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Technology Transfer and Climate Change: A developing country perspective

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Introduction

The role of technology transfer in climate change negotiations is vital. Technology can be regarded as a means to help countries achieve their nationally determined contributions (NDCs). But if technology is to help us mitigate and adapt to climate change, the international community needs to ensure sufficient innovation and technology transfer. Technology must be developed and available everywhere it is needed. There is a consensus that the international community should take measures to accelerate the transfer of environmentally sound technologies (ESTs); however, global warming has increased faster than international cooperation.

A 2020 World Bank report recognizes that existing commercially tested technologies could serve to achieve a significant proportion of the emissions reductions to meet the Paris Agreement's objectives (Pigato *et al.,* 2020, p. ix). The difficulty is that these technologies are not available or being used in large parts of the developing world. The report concludes that governments are not doing enough to transfer these technologies.

The United Nations Framework Convention on Climate

Abstract

The role of technology transfer in climate change negotiations is vital. If technology is to help us mitigate and adapt to climate change, the international community needs to ensure sufficient innovation and technology transfer. One of the main challenges of the technology transfer regime for environmentally sound technologies is that a private and market-led model may not meet global technology transfer needs. This policy brief suggests that governments should explore market, hybrid and non-market approaches to accelerate the transfer of environmentally sound technologies. Developing countries' governments should also explore cooperative approaches to improve their bargaining power, reduce costs and ensure adaptation and innovation capacity in the developing world.

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Le rôle du transfert de technologie dans les négociations sur le changement climatique est essentiel. Pour que la technologie puisse nous aider à atténuer le changement climatique et à nous y adapter, la communauté internationale doit garantir une innovation et un transfert de technologie suffisants. L'un des principaux défis du régime de transfert de technologie pour les technologies respectueuses de l'environnement est qu'un modèle privé et dirigé par le marché pourrait ne pas répondre aux besoins mondiaux dans ce domaine. Ce rapport sur les politiques suggère aux gouvernements d'explorer des approches de marché, hybrides et non marchandes pour accélérer le transfert de technologies respectueuses de l'environnement. Les gouvernements des pays en développement devraient également explorer des approches coopératives afin d'améliorer leur pouvoir de négociation, de réduire les coûts et de garantir la capacité d'adaptation et d'innovation dans les pays en développement.

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El papel de la transferencia de tecnología en las negociaciones sobre el cambio climático es vital. Para que la tecnología pueda ayudarnos en el proceso de adaptación y mitigación del cambio climático, la comunidad internacional debe garantizar que exista suficiente innovación y transferencia de tecnología. Uno de los principales retos del régimen de transferencia de tecnología para las tecnologías respetuosas con el medio ambiente es que un modelo privado e impulsado por el mercado no puede satisfacer las necesidades globales en esta materia. Este informe sobre políticas sugiere que los gobiernos deberían explorar enfoques de mercantiles, híbridos y no mercantiles para acelerar la transferencia de tecnologías ecológicas. Los gobiernos de los países en desarrollo también deberían explorar enfoques cooperativos que permitan mejorar su poder de negociación, reducir los costes y garantizar la capacidad de adaptación e innovación en los países en desarrollo.

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Change (UNFCCC) has adopted a market-based approach focused on firms for the transfer of ESTs. The underlying premise for this choice is that public funds are not enough. Increasingly, research shows that this market-based model has limitations and may also be unable to meet the demands for climate mitigation and adaptation (Sharman, 2022, pp. 6-7; Weko & Goldthau, 2022, p. 3, 8). Other scholars have pointed at the neoliberal biases in negotiations and policy design (Haselip *et al.*, 2015; Oh, 2019).

