



United Nations
Framework Convention on
Climate Change

**TECHNOLOGY
EXECUTIVE
COMMITTEE**

INNOVATIVE APPROACHES TO ACCELERATING AND SCALING UP CLIMATE TECHNOLOGY IMPLEMENTATION FOR MITIGATION AND ADAPTATION



Contents

I. Executive summary	4
II. Introduction	6
A. Background.....	7
B. Objective	9
C. Scope and approach	10
III. Innovative approaches to strengthening the uptake of existing climate technology solutions	12
A. Theoretical background.....	13
B. Case studies.....	17
IV. Synthesis: enabling conditions for accelerated technology uptake	31
V. Key messages and recommendations	35
VI. References	38

Abbreviations and acronyms

CIC	Climate Innovation Center
CSA	climate-smart agriculture
GCF	Green Climate Fund
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and Caribbean
LDC	least developed country
MSP/MSI	Multi-Stakeholder Partnership or Initiative
NAMA	nationally appropriate mitigation action
NAP	national adaptation plan
NDC	nationally determined contribution
TEC	Technology Executive Committee
TNA	technology needs assessment
UNDP	United Nations Development Programme

I. Executive summary

The Paris Agreement calls for international collaboration on technology development and transfer. The technology framework provides overarching guidance to the work of the Technology Mechanism, promoting and facilitating action on technology development and transfer to support the implementation of the Paris Agreement.

This paper explores innovative approaches to stimulating the uptake of existing climate technologies for mitigation and adaptation. Such innovations can be identified in the following areas: how technology options are selected by countries (i.e. as part of low-emission and climate-resilient pathways); how stakeholder views and practitioner knowledge, as well as their preferences, are solicited in climate technology planning; what financial innovations exist for enhancing funding of technology projects and programmes; and what are viable ways of enhancing private sector engagement and incubators.

The role of stakeholders in climate technology planning and implementation is crucial. The rationale for pursuing innovations in stakeholder engagement and capacity-building is fostering their sense of co-ownership. Such stakeholder engagement can aid in the technology planning and implementation process by making a technology option not just technically and economically feasible, but also socially acceptable. In terms of the successful uptake of technology solutions, the role of technology champions is highlighted as crucial.

The paper presents examples of innovation approaches to identifying where and how market systems for enabling technology uptake can be improved, including ways to attract funding for prioritized climate technology programmes and policies. Green or climate bonds are examples of innovative instruments that help countries (re)fund technology investments. These have recently been explored for adaptation. Other ways to attract funding for climate technology deployment are the initiatives of the GCF and multilateral development banks to provide readiness and preparatory support for technology deployment and diffusion.

Stronger engagement of the private sector in climate technology uptake is crucial. Private sector engagement is recognized as a measure for bridging, for example, knowledge, funding and capacity-building gaps and innovative approaches to these include multi-stakeholder partnerships, which are gaining momentum. The Patient Procurement Platform is one such example, set up to create value chains that will result in higher farmer incomes in developing countries. These new approaches allow (inter)national collaborators to align their interests and leverage resources around a complex issue such as food security.

The innovative approaches highlighted in this paper are presumed to achieve a more balanced division between government (push) and private sector (pull) actions to ease the technology scaling up process, especially in the LDCs.





||. INTRODUCTION

A. Background

The Paris Agreement calls for international collaboration on technology development and transfer to support the purpose and goals of “holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels”.¹

The technology framework established under the Paris Agreement will provide overarching guidance to the work of the Technology Mechanism established under the Convention to fulfil the long-term vision of technology development and transfer to improve resilience and reduce emissions. The framework will promote and facilitate action on technology development and transfer to support the implementation of the Paris Agreement.²

The importance of accelerated technology development and transfer was supported by the findings of the Fifth Assessment Report of the IPCC and the IPCC Special Report on Global Warming of 1.5 °C. These assessments included the scales for developing, deploying and diffusing technologies for limiting the increase of global average temperature along with an estimation of the temporal and spatial scales within which the goal of limiting temperature increase can potentially be achieved.

Both reports explored how viable technology options can be integrated into climate-resilient sustainable development pathways for countries. With these pathways, countries can achieve their sustainable development goals alongside low emissions and strengthened climate resilience.

At its 19th meeting, the TEC adopted its rolling workplan for 2019–2022, in which activities are organized in five focus areas reflecting the key themes of the technology framework, namely: innovation, implementation, enabling environment and capacity-building, collaboration and stakeholder engagement, and support.

While innovation is singled out as a key theme in the workplan, several examples of innovative approaches relating to the other key themes can be identified from work carried out under the Convention in areas such as:

- (a) The increasing engagement, using new or updated tools, of country stakeholders in decision-making in country-driven processes such as NAMAs, NAPs and TNAs;
- (b) The improvement of existing tools for describing systems for technology development and transfer, such as market mapping (used in TNAs) (TEC, 2015a) (TEC, 2019) and the identification, prioritization and characterization of enabling conditions for successful technology implementation (Nygaard & Hansen, 2015);
- (c) The improvement in access by developing countries to financial and capacity-building support provided by the GCF (TEC, 2017a).

¹ Paris Agreement, Article 2.

² Paris Agreement, Article 10, paras. 1 and 4.



This paper aims to inform policymakers about innovative approaches to stimulating the uptake of existing climate technologies. These approaches are identified from academic and other research papers and explored through good practice case studies. The focus of the paper is not on technology innovations, but on innovative ideas and actions to accelerate the deployment and diffusion of climate technologies for mitigation and adaptation. The geographical focus of this paper is developing countries, the LDCs and small island developing States.

B. Objective

The overall objective of this paper is to support the TEC in identifying innovative approaches to stimulating the uptake of deployment-ready climate technology solutions with a view to providing policy recommendations to countries, in particular developing countries, and relevant stakeholders on this issue.

The paper:

- (a) Provides background information on the current state of play of innovative approaches to stimulating the uptake of existing climate technology solutions, including recent international developments, trends and efforts;
- (b) Presents an overview of activities, as case studies, undertaken by various stakeholders to apply these innovative approaches in practice;
- (c) Identifies key enabling conditions for successfully applying the innovative approaches defined;
- (d) Offers key messages and recommendations.



C. Scope and approach

Waisman et al. (2019) discussed the consideration of technology development and transfer for climate from three perspectives. The first perspective sets the stage for technology development and transfer in terms of what is required for meeting the purpose and goals of the Paris Agreement to limit global average temperature increase to well below 2 °C, or even to 1.5 °C.

The second perspective focuses on the relationship between the 1.5 and 2 °C temperature goals and sustainable development globally, as well as nationally. This relationship is reflected already in several processes under the Convention, such as NAMAs, NAPs and TNAs, which invite country stakeholders to select options for climate change mitigation and adaptation in the light of national development priorities.

The third perspective described by Waisman et al. (2019) delves into the implementation contexts, systems and enabling conditions for technology implementation. This perspective serves to identify actions that better accelerate, encourage and enable technology uptake and to support countries in improving their policy environment, strategies and legal frameworks for undertaking those actions.

It is this third perspective that underpins the work of this paper. The scope of the paper lies in identifying and assessing, by using recent international research projects, innovative approaches related to several aspects of preparing to scale up and accelerate climate technology uptake. Such innovations can be identified in the following areas: how technology options are selected by countries (i.e. as part of low-emission and climate-resilient pathways); how stakeholder views and practitioner knowledge, as well as their preferences, are solicited in climate technology planning; what financial innovations exist for enhancing funding of technology projects and programmes; and what are viable ways of enhancing private sector engagement and incubators.

Within this contextual framework, this paper discards innovation in the sense of technical innovations during the research and development stages of technology development. Instead, it makes a deliberate choice to focus only on already mature technologies that are awaiting diffusion or uptake and that will benefit from new ideas and approaches which support that. Nevertheless, the deployment of mature technologies in developing countries may require additional research and testing, for example in situations where a technology needs to be modified for operationalization under different climatic conditions (UNDP, Handbook for conducting technology needs assessment for climate change, 2010).

Finally, it is emphasized that the paper, when discussing innovative approaches to accelerating technology deployment, takes a technology-neutral perspective, such that the approaches identified can be replicated for any technology portfolio awaiting diffusion. Through this technology-neutral perspective, the paper explores participatory channels (such as TNAs) through which stakeholders and markets can prioritize their preferred technology options, for both mitigation and adaptation. Such approach is also valuable from the perspectives of efficiency (technology options are selected by markets using cost versus benefit criteria)

and societal acceptance of technologies (i.e. country stakeholders prioritize technologies that maximize combined climate and development gains).

The paper proceeds with briefly elaborating on the theoretical background of innovative approaches to technology uptake (chap. III). For that, the paper identifies aspects along the 'journey' of technology deployment and diffusion and shows, through case studies, how innovative approaches can ease and accelerate the path of technology solutions to wider diffusion. The case studies are identified from programmes under the Convention or other international programmes and (research) projects undertaking case study analysis. The lessons learned are collated and discussed in the synthesis chapter (IV) with the aim of highlighting how developing countries can best utilize the innovative approaches to accelerating the uptake of climate technologies. The paper concludes with key messages and recommendations (chap. V).





