TECHNOLOGY TRANSFER FOR CLIMATE MITIGATION AND ADAPTATION

Analysing needs and development assistance support in technology transfer processes

POLICY BRIEF

UN environment programme
copenhagen climate centre

Preface

This policy brief has been jointly developed by the UNEP-Copenhagen Climate Centre and the OECD-Development Co-operation Directorate. The policy brief focusses on understanding the climate-related technology transfer to developing countries. It looks at the specific bottlenecks that constrain the transfer of climate technologies, and how international support can enable it, and in particular, the role that development co-operation and development finance plays, and can play going forward.

The brief sits at the interface of the climate technology needs of the developing countries, and the role of developmental finance flows in meeting these needs. It consolidates the work on technology transfer processes, technology needs assessments i.e., TNAs at UNEP-CCC, with the work of tracking development finance resources to climate technologies i.e., through the DAC database of the OECD, to conduct analysis and reveal shared insights. In conclusion, the brief sheds light on some priority areas for development co-operation (members and partners), to enable future action on climate-related technology transfer in developing country contexts.

Acknowledgements

This brief was produced by Sara Lærke Meltofte Trærup (Head, Technology - Transitions and System Innovation, UNEP-Copenhagen Climate Centre), Jens Sedemund (Head, Environment and Climate Change Team, Financing for Sustainable Development Division, Development Co-operation Directorate), Alberto Agnelli (Consultant, Development Co-operation Directorate), Padmasai Lakshmi Bhamidipati (Advisor, UNEP-Copenhagen Climate Centre), and Léa Jehl Le Manceau (Research Associate, UNEP-Copenhagen Climate Centre).

Published by UNEP Copenhagen Climate Centre
October 2022

Photo credits
Shutterstock

UNEP Copenhagen Climate Centre
www.unepccc.org

CONTENTS

1. Introduction 4
2. Climate-related technology transfer: setting the stage 5
3. Understanding the technology transfer process 7
4. Understanding developing countries' climate technology needs 9
5. Providing international support for climate-related technology transfer 13
6. Tracking development finance resources for climate-related technology transfer 15
7. Outlook and priorities for development co-operation 19
References 20
Annex I: Introduction to TNAs and data 22
Annex II: CRS Analysis Methodology 22

FIGURES

Figure 1. Unit cost of some low-carbon technologies 6
Figure 2. Key priorities identified through TNAs (adaptation and mitigation) 9
Figure 3. Technology maturity among prioritised technologies 10
Figure 4. Climate-related development finance flows for technology transfer 16
Figure 5. Climate-related development finance flows for technology transfer by sector 17

TABLES

Table 1. Overview of definition of technology maturity 11
Table 2. List of technology related keywords 23

BOXES

Box 1. Technology maturity in the UNFCCC context 11
Box 2. Technology transfer for de-carbonising industry 12
Box 3. Methodology to identify climate-related technology transfer: advantages and limitations 15

1. INTRODUCTION

A transition towards environmentally sustainable, low-emissions and climate-resilient development is a critical component of all countries' ability to achieve the 2030 Agenda for Sustainable Development and the objectives of the Paris agreement. However, current trends in greenhouse gas (GHG) emissions are inconsistent with the achievement of international objectives and even the full implementation of Nationally Determined Contributions (NDC) announced prior to COP26 will lead the world to likely exceed 1.5°C within the 21st century (IPCC, 2022[1]).

Faced with the largest adaptation deficits, developing countries are most exposed to and will also likely face the most severe impacts from climate change. While emissions are disproportionally larger in high income countries, communities constrained by institutional, financial, technological, and capacity weaknesses will be subject to higher levels of human vulnerability and suffer larger economic damages per capita as a fraction of income (IPCC, 2022[2]).

At the same time, technological innovation is helping humanity to get closer to its climate objectives (IEA, 2021[3]). Many options are now available across all economic sectors and offer substantial opportunities to cut emissions and adapt to climate change. Thanks to tailored policies addressing innovation systems, and reduced unit cost of several low-emission technologies in recent years (IPCC, 2022[1]). This offers the opportunity to scale up the deployment of climate-related technologies, including to contexts where financing constraints have so far hindered their adoption.

The availability of climate technologies does not, however, automatically translate to fast deployment across countries and geographies. The process of technology transfer of climate technologies is in fact strongly concentrated among developed countries, which, for the most part, are also the ones responsible for technology innovation. Developing countries face several structural bottlenecks, which constrain their ability to tap into these technologies and deploy them at scale. The resulting low rate of diffusion of climate technologies ultimately slows down climate action.

This policy brief focusses on the climate-related technology transfer to developing countries. In particular, it looks at the specific bottlenecks that slow down the climate technologies transfer process, the enablers that could accelerate it and the role that development co-operation can play.

2. CLIMATE-RELATED TECHNOLOGY TRANSFER: SETTING THE STAGE

Technology innovation, development, and transfer are central to economic growth and development. Growth in living standards and modernization of economic structures critically hinge upon a country's ability to successfully adopt technological change. Over the past two centuries, cross-national differences in the adoption rate of new technologies have accounted for nearly 75% of the divergence in per capita incomes between developed and developing economies (Comin and Mestieri, 2018[4]). Developing countries often exhibit low levels of investment in innovation, despite being the ones with the largest potential returns. This is defined as the "Innovation Paradox" (Cirera and Maloney, 2017[5]).

Most developing countries rely on the technologies developed in high-income countries to improve their productivity and meet their development needs. Their technological advances come through subsequent adoption of those technologies through technology transfer. This implies that technological progress is strongly influenced by their ability to access, adopt, and diffuse technological knowledge generated abroad (UNCTAD, 2014[6]). This makes international technology transfer a critical determinant for reducing the technological, knowledge and capacity gaps, as well as income and wealth gaps between developed and developing countries. Nonetheless, the actual uptake of available technologies in developing countries is often observed to be low.

Despite rising climate change pressures, climate technologies are not widely accessible

Climate technologies are all those technologies that are instrumental in contributing to achieving mitigation and adaptation objectives and they exhibit similar patterns as other technologies, particularly in terms of geographical concentration in high income countries and low levels of diffusion in developing countries. In 1990-2015, 80% of all low-carbon technological inventions were concentrated in high income countries, with Japan, the United States and Germany leading the way (Pigato et al., 2020[7]). High-income countries accounted for 70% of total low-carbon technologies exports value and 62% of imports in 2016 (Pigato et al., 2020[7]), which is higher than their respective share in trade goods (WTO, 2016[8]). While China plays a prominent role in the market of low-carbon technologies, other developing countries remain on the periphery. Low-income countries, for example, represent 0.01% of exports and 0.3% of total imports of low-carbon technologies by value (Pigato et al., 2020[7]). These shares are lower than low-income countries' overall participation in world trade (WTO, 2016[8]).