A problem is that governments have not reached a consensus on how to make these transfers happen and what technology transfers should be about. Technology exporting countries and most global business—multinational firms and international business associations—advocate for a market-based model based on voluntary transfers of technology on terms agreed upon between providers and recipients. Developing and least developed countries—which see technology transfer as a process through which they can create local capabilities to absorb, adapt, replicate and develop their own technologies—promote hybrid mechanisms involving market, hybrid and non-market approaches, including compulsory licensing or mandatory technology transfers. These differences permeate discussions about mechanisms, rules and implementation.

The tension is not only about green industrialization—that is, which countries will become leaders in the production of batteries or electric vehicles (Behuria, 2020), but extends to other fields. Thus, the COVID-19 pandemic has exposed the risks faced by technology importing countries and their population. Those who lack the technology depend on those who have it to protect the health, well-being and human rights of their population.

This policy brief is organized as follows. Section 1 examines the definition of technology and technology transfer, identifying some of the challenges faced by the international community. Section 2 maps the laws and regulations that shape technology transfer, focusing not only on international and domestic public laws but also on contracts and private practice. Section 3 presents the technology transfer regime for environmentally sound technologies. It shows that this regime has omitted a detailed consideration of private rights, obligations and practices. Section 4 focuses on the recent progress of the existing international regime. Its main challenge is that a private sector-led model focused on firms seems incapable of meeting global technology transfer needs. Section 5 provides some policy conclusions and recommendations, namely that governments should explore market, hybrid and non-market approaches to accelerate ESTs transfer, study allocating obligations to some private actors, reconsider some private rights, and examine contracts and private practices. Governments may also want to explore cooperative approaches to improve their bargaining power, reduce costs and ensure adaptation and innovation capacity in the developing world.

1. Two key concepts: technology and transfer

Technology consists of the application of scientific knowledge for practical purposes. A 2012 literature review highlights the hardware, knowledge, and research and development (R&D) dimensions of technology (Wahab *et al.,* 2012). The dominant definition is functional; the United Nations Conference on Trade and Development (UNCTAD) and the Organisation for Economic Cooperation and Development (OECD) conceptualize technology as know-how in manufacturing a product or developing a process or a service (Haug, 1992, pp. 210-11). Technology is about resolving a problem, obtaining a result, or completing certain tasks. The Intergovernmental Panel on Climate Change (IPCC) defines climate technologies similarly, as any "piece of equipment, technique, practical knowledge or skills for performing a particular activity that can be used to face climate change" (IPCC, 2000, p. 460).

But resolving problems through technology is not easily reproducible from one context to another, which leads to the question of technology transfer that is appropriate to the recipient country and its situation. Technology transfer involves the communication or diffusion of technical knowledge, including practical know-how. The issue is whether transfer ends there, or if that stage is just the start of the process. Historically, multinational corporations (MNCs) and business associations have preferred to see technology transfer through the analogy of export (Lachmann, 1966). This means that transfer is complete after the equipment is in place and know-how is communicated, although there may also be a long-term commitment to services such as maintenance and troubleshooting. Developing countries have instead focused on the absorption of knowledge and the ability to adapt it to specific local conditions (Haug, 1992, pp. 222-223). The South Centre has endorsed this position highlighting that technology transfer is fundamental for achieving the United Nations (UN) 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) (Khor, 2013).

The IPCC has adopted a broad understanding of technology transfer, having defined it as a set of "processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change among different stakeholders", and being inclusive of "the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies" (IPCC, 2000, p. 3).

Academics generally agree that capabilities and institutions play a central role in technology transfer. Still, there is disagreement about the causality between transfers and investment, including in relation to low-carbon technologies. The literature shows two main strands of thinking. One focuses on the role of states in promoting education and technical literacy and the existence of domestic firms that can absorb and adapt technology (Rosenberg, 1970, pp. 565-74; Coninck & Sagar, 2015, p. 2). This view is con-

sistent with Mazzucato's research, in which states play a central role in innovation processes (Mazzucato, 2011). The other posture highlights the importance of markets and firms, which provide institutional and organizational mechanisms to facilitate the learning process. Well-functioning markets and the activities of subsidiaries of MNCs are key for this literature (Kolk, 2015, pp. 170-73).