**|||. INNOVATIVE APPROACHES TO
STRENGTHENING THE UPTAKE OF EXISTING
CLIMATE TECHNOLOGY SOLUTIONS**

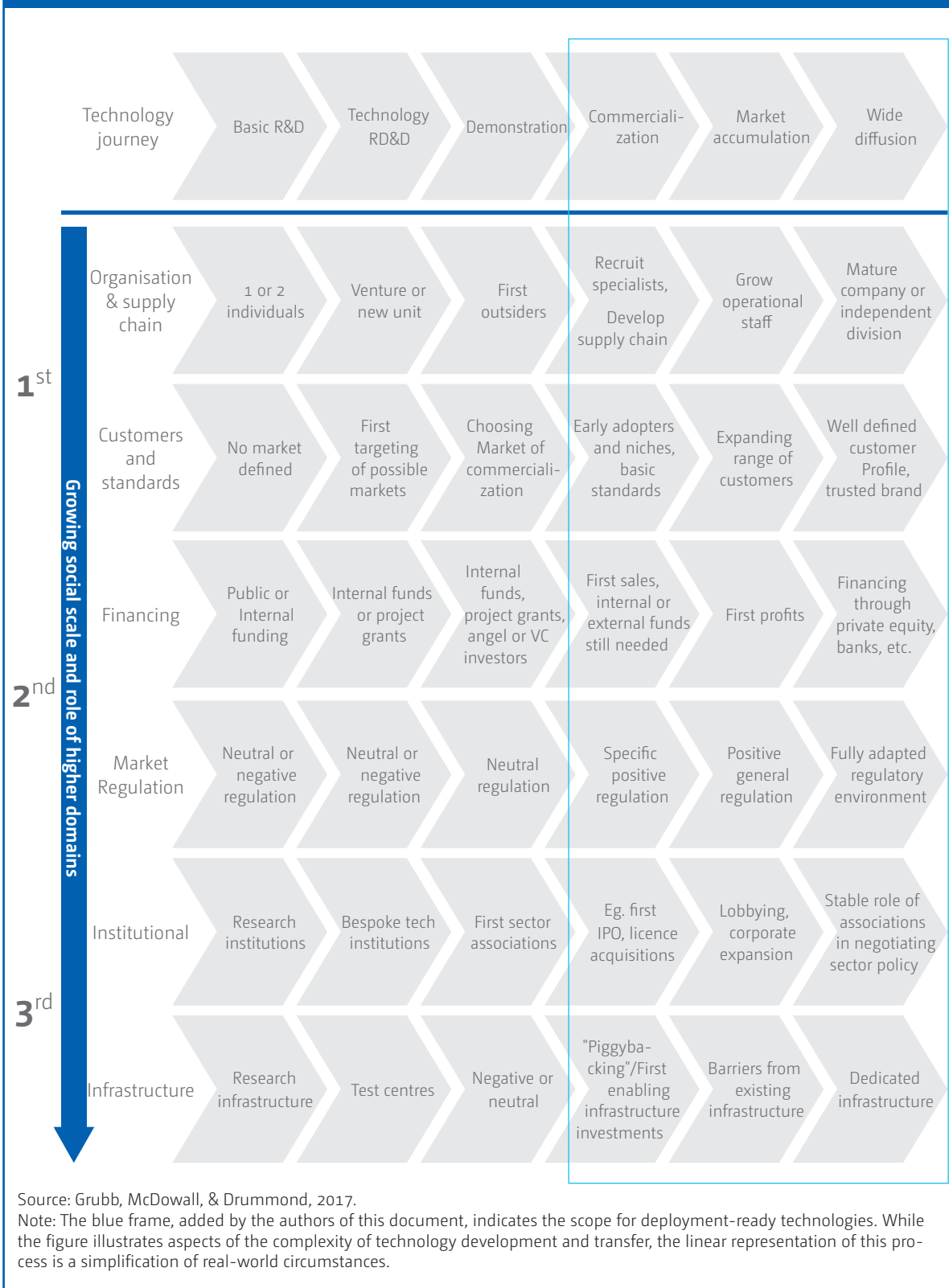
A. Theoretical background

The implications of the collective ability to manage a climate technology transition are enormous: a study by the International Energy Agency suggests that to keep the global rise in temperature to less than 2 °C, the additional cost of deploying energy technologies between 2016 and 2050 is USD 40 trillion (IEA, 2015). As developing countries may account for up to 90 per cent of energy demand growth to 2050 (IEA, 2015), the importance of their technological capabilities to manage this transition effectively and efficiently cannot be overstated.

Innovation is a broad term used to describe both the process and the outcome of developing and adopting technologies and techniques that are put to use in the world. While innovation typically refers to something new, it can also involve adapting or changing something that exists to make it more efficient or better in some other way, and thus more widely adopted (Ockwell & Byrne, 2016). Given the scope of this paper covers innovative approaches to accelerating the uptake of mature, deployable technologies for mitigation and adaptation, an elaboration of factors that play a key role in that acceleration is presented in the rest of this chapter. For these factors, the paper then identifies innovative approaches using good practice case studies.

Often, factors that further technology progress are categorized as ‘pull’ or ‘push’ factors. Grubb et al. (2017), along the technology journey (as shown in figure 1), categorizes factors that are decisive during the technology invention, development and demonstration phases, for example technical knowledge development and basic and applied research and development, as push factors. Pull factors, on the other hand, are more important during the technology maturity phase and in stimulating demand for a technology by users, whether or not those factors are in turn stimulated by regulatory instruments. Two examples of pull factors are the commercial viability of a technology (so that its implementation becomes profitable for market investors) and consumer preference for a particular technology solution.

Figure 1 Order and complexity in innovation systems

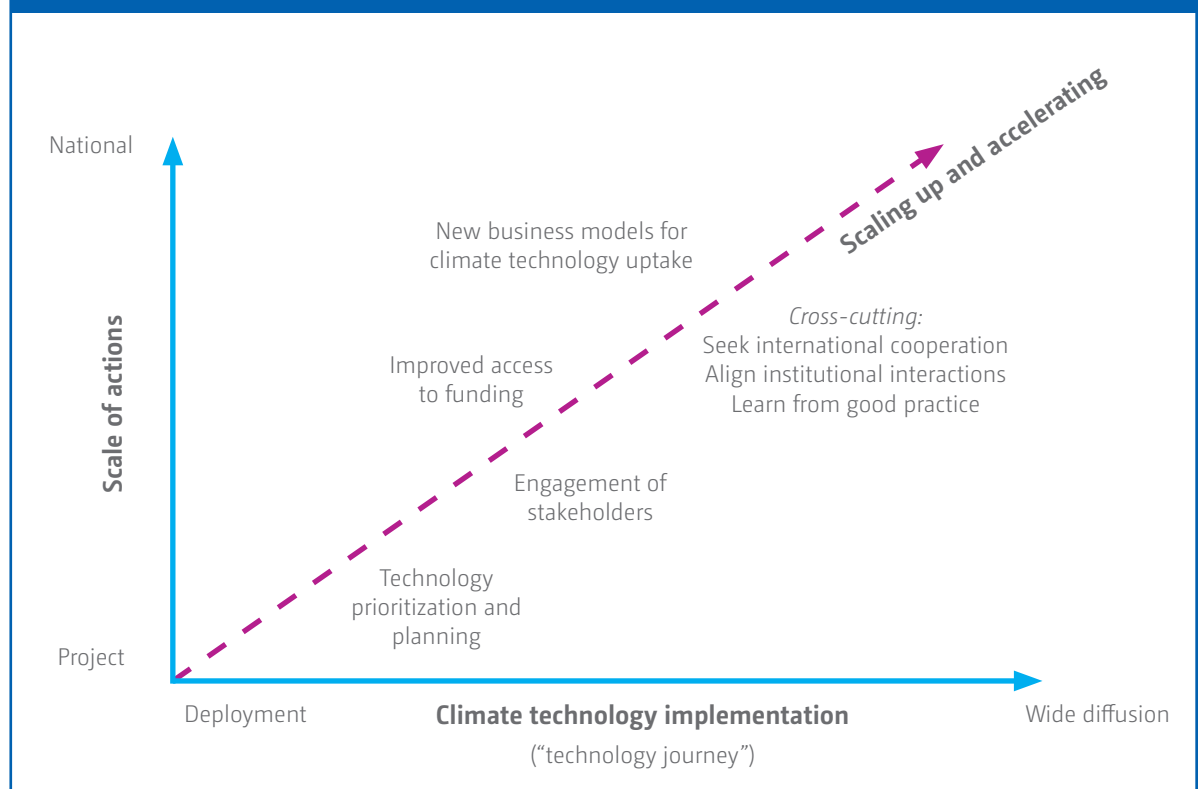


Addressing the factors identified by Grubb et al. (2017), innovative approaches would thus contribute to enhancing (market) systems for accelerating technology deployment and diffusion. This is in line with the perspective of technological innovation systems (Bergek, Jacobsson, Carlsson, Lindmark, & Rickne, 2008) (Bößner, Johnson, & Taylor, Innovation Dynamics in Transition Pathways, 2018), which interpret innovation in the light of, for example:

- (a) Knowledge development, which in the case of climate technologies includes learning activities, adoption trials and learning-by-doing;
- (b) Knowledge diffusion, which facilitates exchange of knowledge among the actors involved and through partners;
- (c) Resource mobilization, which refers to the allocation of financial, material and human capital. The diffusion of climate technologies is often difficult as they are expensive thereby necessitating the intervention of financial instruments such as green bonds, subsidies and other market inventions;
- (d) Advocacy coalitions involving the participation of public and private sector stakeholders to enable institutional support for scaling up technologies for mitigation and adaptation.

As the innovative approaches discussed in this paper focus on accelerating technology deployment and diffusion in developing countries, it is important to consider scaling aspects. As illustrated by Grubb et al. (2017) and figure 1, the application scale of a technology becomes larger along its journey. Scaling up requires that wide groups of stakeholders (at the sectoral and national level) are engaged in technology decisions and that (market) systems are in place, supported by institutions (public or private) required to facilitate the process of uptake. The diagonal dashed line in figure 2 illustrates the scope of scaling up; that is, progressing towards wider diffusion requires the consideration of aspects related to large-scale technology implementation.

