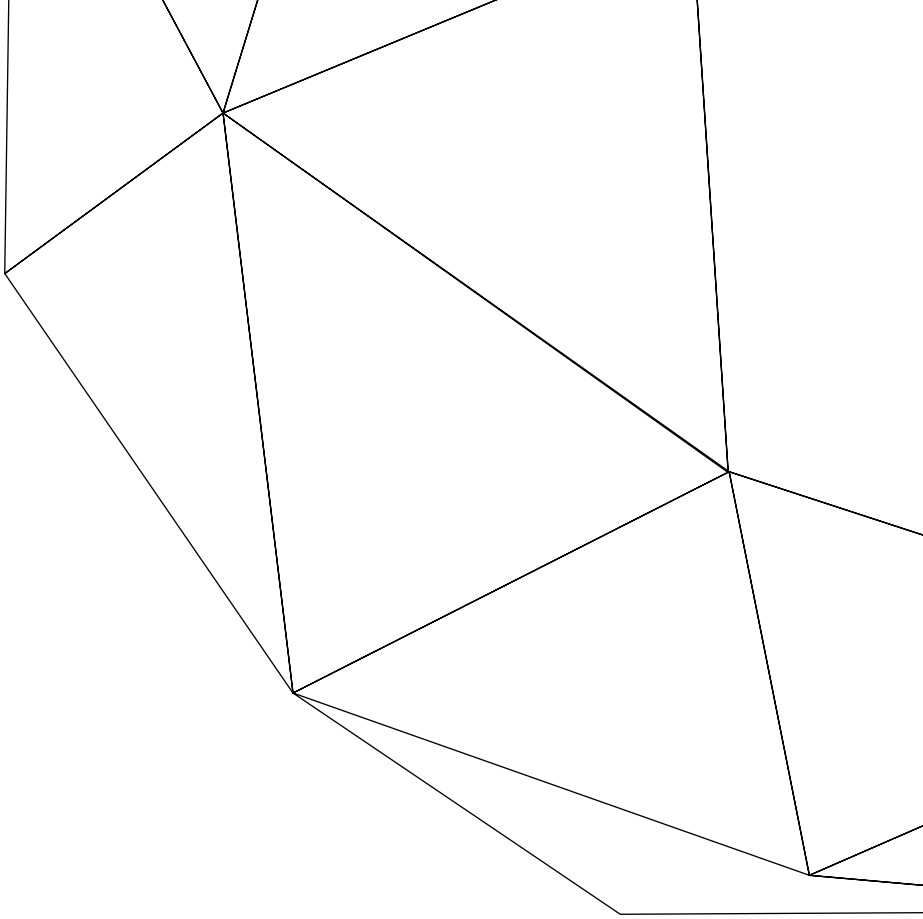

Green Climate Fund working paper No.4

Accelerating and scaling up climate innovation

How the Green Climate Fund's approach can deliver new climate solutions for developing countries

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How the Green Climate Fund's approach can deliver new climate solutions for developing countries

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Abstract

Climate innovation is critical to avert catastrophic climate change, but investment in new climate solutions is hampered by a range of barriers. This Working Paper first identifies the main barriers to climate innovation in developing countries, focusing on each stage of the innovation chain, from the emergence of innovation to its deployment and eventual widespread adoption. Many of these barriers are related to the policy and regulatory environment as well as to technical and macro-economic constraints. They result in high risk perception amongst investors and limited access to long-term affordable financing for climate innovators and entrepreneurs, especially in developing countries.

The paper then outlines the Green Climate Fund's four-pronged approach to overcome these barriers and to accelerate and scale up climate innovation in developing countries. The first prong is to establish a conducive policy and institutional environment for novel climate solutions. The second prong is to catalyze climate innovation by piloting new technologies, business models, financing instruments and practices to establish proof of concept. The third prong is to use scarce public resources to de-risk early investments that will establish a commercial track record for new climate solutions and crowd-in private finance. The final prong of GCF's approach is to accelerate the widespread adoption of commercially proven climate solutions by enhancing the capacity of domestic financial institutions to originate and access capital markets to finance climate investments.

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Introduction

Achieving the Paris Agreement goal of limiting global warming to 1.5°C over the course of the century requires steep reductions in carbon dioxide emissions by 2030 and net zero emissions by 2050 (IPCC, 2018).[1] The Paris Agreement also aims to increase all countries' ability to adapt to the adverse impacts of climate change (UN, 2015). This must be done while and, to a large extent, through eradicating poverty and meeting the Sustainable Development Goals (SDGs) of the United Nations Agenda for Sustainable Development (UN, 2015) by 2030 (Hallegatte et al, 2015).

We are not currently on track to achieve these objectives. The past decade was the hottest on record. The World Meteorological Organization (WMO) estimates there is about a 40 per cent chance of annual average global temperature temporarily reaching 1.5°C above pre-industrial level in at least one of the next five years (WMO, 2021). The atmospheric concentration of carbon dioxide has increased from 280 parts per million (ppm) in the pre-industrial period (1850-1900) to 417 ppm in 2020 and surged past 420 ppm for the first time in recorded history on 3 April 2021 (NOAA, 2020). While there was a short-term decline in carbon dioxide emissions from coronavirus lockdowns in 2020, they will have a negligible effect on the build-up of greenhouse gas concentrations in the atmosphere (Kappelle, 2020).

Countries, communities, and businesses face potentially catastrophic climate change physical, transition, and liability risks. Innovation is a critical element to achieving global climate goals. Innovations in policy, culture, institutions, science, technology, management and finance are all needed if we are to get back on track. The past decade has seen the emergence and diffusion of several transformative climate innovations, which have kept open the window of opportunity to avoid catastrophic climate change.

In the area of climate technology, the 2010-2020 period witnessed a remarkable cost reduction for solar and wind power technologies. The global utility-scale solar PV cost for newly commissioned projects fell by 85 per cent between 2010 and 2020 (IRENA, 2021). It went from being more than twice as costly as the most expensive fossil fuel-fired power generation option to being at the bottom of the range for new fossil fuel-fired capacity in a decade (IRENA, 2021).

One of the most prominent financial revolutions over the past decade has been the exponential development of green bonds. The record USD305.3 billion in green bonds issued in 2020 drove total issuance of green bonds through the milestone of USD 1 trillion in cumulative issuance since 2007 (Climate Bonds Initiative, 2021). Bonds are essential to finance infrastructure. The market for green bonds could encompass a significant part of the USD 6.9 trillion a year required up to 2030 to finance low emission, climate resilient infrastructure and meet climate and development objectives (OECD, 2018).

Business model innovations such as the mobile-enabled pay-as-you-go (PAYG) fostered a paradigm shift for the deployment and widespread diffusion of decentralized PV systems in developing countries. Under a PAYG model, an energy service provider rents or sells solar PV systems in exchange for regular payments through mobile payment systems. Between 2015 and 2020, around 8 million people gained energy access with PAYG models (IRENA, 2020).

A major policy innovation was the adoption of net-zero emission targets to provide long-term visibility to investors, spurred by science and citizen mobilization. As of April 2021, 131 countries responsible for 73 per cent of global emissions have adopted or are considering net zero targets. Climate Action Tracker (2021) found that global warming by 2100 could be as low as 2.0°C if all the net zero targets announced or under consideration were to be achieved. These net zero targets and related policies are starting to drive corporate strategies. Although few have fully disclosed how they plan to reach them, over one-fifth of the world's largest corporations have already pledged to reach net-zero carbon emissions by 2050 (Climate Action 100+, 2021).

Climate innovation holds the promise to put us back on track to achieve the Paris Agreement's goals. In the domain of technology alone, innovations in digital technology and artificial intelligence; material technology; nanotechnology; genetic technology; robotics; biotechnology; transport technology; and energy technology,

to name just a few, have the potential to provide humankind with new fundamental capacities and rewrite our future. For example, the Solar Impulse Foundation has identified 1000 solutions that are both profitable and good for the planet, from the use of membrane filtration and cryogenic distillation to purify methane from landfills for the grid to nutrition-rich protein product derived from mealworm larvae (Solar Impulse, 2021).

But innovation is not guaranteed.

A recent assessment of the progress of the low carbon transition in ten of the highest-emitting sectors of the global economy - power, agriculture and land-use, cars, trucks, shipping, aviation, buildings, steel, cement, and plastics - found that required technologies and business models to support this transition had reached the diffusion stage in only three sectors: buildings, cars, and power. In all the remaining sectors, the transition had hardly begun and required technologies and business models were still at the emerge stage (Victor et al, 2019). These ten sectors together accounted for about 80 per cent of global greenhouse gas (GHG) emissions in 2019.

Innovation does not benefit the poor and the rich, women and men equally. The second industrial revolution was driven by electricity. But for the about around 760 million people worldwide who still lack access to electricity (World Bank, 2021), it might as well have never happened. Similarly, the amount of food produced by person has increased from an average of 2,200 calories per day in 1960 to 2,700 in 2000 (DeFries R., 2014). But in a world that produces enough food to feed everyone, 821 million people – one in nine – still go hungry. Furthermore, approximately three billion people cannot afford a healthy diet and more than three billion people suffer from one or more manifestations of poor nutrition (FAO, IFAD, UNICEF, WFP and WHO, 2020).