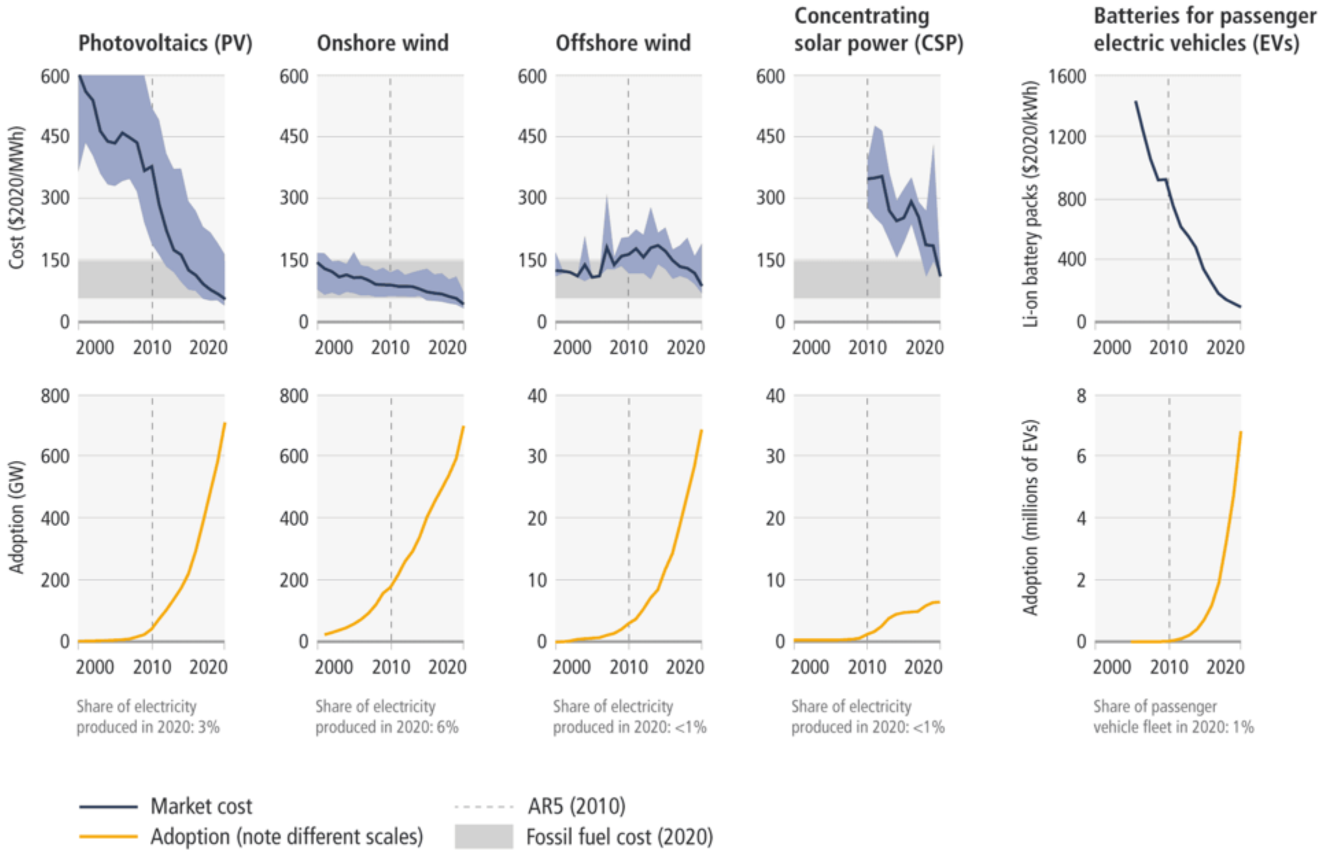
Similarly, also patented adaptation technologies are quite concentrated in a few countries, which are predominantly high-income. Two thirds of all high-value patented climate adaption technologies in 2010-2015 were located in China, Germany, Japan, the Republic of Korea or the United States. 85% of cross-border trade of adaptation-related patents happened in high-income countries and China (Dechezleprêtre et al., 2020[9]).

While the geographical concentration of technology development does not limit per se technology adoption, the low levels of technology transfer does. In the broader development context, this slows down development progress, but in the climate context, bottlenecks to technology transfer risk aggravating climate change and its impact, by both delaying mitigation action and constraining the effectiveness of adaptation. The scale up of technology adoption is an essential precondition to the achievement of global climate goals. To achieve a net zero transition by 2050, the significant gap between the existing technological uptake and what is needed to meet the range of climate and development challenges will need to be filled, including through accelerated, large-scale deployment of all available clean and efficient energy technologies (IEA, 2021[3]).

The economic case for climate technology transfer is becoming increasingly strong

Plummeting unit costs of many climate technologies make their diffusion more financially viable. The IPCC recently documented that the unit cost of many low-carbon technologies such as solar, wind and lithium-ion batteries has continuously fallen since 2010 (IPCC, 2022[1]) and this has been associated with overall larger adoption rates worldwide (Figure 1). This provides an opportunity to unlock investment in low-carbon technologies even in contexts where it has been so far more challenging, such as in many developing countries.

Figure 1. Unit cost of some low-carbon technologies



Source: IPCC (2022[1])

In addition, while climate technologies offer solutions for climate change mitigation and adaptation, their benefits are not limited or exclusive to climate change objectives. Instead, they offer new or alternative solutions in different areas that are important to economic growth and development, from access to energy and clean cooking, to sustained or increased agricultural productivity, or better risk-informed decision making.

3. UNDERSTANDING THE TECHNOLOGY TRANSFER PROCESS

What is technology transfer?

The term technology transfer has several different dimensions and can refer to different processes. In particular, the three most common understandings of technology transfers are i) the process by which knowledge and concepts are transferred from the laboratory to the market place; ii) the process by which knowledge and technologies are transferred from developed to less technologically developed countries; and iii) the process of transferring inventive activities to secondary users (Wahab, Rose and Osman, 2011[10]).

In the climate context, the IPCC provides a broad definition of technology transfer. The IPCC Special Report on Methodological and Technological Issues on Technology Transfer (SRTT) referred to the term 'technology transfer' as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change" (IPCC, 2000[11]). The term 'transfer' was not only limited to the transfer of patented knowledge but was more broadly defined to "encompass diffusion of technologies and technology cooperation across and within countries" (IPCC, 2000[11]). It also "comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies" (IPCC, 2000[11]). This definition is the one employed in this policy brief.

How technology is transferred depends on several factors. These include whether the technology is under intellectual property protection or is non-proprietary; the type of actors involved in the transfer process (e.g., between private parties or between private and public parties) and the stage in a life cycle of technology (e.g., frontier technology, more mature standard technology or a not yet fully developed technology requiring additional R&D investments). Most cross-border technology transfer takes place through market mechanisms. Private firms and market actors can transfer technology in predominantly three ways: international trade, foreign direct investment (FDI), and licensing (Saggi, 2002[12]).

What constrains technology transfer to developing countries?

In many developing countries, technology transfer processes are faced with constraints. Technology transfer through market channels relies on an enabling environment in the destination country. Fundamental and structural constraints constitute serious bottlenecks to the transfer of climate technologies and their mass-scale deployment.

Capacity and knowledge

Capacity and knowledge constraints relate to the broader knowledge base and technological literacy within a country including the human capital-skills and knowledge of the workforce, the governing institutions, the institutional and organizational framework, including the roles and capacities of technology-related institutions and networks.

One factor that can magnify the general challenge of capacity constraints in the context of the transfer of climate technologies relates to the urgency and speed of deployment of climate technologies (UNFCCC, 2022[13]). This is related to the urgency of technological diffusion and deployment in light of the climate emergency. As many key climate technologies are recent, or still emerging, the time spans between their development, pioneering and market roll-out by technology leaders and their transfer to developing countries is cut short and with that the time to gain experience of and develop capacity for these technologies. Importantly, this relates not just to the deployment of technologies, but also limited experience with and capacity for financial structuring, which can also differ to the funding and financing approaches common in high-income economies (OECD, 2021[14]).

High cost of finance

Financing constraints are one of the fundamental challenges faced by developing countries. Developing countries typically face significantly higher costs of financing than high-income economies with deep capital markets. Moreover, many developing countries lack the ability to access or provide financing at long-tenors, other than from development partners.

The cost of and access to finance can be an even greater constraint in the case of climate technologies. Climate technologies are often capital intensive and require mobilising large upfront financing for investment life cycles that often span several decades. Interest rate premia for long-term financing compounding of this over long-time frames, or plan unavailability of finance at these tenors, make the cost of and access to financing a critical factor.

Overall, affordability is often a binding constraint for technology diffusion. However, even where the price or investment volume is identical in developed and developing countries, the difference in financing costs can lead to significant cost differential and higher total costs for a given technology. For renewable energy projects, for instance, the cost of capital in developing countries is significantly higher than in industrialized countries (Steffen, 2020[15]). This can severely constrain the deployment of technologies, even if they provide in principle the least-cost option for achieving mitigation or adaptation outcomes.

