SUBMISSION BY THE SOUTH CENTRE TO THE TECHNOLOGY EXECUTIVE COMMITTEE (TEC) ON WAYS TO PROMOTE ENABLING ENVIRONMENTS AND ADDRESS BARRIERS TO TECHNOLOGY DEVELOPMENT AND TRANSFER AND THE ROLE OF THE TEC

Contents

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A. INTRODUCTION

This contribution has been prepared by the South Centre in response to the call by the TEC for inputs on ways to promote enabling environments and to address barriers to technology development and transfer, including on the role that the TEC could possibly play in this area of work.

This submission focuses on three areas: (1) Barriers to technology development, diffusion and transfer, in particular, the role of intellectual property rights (IPRs) in those processes in the context of developing countries; (2) International cooperation in research and development as a component in promoting an enabling environment and addressing barriers to technology development and transfer; and (3) The role of TEC.

B. BARRIERS TO TECHNOLOGY TRANSFER, WITH PARTICULAR REFERENCE TO IPRS

B1. Technology development

In the developed world, IPRs are generally regarded by the private sector as important incentives to innovate. The exclusive rights that they confer allow title-holders to prevent competition and thereby charge prices above marginal costs. This, in turn, may allow them to recoup research and development (R&D) investment and obtain extraordinary profits. While the availability and enforcement of IPRs, particularly patents, may foster innovation, this will strongly depend on the context where such rights apply. In countries with low R&D capabilities, limited access to capital markets and considerable asymmetries in income distribution, high levels of IPRs protection may have significant negative allocative consequences, without contributing –or even impeding- their technological development[1].

There is a widespread view that the role of the patent system in promoting innovation is less substantial than usually claimed, even in developed countries. Patents may even stifle the very innovation they are supposed to foster.[2] A study, for instance, found that patents do provide profits for their owners, but taking the effect of other owners´ patents

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[*] This submission is substantially based on Correa, Carlos (2011), Pharmaceutical Innovation, Incremental Patenting And Compulsory Licensing, Research Paper 41, South Centre, Geneva; and Correa, Carlos (2012), Mechanisms for International Cooperation in Research and Development: Lessons for the Context of Climate Change, Research Paper 43, South Centre, March 2012; Khor, Martin (2012), Climate Change, Technology And Intellectual Property Rights: Context And Recent Negotiations, Research Paper 45, South Centre, Geneva

[1] See, e.g. Stiglitz, Joseph, (1999), "Knowledge as a global public good", in Kaul, Inged; Grunberg, Isabelle and Stern, Marc, (Eds.), Global public Goods. International Cooperation in the 21 ST Century, New York, p.315.

[2] Jaffe, Adam B. and Lerner, Josh (2004), Innovation and Its Discontents : How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It, Princeton University Press.

into account, including the risk of litigation, companies in most sectors 'would be better off if patents did not exist'[3].

'Collective invention' based on sharing innovations may be more efficient than patenting them. Competition can be a powerful incentive to introduce product, process or organizational innovations. Many important innovations are the result of stiff competition, particularly when different technological options may be pursued. Some studies suggest that innovation not only thrives in a competitive environment, but that more profit can be generated by inventors in a system based on the broad diffusion and common use and improvement on innovations.[4]

Incremental innovations prevail in most sectors, including those relevant for the mitigation of and adaptation to climate change. When incremental innovations prevail, the exclusionary rights conferred by IPRs can lead to underutilization of knowledge, especially for the generation of subsequent innovation. A conflict arises between first and subsequent generation innovators, since knowledge is both an *output* and an *input* in its production process. Hence, the greater the rights conferred to the first generation, the greater the limitations on and the costs for the second generation of innovators. As a result, in cumulative systems of technology, patents may deter rather than promote follow-on innovations.

Mapping the patent situation of particular technologies has become extremely complex and costly. With the reinforcement and expansion of measures for the enforcement of IPRs (such as broadly applicable border measures, expansive doctrines of infringement by equivalence), potential users face the risk of high litigation costs and damages if an infringement is found. Inventing around existing technologies has become increasingly difficult and risky.

In particular, patents can discourage research and innovation by locals in a developing country. When most patents in the country are held by foreign inventors or corporations, local R&D can be stifled. In the case of climate change technologies, patents are highly concentrated in three countries—Japan, Germany and the USA—which account for two thirds of total innovations in thirteen technologies with significant global GHG emission abatement potential[5]. The monopoly rights conferred by patents can restrict local research activities, as the use of patented technologies may be prohibited or expensive. This is particularly the case when patents are granted without a rigorous assessment of novelty and inventive step, leading to the proliferation of patents around a single technology.

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[3] Bessen, James and Michael Meurer (2008), Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk, Princeton and Oxford: Princeton University Press, p. 16.

[4] See, e.g., Torrance, Andrew and Bill Tomlinson (2009), 'Patents and the Regress of Useful Arts', 10 *Colum. Sci. & Tech. L. Rev*. 130.