There are multiple hybrid possibilities between these market and non-market led models, including collaborations to bring together MNCs, domestic firms, and host states (such as through joint ventures). In 1991 Gibson and Smilor pointed out that technology transfer is often "a chaotic, disorderly process involving groups and individuals who may hold different views about the value and potential use of the technology" (Gibson & Smilor, 1991, p. 293). Recent research also suggests that no universal formula applies to all contexts and circumstances (Weko & Goldthau, 2022, p. 3).

Foreign direct investment (FDI), trade, and finance can serve to make technology available where it is needed; however, it may not happen to the extent necessary[1] or fast enough, or the technology may not be adapted to developing countries' needs. UNCTAD has recently warned about a slowdown of FDI in climate change investment (UNCTAD, 2022). Without sufficient technology transfer, understood as creating capabilities in developing and least developed countries, these countries will not be able to address the multiple challenges created by climate change.

2. Mapping the public and private in technology transfer

Most policy discussions on technology transfer focus on domestic and international rules. Domestic laws can restrict or promote technology transfer. They may limit technology transfer deals for anti-trust or security reasons.[2] They may, on the other hand, support these transfers to promote sustainable development or address climate change. Recipient states' regulation also plays an important role. Recipient countries need to create enabling institutions for technology transfer, from intellectual property laws to innovation policies that strengthen their absorptive capacity. They may also want to ensure equal bargaining, fair taxation, full information, and the actual transfer of skills and technological capabilities. Recipient states may also impose performance requirements, mandatory joint ventures or establish R&D commitments (UNCTAD, 2001).

There are numerous sources of international rules related to technology transfer. They include World Trade Organization (WTO) agreements, mainly the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) and the Agreement on Trade-Related Investment Measures (TRIMs). Regional trade agreements have incorporated stronger intellectual property rights (TRIPS plus, see Correa & Yusuf, 2016) and prohibitions or limitations on technology performance requirements, mandatory joint ventures or R&D commitments. A 2020 OECD study states that 60% of regional trade agreements signed between 2010 and 2018 prohibit performance requirements, 58% prohibit technology transfer requirements, 59% prohibit exclusive supplier requirements, and 42% ban R&D requirements (Andrenelli *et al.,* 2020, p. 39). Lastly, some international investment treaties include technology transfer limitations, and investor-state dispute settlement (ISDS) can be used to protect intellectual property rights (IPRs) (Correa & Viñuales, 2016).

Hoekman *et al.* observe that most international economic "rules in place are primarily constraining in nature—they define limits on what is allowed [to states]. Multilateral efforts to identify actions that governments should pursue to encourage [international technology transfer] are largely of a best-endeavor nature" (Hoekman *et al.,* 2004). Strong intellectual property protection and the policy limitations of recipient states can favour foreign investment and licencing, as firms may be more willing to expose their patents and other IPRs to the risks of imitation. However, strong IPRs can ensure the control of foreign markets through exports (without the need of FDI or licencing) while international rules may prevent developing states from using avenues previously used to pursue technological catch-up in the context of industrialization, first in Europe and the United States and later in Japan and Korea (Chang, 2002; Amsden, 2009). Likewise, such rules cannot be used to pursue climate change goals, as developing countries have noted in different fora (European Capacity Building Initiative, 2020, p. 19).

Importantly, however, domestic and international public rules do not encompass all the determinants of technology transfer. Regardless of whether we understand technology transfer as a transaction or as a broader absorptive process, these deals generally involve contracts and private practice (Perrone & Selamé, forthcoming). Most technologies that developing countries import, absorb or adapt are privately owned.

Most attempts to regulate technology transfer in the 1970s recognized the importance of the private sector. The International Chamber of Commerce (ICC) considered the question from a business perspective, especially between the late 1960s and early 1970s, when it submitted a detailed proposal to UNCTAD (ICC, 1972). Developing countries aspired to bring trans-border technology transactions under the scope of UNCTAD's Code of Conduct on the Transfer of Technology (Roffe, 1985). The negotiations of the UNCTAD Code started in 1976 but were discontinued in 1985.