Institutional and regulatory weaknesses

Investment in mitigation technologies in general, and grid-scale energy-related technologies in particular, relies heavily on the presence of well-developed regulatory environment and adequate physical infrastructures (UNFCCC, 2022[13]). In the absence of these preconditions, the adoption of many climate technologies becomes more costly and therefore less viable or competitive.

While regulatory and policy settings play an important role in many technology transfer contexts, they are likely to be particularly relevant for climate change mitigation technologies. Existing country-level policy frameworks are seldom fully conducive to a green energy transition. An important reason is that they were largely created for, and during a period of, fossil fuels as the dominant energy source (Mulugetta et al., 2019[16]), so that the regulatory and policy settings often have a default bias towards incumbent technologies. This is not limited to developing countries, but virtually all economies started from a position of deep carbon entanglement. There often is a general need to shift incentives away from fossil fuels, as well as associated vested interests and political pressure by interest groups in the technological status quo. This tilts the playing field and can constitute insurmountable barriers to entry for mitigation technologies, and contribute to bias in political decisions, further reinforcing trends of underinvestment in climate technologies and ineffective technology transfer (Baker, Newell and Phillips, 2014[17]; Newell and Johnstone, 2018[18]).

The regulatory environment also often has significant effects on the economic competitiveness or viability of an investment. Adverse regulatory settings as well as uncertainty around the policy framework can in fact reduce the return on the investment and lead to sub-optimal level of investment in the new technology (Cirera and Maloney, 2017[5]).

Suitability in the local context

One of the main challenges faced by developing countries is to identify the most suitable technology, given the local context and changing climates affecting localities differently, from out of often many alternative technologies and multiple sources of technologies. Matching those who possess the necessary technologies with those that need them may be difficult and costly for developing countries with limited capacity.

As climate change impacts vary across geographies, technologies need to be suited to local conditions and needs. If one ignores such issues, the technologies may be ineffective, and may prove maladaptive if implemented without recognition of relevant social contexts and environmental processes. Before public policy and investment choices are made to transfer specific technologies, careful consideration is often required to ensure that an innovation ‘fits’ a different context – a new country, industry, firm, farm, household. Conversely, predominantly market-based technology transfer should lead to technology choices and deployment towards those solutions that are best suited to addressing the local needs in the most cost-effective way – subject to the absence of regulatory bias as well as basic development constraints, such as access to finance.

4. UNDERSTANDING DEVELOPING COUNTRIES' CLIMATE TECHNOLOGY NEEDS

Technology needs assessments provide an important source of information on developing countries technology needs

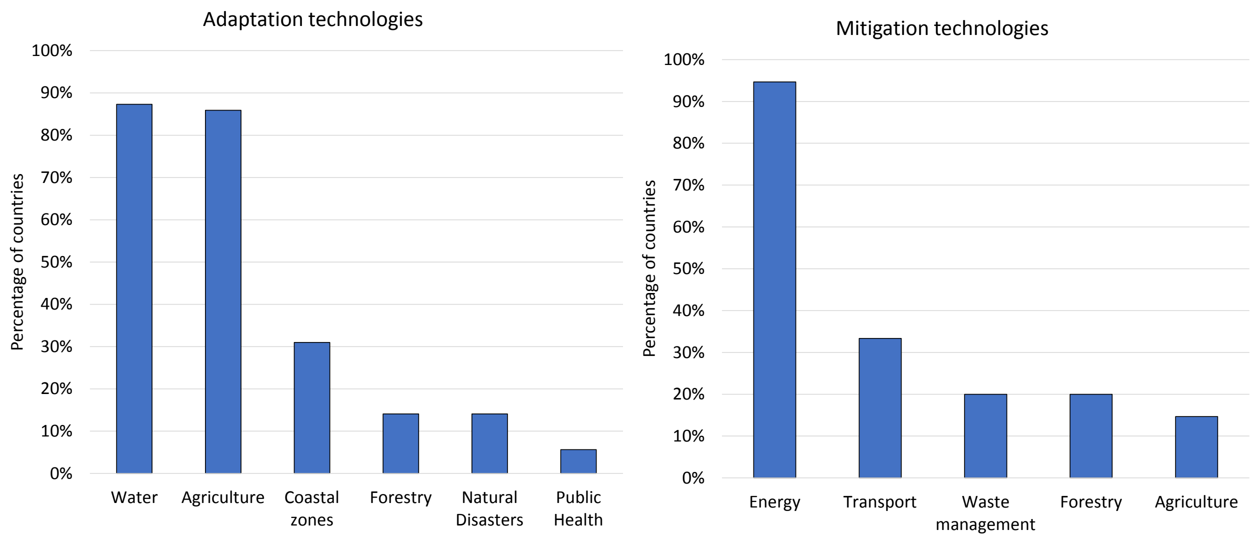
Developing countries' climate technology needs can be tracked using TNAs. The Technology Needs Assessment were introduced under the Convention at COP-7, which defined TNAs as "a set of country-driven activities that identify and determine the mitigation and adaptation technology priorities of Parties" and "particularly developing Parties." In a TNA process, countries prioritise technologies based on a range of criteria that reflects economic, social, and environmental impacts, and hence technologies are prioritised not only based on the climate change mitigation/adaptation potentials.

Through TNAs, there is a good understanding of core technologies prioritised by developing countries for both mitigation and adaptation. In adaptation, water and agriculture are the sectors that are prioritised the most with more than 85% of countries surveyed indicating them as priority areas (Figure 2). Most prioritised technologies in the adaptation sector include irrigation systems, storm surge barriers for coastal protection, crop and soil management technologies, crop diversification and new varieties, water storage and water harvesting. In the mitigation sector, energy is by far the most prioritised sector (95 percent out of 79 countries), while only one country out of three prioritised the transport sector and one out of five the waste and forestry sectors (Figure 2). Most prioritised technologies in the mitigation sector include solar PV, hydropower, electric vehicles, energy efficiency, improved forest management and expansion of public transportation network.

Once the technology needs are identified, next key steps relate to the acceleration and implementation phase. As part of TNAs, developing countries also develop Technology Action Plans (TAPs) to turn their climate technology needs into concrete actions on the ground, with the aim of enhancing implementation. Countries can use them as the basis for seeking additional financing support, for inputs into GCF pipeline, for further project preparation, for setting up new public-private partnerships to reduce country-specific barriers, and to feed into NDC implementation processes. TNAs and TAPs offer a critical avenue to gather knowledge of climate technologies, to determine how to implement prioritized technology solutions and to assess what is realistic and feasible to implement within their country contexts (UNEPDTU and UNFCCC, 2021[19]).