Figure 2 Scope for innovative approaches in scaling up and accelerating climate technology implementation



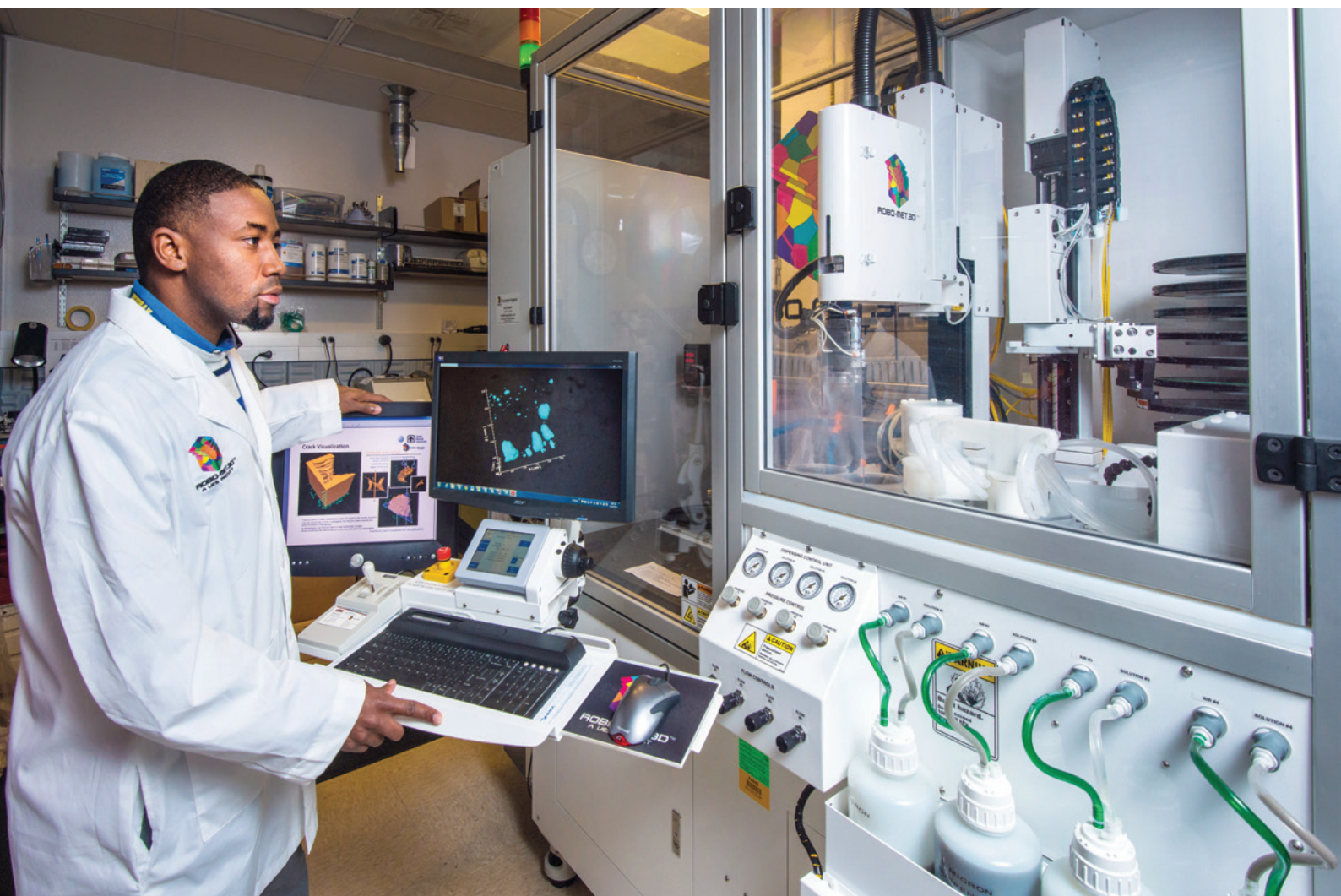
Building on insights into technology development and transfer developed elsewhere (including Grubb et al. (2017), Bergek et al. (2008), Bößner et al. (2018)), this paper focuses on innovative approaches along the diagonal in figure 2 with a view to:

- (a) Prioritizing and planning technologies for mitigation and adaptation as part of or in line with developing countries' sustainable development strategies;
- (b) Building stakeholder capacity in scaled-up technology prioritization and planning;
- (c) Improving access to international funding for technology projects and programmes;
- (d) Highlighting emerging trends in business models for climate technology uptake, for both mitigation and adaptation, including the role of private sector engagement and incubators.

Figure 2 assumes that the journey of a mature, deployment-ready technology starts from the level of a successful demonstration and then proceeds along the scale to wider diffusion at the sector or country level. As such, figure 2 zooms in on the part of the journey in figure 1 covering the stages from commercialization to wide diffusion.

In addition to the aspect of scaling shown in figures 1 and 2, it is clear that climate technology deployment also benefits from acceleration actions. In most of the case studies discussed in the next subchapter, acceleration is implicitly assumed as a result of innovative approaches. After all, innovative approaches strengthen countries' enabling conditions for accelerating deployment of climate technologies on a large scale.

The next subchapter identifies case studies as good practice examples of innovative approaches to deploying the acceleration factors identified in figure 2.



B. Case studies

1. Innovative approaches to technology identification, prioritization and planning

Drawing on experience from processes under the Convention, such as TNAs, NAMAs, NAPs and NDCs (under the Paris Agreement), the planning and prioritization of technologies for mitigation and adaptation has been integral in developing country contexts. A common element across the processes is the embedding of prioritized technologies in an overarching vision for the country, so that solutions for climate change become ‘nationally appropriate’ or ‘nationally determined’. Moreover, while adaptation and mitigation are often treated separately in terms of analysis, reporting and policymaking, the above-mentioned processes have demonstrated how both are often related in practice and can lead to co-benefits.

For example, adapting to soil subsidence in peat areas by raising groundwater levels results in the co-benefit of lower carbon dioxide emissions from peat layers. Humphreys (2019) studied ways of making Chile’s low-emission energy policy (mitigation) more climate-resilient (adaptation). The Global Commission on Adaptation (2019) has also emphasized the need for exploring synergies between adaptation and mitigation.

Embedding technologies for mitigation and adaptation in countries’ development visions requires an assessment of the benefits and knock-on effects within and across sectors when the technologies are scaled up. In TNAs, such assessments are largely done through stakeholder consultations, supported by consultants. The TRANSrisk project,³ commissioned under the European Union Horizon 2020 programme (in September 2015), explored low-emission transition pathways in several countries around the world (including Chile, China, India, Indonesia and Kenya) by integrating, as an innovative approach, quantitative and qualitative research methods. The integrated approach was motivated by the observation that while quantitative models enable the optimization of policy packages based on technology solutions against economic or other quantifiable criteria, they are unable to assess non-quantifiable aspects, such as stakeholder preferences or social resistance (Gaast, et al., 2016).

With qualitative research tools, the views, concerns and preferences of stakeholders can be solicited, and combining these with modelled scenarios enhances the development of pathways for climate action and development that are technically and economically feasible as well as socially desirable. This integrated approach can facilitate easier diffusion processes for climate technologies. Box 1 gives an example of a case study wherein this method was put into practice.

³ See <http://TRANSrisk-project.eu> for more information on the TRANSrisk (Transition Pathways and Risk Analysis for Climate Change Mitigation and Adaptation Strategies) project.



Box 1 Public acceptance of renewable energy in Kenya

The case study of public acceptance of renewable energy in Kenya shows the importance of technology identification, prioritization and planning. This case study was a part of the TRANSrisk project, which analysed the importance of stakeholder engagement during the process of energy technology decision-making in Kenya.^a

Stakeholder engagement took the form of consultations (two) on energy technology options available for the country. The consultations made use of the information-choice questionnaire, which had already been used to gauge public opinion about carbon dioxide capture and storage in the Netherlands.^b The questionnaire provided stakeholders with background information about the suggested technologies, thereby overcoming the problem of 'pseudo opinions' being provided owing to a possible lack of knowledge. The TRANSrisk project in Kenya consisted of 100 interviews and took into account three technologies (wind, solar and geothermal).

By analysing the interviews, it was found that the stakeholders had provided important considerations about the proposed energy technologies, as follows:

- (a) The positive use of land for both solar energy and agriculture;
- (b) The growth in employment resulting from the construction of wind turbines;
- (c) The financial benefits to local communities once it is possible to build wind turbines in local communities;
- (d) The low emissions of wind turbines;
- (e) The necessity of infrastructure development, such as access roads enabling the maintenance and operation of wind turbines;
- (f) The lower price of wind energy compared with solar energy;
- (g) The fact that wind turbines are visible in the landscape, cast shadows and generate noise, and the higher price of wind energy compared with geothermal energy.

These consultations gave an important overview of public opinion. The pros and cons of each technology option informed the strategy of the Kenyan Government to overcome the challenges and accelerate deployment. Public acceptance of renewable energy is instrumental for countries to meet their national energy demand and targets under the Paris Agreement.

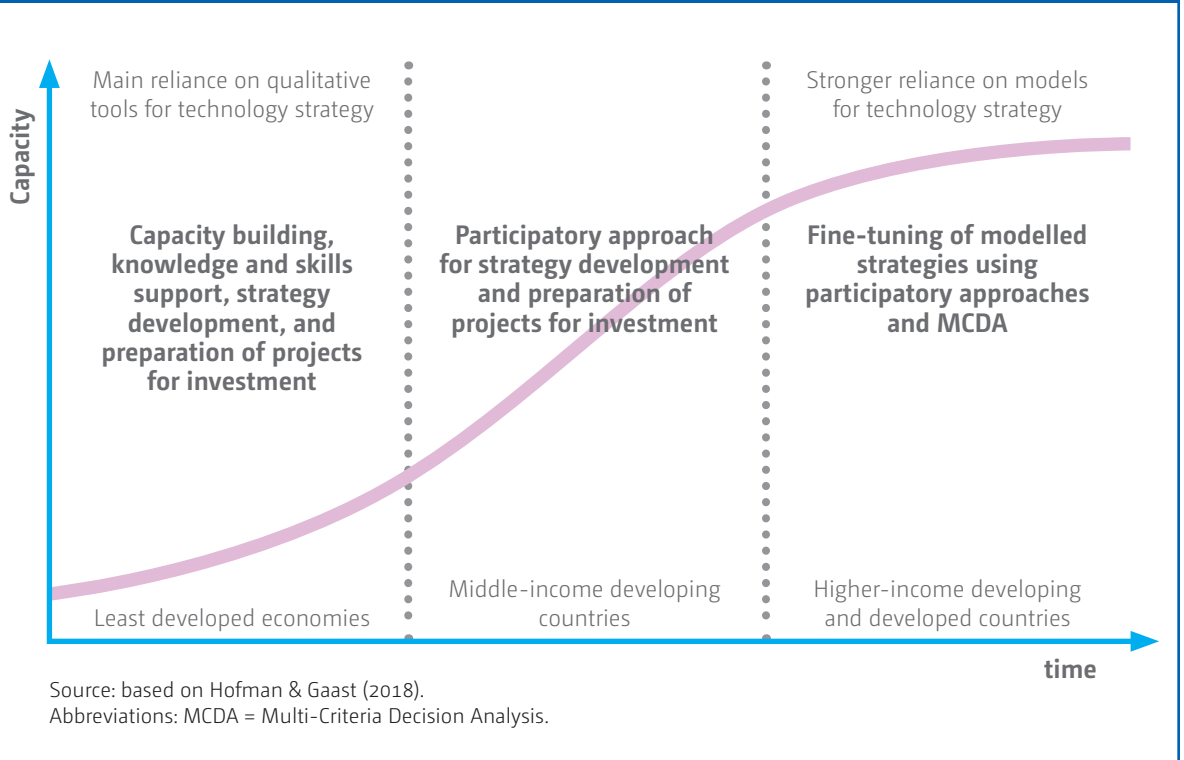
^a (Zwaan, et al., 2018).