Even when innovation materialises on time, it can create new, unforeseen problem on its own and compound rather than solve the problem at hand. When the chlorofluorocarbons (CFCs) were developed in the 1920s, they were touted as a safe substitute for the explosive and toxic ammonia and sulphur refrigerants then commonly in use. However, it was found in the 1970s that these compounds, inert in the troposphere, are transported into the stratosphere by turbulent mixing. Once there, they release halogen atoms that catalyse the breakdown of ozone (O3) into oxygen (O2). The ozone layer prevents most dangerous wavelengths of ultraviolet light from passing through the Earth's atmosphere and harming plants and animals. The miracle compounds of the 1920s had converted into an existential threat to life on Earth half a century later.

Developing markets are essential to accelerate climate innovation. For instance, developing countries have proven quick at developing and adopting the latest digital services and leapfrogging traditional brick-and-mortar business models. Half of the countries in the top 30 in terms of the share of economic output that comes from digital economy are classified as developing countries (Sharma R., 2021). As illustrated by the success of the PAYG model, ICTs are likely to continue driving innovation in developing markets.

Developing economies have also an immense potential to accelerate the deployment of pivotal technologies to de-carbonise high-emitting sectors. For instance, green hydrogen could play a strong role in fully decarbonizing the electricity system, where it could complement renewable energy technologies and battery-based energy storage, as well as the transport, steel, and cement sectors, where it would serve as fuel substitute. Many developing regions offer a great potential for producing low-cost, price competitive green hydrogen with a minimal impact on biodiversity due to large open arid spaces along windy coastlines.

Unleashing the climate innovation potential of developing countries is imperative to meet their unique requirements and scale up global climate action. However, there are many barriers to the development and widespread adoption of inclusive and responsible climate innovation. This is especially the case with developing countries. These barriers translate into higher perceived risks and limited access to finance for climate innovation. Nearly 96 per cent of all venture dollars in climate start-ups went to ventures in Northern America, Northeast Asia, and EU.

The Green Climate Fund (GCF) addresses this by promoting inclusive and responsible climate innovation in developing countries through a four-pronged approach, which seeks to overcome barriers and promote innovation at all stages from the initial incubation of ideas through to their widespread adoption.

This Working Paper analyses the barriers to climate innovation and sets out how GCF's approach can overcome them to deliver new climate solutions to developing countries. The first half of the paper discusses the reasons for the lack of support for climate innovation and technological development in developing countries, including the barriers that exist at all innovation stages while the second half outlines GCF's four-pronged approach to promoting innovation, using practical examples from the GCF portfolio to illustrate its approach.

1. Why does capital not flow to climate innovation and investment in developing countries?

1.1 The investment gap for climate innovation.

The 1992 supplement to the first assessment report by the Intergovernmental Panel on Climate Change (IPCC) emphasized that technological development, including improvements and reassessment of existing technologies, was urgently needed to limit or adapt to climate change. It called for greater cooperation among all nations to improve and transfer existing technologies. It also noted the need to tailor technologies to the domestic technological and human resource capabilities of developing countries and to better develop those capabilities.

Submissions to the United Nations Framework on Convention on Climate Change (UNFCCC) by developing countries (so-called non-Annex 1 Parties to the UNFCCC) strongly echoed this early call. More than 100 non-Annex 1 Parties emphasized the need for international support for technology development and transfer for the implementation of their Intended Nationally Determined Contributions (INDC). But a range of barriers have prevented this need for technological support and capacity building from materialising.

With an estimated USD 18 trillion of negative-yielding debt in OECD countries (Mullen and Ainger, 2020) and low carbon and climate resilient investment opportunities that could yield a direct economic gain of USD 26 trillion through to 2030, capital in search of higher yields should flow to climate friendly projects. These flows should particularly benefit developing countries, where the bulk of investment in low emission climate resilient infrastructure is to take place in the coming decades.

This is not happening. Financing for climate projects in non-OECD countries reached USD 356 billion per year in 2017/2018, or 61 per cent of global climate finance. However, 76 per cent of these resources are deployed in the same country in which they are sourced, revealing a strong preference among investors for home-country investments where risks are well-understood (CPI, 2020). East Asia and Asia-Pacific was the largest regional provider of, and destination, for climate finance at USD 238 billion. Sub-Saharan Africa accounted for only five per cent of climate finance flows in non-OECD countries, at USD 19 billion (CPI, 2019). The bulk of climate finance in Sub-Saharan Africa originates from the public sector (multilateral development banks, national development banks, multilateral climate funds).

This section examines some of the key barriers to investment in climate innovation under the climate finance-specific context of Lucas' Paradox[2] – why doesn't capital flow from rich to poor countries given that the marginal product of capital should be higher in less productive economies (Lucas, 1990)?

The persistent funding gap in transformative climate innovation in developing countries arises from several barriers at each stage of the innovation chain - emergence, diffusion, and widespread adoption. Table 1 summarises different barriers that hinder or prevent climate innovations from taking off in nascent markets based on literature reviews and barrier analyses conducted for the preparation of project proposals to the Global Environment Facility and the Green Climate Fund (Glemarec, 2011; Waissbein et al, 2013; Hafner et al, 2019). The relative importance of these barriers and their specific manifestations varies across countries and technologies.

1.2 Barriers to the emergence of climate innovation

The global start-up economy created USD 3 trillion in value from 2017 to the first half of 2019 (Start-up Genome, 2020) and hold tremendous potential to accelerate climate innovation. Seven out of the ten largest companies in the world are in technology. However, start-ups are prone to failure by nature as they explore new solutions for new markets. An often cited statistic is that nine out of ten start-ups will fail (Start-up Genome, 2019). And the rate of failure is higher for green start-ups (B Gaddy et al, 2016). Green and climate-friendly sectors share some common features that set them apart from other sectors (World Bank, 2017).

With the exemption of green digital technologies, most climate ventures deliver physical products to market and require a full supply chain to service a fragmented customer base. This results in higher upfront capital needs and a longer payback period for prototyping, developing, testing, and financing the distribution of physical products. Furthermore, climate ventures compete in commodity markets (energy, water, waste, etc.) that do not adequately price the benefits of their products in terms of reduced climate and health risks, affecting their growth and return potential (World Bank, 2017).

These sector-specific barriers to climate innovation are magnified in developing countries. At the emergence phase, the combination of sector and country-specific barriers can be broadly clustered into four categories: (i) limited awareness of climate physical/transition/liability risks and new venture opportunities; (ii) limited capacity to ideate or tailor novel approaches; (iii) weak climate innovation and entrepreneurial ecosystems; and (iv) limited access to seed funding and early-stage capital.

There is usually a limited understanding of the range of climate technology solutions, their applicability in each country context, and how to develop markets for scaling them up. Support for ensuring selection of locally appropriate climate technology solutions in developing countries is often weak or absent. Data gaps and unavailability pose an additional challenge to identify emerging needs and validate business models.

A public-private innovation ecosystem is required to drive climate innovation (Mazzucato, 2015). In mature start-up ecosystems, a host of public and private start-up incubation and acceleration schemes[3] makes available offices, technical expertise, manufacturing know-how, information on marketing strategies, help in developing business plans, assistance in raising funds, mentoring, legal guidance, patent application support, facility to benchmark peers, and interface to universities and laboratories, or digital platforms.

Accelerators are recent institutional innovations, originally designed to work with digital start-ups in mature entrepreneurial ecosystems such as Silicon Valley and Boston. In some ecosystems, they can operate profitably thank to the small equity stake they take in each start-up they admit to their programme, without the public financing that typical incubators rely on.

There are estimated to be around 2,000 technology incubators and more than 150 accelerators worldwide. However, less than 70 are estimated to be climate technology incubators and accelerators. Due to fiscal constraints, just 25 of these are in developing countries (UNFCCC, GCF, CTCN, 2018). In what seems to be a positive sign, new accelerator models will be required to meet the specific needs of climate technopreneurs in developing countries (TEC, GCF, CTCN, 2018).

However, there is a multitude of ecosystem gaps to climate tech entrepreneurship that lies outside of the purview of what entrepreneurs alone can possibly tackle and that cannot be offset by simply helping an entrepreneur tweak the start-up business model in an accelerator or incubator programme (JP Racine, 2017). As outlined in Table 1, these include limited consumer awareness of new product categories, shortage of skilled labour, weak infrastructure and logistics, poor IP enforcement capabilities, and sectoral policies that favour incumbent technologies.

Access to finance is another major impediment for innovators in developing countries. There is a gap in the availability of seed capital, as well as early-stage risk capital in a form that is appropriate for capital intensive and slow maturing climate ventures. In mature start-up ecosystems in Europe and North America, climate innovators and entrepreneur meet their funding needs in the ideation and development stages with their own personal assets, investments from family and friends, angel investors and/or start-up seed grants from public programmes.

As start-ups have little or no valuable collateral in their early stages, they usually do not qualify for loan instruments, but the overall start-up ecosystem is sufficiently developed to allow many start-ups to access pre-seed and seed finance on the strength of a compelling business idea. Often, promising new ventures at an early stage might already receive small seed capital injections from government start-up promotion programmes, business angels, seed venture capital or commercial accelerators. For example, the sum of all grants and loan assistance that promote new business start-ups and other entrepreneur initiatives offered by

the government in the United Kingdom is estimated at two billion pounds (ENT Magazine, 2021). In mature start-up ecosystems, venture capital (VC) has also proven an important funding source to bring nascent solutions to commercial scale and competitiveness in markets (Social Progress Imperative, 2021).