Figure 2. Key priorities identified through TNAs (adaptation and mitigation)

As a percentage of respondent countries

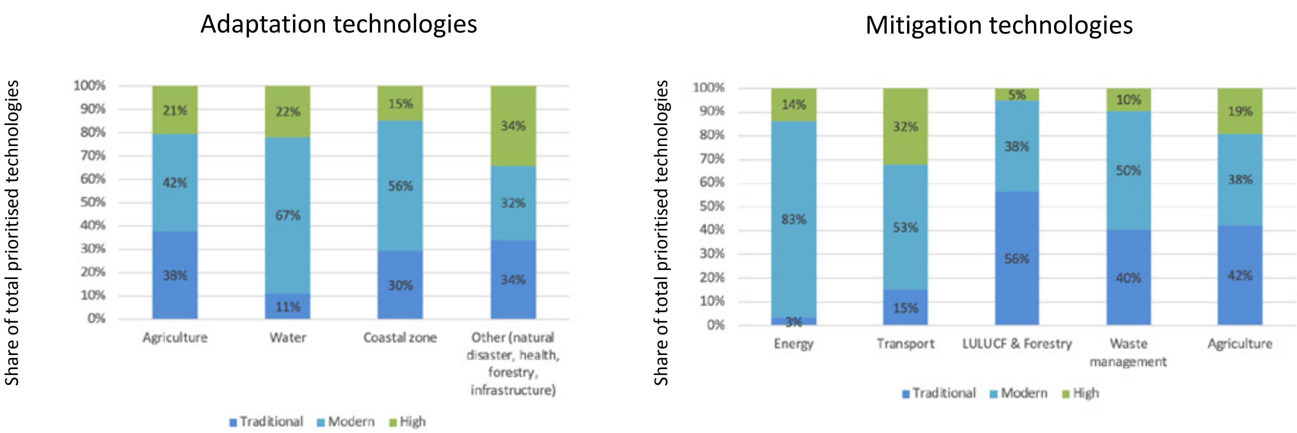


Source: Analysis based on data collected by UNEP-CCC from 79 countries' TNAs, available on www.tech-action.org

Most prioritised climate technologies are not emerging but already mature

Most climate technologies prioritised by developing countries are already at a mature or near mature stage, indicating that the key barrier to take up is access to the technology itself and technology adoption capacity. Within the setting of UNFCCC, climate technologies have been categorised traditional technologies, modern technologies and high technologies based on the level of maturity (Box 1). According to TNAs, developing countries' prioritised technologies are mainly modern or traditional technologies (Figure 3). The energy and transport sector, for instance, are characterised by a low share of emerging/high technologies that are prioritised (14% and 32% respectively). Similarly, in adaptation technologies for agriculture, water and costal zones, emerging/high technologies represent 21%, 22% and 15% of the total.

Figure 3. Technology maturity among prioritised technologies



Source: Analysis based on data collected by UNEP-CCC from 79 countries' TNAs, available on www.tech-action.org

Box 1. Technology maturity in the UNFCCC context
Within the setting of the UNFCCC, climate technologies are also differentiated in terms of their maturity, into traditional, modern and high categories:

- Traditional technologies: from the perspective of the technology cycle, traditional technologies are characterised as mature. Commonalities to technologies that are categorised as traditional are that they are generally low cost and accessible to most countries. In most cases, the traditional technologies are already present in the countries but further dissemination for its wider uptake and application are identified as beneficial from a low-cost perspective and are viewed as an achievable option where governments and donors can create a relatively fast and affordable change.

- Modern technologies are at a stage of the technology cycle where they are still achieving competitiveness. These technologies have been commercialized and are widely, though not universally, available.

- High technologies are characterised by more recent scientific advances and are often partly under development and only available in niche markets particularly when it comes to developing country contexts.

An overview of how the different technology maturity stages relate to the technology cycle are also provided in Table 1 with an overview of geographical dimensions, knowledge requirements, typical challenges, and examples for each stage.

Table 1. Overview of definition of technology maturity

Differences	Traditional technologies	Modern Technologies	High technologies
Stage of development	Developed and implemented for decades, having attained a high level of competitiveness and cost efficiency	Entails relatively newer technologies or use of new materials and improved designs	Fairly recently developed or immature technologies
Geographical dimension	Globally, in varied country contexts across developed and developing economies	Significantly higher diffusion in developed countries and advanced economies/markets	Deployed in very limited, mostly developed country contexts, and in niche markets
Access to knowledge	Skills and knowledge easily available and somewhat accessible by most countries	Fairly advanced skills and knowledge in developed economies and advanced markets	Nascent with limited and exclusive access to knowledge and resources
Typical challenges	Non-financial challenges including resource constraints, governance, behavioural challenges etc.	Finance-related challenges pose a critical barrier for uptake of these technologies	Research & demonstration related challenges
Examples	Conservation agriculture, construction of dykes to protect against flooding, change in farming practices	Wind, solar PV, CSP, drip irrigation, rainwater harvesting systems, mobile pay, hydropower	EVs, hybrid vehicle, hydrogen fuel cells, new battery storage technology, carbon capture, utilization and storage, advanced monitoring and modelling systems

Source: Authors' elaboration based on insights from UNEP-CCC's TNA assessments www.tech-action.org and associated literature

Maturity of technologies and the stage of technology cycle have important implications for technology transfer in the climate context. Technologies are typically more costly at the outset, but usually become cost-effective over time if they are widely disseminated and a market begins to develop. The cost evolution of technologies over their life cycle has particular relevance for developing countries and the climate change contexts. New technologies are often not affordable for developing countries during the early stages of their life cycle. Their transfer and deployment into these markets often only takes place as they become affordable with the cost reductions and global mass production of the mature technology stage.

Depending on the maturity stage, different types of bottlenecks are slowing down adoption. Traditional technologies that are already widely diffused require supporting non-financial aspects such as governance, knowledge, and behavioural factors. Modern or mature technologies, on the other hand, mainly require support related to the cost of finance and to equip developing countries with the adequate capacity to adopt these technologies. High or emerging technologies require significant support on R&D and support to their take-up relates mainly to enabling rapid transfer and deployment to developing countries as these technologies evolve towards maturity (Box 2).

Box 2. Technology transfer for de-carbonising industry

Industry is the single largest energy user and it is responsible for the largest source of CO_2 emissions globally by accounting for 40% of the total. The transition of the manufacturing industry with low-carbon technologies will be critical in achieving mitigation targets.

Technologies needed for industry's low-carbon transition are currently at very different levels of market readiness. It typically takes a decade or more for energy technologies to reach high technology readiness levels, with additional lags between market maturity in advanced and developing countries. The traditional lag for technology deployment from high income to emerging and lower income economies must be reduced, and global deployment and commercialisation of new technologies for decarbonising industries must be accelerated to meet global temperature goals.

More spending on research and development (R&D) will be crucial for those that are at early stages of commercialisation, and more efforts are needed to reduce the higher costs of investments of large-scale demonstration low-carbon projects. Enabling technology transfer can reduce the cost of the overall transition of the industry while increasing its competitiveness. At the same time, it can create local value chains to benefit societies and economies and boost product demand. It is also important to differentiate the areas where financing will be needed. Some technologies although small in scale and highly commercialised, could bring returns fast or may not need debt financing. Others may require a range of innovative and traditional financing to move from technical viability to commercial and large-scale deployment.

In this sense, public funding will be instrumental for technologies that are at early stages of commercialisation in reducing the risks of first-of-a-kind projects and to leverage private investments. Moreover, the transition will require collaboration to facilitate technology transfer such as pilot projects, especially for currently still costly technologies if opportunities exist, and international co-operation will play a critical role in this regard.

Source: OECD (forthcoming), "Framework for Industry's net-zero Transition, Committee report for the Working Party on Climate, Investment and Development".

Bean diversity with climate-resilient properties
©2016CIAT/GeorginaSmith

5. PROVIDING INTERNATIONAL SUPPORT FOR CLIMATE-RELATED TECHNOLOGY TRANSFER

The need for international co-operation on climate technology transfer has long been recognised

Developing and transferring technologies to support national action on climate change has been essential from the beginning of the establishment of the UNFCCC. Under the UNFCC, countries have long highlighted the role of technology in facilitating the achievement of their respective development goals in a more sustainable manner (UNFCCC, 2001[20]; UNFCCC, 2008[21]) and commitments to promote technology transfer to developing countries have been renewed at every meeting of the Convention. The Convention notes that all Parties shall promote and cooperate in the development and transfer of technologies that reduce emissions of GHGs. In 2010, the UNFCCC established the Technology Mechanism with the objective of accelerating and enhancing climate technology development and transfer for both mitigation and adaptation. The UNFCCC synergizes activities of the Technology Mechanism and the Financial Mechanism, which together drives the efforts towards transfer of climate technologies in the international arena.