^b (Best-Waldhofer, et al., 2012).

As mentioned above, TNAs generally do not apply quantitative methods such as models, but mainly rely on participatory processes with stakeholders. An important reason for this qualitative approach is that operating mathematical models for a country requires high-quality data and modelling capacity, which is not always available, especially in the LDCs.

Building on the observations from research projects such as TRANSrisk and processes such as TNAs while considering different capacity levels, Hofman & Gaast (2018) suggested an approach for using qualitative and quantitative assessment tools under different capacity conditions, as shown in figure 3. The figure illustrates how for countries with limited modelling capacity, the core of technology planning and strategy formulation lies in qualitative assessment tools, such as the TNA process, with widespread engagement of stakeholders. In higher-income and emerging economies with well-developed data-collection and modelling institutions, quantitative assessment, combined with stakeholder assessments and decisions, is a more reliable assessment tool. In countries with high-level modelling and data-collection capacity, qualitative tools would be mainly used to fine-tune modelling outcomes to evaluate their social acceptance.

Figure 3 Use of qualitative and quantitative assessment tools under different capacity conditions



2. Innovative approaches to building stakeholder capacity in scaled-up technology prioritization and planning

As explained above, climate change introduces great uncertainty into the development pathways of countries. Technology solutions for mitigation and adaptation, when scaled up, impact sectors and countries as a whole, with impacts that can be beneficial (e.g. development of new markets) but can also imply risks to society (e.g. reduced energy security). Approaches and systems more flexible than the ones used for ‘business as usual’ scenarios are therefore needed. Building stakeholder capacity is one such approach; it ensures ownership and quality of decision-making for climate change.

Within the context of technology uptake, building stakeholder capacity provides the local perspective and ensures equity, efficiency, effectiveness and sustainability. It has the potential to improve the transparency of the technology implementation process, thereby accelerating the uptake of a technology. Stakeholder involvement can help tackle the problems of incumbency and inertia with which (niche) climate technologies are often faced, thus easing the uptake process further (Geels, 2011).

Moving beyond engagement, building stakeholder capacity also aligns with the dissemination of knowledge, facilitating the sharing and application of information and empowering autonomous decision-making. The research project CARISMA analysed viable approaches to opening up public discussions that would be needed for wider social adoption and acceptance of mitigation options (Williges, Gaast, & Tuerk, 2018) (Bößner & Coninck, Addressing social implications of climate change mitigation: lessons from three novel technologies, 2018). The case studies in the CARISMA project shed light on the challenges faced by scaled-up technologies in gaining public acceptance, and its dependence on contextual factors such as lack of knowledge and exclusion of stakeholder views from the decision-making process.

The case studies demonstrate that including stakeholders in the technology planning and development stages has a positive impact on the social acceptance of expanding mitigation technologies. The feeling that a technology project or programme has been imposed on a community can give rise to feelings of discomfort and protest, especially when a technology disrupts the landscape. This is in line with the finding of the IPCC Special Report on Global Warming of 1.5 °C – that enabling people to become actively engaged in the co-design of a technology project or programme increases its social acceptance (Coninck, et al., 2018).

Williges et al. (2018) recommend that (energy and climate) transition processes are accompanied by an ‘institutional innovation’ that enables the active involvement of local or regional stakeholders in designing and planning the transition, as the technology affects their well-being and living environment. As found in Spiesberger et al. (2018), enhancing the engagement of stakeholders, with a focus on people and organizations’ co-ownership of energy and climate decision-making, can be seen as a good example of social innovation.

From the TNA good practice of stakeholder engagement for technology prioritization and planning, the role of ‘champions’ can be highlighted as an emerging approach. Champions are stakeholders who advance a sectoral or national technology option. According to TNA coordinators and consultants, technology champions are crucial for accelerating technology implementation for mitigation and adaptation within developing country contexts (TEC, 2019).

An example of the champions' role can be found in the TNA and NDC work conducted by Lebanon (TEC, 2019). In 2018, in the Lebanese transport sector a tax incentive was introduced for hybrid and electric vehicles to provide financial support to technologies prioritized in the country's TNA. An important stimulus for the incentive was found to be the lobbying by an informal transport group that emerged as a stakeholder during the TNA of Lebanon. The group continued to collaborate beyond the TNA project, including through co-organizing the first e-motor show in the Middle East (held in Lebanon in 2018) and an e-mobility conference (held in Lebanon).

Another example of an innovative approach to stakeholder engagement is the effort of CABI to help smallholder farmers in improving their production yields via the Plantwise programme.⁴ The innovative aspect of CABI's approach lies in the way it approaches farmers, not by confronting them with new solutions for sustainable farming, but by facilitating knowledge exchange at the community level, leaving it up to the farmers to decide whether or not to change. This example is elaborated in box 2.



⁴ CABI, the Centre for Agriculture and Bioscience International, is an intergovernmental, not-for-profit organization aimed at improving people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment. CABI has 49 member countries.



Box 2 Empowering farmers in Bangladesh through dissemination of information

Agriculture accounts for nearly one third of Bangladesh's gross domestic product. Nearly two thirds of the country's population works in agriculture, and about 80 per cent of people depend on it for their livelihoods. The country's major crop is rice, which is planted on 75 per cent of the country's farmland. Other crops include high-value vegetables, fruits and spices. Pests destroy between 10 and 25 per cent of harvests, despite the estimated 49,000 tonnes of pesticides used by farmers every year.

The Plantwise programme led by CABI aims to contribute to minimizing crop losses, increasing food security and alleviating poverty. Programme staff work closely with national agricultural advisory services and they have established a global plant clinic network, run by trained plant doctors, where farmers can find practical plant health advice and solutions. In Bangladesh the programme helped farmers to identify and manage crop problems, as well as increase crop yields and profitability. With increased knowledge of improved farm practices, plant clinic users can rely less on chemical fertilizers to manage pests and diseases.

The Plantwise programme achieved these results through a series of stakeholder interventions and capacity-building initiatives. Data on farmers' knowledge, attitudes and practices, and the impact changes in such knowledge, attitude and practices had on crop yields and farmer income, were gathered. Focus group discussions and one-on-one interviews with 55 farmers (35 men and 20 women) were conducted at the subdistrict level to gather in-depth information. Surveys to gauge farmer interest in attending these sessions were also conducted, which found that the availability of female doctors encouraged more women to participate. The surveys allowed the time and locations of the consultations to suit local needs.

Information on crop health is disseminated through knowledge-sharing applications provided by the plant clinics. A comparison survey of plant clinic users with non-users in Bangladesh revealed that the clinic users' ability to identify and address crop problems was significantly higher than that of non-users (83 and 13 per cent, respectively). The users also showed a greater ability to apply a range of good farm management practices.

Plant clinics are currently located in 10 of Bangladesh's 64 districts. The country's Ministry of Agriculture is interested in mainstreaming the plant clinics in their national extension operations to cover the entire country.

The concept of plant clinics has proven to be appealing to smallholders as it does not impose new farming practices and techniques on traditional knowledge. Instead, the plant clinics take a softer approach, by providing farmers with the option to engage with the plant clinics. This innovative approach to stakeholder engagement makes the process of achieving resilience more inclusive and stakeholder-oriented and provides a token of good entrepreneurship.

The network of plant clinics is reinforced by the Plantwise Knowledge Bank, which is an online gateway providing information on plant health, including diagnostic resources, best practice pest management advice and plant clinic data analysis for targeted crop protection. During 2014–2017, 29 per cent of knowledge bank users were women, and 71 per cent of all users were younger than 35. Nine per cent of all users in the age category 25–34 and 12 per cent in the age category 18–24 were female.

Through its innovative approaches, the Plantwise programme aims to strengthen national plant health systems.

Source: (Rajendran & Islam, 2017).

3. Innovative approaches to finance

The transition to a low-emission and climate-resilient economy requires scaling up and mobilizing a broad range of public, private, international and domestic financial resources. Access to and mobilization of finance remains one of the key challenges in pursuing climate technology projects, programmes and policies in developing countries. Investment in the deployment of climate technologies is expected to absorb a significant share of scaled-up finance.

TEC (2015b) stated the importance of ensuring an integrated approach between technology and climate finance plans and programmes at the national level, in particular the integration of TNAs into relevant national and sectoral plans and programmes, such as NAMAs and NAPs. That paper also stated that in contrast to technologies for mitigation, the sources of financing for technologies for adaptation have largely been public and will likely continue to be so for the most vulnerable countries, with many projects being implemented at the community level or connected with infrastructure projects.

A study conducted by the Global Green Growth Institute (GGGI, 2016) defined innovative financial mechanisms as financial structures that blend financial instruments, reduce specific risk investments and leverage private capital. These mechanisms were deemed necessary to advance climate projects in developing countries and emerging economies through several stages of financing: early stage, bankable, financed and mature (i.e. operational).

This was also illustrated in the work done by the Global Green Growth Institute with India's Ministry of New and Renewable Energy. The objective of the collaboration was to design a blended facility that would unlock debt capital for the Indian off-grid energy sector. The blended facility would open up lending in the sector to flow towards off-grid energy companies by mitigating associated credit risks. To achieve that, the Global Green Growth Institute created an innovative financing facility specifically tailored to the off-grid energy sector. The installed facility met all three characteristics of an innovative financial mechanism by:

- (a) Blending capital from various sources;
- (b) Reducing risk through the use of first loss capital;
- (c) Leveraging: with a first loss capital pool to absorb initial losses to loan portfolios, financial institutions' confidence in off-grid energy companies increases, as does their willingness to lend.

Building on the experience with TNAs, the TEC (2019) highlighted that technology implementation success increases if climate technology projects and programmes are integrated into national-scale policymaking processes for development, climate and finance, including NDCs. That paper provides good practice examples of countries that used TNA outcomes as guidance for other planning and funding acquisition processes, such as those under the GCF, Adaptation Fund and Global Environment Facility, and described how doing so supported the funding and implementation of prioritized technologies and action plans.