From a private perspective, the methods to transfer technology are trade in capital goods, licence agreements (trade in knowledge) and foreign direct investment, including through joint ventures (Haug, 1992, pp. 212-217). They range from one-off transactions to cooperation schemes that may be long-term, as in the case of joint ventures. According to Kolk, firms enter into these deals for market-seeking or cost-efficiency reasons; they do not do

it for charity but for concrete business goals (Kolk, 2015). Data from the OECD indicates that more than half of technology transfer deals are research collaborations, a fourth are licencing agreements, and one eighth are joint ventures (OECD, 2019, pp. 25-30). The information technology (IT) sector prefers research collaborations, the pharmaceutical industry opts for licencing, and the automobile sector favours joint ventures (mainly involving Global North countries and large emerging economies such as India and China). The same dataset suggests that states' involvement in these deals is not unusual (OECD, 2019, pp. 25-30).

The same 2019 OECD report expresses a preference for technology transfer methods that include investors and respect their freedom to contract. The report is positive about measures to facilitate foreign investment, develop and improve local capacity to absorb technologies, and address market failures such as information asymmetries and externalities. However, it criticizes attempts to 'force' technology transfers through joint ventures, conditioning access or markets, and weakening intellectual property rights (OECD, 2019, p. 16). It also considers the role of state-owned enterprises problematic. The OECD report criticizes performance and joint venture requirements (OECD, 2019, p. 31). The report also casts doubt over scholarly work that sees a positive relationship between these measures and technology transfer, noting that forced transfer often entails outdated and marginal technologies (OECD, 2019, pp. 30-32).[3]

The various methods of technology transfer and the role that private and public actors can play show that this field is characterized by significant private-public hybridity. For the private sector, contractual autonomy is central. As noted, in addition to domestic and international public law, this area is significantly shaped by contracts and private practice (Perrone & Selamé, forthcoming).

Evidence about the contractual dimension of technology transfer deals is more difficult to obtain. A look at the ICC model contract of technology transfer indicates that businesses prefer international principles to domestic legal systems, especially when it is possible to combine them with international arbitration (ICC, 2009, pp. 13-15). Firms may choose *lex mercatoria* principles, such as the UNIDROIT (International Institute for the Unification of Private Law) Principles of International Commercial Contracts, in order to avoid mandatory requirements from the laws of the recipient or home country.[4] The ICC model recommends the *lex mercatoria* approach when combined with arbitration, but casts doubts when firms are required to submit their disputes to a national jurisdiction (ICC, 2009, pp. 13-15). If firms have to do so, the ICC suggests choosing a domestic legal system.

3. The international technology transfer regime for climate change

The present international framework to address the climate change challenge was established at the 1992 UN Conference on Environment and Development in Rio de Janeiro (Sands, 2003). Its three pillars are the Rio Declaration, Agenda 21, and the UNFCCC. Multiple aspects of climate change were discussed in Rio de Janeiro, including the relevance of ESTs transfer to accelerate the transition to a low-carbon economy. Since 1992, technology has become more central to the climate change debate, as shown by the debates leading to the Paris Agreement and recent negotiations.

The Rio Declaration and Agenda 21 approach the challenges of climate change and technology transfer by focusing on the role of states and international organizations. These non-binding documents declare that states have common but differentiated responsibilities, which respond to the fact that Global North countries hold a larger responsibility in generating the ongoing climate crisis because of their historic carbon emissions. However, they say nothing about corporate responsibility for climate change, omitting questions such as corporate obligations (including a duty to cooperate) or the private dimension of technology transfer deals. The private sector supports the use of technology as a key strategy to mitigate and adapt to climate change (Brulle, 2022, p. 10) but subject to their own choices (including whether to transfer technology or not) and practices.