International development co-operation is a key lever that developing countries can use to address the bottlenecks that slow down the transfer of climate technologies and to provide the finance needed. development co-operation can provide additional resources and capacities to address structural and institutional constraints that challenge the smooth transfer of these technologies, resulting in persistent under-investment and low uptake of many climate technologies. Through direct financing, capacity building and policy support, it can facilitate the technology transfer process and scale up application of climate technologies (OECD, 2021[22]).

Supporting the technology transfer process has been an important dimension of development co-operation activities, especially given the role of technology for both social and economic development as well the financial and capacity gaps in promoting technology transfer in developing countries. While the importance of climate technology transfer is recognised in international fora and in high-level strategies, interviews with several development agencies conducted for this report have shown that development agencies seem to lack clear and holistic strategies and mechanisms to support technology transfer or to identify and effectively respond to countries' specific technology needs.

Several development co-operation instruments are available to promote climate-related technology transfer

The understanding of technology transfer through development co-operation has evolved from direct support and financing of projects that implies the transmission of a specific technology to developing countries, to support for the broader enabling environment. Many donors do not only directly design, execute, or finance projects but also work in partnership with other actors, playing an important role in enabling technology transfer through support to knowledge and capacity, as well as by helping establish relevant regulatory or policy settings that shape and define the enabling environment for technology transfer in developing countries.

Development agencies and multilateral institutions can promote the technology transfer process through different instruments outlined below.

Direct financing

Development banks and development finance institutions often directly finance "hard" technology transfer by providing direct support to the transfer and deployment of specific technologies. Their provision of financing at concessional terms, as well as risk management ability, are key assets, in particular, for the ability to provide long-term finance for infrastructure that use new technologies. Moreover, direct funding support from donor programmes can facilitate testing and demonstration of various technologies across sectors.

Capacity building, technical assistance, and capacity support

Development co-operation provides technical assistance and capacity building support to domestic institutions, national governments, and the private sector to equip them with the right capacity to be able to absorb and successfully deploy new technologies. Donors can also provide funds for vocational education and training and establish knowledge-exchange platforms and partnerships between research centres and universities.

Policy support

With regard to regulatory environments, development partners regularly work with developing countries' governments on enhancing national policies, regulatory frameworks and innovation systems. With regard to climate technologies, this includes activities to inform the adoption of new policies and regulations more conducive to climate technology transfer. This can include introducing new ideas and new knowledge to support the policy making process, through training of country staff and technical assistance to identify and implement changes in laws, regulations, and governance frameworks.

Mobilising and catalysing additional finance

Despite their central role in funding projects and initiatives in developing countries, development co-operation resources, such as ODA, are a limited and essentially inelastic source of financing. In light of this, donors are increasingly looking to establish synergies with the private sector-led activities, including with regard to the technology transfer dimension. Blended finance is one tool donors use to unlock investment in climate technologies by catalysing private sector capital, through a variety of financial instruments that are structured to reduce and manage the risk of investing in specific technologies or infrastructure (OECD, 2018[23]). Development actors can play a big role to de-risk the technologies and be essentially the VC actors in climate in developing countries. Development is also important in providing proof of concept for technologies that will eventually allow SDG markets to develop.

Solar PV combined with agriculture
Shutterstock

6. TRACKING DEVELOPMENT FINANCE RESOURCES FOR CLIMATE-RELATED TECHNOLOGY TRANSFER

There is still no way to quantify development finance flows for climate-related technology transfer

Development finance constitutes the vast majority of international climate finance in developing countries (OECD, 2021[24]). Climate-related development finance flows have been increasing in recent years, with development co-operation taking centre stage in the promotion of climate related projects in developing countries. Aggregate data produced by the OECD show that climate finance provided and mobilised by developed countries for developing countries in the context of the United Nation Framework Convention on Climate Change (UNFCCC) reached a peak of USD 79.6 in 2019, up from 78.9 billion in 2018 (OECD, 2021[24]).

No attempts at quantifying development co-operation support to technology transfer are available. In particular, the way in which statistical information on climate-related development finance is collected does not include any specific marker that indicates whether an activity contributes to technology transfer objectives. This section attempts to provide an initial mapping of the support for climate technology transfer by analysing the project descriptions provided by providers of development co-operation. Through the analysis of the climate-related development finance database, the following sections will provide an overview of climate related development finance flows for technology transfer-related activities (see Box 3).

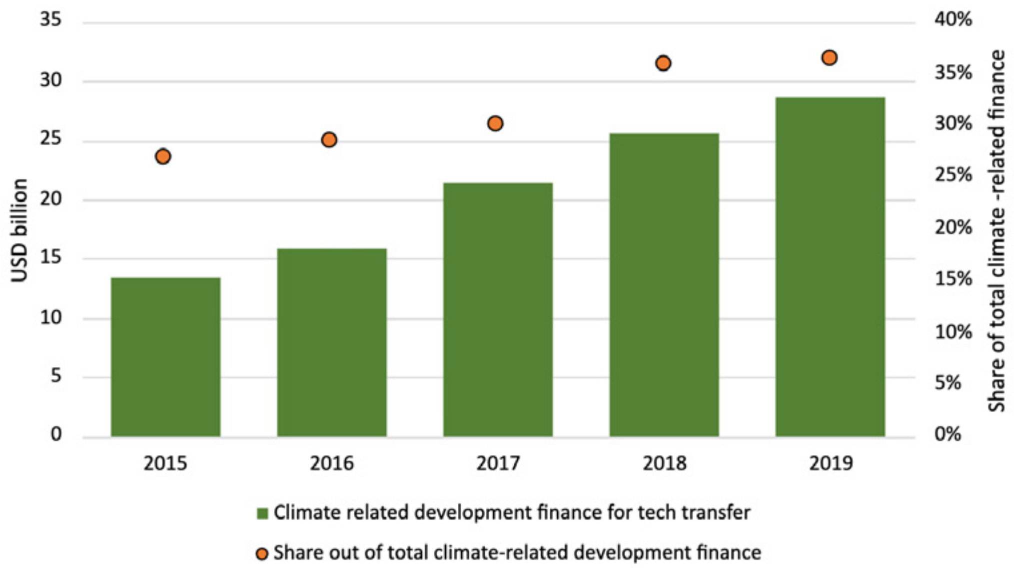
Box 3. Methodology to identify climate-related technology transfer: advantages and limitations

To identify climate-related activities with technology transfer objectives, this study developed a keyword search that allows to capture technology transfer-related projects to a reasonable degree of confidence and produced some preliminary estimates of development co-operation support for this goal (see Annex for methodology). Although these estimates strongly rely on the accuracy of project descriptions, they can provide some preliminary trends and allow to draw some insights, including to show how donors' trends match with developing countries' priorities as assessed by the TNAs. For each sector code, specific English technology-related keywords were identified. A more detailed description of the methodology can be found in the Annex II.

Development finance for climate-related technology transfer is rising

Outpacing the growth in climate-related development finance, it is estimated that technology related transfer has increased at a higher rate. The amount of technology-related climate development finance has significantly increased between 2015 and 2019, from USD 13.3 billion to USD 28.6 billion, outpacing the growth rate in total climate-related development finance. This is shown by the share of activities including a technology transfer component, which moved from 27% in 2015 to 36% in 2019 (Figure 4).

Figure 4. Climate-related development finance flows for technology transfer (2015-19), USD billion



Source: Authors calculation based on OECD Climate-related development finance database

Development finance for climate-related technology transfer mainly targets energy and transport and to a lesser extent agriculture and water

Across sectors, mitigation is disproportionately targeted when compared with adaptation. Overall, mitigation-related technology transfer across all donors accounted for 69% of total commitments, while an additional 11% targeted mitigation and adaptation together. Adaptation, on the other hand, receives fewer resources than the mitigation sector. However, the deployment of technologies to address the challenges posed by climate change in sectors like agriculture and water supply demands equal attention. Energy and transport receive the vast amount of resources, followed by agriculture and water – but to a lesser extent (Figure 5). Energy and transport projects often require large upfront investment, often allocated as concessional loans and therefore driving up total allocations for the sector.