An example of an innovative approach to leveraging private funding through a contribution by the GCF is that of the commercial finance institute XacBank, which developed a loan programme for the revitalization of the energy sector in Mongolia (TEC, 2019). Using the outputs of the TNA for Mongolia, XacBank prepared a proposal for the GCF. The contribution of the GCF of USD 20 million to the overall project investment of USD 60 million enabled XacBank to negotiate more favourable loan conditions from other funding providers.

Financing climate technology requires a combination of ‘long-lasting, loud and legal’ policy incentives, market facilitation and public finance. The scaling up of financing faces constraints unless capital markets can be tapped into. To jump-start access to capital markets, multilateral development banks have acted as the initial catalyst for the climate bond market by issuing the first climate bonds. Since 2013, the market for climate bonds has grown exponentially, reaching USD 53 billion by the end of 2014 (CBI, 2015).

Over the years, green bonds have acquired a significant share of the bond market. They are instruments for financing or refinancing green projects that deliver environmental benefits and where the product, technology or business model concerned is mature and deployable (so-called late stage finance). The bonds have become increasingly popular for financing both mitigation and adaptation. For instance, in Latin America and the Caribbean, the Inter-American Development Bank developed a green bond facility to provide capital for energy efficiency projects. The facility met the challenges of capital availability through asset-backed securities (Humphreys, 2019). Another illustrative example of climate bonds working as an instrument of innovation can be found in box 3.



Box 3 Fiji’s sovereign green bonds for securing a greener future

As a small island developing State in the Pacific, Fiji is on the front line of combating climate change. The damage done by 2016’s Tropical Cyclone Winston, which caused economic losses that amounted to almost one third of the country’s gross domestic product, hinted at the potential for even greater damage and displacement in the future. Close to 20 per cent of the Pacific island region’s 10 million people is projected to be displaced as a result of climate change by 2050.

To safeguard its 900,000 citizens and their livelihoods, Fiji has developed and launched sovereign green bonds. It is the first developing country to do so. The effort was supported by the International Finance Corporation and the World Bank. The first tranche, which floated 40 million Fiji dollars (about USD 20 million), drew unprecedented demand from investors and was oversubscribed by more than double that amount. The bonds helped Fiji create a new way of mobilizing finance for development and develop a market for private sector capital seeking investment opportunities that support climate resilience and adaptation.

Likely projects to be financed with proceeds from the green bonds include those in crop resilience, flood management in sugar cane fields, reforestation, and the rebuilding of schools to better withstand violent weather. The projects will all follow the internationally developed Green Bond Principles. Fiji also aims to use bond proceeds for projects supporting its commitment to achieve 100 per cent renewable energy and reduce its carbon emissions in the energy sector by 30 per cent by 2030.

Fiji’s sovereign green bonds are the first bonds with an emphasis on adaptation, that is, building the country’s resilience to climate change. To become sovereign green bond issuers, countries must have in place a green bond policy framework that reflects international guidelines for the use of proceeds, disclosure and reporting.

At the request of the Reserve Bank of Fiji, the International Finance Corporation and the World Bank provided technical assistance to the Fijian Government, and the sovereign green bonds were developed in just four months. This collaboration took place under the broad three-year Capital Markets Development Project supported by the Australian Government. Through this partnership, the Australian Government and the International Finance Corporation are helping to stimulate private sector investment, promote sustainable economic growth and reduce poverty in the Pacific.

Source: (Government of Fiji, 2017).

Knowledge institutions can support access to climate finance for developing countries. For instance, the Climate Finance Ready portal, developed through a partnership between the Adaptation Fund and the Climate and Development Knowledge Network, offers information, advice and case studies to support developing countries in their efforts to access climate finance.

Innovative financial measures for accelerating the uptake of adaptation technologies has been limited. Interventions have mostly been led by multilateral development banks, with limited involvement of the private sector. The private sector is largely represented by life insurance companies, pension funds and sovereign wealth funds working to finance adaptation action.

One such exercise in innovation is the development of catastrophe bonds (or ‘CAT bonds’) – a high-yield instrument for building the in-house resilience of insurance companies in the event of natural disasters. CAT bonds have also led to better preparedness and greater involvement of insurance providers in climate change efforts. These bonds benefit the insurance industry because the capital raised lowers insurance companies’ out-of-pocket costs for natural disaster coverage. They also provide insurance companies with cash when they need it the most, which could prevent them from needing to file for bankruptcy because of a natural disaster. CAT bonds have been purchased by insurance providers such as AXA.

Innovative approaches to enhancing developing countries’ access to finance for adaptation can also be found in training. The International Development Research Centre, among other institutes, provides a training programme that equips participants from research, policy and private sector backgrounds with the skills to design and implement tailored interventions for mobilizing finance for adaptation. The enhanced skills aim help to narrow the often existing gap in developing countries between prioritized actions for adaptation (e.g. at the community level) and the countries’ ability to mobilize public and private funding for the actions. Enhanced access to finance for adaptation solutions is among the action tracks identified by the Global Commission on Adaptation (2019).

There have been recent examples of institutional interventions in financial systems in the form of the creation of benchmarks for financial products that incorporate climate change considerations. These benchmarks help institutional investors with sustainability mandates in allocating capital to climate-friendly economic activities. For example, in November 2019, the European Union adopted a regulation creating harmonized, minimum standards for “Paris-aligned benchmarks” (more ambitious) and “climate transition benchmarks” (less ambitious) (European Commission, 2019).

In a similar vein, classification schemes are being created by regulators and private standardizers, for example for classifying an investment as climate-friendly and making it eligible for climate bonds. The purpose of such classification is to channel to firms that engage in genuinely sustainable or climate-friendly investments (while combating greenwashing). As an example, the European Union regulation can be mentioned about the information to be disclosed by investors to establish their claims of offering environmentally sustainable products (European Council, 2019).

These examples of interventions are in accordance with the purpose and goals of the Paris Agreement, namely, that to make “finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development”.⁵

⁵ Paris Agreement, Article 2, para. 1(c).

4. Innovative approaches to private sector engagement and incubators

Olhoff et al. (2016) estimated that the costs associated with adapting to climate change impacts are at least two to three times higher than available international public finance for adaptation. International public finance available for climate change adaptation in 2014 was USD 23 billion. By 2030, it is estimated that adaptation costs will be in the range USD 140–300 billion per year. Even with a large increase in public sector contributions, the amount of finance required to support adaptation in developing countries is beyond what expected public finance will be able to contribute.

Private sector engagement has been recognized as the measure through which this massive gap in adaptation finance can be bridged. UNDP has made strides in this direction through its framework of “Convening, Catalyzing and Capitalizing” (the ‘3Cs’) (UNDP, THE ‘3CS’ FRAMEWORK, n.a.). By this mechanism, UNDP implements capacity-building related to climate resilience so that policies and regulatory reform can take place to support the private sector in increasing its ability to absorb impacts and make available products and services that can help society.

Private sector engagement has seen growing momentum through the establishment of multi-stakeholder partnerships and multi-stakeholder initiatives. For instance, the Patient Procurement Platform, established in 2015 by the United Nations World Food Programme in partnership with Grow Africa and Rabobank, aims to create efficient value chains to enhance farmers’ income. It aspires to reach 25 countries globally, and currently operates in Rwanda, the United Republic of Tanzania, and Zambia. The focus of the Platform in each country depends on what that country’s main crop is. To fulfil its aim, the Platform has forged partnerships with private sector actors such as Bayer, Syngenta and Yara International (international fertilizer and agribusiness companies), the Alliance for a Green Revolution in Africa, the International Finance Corporation and local members of the value chain.

The success of multi-stakeholder partnerships in catalysing private sector participation can be attributed to the fact that it allows all collaborators to align their interests and leverage resources around a complex issue such as food security. It allows organizations to share risks and combine their resources and competencies to maximize value.

Growing trends in incorporating corporate social responsibility within business models has further motivated the engagement of the private sector. This is especially true of insurance, logistics, and technology service providers who have been contributing with expertise and knowledge products in the field of disaster management and relief. For example, companies such as Microsoft (through its innovation centre), Google and IBM have provided solutions (technology, funding and expertise) for scalable and efficient disaster preparedness.

The Middle East Institute identified the benefits of and the enabling conditions that lead to such interventions (Bassegy, 2016). Its findings included:

- (a) Government resources are conventionally subject to competitive allocation across diverse human needs. By participating in the disaster response process, private sector entities build their own resilience and also engender a culture of tolerance in their host communities;
- (b) The decentralized structure of private entities facilitates a shortened turnaround response time.

Another vehicle for innovation in mobilizing finance for accelerated technology uptake has come through international organizations such as the Global Innovation Lab for Climate Finance.⁶ This organization aims to catalyse this process by drawing on experience and expertise from around the world to identify, design and pilot the next generation of climate finance instruments. It is a part of broader government and private sectors efforts to scale up climate finance.

The Lab brings public and private sector representatives together in a dialogue to enable a shared understanding of goals and perspectives and jointly identify barriers and solutions to mobilizing investment. By developing project-ready solutions, it complements and feeds in to existing processes (e.g. NDCs) and Financial Mechanism operating entities (e.g. GCF) under the Convention, as well as climate disclosure and impact investment efforts.

The Global Innovation Lab for Climate Finance has served as an incubator and model for several programmes. For instance, in India, a lab has been set up in collaboration with India's Ministry of New and Renewable Energy and with the support of the Shakti Sustainable Energy Foundation, the David and Lucille Packard Foundation, the United Kingdom's Department for International Development and the Oak Foundation. The initiative aims to provide concrete solutions to the financing challenges in investing in green infrastructure in India.

Another innovative approach to engaging the private sector has come through the launch of the infoDev (a World Bank programme) Climate Technology Program. The aim of the programme is to accelerate the development and transfer of locally relevant climate technologies. Its flagship activity was designing and implementation of CICs, which are currently active or planned in seven countries or regions: Ethiopia, Ghana, Kenya, Morocco, South Africa, Viet Nam and the Caribbean. The CICs represent a holistic and tailored approach to innovation in financing, business advice, policy advocacy and technical assistance.