The UNFCCC provides a framework for the fight against climate change that promotes cooperation but that—on balance—favours private-led solutions (Zhou, 2019, pp. 37-38). Article 4 of the UNFCCC creates a series of state commitments regarding ESTs technology transfer. It states that all countries have to cooperate and promote technology transfer. The scope of this obligation includes not only the technologies but also the legal systems and market conditions necessary to promote ESTs transfer and innovation.

Article 4 also establishes specific obligations for Global North and Global South countries. The former assume the primary responsibility to transfer and finance ESTs, depending on the circumstances of each country. Global North states have an obligation of solidarity and assistance. This distribution of the burden suggests that these states are expected to facilitate and finance the transfer of private technologies (Zhou, 2019, p. 43). Global South countries are expected to focus on domestic climate change mitigation and adaptation, make the best use of climate change aid, and create an enabling environment to receive new technology. The latter requires an appropriate framework for foreign investment (Minas, 2020, p. 244).

Like the Rio Declaration and Agenda 21, the UNFCCC—an international treaty binding only on the States parties—has no obligations for corporations. According to article 4.5 of the UNFCCC, other organizations "may also assist in facilitating the transfer of such technologies".

This voluntary approach is consistent with the position of technology exporting countries and MNCs in other fora (such as the negotiations of a UN binding treaty on transnational corporations and other businesses and human rights).[5] The premise is not that the private sector has no part to play. Private initiative and autonomy are conceptualized as the best way to ensure that firms can 'assist' in transferring technology.

The transfer of ESTs was also discussed at the Kyoto Protocol negotiations in 1997. But the Protocol did not strengthen or develop the commitments included in the UNFCCC. Instead of private or public commitments, the Kyoto Protocol promotes an enabling environment focusing on the attraction of foreign investment and the facilitation of licencing agreements. The Protocol created the Clean Development Mechanism (CDM) "to help channel private investment towards climate-friendly projects" (Yamin, 1998, p. 122). There is mixed evidence concerning the contribution of CDM to emissions reductions (Bertanathalie *et al.,* 2017; Mele *et al.,* 2021); however, most studies indicate that CDM projects are primarily located in large emerging economies and that the price dynamics of certified emissions reductions determine the functioning of this mechanism (Paulsson, 2009; Mele *et al.,* 2021).

At the 7th Conference of the Parties of the UNFCCC (COP 7) in 2001, states created the Expert Group on Technology Transfer to study how to promote technology transfer. The Group was not very successful; developing countries did not approve of its top-down planning approach (Minas, 2020, pp. 244-45). For the following seven years, most efforts focused on gathering and disseminating information on available technologies—public and privately owned—and assessing future needs for addressing climate change.

The 2007 Bali Action plan made technology transfer one of the four 'building blocks' of future negotiations, calling for "enhanced action on technology development and transfer to support action on mitigation and adaptation" (Zhou, 2019, p. 63). However, very little was decided in Bali about how to make successful technology transfers. A year later, the COP 14 approved the Poznan Technology Transfer Program (European Capacity Building Initiative, 2020, p. 15).

The discussion continued in Copenhagen in 2009, at COP 15, when developing countries asked for specific mechanisms to accelerate public and privately-owned technology transfer. To make this possible, they proposed reconsidering the balance between IPRs and climate change in order to ensure that ESTs are available on an affordable basis. Their requests included the possibility of compulsory licences, patent pools, limited-time patents, and a review of other limitations defined by the TRIPS Agreement (European Capacity Building Initiative, 2020, p. 19). Developed countries and business associations rejected these proposals. Various MNCs responded by creating the Innovation, Development and Employment Alliance, a business association which continues to advocate on the importance of markets and IPRs for climate change action (European Capacity Building Initiative, 2020, p. 39). The COP 15 concluded that "early and rapid reduction in emissions, and the urgent need to adapt to the adverse impact of climate change, requires large-scale diffusion and transfer of, or access to, environmentally sound technologies" (UNFCCC, 2009, p. 2). The unresolved issue was how to make these transfers happen.