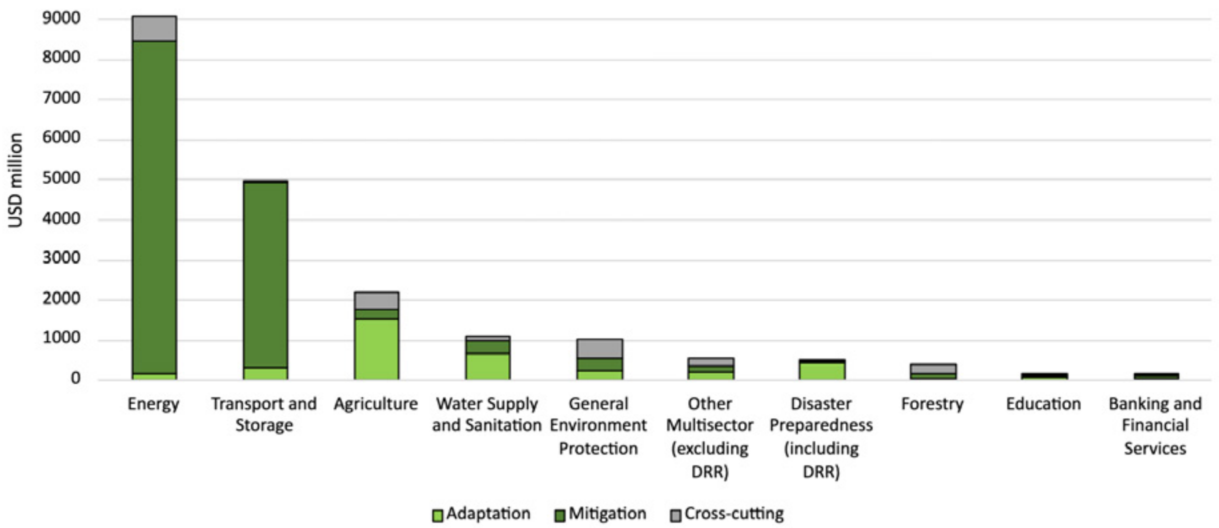
Development co-operation flows to technology transfer in the energy sector seem to align with developing countries' prioritisation. Development co-operation support for mitigation-related technology transfer in the energy sector totalled USD 8.9 billion a year in 2015-19 or 53% of development finance for mitigation-related technology transfer. The overall trend shows an increase in the flows targeting technology transfer in the energy sector, which between 2015 and 2019 moved from USD 6.5 billion to USD 10.4 billion.

Overall, donors seem to regard the energy sector as an important focus area to support developing countries in their transition to low-emission economies. This prioritisation of energy in the climate portfolio of development co-operation providers shows an alignment between countries' needs and development finance support. Amongst the energy sub-sectors, the ones that receive most funding for technology transfer are energy generation from renewable sources (multiple technologies) (30%), solar energy for centralised grids (15%) energy policy and administrative management (11%) and electric power transmission and distribution (11%).

Development co-operation flows to technology transfer in the transport sector are also increasing. In 2015-19, USD 5.0 billion a year in climate-related development finance were committed for transport-related technologies. From the results of the analysis, development finance in the sector has increased significantly in recent years, from USD 2.6 billion a year in 2015-16 to USD 8.2 billion a year in 2018-19. Most these resources (67%) have been allocated for rail transport, followed by road transport (18%) and transport policy and administrative management (11%). Mitigation is by far the more targeted than adaptation in the transport sector, with 94% of total resources targeting mitigation as a specific or crosscutting objective.

Between 2015 and 2019, climate-related development finance in support of technology transfer in the agriculture sector has grown from USD 1.7 billion a year in 2015-16 to USD 2.5 billion in 2018-19. 90% this funding targeted climate change adaptation. This shows the strong focus of climate development finance on supporting adaptation through the introduction of new technologies and farming practices. When considering the subsectors most targeted within the agriculture sector, it is possible to see that agricultural water resources receive approximately 31% of total funding for the sector, followed by agricultural development (28%) and agricultural research (13%).

Figure 5. Climate-related development finance flows for technology transfer by sector (2015-19, annual average), USD million



Source: Authors calculation based on OECD Climate-related development finance database

Development finance for climate-related technology transfer originates both from bilateral and multilateral sources and mainly uses debt instruments

Both bilateral and multilateral providers play important roles in contributing to the transfer of climate technologies via development co-operation. In 2015-19, DAC Members committed an average of USD 11.8 billion to projects integrating a climate-related technology transfer element. The sectors that DAC Members targeted the most are the energy sector (34%), transport and storage (28%), agriculture (12%), environmental protection (8%) and water supply and sanitation (5%). Most of this funding took the form of debt instruments (59%), followed by grants (40%) and equity investment (1%).

Multilateral providers of development co-operation committed an average of USD 9.1 billion a year for climate-related technology transfer activities in 2015-19. The sectorial distribution is even more concentrated on the energy sector, where 55% of the committed total resources are concentrated in mainly the energy sector. The energy sector is followed by transport and storage (18%), agriculture (9%), water supply and sanitation (6%) and disaster preparedness (3%).

When looking at volumes, debt instruments are by far the most used financial instruments to finance projects for climate technology transfer. 68% of total development finance resources allocated for this goal were in the form of debt instruments, followed by grants (30%) and equity investment (2%).

Debt instruments disproportionately target mitigation activities. 85% of activities financed through loans targeted mitigation purposes either exclusively or alongside adaptation objectives, while only 18% targeted adaptation as an exclusive or overlapping component. This is consistent with high capex of climate mitigation technology and show that large-scale projects, including major infrastructure, use debt finance and can have very large scales. Differently from other sectors, a majority of funding (57%) committed to the agriculture sector uses grants as financial instrument, while only 42% uses debt instruments. The reasons for this are the more limited scale of typical interventions, as well as lower capital-intensity of technologies to be deployed in the agriculture sector, and the higher focus on interventions in support of awareness and technical capacity.

Financing for climate technology transfer follows a slightly different regional trend than climate-related development finance overall. In 2015-19, 56% of resources for technology transfer flowed to Asia while Asia only represents 42% of total climate-related development finance, and approximately 33% of total official development finance. Conversely, Africa received 22% of resources for technology transfer, while receiving 29% of total climate-related development finance and 35% of total official development finance. While transport and energy always rank among the top sectors in all regions, in Asia they represent 59% of total funding, while in Africa only 33%. Conversely, the agriculture sector which in Africa receives 16% of total funding only receives 8% of funding in Asia.

Clean cookstoves as an alternative
Flickr

7. OUTLOOK AND PRIORITIES FOR DEVELOPMENT CO-OPERATION

The analysis of developing country's technology needs assessments and of development co-operation allocations of official development finance resources suggests some priorities for future action on climate-related technology transfer.

1. Align allocation of development co-operation support with country priorities

It is broadly recognised that development co-operation interventions need to align with developing countries' own plans and priorities to be effective and achieve impact. Technology Needs Assessments and Technology Action Plans, and the process of developing them in alignment with NDC goals, offer a concrete opportunity to establish synergies between the donor community and developing countries by providing a platform whereby information can be shared, common approaches designed, and financial resources mobilized. In this context, donor agencies should consider enhancing the co-ordination of their support with developing countries' own strategies to ensure that their support reinforces country efforts.

2. Focus more on potential for large-scale impacts of mature technologies for adaptation

There is a need to increase focus on supporting the diffusion of adaptation technologies through knowledge-diffusion and capacity building efforts. As shown in the TNAs analysis, prioritised adaptation technologies are to a large extent already mature. Constraints to their further diffusion therefore relate primarily to governance, knowledge and capacity, rather than just affordability per se. Development co-operation efforts could focus on strengthening information diffusion, capacity building and adaptation of technologies to local contexts. Despite significant prioritisation of adaptation sectors (water and agriculture) and technologies by developing countries, there remains a mismatch in the volume funding flows in favour of mitigation technologies. At the same time, this trend may be driven at least to some extent by the more capital-intensive nature of many mitigation interventions.