The Caribbean CIC was established in 2014. Its objective is to support Caribbean entrepreneurs and new ventures in developing and commercializing locally appropriate solutions to climate-related problems. As the only 'clean tech' incubator in the Caribbean, the Caribbean CIC is like a start-up operating in an unknown environment. In its first two years of operation, the centre focused on setting up its physical infrastructure and governance structure, identifying a pipeline of clean tech entrepreneurs and developing and testing business support services for these entrepreneurs.

The Caribbean CIC developed a suite of service offerings targeting entrepreneurs at different stages of their business journey. These include interventions such as:

- (a) Idea generating sessions wherein inexperienced entrepreneurs are exposed to climate-related market problems by connecting them to market leaders, thus also creating transparency around these problems;
- (b) A boot camp session wherein entrepreneurs turn ideas into concrete business plans and also develop a viable business model along with conducting basic market research;
- (c) A six-month accelerator programme offering standardized services for the development of market, product and company infrastructure.

⁶ <https://www.climatefinancelab.org/>.

The Caribbean CIC used the hub and spoke model⁷ to ensure dissemination of its services throughout the Caribbean countries.

The potential of private sector involvement in climate issues lies in the business ethos of private sector companies. In a competitive business environment, corporate social responsibility is not an attitude contingent on business disposition, but a disposition reflective of the realities of the business environment (Bassey, 2016).

Governments can better partner with private sector entities by designing a framework for private sector engagement, including a “communication strategy that clearly outlines, how the project links to overarching goals such as mitigating climate change ..., what the subgoals of project partners are and how they may contribute to the overall project” (Lindner & Coninck, 2017). This requires adapting traditional systems to be more inclusive and collaborative and empowered with new business and risk assessment models. Box 4 illustrates this approach through the example of digitalization in the agriculture sector in Zimbabwe.



Box 4 Digitalization in the agriculture sector for smallholders in Zimbabwe

There has been significant growth in digitalization in agriculture in Africa over the past 10 years. In 2019, both the European Union–African Union Task Force Rural Africa Report and the Communiqué from the Global Forum for Food and Agriculture highlighted the power of digitalization to transform agriculture. The digitalization solutions offered include advisory services, market linkages, finance access, supply chain management and macro agricultural intelligence, as well as multiple downstream solutions. Private sector companies have been the pioneers in leading the movement towards digitalization in Africa.

AgriFin Mobile, a programme implemented by Mercy Corps, facilitated the partnership between Econet, the largest mobile network operator in Zimbabwe, and the Zimbabwe Farmers’ Union to develop a bundled product for smallholders. Econet also developed a platform called EcoFarmer, which delivers agriculture services to smallholders via unstructured supplementary service data (i.e. USSD) and short message service (i.e. SMS). Currently, farmers who are signed up to Econet can contact a toll-free call centre to learn more about agriculture inputs and market prices. Farmers can also subscribe to EcoFarmer to receive SMS messages with agronomic information. Eventually, farmers will be able to access mobile-based financial services through this initiative.

The business model developed by Econet and the Zimbabwe Farmers’ Union increased both the number of paying users of EcoFarmer and the number of Union members. The EcoFarmer platform has over 700,000 registered farmers, and since the partnership began in 2015, over 20,000 farmers have subscribed to the Zimbabwe Farmers’ Union EcoFarmer Combo.

The innovative business model is built on the commercial agreement between Econet and the Zimbabwe Farmers’ Union. The partnership has succeeded because both partners’ financial and social goals are aligned and the organizations are thus able to complement each other: the Union by providing on-the-ground access and coaching to farmers, and Econet by providing farmers with access to services they need to improve their activities, that is, extension messages, trade platforms and insurance.

The Zimbabwe Farmers’ Union EcoFarmer Combo is a unique example of a farmers’ organization and the private sector partnering successfully. It departs from traditional approaches wherein large companies try to reach farmers through their existing network of agents with high costs and low returns.

Source: (FAO, 2018).

⁷ The hub and spoke model is used when there are multiple locations sourcing, with a central location (the ‘hub’) providing a single point of contact with the client, while the in-country extensions (the ‘spokes’) are spread across the globe. The hub has centralized responsibilities and the spokes are the delivery centres.

5. Cross-cutting aspects of innovative approaches

The case studies discussed above have highlighted a number of innovative measures for accelerating and scaling up the implementation of technology solutions for mitigation and adaptation. These relate to:

- (a) Planning low-emission and climate-resilient strategies and policies;
- (b) Engaging stakeholders to achieve better informed decision-making and enhanced social acceptance;
- (c) Improving access by developing countries to international funding opportunities;
- (d) Facilitating private sector engagement through start-up companies.

Across the case studies, a number of cross-cutting aspects were identified as essential to the success of innovative approaches. These are briefly elaborated below.

Aligning interactions among institutions is an important condition for ensuring that rules and regulations, required for accelerating and scaling up technologies, are followed and agreed actions undertaken (Chaffin & Gunderson, 2016) (Young, 2016). From the literature, it can be concluded that institutional capacity enhancement should focus not only on formal measures, such as policy instruments with enforcement rules, but also on informal rules, as these may be applicable in specific country situations such as informal settlements (Kaika, 2017) (McGranahan, Schensul, & Singh, 2016) (Simone & Pieterse, 2017).

Moreover, the importance of organizing policy institutions for the successful implementation of climate plans has been highlighted by the TNA good practice report (TEC, 2015a) (TEC, 2019). For instance, TEC (2019) concluded that technology action plans under a TNA that were produced with the active engagement of key ministries (e.g. finance, economic affairs, and agriculture) were more likely to be considered in national strategy formulation.

Learning from technology transfer actions, implemented via policies and programmes, can form valuable knowledge for developing the next policy rounds. In order to strengthen this learning impact, the TEC, for example, has recommended a communication tool for keeping track of the results of the Global TNA Project (TEC, 2017b). With this communication tool, developing countries can communicate what progress they have made with their implementation of prioritized technologies for mitigation and adaptation, including areas where they met obstacles and how these were resolved. The tool thus enables countries to report on progress and also on potential improvements in international capacity-building support. Furthermore, it could help build a tool for monitoring and reporting on progress with NDC implementation, which is often underdeveloped in many countries (Araos, et al., 2016) (Lesnikowski, et al., 2017) (Magnan & Ribera, 2016).

An example of the need for innovative ways of measuring progress is the absence of a standardized global metric to deem a solution for adaptation as 'adaptive' or 'not-adaptive' to climate change impacts. In this context, it becomes important to estimate possible climate change impacts on a country's ability to achieve national and local development goals, and then to assess how well adaptation actions help reduce these impacts nationally or locally. Measuring adaptation progress is then done in synergy with the national or international and the local perspective (Global Commission on Adaptation, 2019).

Across the case studies in this subchapter, an aspect of international collaboration is identified. As implored by the Paris Agreement, international cooperative action against climate change concerns both mitigation and adaptation pathways, especially to support developing countries and the most vulnerable countries in taking climate action. Moreover, the Paris Agreement specifically calls upon international cooperation outside the Convention, which can occur among countries and industries and may also include academic institutions for research and innovation support.

Considering that many developing and vulnerable countries experience knowledge and institutional gaps, international collaborations can serve as a complementary process allowing developing countries to build capacity through knowledge-sharing, while developed countries can find new and innovative (collaborative) business opportunities and minimize risk for these. This is illustrated by the case study in box 5.



Box 5 Africa Climate-Smart Agriculture Alliance: an innovative approach to international, national and local collaboration

The Africa Climate-Smart Agriculture Alliance was launched at a side event during Africa Climate Week in 2014. The Alliance works to increase the uptake of CSA practices, particularly in the most vulnerable rural communities. CSA describes agricultural practices, approaches and systems that sustainably and reliably increase food production and the ability of farmers to earn a living, while protecting or restoring the environment. The combined effects of climate change, inequity and population pressures escalate the food and nutrition security and income challenges faced by sub-Saharan Africa's smallholders.

Since its conception, the Alliance has transitioned from developing and refining its continental structure, systems and frameworks to facilitating multi-sectoral in-country engagement and collaboration and supporting the development of national CSA plans and scaling-up proposals. The resulting country-level partnerships that have formed for CSA implementation reflect the core purpose of the Alliance and the significant progress being made towards its overarching goal of 6 million smallholder households practising CSA by 2021.

The Alliance has so far mobilized in-country partnerships in eight countries: Ethiopia, Kenya, Madagascar, Malawi, Niger, Uganda, United Republic of Tanzania, and Zambia. In each of these countries, the Alliance is working collaboratively to support the respective Governments to develop and implement CSA programmes within their national agriculture investment plans. These partnerships were forged through the interventions of regional bodies such as the New Partnership for Africa's Development and the Common Market for Eastern and Southern Africa, which facilitated meetings between country focal points from each of the Alliance steering committee organizations and the respective national Governments.

At the continent level, the Alliance has facilitated pan-African action towards CSA in various ways. For example, Zambia's Ministry of Agriculture and the Alliance jointly held a five-day national inception workshop, which was attended by representatives of and focal points from governments, regional political institutions, multilateral and United Nations agencies, international and local NGOs, technical and research organizations, farmers' organizations and the private sector, as well as by farmers. The workshop allowed a broad collaborative approach to mapping and prioritization, the formation of a National CSA Steering Committee, and the development of an activity plan. In the ensuing months, the foundation of a country-level CSA scaling-up proposal has been developed.

Source: (Girvetz & Armitage, 2015).



**IV. SYNTHESIS: ENABLING
CONDITIONS FOR
ACCELERATED
TECHNOLOGY UPTAKE**

In the previous chapter, an array of innovative approaches that support climate technology solutions in their development and transfer towards large-scale implementation within countries was discussed. While this paper's focus has been on mature technologies, it has also posed the question why existing and mature technologies, at least given their deployment and diffusion in developed and high-income developing countries, do not come off the ground on a large scale in many developing countries. Exploring the (innovative) enabling environment for technologies in developing countries, therefore, became the prerogative of this paper.