For this purpose, the Technology Mechanism and the Financial Mechanism were created in 2010 (at COP 16 in Cancun). The Technology Mechanism consists of a policy and a technical body: the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN) (Minas, 2020, p. 244). The TEC focuses on technology policy issues, including the financial dimension, and issues recommendations for states. Its main objective is to accelerate the development and transfer of ESTs. The CTCN promotes EST transfers in line with the sustainable development priorities of recipient countries. Its responsibilities include dealing with national designated entities and processing their technical assistance and EST transfer requests. The CTCN also fosters collaboration, promotes access to knowledge on ESTs, and strengthens networks and partnerships. During the negotiations, states also recognized the important role of funding, especially in a context in which most ESTs are privately owned. The Financial Mechanism would serve to raise funds to enable technology transfer; presently, it consists of the Global Environmental Facility and the Green Climate Fund, in addition to funding from other international organizations and development agencies (Minas, 2020, p. 251).

The transfer of ESTs was reassessed during the COP 21 in Paris in 2015. The Paris Agreement adopted a more ambitious approach to climate change, with the objective of keeping the temperature increase well below 2 degrees Celsius above pre-industrial levels (ideally close to 1.5 degrees Celsius). These negotiations again showed tensions between the Global North and Global South countries, as the latter wanted specific financial commitments linked to the costs of IPRs and the former resisted any reference to IPRs. Ultimately, states agreed to strengthen the existing mechanisms and increase all states' capacity to mitigate and adapt to climate change, specifically for the most vulnerable states, such as small island countries (Minas, 2020, pp. 246-47). The Paris Agreement created the Technology Framework to provide overarching guidance to the Technology Mechanism.

In Katowice in 2018, COP 24 decided that the TEC and the CTCN would implement the Technology Framework under the guidance of the Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement. The Framework has five priorities: 1) innovation through new collaborative approaches, 2) implementation of mitigation and adaptation technologies, 3) ensuring an enabling environment, 4) supporting Global South states, and 5) engaging with stakeholders at the local, national, regional and global level. The ambition is to attain

'transformational' change, which the UN has said requires a vital role for the private sector (Mersmann *et al.,* 2014, p. 3). The parties also agreed on the importance of strengthening the links between the Technology and Financial Mechanisms, and to revise the performance of the technology framework during 2021 and 2022.

4. Recent progress of the ESTs transfer regime under the UNFCCC

The 2020 CTCN Progress Report shows that the CTCN and the TEC have paid significant attention to the role of the private sector and the links between technology transfer and finance (CTCN, 2021). The TEC involved actors from governments, civil society, academia, and business. The CTCN acted as a 'de-risking facility for attracting private sector finance' and as a nexus with the Financial Mechanism (CTCN, 2019, pp. 10-11). It also looked into 'legal and regulatory frameworks', as legal innovation can often be a prerequisite for technology innovation (CTCN, 2019, pp. 4-6). The TEC and the CTCN do not seek to shape private practices, but both bodies have suggested that their outputs should inform dealings, contracts, and template agreements (Minas, 2020, p. 253). These policy positions and recommendations suggest a model in which private and public actors have clear roles: states define appropriate rules of the game, provide public funds, and establish an enabling investment environment, while private actors carry out research, innovation, and technology transfer.

The 2021 Joint Annual Report of the TEC and the CTCN reflects a similar position (UNFCCC, 2021). The report states that accelerating innovation and technology transfer is imperative, recommending that states increase the coordination between technology and finance. Specifically, they called on states to focus on financial mechanisms and private-public collaborations. The TEC underscored that climate bonds, green bonds, and public incentives may serve to reduce business risks and attract projects to the Global South (UNFCCC, 2021, pp. 10-12). At COP 26, the UN Special Envoy for Climate Action and Finance noted that private finance will allow firms to realign their business models, amplifying the effectiveness of government policies (Carney, 2021, p. 3). Public and blended finance "will fund the initiatives and innovations of the private sector and turn billions committed to climate investment through public channels into trillions of total climate investment" (Carney, 2021, p. 5). The CTCN similarly stated that the international community should look into guidelines to facilitate technology transfer, promoting the involvement of private actors and private-public collaborations (UNFCCC, 2021, pp. 24-25).