3. Address bottlenecks to mature technologies adoption and prepare the ground for future adoption of frontier technologies

As shown in this paper, developing countries' prioritised climate technologies are for the most part mature or at near maturity stage. This implies a need to look at structural factors that inhibit the transfer and deployment of a technology, including regulatory, policy or other features that characterise a given sector, as well as access to and cost of finance. For near-market maturity emerging technologies, ensuring appropriate regulatory and policy settings are equally central, especially where technology deployment may be largely the result of public investment or procurement decisions.

Concessional finance or funding to enhance affordability of technologies is likely to be particularly effective when provided in the context of programmatic support for an enhanced enabling environment. In both cases, embedding focused support for specific technologies needs to go along with a long-term focus on strengthening institutional and human capacity for absorptive capacity and fabric for technology transfer. A focused approach to strengthening key enablers for technology transfer, and enhance local absorptive capacity, is likely to hold more promise for transformational impacts than a focus on scaled up project finance for specific technologies.

4. Develop holistic strategies for climate-related technology transfer

The paper shows that substantial volumes of development co-operation are dedicated to activities that include the transfer of climate technologies. The activities of development co-operation cover virtually all dimensions of technology transfer – from direct transfer of technology hardware, to focused capacity development for its deployment, to supporting broader technology capacity, to policy support measures for the enabling environment, to dedicated funds and financing instruments for climate technologies. Despite these efforts, and despite the centrality of climate objectives, SDGs, and climate technologies in many individual donor programmes, most donors do not have a clear policy for a strategic or programmatic approach to supporting developing countries for accelerated transfer of key climate technologies. Improved technology transfer outcomes and impact will require more strategic approaches by development co-operation – both within and between donors and development actors.

REFERENCES

Baker, L., P. Newell and J. Phillips (2014), "The Political Economy of Energy Transitions: The Case of South Africa", New Political Economy, Vol. 19/6, pp. 791-818, https://doi.org/10.1080/13563467.2013.849674 [17]

Cirera, X. and W. Maloney (2017), The Innovation Paradox: Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up, Washington, DC: World Bank, https://doi.org/10.1596/978-1-4648-1160-9 [5]

Comin, D. and M. Mestieri (2018), "If Technology Has Arrived Everywhere, Why Has Income Diverged?", American Economic Journal: Macroeconomics, Vol. 10/3, pp. 137-178, https://doi.org/10.1257/mac.20150175 [4]

Dechezleprêtre, A. et al. (2020), Invention and Global Diffusion of Technologies for Climate Change Adaptation: A Patent Analysis, [Research Report] The World Bank. 2020. ffhal-03109935, https://hal-mines-paristech.archives-ouvertes.fr/hal-03109935 [9]

IEA (2021), Net Zero by 2050 A Roadmap for the Global Energy Sector, International Energy Agency, https://iea.blob.core.windows.net/assets/beceb956-0dcf-4d73-89fe-1310e3046d68/NetZeroby2050-ARoadmapfor-theGlobalEnergySector_CORR.pdf [3]

IPCC (2022), Impacts, Adaptation and Vulnerability: Summary for Policy Makers, Working Group II contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf [2]

IPCC (2022), Mitigation of Climate Change: Summary for Policy Makers, Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, https://report.ipcc.ch/ar6wg3/pdf/IPCC_AR6_WGIII_SummaryForPolicymakers.pdf [1]

IPCC (2000), Methodological and Technological Issues in Technology Transfer, Intergovernmental Panel on Climate Change, https://www.ipcc.ch/site/assets/uploads/2018/03/srtt-en-1.pdf. [11]

Mulugetta, Y. et al. (2019), Bridging the gap: Global transformation of the energy system, United Nations Environment Programme (UNEP, Nairobi), https://unepdtu.org/publications/bridging-the-gap-global-transformation-of-the-energy-system/ [16]

Newell, P. and P. Johnstone (2018), "The Political Economy of Incumbency", in The Politics of Fossil Fuel Subsidies and their Reform, Cambridge University Press, https://doi.org/10.1017/9781108241946.006 [18]

OECD (2021), Climate Finance Provided and Mobilised by Developed Countries: Aggregate Trends Updated with 2019 Data, Climate Finance and the USD 100 Billion Goal, OECD Publishing, Paris, https://dx.doi.org/10.1787/03590fb7-en [24]

OECD (2021), Investing in the climate transition: The role of development banks, development finance institutions and their shareholders, OECD Development Co-operation Directorate,, https://www.oecd.org/dac/financing-sustainable-development/Policy-perspectives-Investing-in-the-climate-transition.pdf [14]

OECD (2021), Strengthening Climate Resilience: Guidance for Governments and Development Co-operation, OECD Publishing, Paris, https://dx.doi.org/10.1787/4b08b7be-en [22]

OECD (2018), Making Blended Finance Work for the Sustainable Development Goals, OECD Publishing, Paris, https://dx.doi.org/10.1787/9789264288768-en [23]

Pigato, M. et al. (2020), Technology Transfer and Innovation for Low-Carbon Development, The World Bank, https://doi.org/10.1596/978-1-4648-1500-3 [7]

Saggi, K. (2002), "Trade, Foreign Direct Investment, and International Technology Transfer: A Survey", The World Bank Research Observer, Vol. 17/2, pp. 191-235, https://doi.org/10.1093/wbro/17.2.191 [12]

Steffen, B. (2020), "Estimating the cost of capital for renewable energy projects", Energy Economics, Vol. 88, p. 104783, https://doi.org/10.1016/j.eneco.2020.104783 [15]

UNCTAD (2014), Transfer of Technology and knowledge sharing for development, United Nations Conference on Trade and Development: Science, technology and innovation issues for developing countries, https://unctad.org/system/files/official-document/dtlstict2013d8_en.pdf [6]

UNEPDTU and UNFCCC (2021), From Needs to Implementation: Stories from the Technology Needs Assessment, United Nations Environment Programme (UNEP), United Nations Framework Convention on Climate Change (UNFCCC). Copenhagen, Denmark, https://tech-action.unepdtu.org/wp-content/uploads/sites/2/2021/10/2021-10-tna-stories-web.pdf [19]

UNFCCC (2022), Enabling Environments and the Challenges to Technology Development and Transfer, UNFCCC, Technology Executive Committee, Climate Change Secretariat, https://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/tec_enablingenvironments/d611c896c4dd44c79c79ec8938625a88/b8730b-2990284c17887b1f511b5a2f7c.pdf [13]

UNFCCC (2008), Development and transfer of technologies, Report of the Conference of the Parties on its fourteenth session, Decision 2/CP.14. UNFCCC., http://unfccc.int/resource/docs/2008/cop14/eng/07a01.pdf [21]

UNFCCC (2001), Development and transfer of technologies, Report of the Conference of the Parties on its seventh session, Decision 4/CP.7. UNFCCC., http://unfccc.int/resource/docs/cop7/13a01.pdf#page=22 [20]

Wahab, S., R. Rose and S. Osman (2011), "Defining the Concepts of Technology and Technology Transfer: A Literature Analysis", International Business Research, Vol. 5/1, https://doi.org/10.5539/ibr.v5n1p61 [10]

WTO (2016), Developing economies' participation in World Trade, World Trade Organisation, https://www.wto.org/english/res_e/statis_e/wts2016_e/wto_chapter_06_e.pdf [8]

ANNEX I: INTRODUCTION TO TNAS AND DATA

The GEF has since 1999 supported efforts to facilitate and improve technology transfer to developing country Parties under the UNFCCC through a Technology Needs Assessment (TNA) process (UNFCCC, 2001). Originating from the Poznan Strategic Programme on Technology Transfer, established in 2008, a second generation of the TNA process was initiated, with almost one hundred developing countries included in this process. The TNAs aim to increase the level of investment in the transfer and diffusion of technology to assist developing countries address their needs for climate technologies (UNFCCC, 2008).