In emerging and frontier markets, most entrepreneurs also face a much more difficult situation when launching a start-up as personal assets and assets of family and friends are usually very limited and start-up promotion programmes funded by governments are scarce. There are few early-stage investors or angel investors, and those who operate in developing countries tend to shy away from climate technologies due to their high upfront capital requirements, dependence on local manufacturing, supply chains, infrastructure, technological know-how to scale up, as well as longer payback period compared to conventional technologies. As such, even if they make it through the initial assessment of a VC funder, they are likely to lose out to non-climate competitors (GIZ 2020). Climate VC funding is overwhelmingly – over 93 per cent – focused on core markets in USA, Canada, China, and Europe.

In short, the so-called 'valley of death' (the gap between initial seed funding and more mature, long-term finance) for climate start-ups in in developing countries starts earlier and ends later - becoming a forbidding obstacle. This calls for new financing models to support climate technology ventures and accelerate climate innovation in developing countries. Specialty financing has driven the growth of some mature green subsectors (World Bank, 2017). The project finance approach enabled by power purchase agreements (PPAs) drives investments in renewable energy technology and consumer financing and has been key to scale up energy efficiency and clean energy systems in both developed and developing countries. Financial innovation is necessary to create new specialty financing instruments to meet the needs of green enterprise (World Bank, 2017).

1.3 Barriers to the deployment of climate innovation

The deployment stage for innovation refers to the transition from the emergence of an idea to its deployment. This stage might require multi-billion-dollar investment in infrastructure development or manufacturing capacity to deploy at scale innovations successfully piloted during the emergence phase. Novel technologies and practices are hampered at the deployment stage by an array of financing and entrepreneurial barriers.

These barriers can also be broadly placed into the following four clusters: (i) higher perceived policy and regulatory risks in comparison to incumbent technologies and practices; (ii) higher perceived technical and operational risks in comparison to incumbent technologies and practices; (iii) higher perceived markets and socio-economic risks in comparison to incumbent technologies and practices; and (iv) lack of access to affordable, long-term project finance.

Political and regulatory risks arise from governmental action, including changes in policies or regulations that adversely impact infrastructure investments. For example, complex, inconsistent, or opaque licensing procedures lead to transaction delays and costs. Similarly, changes in tariff regulations or off-taking contract renegotiation can affect the profitability of investments. And even the best new green energy technology in the world will not be competitive if fossil fuels are heavily subsidised. Market and macro-economic risks are subject to governmental action but can also arise from broader shifts in the industry and/or economic environment. These include macroeconomic variables like inflation and exchange rate fluctuations, as well as uncertainty in consumer demand.

Technical, operational and liquidity risks are determined by the skills of the operators and managers and are related to the features of the project, project complexity, construction, and technology. These risks can also arise from the lack of supporting physical infrastructure (e.g., cranes or roads to unload and transport wind turbines or poor grid infrastructure). Liquidity risks arise from operational delays and cost overrun due to limited familiarity with a novel technology or practice.

Risks also vary across the life of the project. Entrepreneurs are particularly exposed to development phase risks as they are usually financed by personal equity and represent a sunk cost. Construction, operation, and

termination phase risks will be taken into consideration in the investment calculus of both entrepreneurs and financiers.

In sum, these risks translate into higher hurdle rates for entrepreneurs and financiers. Entrepreneurs will require higher expected returns before investing their time and personal equity in a renewable energy project. Similarly, providers of financing will demand a higher margin and will offer less attractive financing terms to compensate themselves for these higher risks. In practice, this translates into higher interest rates (debt) and required returns (equity), shorter loan tenors, and a higher share of more costly equity in capital structures. These high financing costs and rigid financing structures affect the attractiveness of climate technological and infrastructure investments.

These risks are magnified for novel climate investment in developing countries (DFID, 2019; UNDP, 2013; UNDP, 2018; Glemarec et al, 2016). High financing cost particularly penalises climate investments given their reliance on new technologies and practices and usual cash flow profile - higher upfront capital requirements but lower operating and maintenance costs compared with high emission, climate vulnerable investments. For example, climate-resilient roads will typically require higher upfront investments and new engineering practices but require less annual maintenance. The longer payback period of low emission, resilient infrastructure compared with climate-vulnerable investments and their high sensitivity to policy stability (e.g., renewable energy and feed-in-tariffs) will be additional sources of concerns for entrepreneurs and financiers, particularly for early-stage technology and practice in early-stage markets.

Over the past three decades, several actions have been taken to remove these barriers to the deployment of climate technologies and practices. Notably, a variety of policy and financing instruments have been developed to use public funds to de-risk and crowd-in private capital in pioneer investments in new markets, technologies, and practices. The Addis Ababa Action Agenda (AAAA) puts forward a set of principles for blended public and private finance; and different actors, including the OECD and the Development Finance Institutions Working Group, have defined principles for their activities in line with the AAAA (Blended Finance Taskforce, 2018).

Blended finance mechanisms are complex to design and can use a wide range of public instruments to increase the risk-reward profile of green investments through the 'three Ts': treating risk (e.g., grants for technical assistance to create a conducive policy environment to seat and operate an asset); transferring risk (e.g., loan guarantees to fully or partially transfer the risk of default to a third party); and taxing risk (e.g., negative tax such as tax breaks or subsidies or positive tax such as carbon tax to increase the comparative reward of green investments) (UN IATF, 2020).

No instrument can single-handedly remove the range of possible barriers faced by entrepreneurs and financiers to invest in transformative climate initiatives. For example, credit lines to local financial institutions are powerful instruments to address liquidity or credit constraints while risk-return enhancing mechanisms such as first loss equity will prove more effective in mitigating the high business risks of innovative ventures.

Blended public and private finance can provide a solution. However, the experience of blended finance in climate change is mixed to date. Public funds have been found to have a low leverage[4] on private funds for low carbon investments - less than 1:2 - compared to a range between 1:3 and 1:15 for traditional public finance (Blended Finance Taskforce, 2018; Lecocq and Ambrosi, 2007; Maclean et al, 2008; Ward et al, 2009). Over the past decade, blended finance has usually taken the form of relatively safe senior debt rather than more risky instruments such as equity or guarantees to take on early-stage or 'pioneer' risk or achieve a higher leveraging ratio such as subordinated debt, equity, risk-sharing facilities, guarantees or grants (Attridge and Engen, 2019).

Blended finance for climate investment has also mostly benefited high-and middle-income countries, largely bypassing Least Developed Countries (LDCs), and has catalysed private investment mostly in mature technologies and business models such as on-grid renewable energy technologies. Of all the private finance mobilised by official development finance interventions between 2012 and 2017, approximately USD 9.3 billion, or six per cent, went to LDCs, whereas over 70 per cent went to middle-income countries.

Energy, banking, and financial services are the largest sectors supported by blended finance, accounting for 23 per cent (USD 2.16 billion) and 19 per cent (USD 1.8 billion) respectively during the same 2012-2017 period.

New forms of blended finance must be experimented to better work for scaling up new climate solutions, serve LDCs and Small Island Developing States (SIDS), achieve higher leveraging ratio, and de-risk a broader range of climate priorities such as climate resilient infrastructure and nature-based climate solutions.

1.4 Barriers to widespread adoption of climate innovation

During the final phase of the innovation chain, the new entrant becomes the incumbent, adoption is pervasive and leads to transformative sector-level changes in the methods of building and maintaining infrastructure, producing, and selling goods and services (Victor et al, 2019).

The widespread adoption of new climate solutions requires wider system adjustments involving a variety of actors, including policymakers, public administrators, firms, financiers, civil society organisations and users. The actions of these groups will not only be driven by cost-benefit analyses but also by the availability of information, values and beliefs, incentives, skills, and access to long-term, affordable finance matching the longer pay-back period of climate investments.

This process is hindered by a range of market and non-market barriers. These barriers can also be broadly placed into the following four clusters: (i) higher perceived policy and regulatory risks in comparison to incumbent technologies and practices; (ii) higher perceived technical and operational risks in comparison to incumbent technologies and practices; (iii) higher perceived markets and socio-economic risks in comparison to incumbent technologies and practices; and (iv) lack of access to affordable, long-term project finance.

Enabling environments rely on norms and values such as shared concerns, economic and political interests, shared narratives, shared vision, and cultural acceptance. Many carbon-intensive industries and firms have been deeply entrenched in traditionally prevailing norms and values and they have been able to resist changes through political lobbying or forging a negative public narrative against transformative climate innovation.

History shows that radical changes often require new entrants to win a battle of ideas against incumbents. Beliefs, norms, and values are critical to the widespread adoption of technologies and practices and a key task of policy and opinion makers to accelerate the transition to net zero emission climate resilient development will be to foster normative shifts.

The widespread adoption of early cars, for example, was hindered by high cost, lack of standardisation, lack of road infrastructure and filling stations, and negative public perception. They were initially seen as toys for the rich, killing people and livestock, and hindering pedestrian, bikes, and horse carriage movements. Eventually they became adopted due to their lower cost resulting from mass production, but the adoption was also facilitated by growing health and cultural concerns about horse excrements and the success of automakers in developing a new vision for the future.