The 2022 Joint Annual Report of the TEC and the CTCN also grants significant relevance to the private sector, highlighting the need to increase its contribution to ESTs transfer in developing and least developed countries (UNFCCC, 2022, p. 11). The TEC and CTCN warned that insufficient funding continues to be a key challenge. Public funds are limited and therefore it is necessary to tap on the private sector (UNFCCC, 2022, p. 11, 23).

In 2022, the TEC prepared a report on the enabling conditions to facilitate ESTs transfer. The report concluded that the main obstacles are financial, economic, legal and regulatory (TEC, 2022, pp. 11-13). Technical problems were ranked as less relevant. The international community and individual countries should explore "a combination of market stimulation and human capacity development", including establishing "an essential bridge between the policy and finance communities" (TEC, 2022, p. 29) The report stated that "[m]arket opportunities, investment procedures and profitability criteria are key words used in discussing the incentives and behaviour of both the providers and recipients of technology" (TEC, 2022, p. 26). A lack of incentives for the private sector, as well as poor linkages between the public and the private sector, are presented as significant obstacles for ESTs transfer. Accordingly, the report suggests that the CTCN should facilitate "international partnerships among public and private stakeholders to accelerate the innovation of environmentally sound technologies and their diffusion to developing country Parties" (TEC, 2022, p. 26).

The TEC and CTCN have recently highlighted the importance of promoting capacity building and the actual transfer of technology (TEC, 2019). However, Sharman points out that "support for sustained and transformational institutional and innovation capacity-building is generally still regarded as a shortcoming of the international regime" (Sharman, 2022, p. 6). A 2018 study indicates that only around one third of ESTs transfer projects have been successful, based on the ability of the recipient to operate, maintain, replicate and innovate the received technology (Kirchherr & Urban, 2018, p. 604). Another one-third had mixed results; the recipient could operate the technology but not replicate it. The last third were considered a failure. A 2022 study confirms these findings, concluding that present international initiatives do not address the key capacity-building components of knowledge transfer (Weko & Goldthau, 2022).

In addition to financial and economic obstacles, research indicates that firms are not interested in losing control of value creation (Bayer and Urpelainen, 2013; Oh, 2019). Private actors have little or no incentive to promote national systems of innovation or domestic technological capacity. Private actors have a strong incentive to protect their ownership advantages and prevent competition (Weko & Goldthau, 2022, p. 7; Sharman, 2022, p. 6). According to this research, the existence of absorptive capacities in the recipient country could discourage ESTs transfers (Weko & Goldthau, 2022, pp. 7-8).

5. Conclusions: some policy options

The work of the TEC and CTCN is laudable; however, growing research suggests that a private-led model for ESTs transfer focused on firms—and based on financial mechanisms, investment incentives and enabling

measures—has limitations. There is a need for more ESTs transfer capable of generating absorptive and adaptive capabilities in receiving countries.

On numerous occasions, the TEC and the CTCN have stated that public aid or development funds are insufficient to ensure enough ESTs transfer to the developing world. However, this important finding does not necessarily imply that private actors can resolve this significant gap through market incentives. Private actors are likely to transfer ESTs when these deals are profitable or they receive sufficient economic incentives. Even if profitable, firms may choose not to transfer ESTs if they perceive that transfers may create competition or IPRs protection is weak in the receiving country. Conversely, such a situation may encourage them to license the technology, obtain a payment for it, rather than to leave the market open to potential competitors.