Between 2010 and 2013, TNAs were conducted in 36 developing countries to. Since late 2014, a second phase of TNA included 26 new countries. In 2018, 22 additional countries, mainly least developed countries (LDCs) and small island developing states (SIDS) initiated their TNA as part of Phase III of the global TNA project. In 2019, the GEF approved Phase IV of the global TNA project, which will provide support to 17 LDCs and SIDS. In addition to the GEF support, the Green Climate Fund (GCF) strategic plan identifies developing countries' intended nationally determined contributions and TNAs as important reference points for GCF programming.

A key outcome of the TNA process is the technology action plan (TAP). A TAP is a concise plan for the uptake and diffusion of prioritised technologies that will contribute to the country's social, environmental and economic development and climate change mitigation and adaptation. Since 2010, as part of their TNAs, developing countries have also developed technology action plans (TAPs), which are concrete action plans for the implementation of their prioritized technology needs. Developing countries are currently seeking support for more than 550 TAPs and more than 450 Project Ideas that they prepared between 2009 and 2018. More TAPs are currently being prepared by 23 countries and will be available by the end of 2021 and 17 additional by end 2023.

A stepwise guidance to the TNA process and its organisation has been made available via UNEP DTU Partnership (UDP) (Haselip, et al., 2019). Moreover, several additional guidance documents have been added to support the TNA process, focussing on technology prioritisation, stakeholder engagement, gender aspects, finance, as well as support on content in specific sectors. All guidance and tools are made available on the TNA website www.tech-action.org including also a TNA database providing an overview of which technologies countries have prioritised.

ANNEX II: CRS ANALYSIS METHODOLOGY

Data source

Aid activities data were extracted from the OECD Climate-related development finance database. The climate-related development finance database collects information on climate-related development finance from bilateral and multilateral sources based on the OECD DAC statistics. Data include bilateral activities targeting climate change objectives identified using the Rio markers for climate change mitigation and climate change adaptation and climate-related multilateral activities (outflows) collected from multilateral providers active in the climate field identified using the Rio markers or Climate Components methodologies.

Climate-related development finance activities are reported using two different methods:

- The Rio markers methodology applied to development finance by bilateral rpoviders and non-bank multilateral institutions and programmes uses a scoring system from 0 to 2, depending on whether the project targets climate change mitigation and climate change adaptation as a significant (1) or principal (2) component.

- The climate component methodology applied to development finance by multilateral development banks identifies the climate component (i.e. share of total funding) within each project based on based on the MDB-IDFC common principles for climate finance tracking.

Methodology

To identify technology transfer-related aid activities, a keyword search methodology was applied to the aid activities included in the Climate-related development finance database. The list of keywords used can be found in the table below. To minimise the number of false positive projects captured through the methodology, each keyword sub-group was applied only to a list of sector codes which were considered relevant, while excluding other sectors.

Table 2. List of technology related keywords

Sector	Keywords
General Keywords	tech| ict | information and communications technology|know-how | research | r&d | research and development| train| innovat| digital| vocational| software| build capacity| technical assistance| skill| science| scientif| university| capacity buil|carbon capture| high-efficiency| high efficiency| wetland restoration| seawall|floodwall| landscape approach| geographic information system| metereological| satellite|mangrove| waste recovery|heat pump| methane recovery|bioreactor| bio-energy| bioenergy| electrification| engineering| climate service| metereolog| satellite|mapping| early warning| seawall|research| methane recovery| bioreactor|technolog|know-how|capacity| waste recovery| circular economy|innovat| science| technical|scient|skill| university|vocational|techniqu| landscape approach| power plant|recycl|flood|-forecast| know-how|sensor| beach nourishment| digital|software| climate service| metereolog| satellite|mapping| early warning| seawall|sea wall
Energy	bioenergy| bio-energy| biogas| bio-gas|composting| bioethanol| bio-ethanol|biodiesel| bio-diesel|biofuel| bio-fuel|biomass| bio-mass|bio-digester|biodigester|gasification|biolatrines|bio latrines|anaerobic digestion| photovoltaic|solar home systems|solar lantern| solar pv| pv systems| pv kit| solar home systems|solar water heater|solar farm|solar dryer|solar thermal|solar mini grid|solar powered pump|solar salt|solar panels|solar mini grid|wind energy|energy conservation|solar energy| photovoltaic| heat pump| heat recovery| hydrogen| electric vehicle| hydropower|marine energy|wave energy|tidal|offshore wind| ocean energy|hydro-electric|hydroelectric|hydro electric|thermal|coating| efficiency|solar|renewable| combined heat and power
Water	rainwater collection| dam | dams | reservoir| micro catchment| rainwater harvesting| hillside storage | collection ponds| alternate wetting| sprinkler| subsurface irrigation| wet and dry irrigation|tidal irrigation| drip irrigation|community irrigation|improved irrigation|hydro dam| hydrodam|drainage|improved irrigation|polder management|land suitability zoning| irrigation| water use association| deepening of ponds| hydropower| waste treatment|compost| water catchment | water harvesting| water storage|rainwater collection| water saving| wastewater treatment|water resources conversation| storage reservoir| pond|
Transport	bus| tramway| ferry| mass transit|energy efficient| retrofit| electric vehicle|electric transport| low-carbon| hybrid| mode transfer| non-motorized transport|no motorized transport| non motorised transport| non-motorised transport| efficiency| decongestion|inspection system|traffic management | shift from| hybrid car| hybrid vehicle| traffic
Agriculture	vertical farming| pathogen| climate resilient crops| crop management| smart irrigation| crop rotation| fertiliser| fertilizer|land planning| agroforestry| agro pastoralism| feed improvement| nutrition enhancement| mariculture| aquaculture| fish farming|sustainable fish| integrated crop livestock aquaculture forest| integrated-crop- livestock-aquaculture-forest| integrated farming| mulching| windbreak| mixed farming| pest management| slow forming terraces| microdose| nitrogen optimisation| nitrogen optimization| optimisation of nitrogen| optimization of nitrogen| improved storage| freezing| drying| innovative farming| community-based| drought tolerant| drought-tolerant| flood tolerant| flood-tolerant| heat tolerant| heat-tolerant| salt tolerant| salt-tolerant| pest tolerant| pest-tolerant| early maturing| new variet| improved variet|crop breed| short duration crop| short duration variet|diversificati|climate resilient livestock| climate resilient crop| crop cloning| precision farm| invasive spec| rainwater collection| dam | dams | reservoir| micro catchment| rainwater harvesting| hillside storage | collection ponds| alternate wetting| sprinkler| subsurface irrigation| wet and dry irrigation|tidal irrigation| drip irrigation|community irrigation|improved irrigation|hydro dam| hydrodam|drainage|improved irrigation|polder management|land suitability zoning| irrigation| crop rotation| forest management| pathogen| agroforestry| pest control|genetic| reforestation| forest conservation| | drought resistant| drought-resistant| soil manage|manage soil| irrigation system| irrigation method crop management| climate resilient| conservation agriculture|drainage

Source: Authors

Limitations

Despite being the best attempt at quantifying technology transfer -related climate-related development finance, this methodology has a number of limitations:

- It strongly relied on the accuracy of project descriptions.
- It is based on a keyword search methodology which only captures whether a word is mentioned or not in the project description, without analysing the broader context in which the word is used.

The aggregate figures presented tend to over-estimate the contribution of bilateral donors by assigning the same weight to activities which are Rio-marked as either 1 or 2 and to under-estimate the contribution of multilateral donors by using

@UNEPCCC

UNEPCCC.ORG