At the 1939 World's Fair, General Motors presented Futurama, an "artistic conception" that outlined their vision for the world of 1960. With the help of imagery borrowed from avant-garde artists such as the Italian Futurists, it popularised a vision of unconstrained mobility facilitated by intensive road infrastructure and new technologies such as autonomous vehicles. This vision of the future and its new norms and values contributed to the public consensus that led to the US Interstate Highway System, 90 per cent of which was funded by the federal government (Victor et al, 2019). This cross-continental infrastructure consolidated the position of automobiles as the dominant transit system.

The importance of access to finance, key for the emergence and diffusion of climate innovation, is magnified for widespread adoption. Even if new climate technological solutions materialise on time, achieving their widespread adoption to foster a rapid transition to a net-zero emission, climate-resilient economy will require significantly more investment. And most of this investment will have to be mobilised by domestic financial systems due to the strong home-country preference of financiers.

The power sector is one of the three highest-emitting sectors where required technologies and business models to support the net zero transition has reached the diffusion stage. Over the past decade, the levelised costs of solar and offshore wind has dropped by 83 per cent and 62 per cent respectively. Despite these dramatic reduction in costs, investments in renewable energy technologies are still falling short from the required levels to fully decarbonise the power sector by 2050. The International Energy Agency (IEA) estimates that annual clean-energy investment would have to exceed USD 4 trillion by 2030, which is three times the average over the past five years.

Accordingly, a key objective of the Paris Agreement (Article 2.I.c) is "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development". This shift has yet to happen. Private investments in Sustainable Development Goals (SDG)-related infrastructure in developing countries were lower in 2018 than in 2012 (UN IATF, 2019). In contrast, the top 33 banks alone allocated USD 654 billion to fossil fuel financing in 2019, more than double their commitments to sustainable finance – USD 292.3 billion – in the same year (Avery, 2019).

Several initiatives are ongoing to strengthen price signals to redirect financial flows towards low emission climate resilient investment (Hourcade et al, 2021). In addition, aligning finance flows with climate action requires new valuation methodologies and skills to better assess the risk-reward profile of new climate solutions. The higher upfront costs and technology risks of climate investment must be balanced against their lower operational costs and lower climate physical, liability and transition risks.

Pricing climate risks is proving a daunting challenge for entrepreneurs and financiers alike, who are de facto asked to estimate the likelihood of various climate scenarios and their implications for physical, liability and transition risks at the firm and project levels. Investors are used to deal with probabilities, not uncertainty (Scoblic and Tetlock, 2020). These capacity constraints and limited track record of climate innovation are likely to result in mispricing and hamper access to finance. Universally accepted valuation methodologies for new climate assets, goods, and services; climate risks disclosure; and common, trusted green standards and labels for green financial products will be prerequisites for sector-wide reconfiguration (Bayat-Renoux et al, 2020).

The mispricing of risks is compounded by strong home-country preference and limited familiarity of global investors with developing markets. Research on default rates published in 2019 by the international credit rating agency Moody's demonstrates that the probability of default attributable to project financings in Africa (0.69 per cent) and Asia (0.70 per cent) are higher than in Western Europe (0.40 per cent) but lower than North America (1.12 per cent). The Moody's data demonstrates that investing in infrastructure in developing countries over the long-term is not significantly riskier than investing in infrastructure in developed countries. Sharing of knowledge of commercially successful investments at scale in each geography will be critical to address this perception bias.

Strengthening the capacity of domestic public and private institutions to finance at scale climate-friendly investment will be ultimately key to the widespread adoption of new climate solutions. The entire financial supply chain will need to be deepened, from identifying new opportunities to originating and developing projects and financing them through accessing international and domestic capital markets. For instance, Public Development Banks (PDBs) can play a critical role to align finance with sustainable development and foster the widespread adoption of new climate solutions in developing countries.

There are almost 260 Public Development Banks in developing countries, representing USD 5 trillion in assets (GCF/IDFC, 2020). These National and Regional Development Banks have the capacity of extending more than USD 400 billion in climate finance per year. Doubling their investment capacity or leverage effect would be enough to bridge the infrastructure investment gap. However, only 58 National Development Banks (NDBs) in developing countries are accessing international capital markets to capitalise their operations. Issuing green bonds could be a game changer for NDBs and international efforts to scale up climate action.

Of the USD 305 billion green bonds issued in 2020, just USD 8.9 billion or three per cent were from the developing world (excluding China). Furthermore, the total global volume of green bonds issuance from

developing countries has been reducing in per centage terms over the past three years. Consequently, increasing green bond issuance from developing countries represents a significant market opportunity to meet the climate finance gap.

Table 1: Barriers to climate innovations in developing countries.

Stage	Barriers	Description
1. Emergence	1.1 limited awareness of climate physical and transition risks as well as new venture opportunities	• Limited understanding of climate change causes, effects and impacts on local living conditions. • Limited knowledge of government objectives, international commitments, and actions. • Limited capacity of entrepreneurs and investors to assess climate impacts in terms of new venture opportunities. • Limited understanding amongst policymakers of climate innovations' potential to boost economic activity in certain sectors, generate income, create jobs and reduce inequalities, especially post-COVID-19. • Limited awareness of public decision-makers of available policy instruments to improve market conditions for climate innovations (e.g., R&D investments, regulations, equity-free pre-seed and seed-grants for start-up to cover expenditures, public procurement schemes, intellectual property frameworks, etc.) • Limited data availability to assess opportunities and validate business models.
	1.2 Limited capacity to ideate or access and adapt novel approaches	• Insufficient critical mass of entrepreneurs engaged in home-grown ideation of novel and transformative climate solutions. • Limited access to "global" solutions to reduce GHG emissions and climate vulnerabilities whose technical feasibility and commercial competitiveness have already been proven in other geographies. • Limited knowledge and experience of skilled entrepreneurs in developing and validating climate business ideas and business models.
	1.3 Lack of supportive innovation and entrepreneurial ecosystems	• Incomplete, unclear or inconsistently implemented regulations to support climate-friendly innovation and businesses. • Lack of incubators and accelerators to support climate technopreneurs in refining business models and forging strategic partnerships. • Limited means to adapt global solutions to local contexts due to inadequacies in infrastructure and logistics. • Limited data availability to validate market opportunities for climate solutions and business ideas. • Historical monopolies and sectoral policies that favour incumbent technologies. • Limited access to tried and tested operating procedures for reaching market fit due to a relatively low number of historical climate start-ups.
	1.4 Limited access to early-stage capital and VC's short investment horizons and high return expectations	• Venture capital model is inappropriate for financing climate-friendly ventures that are capital intensive, have long payback period and high ERR but low IRR. • The high-risk perception of climate ventures is elevated further for VC investments in emerging and frontier markets. • Lack of an exit market through company IPO or sell to another company or fund. • Limited awareness of most public/official development/impact investors of the venture capital gap in early-stage climate solutions in emerging and frontier markets • Difficulties for public/official development/philanthropic investors to establish the climate and public rational of a specific investment opportunity. • Difficulties for public/official development/impact investors to invest public budgets in early-stage ventures due to the risk-aversion of supervisory mechanisms and mandate restrictions
2. Deployment	2.1 Higher perceived political, policy, market, and socio-economic risks	• New climate technologies, infrastructure and practices usually requiring higher upfront costs and have longer payback periods, and as such are perceived as having higher market, socio-economic, political and regulatory risks that adversely impact novel, complex, long-term investment. • Political and regulatory risks include contract renegotiations (ex: renegotiation of long-term power purchase agreements in term of tariff regulation or contract duration); regulatory approval and licensing processes for new

		technologies; business law and taxation, political upheaval, or expropriation. etc.) High risk perception is elevated further for climate ventures in emerging and frontier markets.
	2.2 Higher perceived technical, operations and financial risks	• Lack of technological track record, risk of construction delays and lower than expected technical performance and new skills acquisition requirements. • Quantitative and qualitative deficit of supporting physical infrastructure (ex: cranes and roads to unload and transport wind turbines or poor grid infrastructure) • Liquidity risks arising from technical and operation
	2.3 Higher perceived market, and socio-economic risks	• Market and social risks include uncertainty about consumers' demand for novel products and services and social acceptance. • Macro-economic risks include changes in macro-economic variables such as inflation, real interest rates and exchange rate fluctuations; or default of counterparty (ex: utilities for renewable energy or water technologies).
	2.4. Lack of access to long-term affordable project finance	• Limited domestic fiscal capacity to support investments with high economic returns but limited bankability in early-stage markets. • Limited domestic capital markets and financial institutions and reliance on foreign investors/international capital markets • Higher return expectations from entrepreneurs and investors to compensate for higher perceived risks affect the financial attractiveness and bankability of projects.
	2.5 Lack of public resources to de-risking innovative investments targeting early-stage markets	• Limited capacity of government officials to identify and finance public instruments to de-risk investments at scale in early-stage climate technologies and practices mismatch in emerging and frontier markets. • Mandate restrictions for public/official development/impact investors to invest public budgets in scaling up early-stage technologies and markets due to the risk-aversion of supervisory mechanisms and mandate restrictions
3. Adoption	3.1 Misalignment of policies, norms, and values.	• Opposition to market reconfiguration or inertia from historical operators and monopolies, • Legacy policies and regulations • Distributional trade-offs and/or benefits capture • Challenge to establish norms and values.
	3.2 Misalignment of finance with climate action	• Limited disclosure of climate physical, liability and transition risks by firms and asset managers • Tyranny of quarterly performance reports- mismatch between short term business cycles, medium-term political agenda and long-term climate physical, transition and liability risks. • Lack of standards and taxonomies and outdated or inadequate valuation methodologies. • Lack of global, regional, national institutions to foster normative and behavioural shifts.
	3.3 Capacity barriers to widespread adoption	• Low customer awareness of the benefits and availability of climate-friendly products. • Limited knowledge of financiers of climate physical, liability and transition risks and capacity to incorporate them into every financial decision. • Proprietary nature of information and financial barriers to technology/practices transfer. • Limited capacity of domestic financial institutions and firms to originate, develop, finance and implement climate friendly investments.
	3.4 limited access to long-term affordable finance	• Low domestic saving rates and capacity of domestic institutions to mobilize these savings. • Limited capacity of domestic institutions to access global and domestic capital markets. • Lack of instruments to mitigate local currency and interest risks.