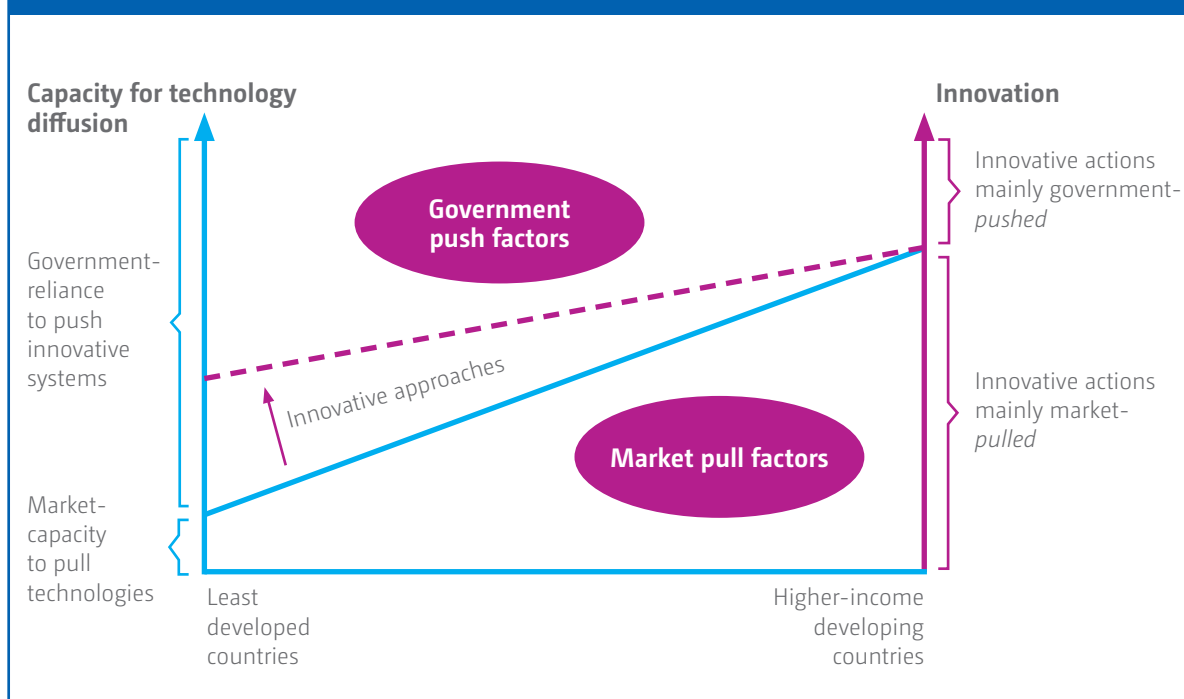
In this chapter, key conditions are identified for utilizing the innovative approaches discussed in chapter III. Where applicable, the paper distinguishes between conditions to be fulfilled by governments to push and market-led conditions that pull mature technologies in developing countries.⁸

Based on the case study analysis in chapter III, it is presumed that, in general, countries with higher development rates need to rely less on government-led push factors. For example, while the case study on unlocking debt capital for India's off-grid energy sector shows a balanced involvement of the government and private sector companies, the case of sovereign bonds in Fiji shows full reliance on government push actions. This is illustrated in figure 4, which shows (with the blue line) that a country with a relatively highly developed capacity for technology diffusion usually can rely more on market-based pull conditions. In contrast, the LDCs would rely more on government actions to push climate technologies towards wider diffusion.

The presumption, based on the case studies, is that with the innovative approaches described, the division between government (push) and private sector (pull) actions will become more balanced (easing the scaling up process), especially in the LDCs. This presumption is represented by the dashed green line in figure 4, which is shifted upward, especially in lower-income developing countries.

⁸ This distinction between market pull and government push factors is in line with theoretical papers on technology development and transfer (e.g. Grubb et al. (2017)). While these papers identify government push and market pull factors during the entire technology development and transfer journey, this paper focuses on push and pull factors for existing mature technologies in order to distinguish what governments can do to stimulate technology uptake in development and what can be expected from markets.

Figure 4 Pull and push factors for mature technologies in developing countries



Linking this insight to the aspect of international collaboration, it can be argued that countries where innovation relies mainly on government action would benefit more strongly from government-to-government collaboration, receiving capacity-building support from multilateral (financial) organizations and United Nations bodies, such as the Climate Technology Centre and Network. On the other hand, developing countries with more mature and efficient market systems for technology uptake would benefit more from multi-stakeholder partnerships (as described in chap. III.B.4), such as multinational enterprise collaboration, through which an existing mature technology in one country is transferred to another country.

Further elaborating on this insight, it is emphasized that a country's innovative capacity through market-led pull factors also strengthens a country's capacity to pursue technology-neutral development. After all, if market systems are sufficiently developed, technology options will come to the fore on the grounds of cost-effectiveness criteria given government-induced and socially supported targets for development and climate. This is illustrated by the example in box 4: the already developed telecom market in Zimbabwe enabled diversification of agriculture digitalization technology.

This is not to say that development of technology portfolios in the LDCs cannot be technology-neutral, but there can be cases where a country's preference for a technology (based on stakeholder consultation, such as a TNA) is not eligible for funding by a donor country because its funding programme aims at pursuing a different technology (TEC, 2019).

In the table below, based on the analysis in chapter III, key conditions are highlighted for utilizing the innovative approaches to climate technology uptake towards a more balanced public-private engagement. Where possible, these conditions have been characterized for the LDCs and middle- to higher-income developing countries.

Conditions for innovative approaches to large-scale climate technology uptake

Innovative approach	Conditions for the LDCs (relatively stronger public sector push)	Conditions for middle- to higher-income developing countries (relatively stronger private sector pull)
Combined and iterative use of models and improved participatory processes (see chap. III.1 above)	Knowledge and capacity to use qualitative analytical tools for participatory processes in order to solicit insights and practitioner knowledge from country stakeholders in countries with limited modelling capacity	High-quality databases for mathematical models for scenario development Participatory assessments to complement quantitative analyses in order to evaluate social acceptance of the scaling up of technologies
Enhanced social engagement in technology planning and implementation (see chap. III.2 above)	Easy stakeholder access to technology solutions and allowing stakeholders to choose from available options in order to retire the conventional sentiment that climate technologies are imposed on stakeholders	The careful planning of stakeholder engagement, which is an opportunity for stakeholders to co-design technology projects and is likely to enhance social acceptance of technology projects and programmes
Enhanced access to funding (see chap. III.3 above)	Government-led collaborations with international funding agencies and funds (such as the GCF), multilateral banks and development banks Technical and resource assistance from the GCF and multilateral development organizations to improve access to climate finance and leverage private finance	The creation of benchmarks for innovative financial products such as climate bonds, so that funding is truly allocated to climate investments rather than being used for greenwashing Effective collaborations between financial institutes and governments to blend capital and reduce risks For adaptation, government policies that help strike a balance between problems of finance mismatch (for investors) and returns be accrued by society as a whole and not just the investors
Private sector engagement and incubators (see chap. III.4 above)	The alignment of partners' interests when establishing multi-stakeholder partnerships for deploying climate technologies Alliances with global incubation programmes (e.g. those managed by United Nations agencies or multilateral organizations) to foster the development of start-ups Strategic interventions by regional bodies (e.g. New Partnership for Africa's Development and Common Market for Eastern and Southern Africa)	The incorporation of corporate social responsibility in business models so that private sector investment in climate projects becomes more attractive Clear motivations of public and private parties in a collaboration so that these motivations do not hamper the achievement of the overarching (climate) goal
Cross-cutting aspects of innovative approaches (as applied to the LDCs and developing countries) (see chap. III.5 above)	Effective and efficient interlinkages among country institutions to stimulate and enforce accelerating actions Tools and metrics for measuring progress of technology implementation programmes, with the specific goal to gather good practices in overcoming barriers and reap investment opportunities by creating and utilizing enablers for technology deployment International cooperative action to support countries in pursuing mitigation and adaptation pathways, with a specific call for international cooperation among countries, industries and knowledge centres for knowledge and capacity support at multiple public and private sector levels	



V. KEY MESSAGES AND RECOMMENDATIONS

This paper has highlighted innovative approaches to accelerating and scaling up the implementation of climate technologies for mitigation and adaptation in developing countries. While market and government stakeholders both play crucial roles in climate technology deployment, it has been concluded that through innovative approaches, market pull actions can alleviate the burden of government push actions, especially in the LDCs. Implications for the roles of international and national stakeholders, both public and private, are elaborated below in the form of a number of recommendations.

Stakeholders, representing public and private sectors in countries, are key in the process of technology planning and diffusion. Effective stakeholder engagement (through co-design) results in stronger alignment of countries' climate plans with their sustainable development goals and strategies. From such active engagement, technology champions emerge. These champions propel the development of prioritized technologies, lending support to the policies already in place for technology diffusion. Champions also support technology-neutral and demand-driven decision-making, both in the LDCs and higher-income developing countries.

Private sector participation is crucial for accelerating the deployment of climate technologies as it supports the mobilization of private sector funding and capacity-building for technology implementation. The innovative approaches discussed in this paper moreover enable a more balanced public–private collaboration for accelerating the uptake of climate technologies for mitigation and adaptation, including:

- (a) Multi-stakeholder partnerships with public and private actor engagement;
- (b) Private investors leveraging public funding, supporting public–private actions to mitigate investment risks;
- (c) International collaboration between (multinational) enterprises and governments.

Strengthened private sector involvement is supported by **government actions** in developing countries, including:

- (a) Implementing financial instruments that help close finance gaps in developing countries for scaling up climate technology programmes and prevent finance mismatch;
- (b) Mitigating investment risks for private investors and funders, so that private investors have stronger incentives to leverage existing (international) public funding with private capital;
- (c) Enabling institutional reforms towards stronger enforcement of policies and measures;
- (d) Establishing government-led collaboration with international funding agencies and funds;
- (e) Promoting the active participation of key ministries in national planning processes for low-emission and climate-resilient development;
- (f) Evaluating technology implementation policies, so that lessons learned can be used in future programmes and communicated with other countries and international bodies, as good practice examples or calls for international financial and capacity support;
- (g) Designing measures to ensure that benefits from adaptation projects are accrued to the initial investor as well as to society as a whole.

International institutions, including multilateral development organizations, play a key role in incubation actions for progressing the implementation of proven climate technologies as they:

- (a) Provide efficient linkages between complementary institutions and stakeholders of different countries;

- (b) Enhance access (especially for the LDCs) to international funding programmes through technical or resource assistance;
- (c) Facilitate alliances and partnerships to leverage resources for scaling up projects and foster the development of start-ups through global incubation programmes.