The COVID-19 pandemic has provided lessons that may be useful for ESTs transfer. The even distribution of ESTs is of paramount importance and developing and least developed countries have the right and the obligation to explore different options to ensure that their population have access to the tools generated by ESTs to face the climate crisis.

In this context, developing and least developed countries may want to consider hybrid or non-market mechanisms to involve public and private actors in the UNFCCC and ESTs transfer. Article 6(8) of the Paris Agreement recognizes the importance of non-market approaches. These approaches may or may not include private actors, but it seems reasonable to involve MNCs and other private actors that own or are developing crucial ESTs.

The contribution of private actors to ESTs transfer could be enhanced by considering the creation of international obligations of private actors, such as MNCs. Private actors have no obligations to transfer ESTs under international law, and there is no discussion about imposing such obligations on certain private actors at present. The international community may want to consider whether or not to allocate some responsibility to some MNCs or large firms, taking into account the public funding they receive or whether these firms have been large carbon emitters.

Private rights, such as IPRs, could also be part of these discussions. Developing countries have highlighted the importance of revisiting IPRs in the context of climate change, but IPRs remain outside the debate. Other mechanisms to accelerate ESTs transfer, such as performance, joint venture or R&D requirements, remain contested.

Governments may want to examine applicable law and dispute settlement clauses in ESTs transfer deals, and scrutinize other provisions that may limit the transfer of capabilities and adaptive capacity to technology importing countries. Most academic and policy focus has been put on international and domestic public laws, paying less attention to ESTs deals. Mapping these deals and corporate strategies may increase transparency and help developing and least developed countries to improve their capacity to negotiate better deals. The international community can request firms to provide this information and to work together with technology exporting countries to ensure an effective transfer of ESTs.

The international community may also want to consider creating some mandatory rules for ESTs transfer deals. The principle of autonomy of the parties does not take into account the full magnitude of the climate change crisis.

Technology importing countries may also want to consider whether and how experiences and lessons from public health and access to medicines are replicable in the context of climate change and technology. Again, lessons from the COVID-19 pandemic may be useful. States may improve their bargaining power through collaborative agreements such as innovation cooperation or pooling demand (Weko & Goldthau, 2022). Previous work by the South Centre discussed ideas such as a 'Global Technology Pool for Climate Change' or a 'R&D Model for Future Technologies' (Khor, 2013). Regional trade agreements may be valuable platforms for developing countries and implement cooperative approaches. Least developed countries may combine cooperative strategies with the obligation of developed countries "to provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer" (TRIPS Article 66.2).

Endnotes:

[1] For instance, the COVID-19 pandemic made it clear the risks related to technological dependency, as many developed states prioritized domestic needs over global urgencies. Calls from the World Health Organization (WHO) did not modify this behaviour (WHO, 2021).

[2] As illustrated by the measure adopted by the United States in October 2022 to ban export of advanced semiconductor technologies to China. See, e.g. https://www.gibsondunn.com/us-new-export-controls-on-china-for-semi-conductor-manufacturing-technology-advanced-semiconductors-in-new-phase-strategic-tech-competition/#:~:text=Generally%20speaking%2C%20the%20new%20restrictions,effect%20on%20October%2021%2C%202022.

[3] The World Business Council For Sustainable Development has also argued that the most successful technology transfers involve business-to-business partnerships (Zhou, 2019, p. 63).

[4] Following the COVID-19 pandemic, research has shown that some pharmaceutical MNCs asked states for the application of foreign laws, international arbitration and other favourable provision in the contracts for the sale of COVID-19 vaccines (Rizvi, 2021).

[5] See, e.g., Daniel Uribe and Danish, *Designing an International Legally Binding Instrument on Business and Human Rights* (Geneva, South Centre, 2020). Available from https://www.southcentre.int/wp-content/uploads/2020/07/Designing-an-International-Legally-Binding-Instrument-on-Business-and-Human-Rights-REV.pdf.

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