2. How GCF is accelerating climate innovation and investment

The first half of this working paper identified the array of barriers to climate innovation in developing countries that exist at the emergence, deployment, and widespread adoption stages. The second half of the paper outlines how GCF is using its climate finance programming to help developing countries overcome these barriers and to accelerate and scale up new climate solutions to achieve the goals of the Paris Agreement.

2.1 GCF's mandate to foster paradigm-shifting investment

GCF was established at the UNFCCC COP16 in Cancun, Mexico in 2010. Parties to the UNFCCC determined GCF would be an operating entity of the Financial Mechanism of the Convention under Article 11 by decision 1/CP.16 (UNFCCC, 2011).

As a key element of the Paris Agreement, the Fund's mandate is to promote a paradigm shift towards low emission and climate resilient development pathways in developing countries (GCF, 2011). Paragraphs 35 and 38 of the Governing Instrument mandate GCF to finance agreed full and agreed incremental costs for activities to enable and support enhanced technology development and transfer, including innovative approaches. Subsequent GCF Board decisions have reaffirmed this mandate (GCF, 2011).

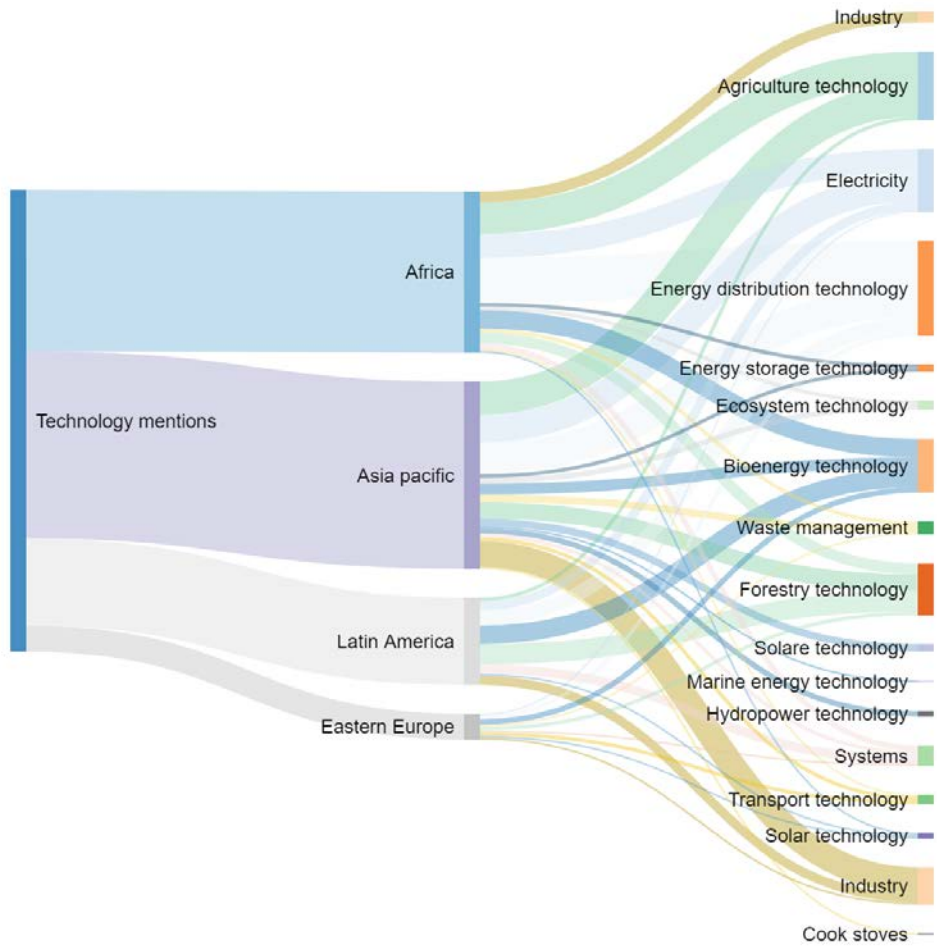
As a multilateral climate fund, GCF has several attributes that allow it to foster innovation. GCF is a partnership organisation. It operates through a network of over 200 Accredited Entities and delivery partners who work directly with counterparts in developing countries on project design and implementation (GCF, 2021b). Partners include international and national commercial banks, multilateral, regional and national development finance institutions, United Nations agencies, civil society organisations and equity fund institutions.

This open partnership enables the Fund to foster unprecedented coalitions between public policymakers, private investors, development agencies, and civil society organisations to achieve transformative change. By leveraging the risk management capacity of its partners and its own set of investment, risk, and results management frameworks, GCF can accept higher risks to support innovation.

GCF uses a range of financial instruments in a highly flexible manner. It can structure its financial support through a flexible combination of grant, concessional debt, guarantees, or equity instruments to leverage blended finance and crowd-in private investment for climate action in developing countries. This flexibility enables the Fund to pilot new financial structures to support the creation of new markets for new climate solutions.

An analysis of the portfolio of approved GCF funding proposals as of 31 March 2021 indicates that 65 per cent of all projects have at least one technology component. Figure 1 presents a breakdown of supported technologies per region.

Figure 1: Examples of technologies supported by the GCF portfolio.



The innovation path from the idea to a scalable technology that works — through experiments, research grant applications, investment pitches, piloting and refining, regulatory approval, finance at scale, manufacturing agreements, supply chains and normative shift to displace incumbents — is long and uncertain. It can take decades before an innovation reaches markets. Energy-related examples in recent decades include consumer products such as LEDs and lithium-ion batteries, which took ten to 30 years to go from the first prototype to the mass market (EPO/IEA, 2021).

GCF has therefore adopted a four-pronged approach to accelerate and scale up transformative climate innovation: (i) establish a conducive environment for climate action; (ii) facilitate the emergence of climate innovation; (iii) de-risk market creating projects that will establish a commercial track record and crowd-in private finance for new climate solutions; and (iv) align finance with sustainable development to accelerate the widespread adoption of new climate solutions.

The following section outlines how each of these four prongs helps to foster and support climate innovation, providing practical examples from the GCF portfolio.

2.2 Establishing a conducive environment for climate action

Under its first prong, GCF develops the capacity of policymakers and local actors to: (i) create a conducive environment for the emergence, diffusion, and widespread adoption of climate innovation; (ii) maximise the co-benefits between mitigation, adaptation, and sustainable development; and (iii) translate Nationally Determined Contributions (NDCs) into detailed financing plans.

A supportive regulatory environment and public support are essential to remove the barriers to climate innovation and investment as discussed above. Bloomberg New Energy Finance found that, on average, countries with strong policies to support clean energy attract seven times as much clean-energy investment as emerging markets without such policies. Direct public support is equally important. In addition to their role as enablers, governments are essential to the creation and development of new markets as customers (green procurement) and co-financiers (subsidies, sovereign guarantees, and co-investment).

The need to address market and investment barriers to low-carbon options has inspired the development of a wide array of public measures modelled around the energy efficiency policies conducted since the 1970s (Hourcade et al, 2021; Glemarec, 2011). According to the IEA's Policies and Measures Database, over 5,500 climate policies and instruments are currently used globally today.[5] The objective of climate investment policies is to create conditions for attractive investment risk/reward profiles, adapted to different types of investors, either through reducing risks or increasing rewards (Glemarec, 2011). Table 2 shows the main types of policy instruments.

Table 2: Environmental policy support instruments.