VI. REFERENCES

- Araos, M., Berrang-Ford, L., Ford, J., Austin, S., Biesbroek, R., & Lesnikowski, A. (2016). Climate change adaptation planning in large cities: A systematic global assessment. *Environmental Science and Policy*, *66*, 375–382.
- Bassey, C. (2016). *Private Sector Engagement in Disaster Response: Opportunity and Lessons*. Retrieved: March 10, 2020, <https://www.mei.edu/publications/private-sector-engagement-disaster-response-opportunity-and-lessons>
- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the Functional Dynamics of Technological Innovation Systems: A Scheme of Analysis. *Research Policy*, *37*(3), 407–429.
- Best-Waldhober, M. d., Daamen, D., Ramirez, A., Faaij, A., Hendriks, C., & Visser, E. d. (2012). Informed public opinion in the Netherlands: Evaluation of CO₂ capture and storage technologies in comparison with other CO₂ mitigation options. *International Journal of Greenhouse Gas Control*, *10*, 169–180.
- Bößner, S., & Coninck, H. v. (2018). *Addressing social implications of climate change mitigation: lessons from three novel technologies*. Nijmegen, the Netherlands: CARISMA project (Horizon 2020) Deliverable 4.4.
- Bößner, S., Johnson, F., & Taylor, R. (2018). *Innovation Dynamics in Transition Pathways*. www.transrisk-project.eu: TRANSrisk (Horizon 2020).
- CBI. (2015). *Green Bond Market Roundup*. <https://www.climatebonds.net/files/files/2015%20GB%20Market%20Roundup%2003A.pdf>: Climate Bond Initiative.
- Chaffin, B., & Gunderson, L. (2016). Emergence, institutionalization and renewal: Rhythms of adaptive governance in complex social-ecological systems. *Journal of Environmental Management*, *165*(doi:10.1016/j.jenvman.2015.09.003), 81–87.
- Coninck, H. d., Revi, A., Babiker, M., Bertoldi, P., Buckeridge, J., Cartwright, A.,... Sugiyama, T. (2018). Strengthening and Implementing the Global Response. In V. MassonDelmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P. Shukla,... T. Waterfields (Red.), *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*. Intergovernmental Panel on Climate Change.
- European Commission. (2019, November 27). *Regulation (EU) 2019/2089 of the European Parliament and of the Council of 27 November 2019 amending Regulation (EU) 2016/1011 as regards EU Climate Transition Benchmarks, EU Paris-aligned Benchmarks and sustainability-related disclosures for benchmarks*. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32019R2089>
- European Council. (2019, December 17). *Proposal for a Regulation of the European Parliament and of the Council on the establishment of a framework to facilitate sustainable investment*. <https://data.consilium.europa.eu/doc/document/ST-14970-2019-ADD-1/en/pdf>
- FAO. (2018). *How AgriFin Mobile is assisting smallholder farmers in Zimbabwe*. Retrieved: March 13, 2020, <http://www.fao.org/e-agriculture/blog/how-agrifin-mobile-assisting-smallholder-farmers-zimbabwe>
- Gaast, W. v., Szendrei, K., Watajewski, J., Szpór, A., Pizarro, C., Gonzales, M., & Hanger, S. (2016). *Complementarity of qualitative and quantitative analytical tools*. Groningen, the Netherlands: Deliverable 2.2 of the TRANSrisk project (H2020).
- Geels, F. (2011). The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40.
- GGGI. (2016). *Mind the Gap: Bridging the Climate Financing Gap with Innovative Financial Mechanisms*. Seoul, South Korea: Global Green Growth Institute.

- Girvetz, E., & Armitage, C. (2015). *The Africa CSA Alliance: path to implementation*. Retrieved: March 13, 2020, <https://ccafs.cgiar.org/blog/africa-csa-alliance-path-implementation#.XnDriqhKgdU>
- Global Commission on Adaptation. (2019). *Adapt Now: A Global Call for Leadership on Climate Resilience*. Groningen, the Netherlands; Washington, D.C., USA: Global Center on Adaptation; World Resources Institute.
- Government of Fiji. (2017). *Fiji Launches First Emerging Market Green Bond and Third in World*. Retrieved: March 10, 2020, <https://cop23.com.fj/fiji-launches-first-emerging-market-green-bond-third-world/>
- Grubb, M., McDowall, W., & Drummond, P. (2017). On order and complexity in innovations systems: Conceptual frameworks for policy mixes in sustainability transitions. *Energy Research and Social Science*, 33, 21-34.
- Hofman, E., & Gaast, W. v. (2018). Enhancing ambition levels in nationally determined contributions—Learning from Technology Needs Assessments. *WIRE's Energy and Environment*, 8(1).
- Humphreys, A. (2019). *The Role of Green Bonds in Financing Climate Change Adaptation in the Chilean Electricity System*. Groningen, the Netherlands: Master thesis at Hanze University of Applied Sciences.
- IEA. (2015). *World Energy Outlook*. Paris, France: International Energy Agency.
- Kaika, M. (2017). Don't call me resilient again! The New Urban Agenda as immunology ... or... what happens when communities refuse to be vaccinated with "smart cities" and indicators. *Environment & Urbanization*, 29, 89-102.
- Lesnikowski, A., Ford, J., Biesbroek, R., Berrang-Ford, L., Maillet, M., & Araos, M. (2017). What does the Paris Agreement mean for adaptation? *Climate Policy*, 17, 825-831.
- Lindner, S., & Coninck, H. d. (2017). *How should international institutions promote research and innovation collaboration for climate change mitigation?* Nijmegen, the Netherlands: CARISMA project Horizon 2020.
- Magnan, A., & Ribera, T. (2016). Global adaptation after Paris. *Science*, 352, 1280-1282.
- McGranahan, G., Schensul, D., & Singh, G. (2016). Inclusive urbanization: Can the 2030 Agenda be delivered without it? *Environment and Urbanization*, 28, 13-34.
- Nygaard, I., & Hansen, U. (2015). *Overcoming Barriers to the Transfer and Diffusion of Climate Technologies: Second edition*. UNEP DTU Partnership, Technical University of Denmark, ISBN: 978-87-93130-80-7.
- Ockwell, D., & Byrne, R. (2016). Improving technology transfer through national systems of innovation: climate relevant innovation-system builders (CRIBs). *Climate Policy*, 16(7), 836-854.
- Olhoff, A., Dickson, B., Puig, D., Alverson, K., & Bee, S. (2016). *The Adaptation Finance Gap Report*. Nairobi, Kenya: United Nations Environment Programme.
- Rajendran, G., & Islam, R. (2017). *Plant clinics in Bangladesh: are farmers losing less*. DOI: <https://dx.doi.org/10.1079/CABICOMM-25-8072>: CABI case study 19.
- Simone, A., & Pieterse, E. (2017). *New urban worlds: inhabiting dissonant times*. Cheltenham, UK: Edgar Alger.
- Spiesberger, M., Gomez Prieto, J., & Seigneur, I. (2018). Smart specialisation and social innovation: from policy relations to opportunities and challenges. *S3 Policy Briefs Series, Number 2*.
- TEC. (2015a). *Good Practices of Technology Needs Assessments*. Bonn, Germany: Technology Executive Committee, TEC/2015/11/8.

- TEC. (2015b). *Enhancing Access to Climate Technology Financing*. Bonn, Germany: Technology Executive Committee.
- TEC. (2017a). *TEC Brief #10: Technological Innovation for the Paris Agreement*. Bonn, Germany: UNFCCC.
- TEC. (2017b). *Draft methodology on monitoring and evaluation of the implementation of technology needs assessment results*. Bonn, Germany: UNFCCC Technology Executive Committee.
- TEC. (2019). *Draft paper on experiences, lessons learned and good practices in conducting TNAs and implementing their results*. Bonn, Germany: TEC/2019/19/5.
- UNDP. (2010). *Handbook for conducting technology needs assessment for climate change*. New York, USA: UNDP.
- UNDP. (n.a.). *THE '3C'S' FRAMEWORK*. Retrieved: March 10, 2020, <https://www.adaptation-undp.org/privatesector/>
- UNEP. (2018). *The Adaptation Gap Report 2018*. Nairobi, Kenya: United Nations Environment Programme (UNEP).
- Waisman, H., Coninck, H. d., & Rogelj, J. (2019). Key technological enablers for ambitious climate goals: insights from the IPCC special report on global warming of 1.5 °C. *Environmental Research Letters*, volume 14, number 11.
- Williges, K., Gaast, W. v., & Tuerk, A. (2018). *Scaling up Mitigation Technologies in Integrated National Energy and Climate Plans*. Graz, Austria: CARISMA project (Horizon 2020), Deliverable 4.5.
- Young, O. (2016). *Governing Complex Systems: Social Capital for the Anthropocene*. Cambridge, MA, USA and London, UK: MIT Press.
- Zwaan, B. v., Dalla Longa, F., Boer, H. d., Johnson, F., Johnson, O., Klaveren, M. v.,... Wanjiru, H. (2018). *An Elicitation of Public Acceptance of Renewable Energy in Kenya*. Nairobi, Kenya: Deliverable 2.5 of the TRANSrisk project (Horizon 2020).



Acknowledgements

The Technology Executive Committee extends its appreciation to Wytze van der Gaast, Sumiran Rastogi and Ana Cassanti from the Joint Implementation Network for their support in preparing this paper. It also extends its appreciation to the representatives of observer organizations participating in the TEC task force on implementation for the inputs provided throughout the preparation of this paper.





About the Technology Executive Committee

The Technology Executive Committee is the policy component of the Technology Mechanism, which was established by the Conference of the Parties in 2010 to facilitate the implementation of enhanced action on climate technology development and transfer. Along with the other component of the Technology Mechanism, the Climate Technology Centre and Network, the committee is mandated to facilitate the effective implementation of the Technology Mechanism.

Contact Details

The Technology Executive Committee may be contacted through the United Nations Climate Change Secretariat

Platz der Vereinten Nationen 1, 53113 Bonn, Germany
E-mail: tec@unfccc.int

Website: www.unfccc.int/ttclear/tec

© June 2020 UNFCCC

United Nations Framework Convention on Climate Change
All rights reserved

This publication is issued for public information purposes and is not an official text of the Convention in any legal or technical sense. Unless otherwise noted in captions or graphics, all matter may be freely reproduced in part or in full, provided the source is acknowledged.

A digital copy of this report can be downloaded from:

<https://unfccc.int/ttclear/innovativeapproaches>



#climatetech



United Nations
Framework Convention on
Climate Change