	Information and empowerment instruments	Control and regulatory instruments	Economic and market instruments	Institutional instruments	Financial instruments
Market Creation Instruments	Rely on knowledge, communication, and persuasion to influence behaviour and supply skilled labour.	Rely on the establishment of obligations, encouraging or prohibiting or restricting certain types of behaviour	Financial incentives and disincentives to influence private sector behaviour and investment decision-making	Create an institutional and organizational environment to facilitate policy and technology development and deployment	Direct public sector (co) investment to establish a proof of concept or commercial track record of new solutions
Demand-side instruments	▶ Information disclosure and green taxonomies (climate risks, carbon liabilities, etc.) ▶ Long-term policy commitment and targets ▶ Valuation methodologies ▶ Public awareness and persuasion	▶ Macro-prudential regulations (climate stress tests for banks and insurers, etc.) ▶ Mandates ▶ Ban ▶ Zoning ▶ Building codes ▶ Norms and minimum performance standards ▶ Standards and labels	▶ Carbon taxes, phase out of fossil fuel subsidies ▶ Development of new asset classes ▶ Fossil fuel divestment by public financial institutions ▶ Taxes/tax breaks (e.g., carbon taxes) ▶ Charges and penalties ▶ Favourable tariffs ▶ Green procurement ▶ Advanced market commitment ▶ Tradable permits and quotas	▶ Green finance regulatory networks, asset managers coalition and central bank coordination mechanisms ▶ Establishment / restructuring of environmental institutions ▶ Development of R&D networks and ecosystems	
Supply-side instruments	▶ Investment in education and research ▶ Technical and vocational training and retooling	▶ Streamlining licensing processes	▶ Power purchase agreements ▶ R&D commissioning ▶ Property rights agreements	▶ Dedicated financial institutions (green banks, green guarantee companies, green bond platforms, etc.)	▶ Public sector-led R&D ▶ Project concessional finance (grant and loans) ▶ Incubation grants/venture capital ▶ Guarantees ▶ Equity investment

Source: Hourcade et al, 2021

Every single policy has a cost, either to the ratepayer or the taxpayer. The optimal policy mix for the promotion of climate investment will not be the same everywhere as industrial, emerging and developing countries have different resources, challenges, needs and priorities. Different country and clean technology market characteristics mean that there is no one-size-fits-all best policy approach.

It should be noted favourable climate investment policies cannot substitute for an overall positive investment environment. Before making a climate investment, financiers will assess several project-specific (resources, technology, skills, energy intermediaries, operations, and management, etc.) and non-project-specific risks (country risks, size of the economy, macro-economic conditions, investment policies, currency risk, tax rates, proximity to markets, technology, supporting and delivery infrastructure, etc.). A comprehensive strategy to attract investment would seek to enhance capacity in all these areas (Glemarec, 2011). However, targeted policies and regulations can still work effectively within countries that struggle with setting an overall positive regulatory regime and sector policies can be effectively implemented in parallel with broader efforts to establish a conducive investment environment (World Bank, 2017).

Regulations in green sectors are generally incomplete and applied inconsistently in developing countries (World Bank, 2017). Therefore, GCF has developed a dedicated grant-based Readiness Programme to strengthen the capacity of developing countries to design, finance and implement integrated climate strategies and policies, which is accessible to all Developing Country Parties to the UNFCCC. Furthermore, GCF aims to ensure at least 50 per cent of readiness support goes to particularly vulnerable countries, including Least Developed Countries (LDCs), Small Island Developing States (SIDS) and African States. As of October 2021, GCF has approved 456 readiness grants to 136 countries for a total budget of over USD 300 million.

The COVID-19 pandemic has increased urgency for policy and planning integration. To stimulate the economy and mitigate the impact of COVID-19, governments are undertaking large-scale expansionary fiscal measures. Depending on their green contents, these stimulus measures can either entrench our dependence on fossil fuels or accelerate our transition to net zero emissions by 2050. However, the UN Environment Programme estimates that so far only 18 per cent of recovery spending and only 2.5 per cent of total spending will enhance sustainability in the 50 largest economies. Equally concerning, developed countries were able to spend 17 times more in stimulus measures on a per capital basis than developing countries.

Thus, under the first prong of an enabling environment for climate action, GCF is leveraging its grant readiness resources to assist developing countries in designing green, climate resilient economic stimulus measures and in exploring innovative financing instruments to finance them without increasing their debt burden. For example, GCF will support Saint Lucia's efforts, one of the SIDS hardest hit by climate change, in translating its Nationally Determined Contributions under the Paris Agreement into a detailed investment plan exploring financial innovations like resilience bonds and climate debt swaps to supplement public resources, and to finance its climate ambition in the context of the Covid-19 pandemic without increasing its debt burden.

2.3 Facilitating the emergence of climate innovation

Under its second prong - facilitating the emergence of climate innovation - GCF pilots new technologies, business models, financing instruments and practices to establish proof of concept.

By acting as a market incubator, GCF supports technology need assessments and strengthens entrepreneurial and innovation ecosystem. Recognising that the traditional model of incubators and accelerators developed for digital start-ups in high-income countries have limitations for climate technologies in low-income countries, GCF explores new incubation and acceleration models to enlarge the pool of climate innovators and entrepreneurs in developing markets. GCF also provides early-stage equity capital and growth stage capital.

To illustrate this approach, GCF has granted project development funds to the Korean Development Bank (KDB) and the Global Green Growth Institute (GGGI) to develop an integrated approach to overcome the numerous barriers that climate start-ups face in emerging and early-stage markets in East Asia. This initiative will include the following set of technical support and financing solutions tailored to climate start-ups and small and medium-sized enterprises (SMEs):

a. Strengthening local climate tech start-up ecosystems: The entrepreneurial ecosystem is the supporting environment – the system of institutions, actors, and linkages – in which entrepreneurs are embedded as they innovate. Thus the programme will facilitate the conversion of discoveries into innovation through strengthening linkages between knowledge institutions (universities, research institutes, etc.) and innovators. It will also facilitate partnerships between the private sector and innovators, to enable start-ups to better estimate market demand, create product awareness, and build full supply chains for the manufacturing and delivery of physical products. Finally, it will bridge financiers and innovators to broaden access to early-stage growth finance.

b. A collaborative research, development, and business (R&DB) platform to develop business models that fit the countries' technology needs: The importance of new business models to the success of green sectors in developing countries cannot be overstated. The literature documents how business model innovations provide a better source of competitive advantage and were comparatively less

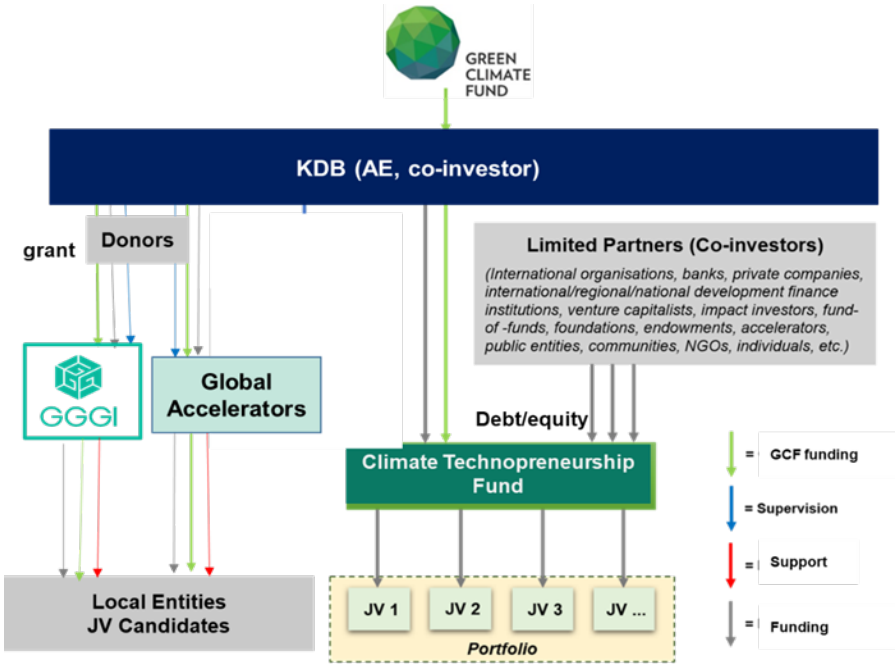
expensive and time consuming than technology or product design innovations in developing countries (World Bank, 2017).

c. Incubation and acceleration services for local "greenpreneurs": There is a need to pilot new incubator and accelerator models for developing country contexts. Such models might take into greater account the diverse needs of entrepreneurs and technology users in relation to differing cultural contexts, local communities, income levels and gender considerations. This can range from extending the usual accelerator graduation period for climate start-ups to encouraging well-functioning existing incubators and accelerators to expand into climate technology markets to the creation of multi-country incubators and accelerators.

a. Joint ventures (JVs) and effective partnership models between local start-ups and global technology companies: Joint ventures merging the technological and supply chains capacity of global technology companies and the local knowledge and networks of domestic investors can facilitate technology transfer, reduce technological development lead time, and facilitate access to finance while ensuring country ownership and sustainability.

b. USD 100 million fund to provide early-stage equity capital for technology transfer and business acceleration: The conventional venture capital model is a poor fit for financing climate-friendly ventures and there is a dearth of risk and growth capital for climate innovation in developing countries (Gaddy et al, 2016; World Bank, 2017). Private finance requires well-conceived projects that have project equity already in place to provide low-interest debt financing. The need to secure grant/equity is particularly high for start-ups as they face higher default risks and have yet to establish strong banking relationships. Blended finance can play a critical role to underwrite the risks for institutional investors and banks by assuming first loss positions or providing performance guarantees. For this green technopreneurs fund, GCF will act as an anchor investor and provide first loss equity.

Figure 2: Illustration of an integrated approach to climate start-ups in developing countries.



KDB = Korean Development Bank; GGGI = Global Green Growth Institute; AE = Accredited Entity

GCF is also developing different types of growth-stage debt to provide climate enterprises with the required lower-cost operating and expansion capital as they transition from product development and early sales into growth stage. For example, GCF is providing USD 20 million in equity and USD 5 million in grants to Acumen's USD 110 million KawiSafi Ventures Fund to leverage private equity for SMEs involved in off-grid renewable energy in East Africa. The KawiSafi Fund makes investments of USD 2-10 million in 10 to 15 clean energy small and medium-sized enterprises in Kenya and Rwanda. It also invests in other parts of the ecosystem such as consumer finance, mobile payment, and metering/monitoring technologies. These investments have recently

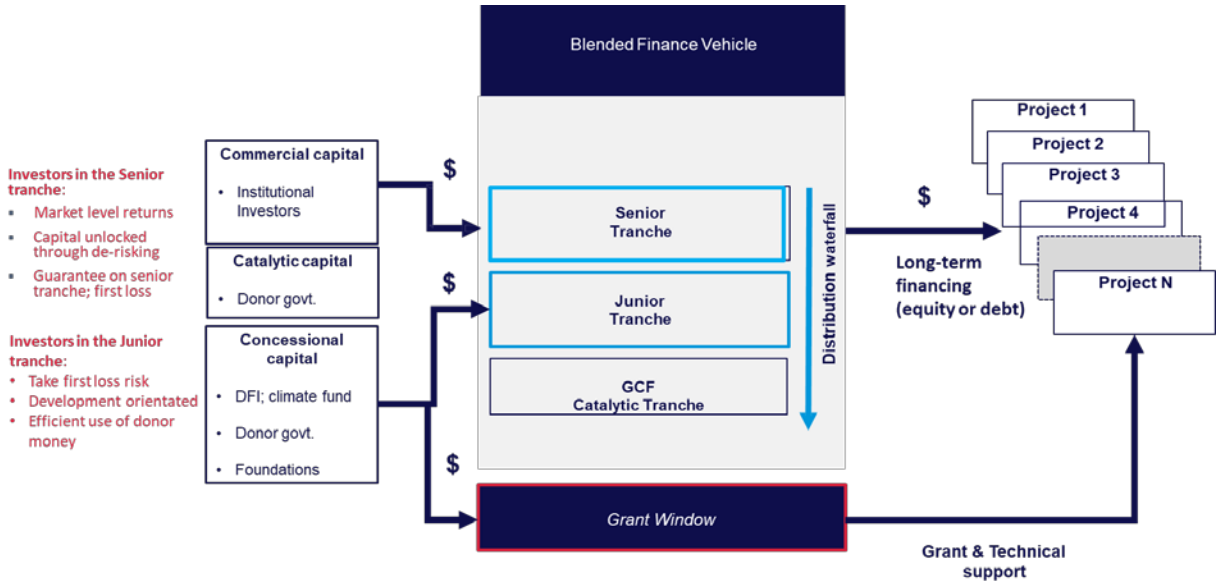
been supplemented by the creation of a new emergency relief fund specifically aimed at overcoming COVID-19 economic shocks to low-carbon energy companies in Africa. This Energy Access Relief Facility will provide vital liquidity to these companies in the form of low-interest, unsecured junior loans.

2.4 Mobilising finance at scale

Under its third prong, GCF mobilises finance at scale by using scarce public resources to de-risk market creating projects that will establish a commercial track record and crowd-in private finance to deploy new climate solutions at scale.

In mature economies, innovators with functional solutions that have been successful piloted can turn to local banks to finance the deployment of their products. As discussed in the first part, the valley of death in developing countries can extend well into the commercialisation phase, with severe barriers to access both debt and equity finance. To remove these barriers, GCF leverages its capacity to deploy a wide range of grant and non-grant instruments to explore new forms of blended finance to address the limits of conventional blended finance. For example, figure 3 outlines the generic structure developed by GCF with its private equity partners to mobilize private finance to and make blended finance works better for the most vulnerable, adaptation and ecosystem-based solutions.

Figure 3: GCF's generic fund structure to leverage private equity to scale up climate action.



GCF investment (first loss equity position, first loss guarantee, anchor investment, etc.) is pivotal to unlock private capital. By serving as anchor investor – the first investor to commit to a fund- and/or taking the most junior position and the first investor to suffer financial losses if the fund underperforms – GCF de-risks the investments of more risk averse but larger co-financiers such as institutional investors.

Technical assistance plays an important role in GCF's blended finance transactions in LDCs, including helping to put in place the right capacities and institutions to identify, analyse and structure blended operations, and to strengthen investees' operational efficiency and environmental, social and governance (ESG) compliance (OECD/UNCDF 2019). The grant window aims to achieve these objectives and usually builds on earlier capacity development efforts to establish an enabling investment environment financed through GCF's Readiness Programme (GCF, 2021).

The ambition of such a structure is to demonstrate the commercial viability of transformative low emission, resilient investment. If successful, the blended finance structure will establish a track record and enable financiers to re-assess the risks of specific classes of climate assets. In turn, this re-assessment of the risk-reward profile of these investments will enable their market-driven diffusion and widespread adoption.

As an equity financier, GCF will be able to recover its investment and reinvest in similar ventures if the blended finance structure meets its investment return targets. In this situation, public finance is used as a true catalyst to accelerate private investment, as it is reconstituted at the end of the investment cycle for further deployment. GCF is using this generic fund structure to make blended finance work for climate mitigation and adaption technologies, nature-based solutions, and the most vulnerable.

Case study: Subnational Climate Fund

This generic structure was adapted for the Subnational Climate Fund Global (SCF Global) managed by Pegasus Capital Advisors. This project, approved by the GCF Board in 2020, leverages USD 150 million in first loss equity investment from GCF to mobilise USD 600 million of senior private equity for mitigation and adaptation solutions at the subnational level (provinces, municipalities). A multiple of this amount is expected to be catalysed in entrepreneur equity and debt finance. GCF's anchor funding and first loss equity coverage will unlock both public investors and private institutional investors (Pegasus Capital Advisors, 2020).

This is the first time an impact equity fund mobilises public (20 per cent) and private sector (80 per cent) funding at scale to de-risk subnational middle scale infrastructure projects. The subnational level is key as 70 per cent of known climate solutions are located within the boundaries of subnational authorities. Significant additional investment is needed at the subnational level to achieve the goals of the Paris Agreement.

At the same time, private investment is limited by several barriers that result in chronic underfunding of bankable mitigation and adaptation projects at the subnational level, specifically at the deal size of USD 5-75 million. Thousands of high merit subnational projects are bypassed by commercial financing because investors prefer perceived safer and larger investments. Almost half of the 42 countries participating in the programme are LDCs and SIDS - the most vulnerable countries to climate change - which are most often overlooked even at the national level by private equity finance because of perceived higher risks or lower long-term market opportunities.

The equity fund implemented with Pegasus is complemented by a Technical Assistance Facility that is implemented with the International Union for the Conservation of Nature. This USD 18 million grant facility will support the development of investment projects for submission to the fund by establishing proof of concept for mitigation action and blueprints for climate resilience, as well as establishing tools and metrics to be used by investors to track impact, and building the capacity of project developers and local and regional actors to participate in the fund.

By 2030, up to USD 300 billion per year will be needed for climate adaptation in developing countries alone (UNEP 2016), but adaptation receives only five per cent of all climate finance – and almost no tracked private investment6. Thus Pegasus is exploring options to adapt this approach to support innovative adaptation technologies (water efficiency devices, climate resilient agricultural and climate analytics apps, etc.) and ecosystem-based solutions (coastal and marine ecosystem protection, etc.).

Some of the first projects to be financed by SCF Global are expected to be climate-smart agricultural parks in Caribbean states. These 'agriparks' will be designed to withstand extreme weather events and will deploy a range of innovative agricultural technologies (aquaponics, hydroponics, algae farms, etc) to overcome land and water constraints and enhance food security. SNCF equity investment in these agriparks is expected to directly leverage 5 to 10 times more resources in private equity and debt. The initial 1:5 leveraging ratio of GCF in SNCF could thus result in a total leveraging ratio of 25 to 50. This is consistent with the leveraging ratio required to convert the billions of public climate finance available into the trillions of investments required to achieve the SDGs and Paris Agreement's goals.

Ultimately, GCF will be able to recover the entirety of its investment and reinvest in similar ventures if the equity fund meets its investment return targets. In this situation, public finance will be used as a true catalyst to accelerate private investment, as it is reconstituted at the end of the investment cycle for further deployment. GCF is increasingly using this generic fund structure to catalyse private finance for innovative adaption technologies and nature-based solutions such as coral reef protection.

2.5 Aligning finance with sustainable development

As indicated in Part I, investors have a strong preference for home-country investments where risks are well-understood. Strengthening and aligning national financial institutions with sustainable development is a pre-condition to accelerate the widespread diffusion of commercially proven new climate solutions. Under its fourth and final prong, GCF strengthens the capacity of domestic financial institutions to: (i) mainstream climate risks and opportunities in investment decision-making; (ii) originate and development climate investments; (iii) access domestic and international capital markets to finance climate investments; and (iv) apply strong environmental, social and governance standards for inclusive and responsible new climate solutions.

This approach entails developing the capacity of domestic financial institutions to adopt new asset valuation methodologies to better assess the benefits of low emission climate resilient investment and transform them into a new class of assets. For example, GCF is collaborating with two global coalitions to develop new valuation and labelling methodologies for climate-resilient infrastructure. These new asset valuations methodologies will enable investors and financial institutions to balance the higher upfront costs, longer payback period and higher technology risks of new climate solutions with their lower operations and maintenance costs and lower climate physical, transition and liability risks. This could lay the foundation for governments and firms to issue resilience bonds to better finance the higher upfront costs of climate resilient infrastructure – as in the case of a climate resilient road that will initially cost more than a conventional road but will be less vulnerable to climate change.

Like people, companies and municipalities can borrow from banks, but issuing bonds is often a more attractive proposition. The interest rate requested by bond investors is usually less than the interest rate available from banks. However, in developing countries, notably LDCs and SIDS, the market for green bonds and green asset-backed securities (ABS) remains in infancy. As mentioned in Part 1.4, only three per cent of green bonds were issued by firms and financial institutions in developing countries in 2020 (excluding China). Shallow capital markets; the high cost of issuance due to developing countries' credit ratings; the issue of minimum size; and the lack of appropriate institutional arrangements for green bonds are common barriers to deepening this market.

With its partners, GCF is supporting developing countries' efforts to issue green bonds, green ABS and develop new financing instruments such as climate resilient bonds. In one such case, it helped the Development Bank of Southern Africa establish a dedicated climate investment facility and may also assist them to design the first municipal bonds for recycled water in South Africa, creating a new asset class to foster adaptation to climate change. As mentioned in part I, developing the capacity of National Development Banks (NDBs) in accessing international capital markets to capitalise their operations. Issuing green bonds could be a game changer for NDBs and international efforts to scale up climate action.

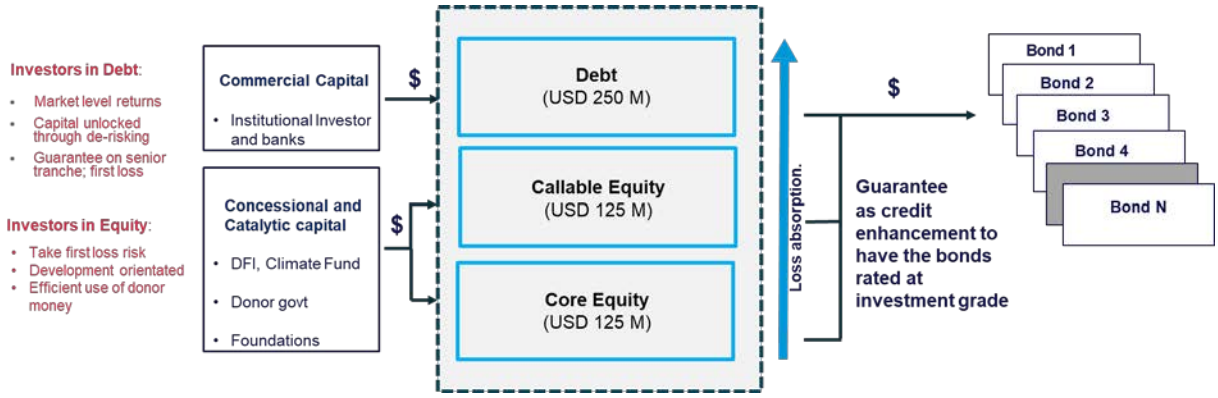
GCF's grant assistance can also be leveraged by developing countries to ready their stock exchanges to float bonds. For example, GCF supported the Government of Jamaica to set up a Caribbean green bond listing on the Jamaica Stock Exchange, which will enable it to float green/adaptation bonds through a dedicated green bond facility.

GCF's support has enabled the Jamaican Government to assess the current structure of the debt capital market for bonds and the suitability for green bond growth; develop appropriate policies and guidelines based on international standards and Green Bond Principles; and strengthen the capacity of key market players from across the region. The ambition of the green bond facility is to facilitate the aggregation of project assets (from public and/or private sources) and their refinancing through the proceeds of green bonds and ABS to accelerate the implementation of the country's NDCs.

Guarantees can play a key role to enhance the credit profile of bonds and facilitate developing countries' access to global capital markets. A guarantee can act as a credit enhancement mechanism for a new issuer by guaranteeing the partial or total repayment of the money borrowed. GCF, with its partners, is experimenting different financing structures to guarantee the issuance of green and climate resilient bonds and ABS in developing countries. Figure 4 summarizes the generic structure of a green guarantee company being

developed by GCF partners with a GCF preparatory project grant to catalyse green bond markets in developing countries.

Figure 4: GCF's generic green guarantee company structure to catalyse green ABS in developing countries.



To be transformative, innovations must also be inclusive and responsive. Another essential contribution of GCF is therefore to facilitate the adoption of environmental, social and governance safeguards by national finance institutions to ensure that new climate solutions are inclusive and responsive. The primary objective of environmental and social safeguards (ESS) and environmental and social management systems (ESMS) are to avoid, minimise, mitigate, and compensate for the adverse effects of activities that may impact society and the environment. However, they are also powerful instruments to improve the design and diffusion of new climate solutions through leveraging expertise from a broad range of stakeholders; assessing and monitoring risks and benefits in a systemic manner; and enabling the implementation of adaptative measures as required.

The evaluation literature has long noted that complying with ESS standards was a key challenge for efficient access to financial resources by developing countries (GCF IEU, 2020). Enabling domestic institutions to develop and apply robust environmental, social, governance (ESG) procedures is a priority area of cooperation to ensure that stronger ESG standards do not become a barrier to public climate finance but, instead, facilitate the access of domestic institutions to capital markets. Strong ESG will mitigate the risk that new climate solutions generate new problems of their own and are rejected because they are perceived as unfair. They should also enable access to finance at a lower cost through the issuance of green, climate resilient bonds backed by robust and transparent ESG methodologies that would meet the increasing demand from individual savers and institutional investors for climate-compatible investment products.

Conclusion

Climate innovation is an imperative of our time to avoid catastrophic climate change and to achieve the SDGs - the first-ever humankind agenda for people, prosperity, peace, and the planet. Innovation is not an option.

Innovation can help put us on track to reach the Paris Agreement goals and achieve inclusive and sustainable growth. An influential report at the beginning of the 1980s concluded that climate change was uncertain but innovation to address it was certain. Contrary to this assumption, climate change is certain, but innovation is not. Innovation is not inevitable, particularly in developing countries. To achieve the climate innovation promise, integrated policy development will be critical to remove barriers to novel ideas at the emergence, diffusion and adoption stages of the innovation cycle, of which the barriers are magnified in developing economies.

The higher upfront capital requirements of many climate investments translate into longer payback periods. Despite their potentially higher return on capital, the cash profile of these climate investments compounds barriers to capital flows from mature markets to early-stage markets. This implies that private investment in climate innovation will be sub-optimal in the absence of government support. A key challenge is to identify, design and implement an effective portfolio of policies to establish a conducive environment for climate innovation. New forms of blended finance must also be explored to accelerate climate innovation and investment.

Blended finance usually takes the form of relatively safe senior debt rather than more risky instruments such as equity or guarantees that could have higher leveraging ratios and better meet the needs of private investors to finance the emergence, deployment, and widespread adoption of new climate solutions. Grants for capacity development and pre-seeding and seeding finance to incubate new climate solutions combined with de-risking instruments such as first loss equity and guarantees to deploy them have the potential to scale up private climate finance in early-stage markets.

GCF's four-pronged approach to overcoming barriers to climate innovation is a core element of how it delivers on its ambitious mandate of promoting a paradigm shift towards low-emission and climate-resilient development pathways in developing countries. By establishing a conducive environment, catalysing innovation, mobilising finance at scale, and aligning finance with sustainable development, GCF seeks to overcome barriers to innovation and open to developing countries new avenues to realise their climate ambitions.

Notes

1. The IPCC has been documenting the causes and impacts of climate change since 1988 and released its sixth "Assessment report" in 2022.
2. In his now classic paper "Why capital does not flow from rich to poor countries", Lucas (1990) calls this paradox a central question for economic development. It is also a central question for addressing climate change.
3. Accelerators help start-ups in refining prototypes and sharpening business concepts to have the best chance of achieving external funding. Start-ups are usually supported for a three-to-four-month period, at the end of which they graduate. Start-ups entering incubators may be supported for a longer time, and the equity taken in each start-up tends to be much higher than the accelerators. Investment in the start-up can be provided by the incubator itself.
4. In finance, leverage is any technique involving using debt rather than equity in the purchase of an asset, with the expectation that the after-tax profit to equity holders from the transaction will exceed the borrowing cost and thus act as a lever in physics and amplifies multiple times the effect of equity. In climate finance, leverage refers to the effect of public finance to catalyse larger private sector financial flows. Leveraging enables the climate impact of scarce public money to be multiplied to address climate change at scale.
5. Only USD 22 billion of USD 410 billion of global climate in 2015-2016 went to adaptation, and the vast majority was public finance. Climate Policy Initiative, Global Landscape of Climate Finance 2017.

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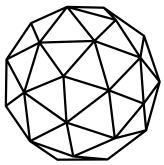

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