[5] Antoine Dechezleprêtre, Matthieu Glachant, Ivan Hascic, Nick Johnstone, Yann Ménière (2008), Invention and Transfer of Climate Change Mitigation Technologies on a Global Scale: A Study Drawing on Patent Data. Final Report, MINES,CERNA, AFD, Paris, p. 4. The referred to technologies include wind, solar, geothermal, ocean energy, biomass, waste-to-energy, hydropower, methane destruction, climate-friendly cement, energy conservation in buildings, motor vehicle fuel injection, energy-efficient lighting and Carbon Capture & Storage (CCS).

Strategic patenting and lax patentability standards, explain the surge in patent applications and grants in many countries. A large number of patents that would not be granted if the novelty, inventive step (or non-obviousness) and industrial applicability standards were rigorously applied are approved every year in various fields of technology.

Patent proliferation is a direct consequence, on the one hand, of strategic patenting approaches and, on the other, of the relaxation of the standards applied for the examination of patent applications, rather than of robust rates of innovation or the need of protection against imitation.[6] As a US federal appeals court judge recently stated,

> "In most [industries], the cost of invention is low; or just being first confers a durable competitive advantage because consumers associate the inventing company's brand name with the product itself; or just being first gives the first company in the market a head start in reducing its costs as it becomes more experienced at producing and marketing the product; or the product will be superseded soon anyway, so there's no point to a patent monopoly that will last 20 years; or some or all of these factors are present. Most industries could get along fine without patent protection".[7]

The steady increase in the number of patent applications and grants is largely explained by firms' strategies aimed at creating large portfolios of patents ('patent tickets') in order to prevent competitors from entering into a particular field, acquiring bargaining chips to get access to others' technologies or be better positioned as a defendant in eventual litigation. A report by the World Intellectual Property Organization (WIPO) described 'strategic patenting behaviours' as those:

> "practices aimed at blocking other firms from patenting, creating a thicket of defensive patents around a valuable invention to prevent competitive encroachment and litigation, and to enhance patent portfolios for cross-licensing negotiations … Some firms also use patents to block fellow competitors or to extract rents from other firms; non-practicing entities in particular have emerged which are said to litigate against other firms based on their patent portfolios"[8].

Although 'patent thickets' are well known in some sectors, such as information and telecommunication technologies[9] and pharmaceuticals,[10] they can arise in any sector where innovation-based competition is strong, including many areas of ESTs.

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[6] See, e.g., Jaffe, Adam B. and Lerner, Josh (2004), Innovation and Its Discontents : How Our Broken Patent System is Endangering Innovation and Progress, and What to Do About It, Princeton University Press;

[7] Richard A. Posner (2012), Why There Are Too Many Patents in America, available at http://www.theatlantic.com/business/archive/2012/07/why-there-are-too-many-patents-in-america/259725/.

[8] WIPO (2011), 2011 World Intellectual Property Report. The changing phase of innovation, Geneva.

[9] For instance, Google was reported to pay U$S 12,5 billion to get access to 17.000 patents held by Motorola in relation to mobile phone technologies.

[10] For instance, one single anti-retroviral, ritonavir, is protected by up to 800 patents. See WIPO (2011), Patent Landscape Report on Ritonavir, available at http://www.wipo.int/freepublications/en/patents/946/wipo_pub_946.pdf.

B2. Technology transfer and diffusion

The concept of transfer of technology has been ambiguously used in climate change and other debates, as well as in the academic literature. Sometimes, the sales of equipment embodying particular technologies are deemed to constitute a form of 'transfer'. But, unless there is local technical capacity and legal space for reverse engineering, sales do not lead to learning and the creation of a viable technological base. A recent study noted that although 'the deployment of technological goods is what matters to address climate change, the transfer of technological capabilities is indeed the key to developing countries…'[11] Such transfer, however, is not only important to open new business opportunities, but to accelerate the deployment of technologies to address climate change through local production. As noted in the same study, '[F]rom a general interest point of view, it also reduces costs through increased competition'[12].

Hence, actions on transfer of technology to be taken in the context of the UNFCCC need to aim at the actual *transmission of knowledge*. 'Technology' should be defined for this purpose –as proposed in the UNCTAD draft International Code on the Transfer of Technology- as 'systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service'[13]. This concept does not extend to the transactions involving the mere sale or mere lease of goods[14]

Opinions on the role of IPRs in the process of transfer of environmentally sound technologies (ESTs) to developing countries significantly diverge. Developed countries have generally held the view that they provide an effective platform for the transfer of protected technologies. The recognition of IPRs would, in accordance with this view, reduce the risk of imitation and create incentives for right-holders to license-out their technologies.

However, developing countries have repeatedly expressed their concerns about the impact of IPRs, particularly patents, on technology transfer. IPRs normally provide for exclusive rights that can be used to prevent access to the needed technologies or subject their transfer to high prices or other restrictive conditions. These concerns have been recognized in various international instruments and fora. Thus, para. 34.10 of Agenda 21 stated that

> "Consideration must be given to the role of patent protection and intellectual property rights along with an examination of their impact on the access to and transfer of environmentally sound technology, in particular to developing counties, as well as to further exploring efficiently the concept of assured access for developing countries to environmentally sound technology in its relation to proprietary rights with a view to developing effective responses to the needs of developing countries in this area."

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[11] Arnaud de la Tour, Matthieu Glachant et Yann Ménière (2010), Innovation and international technology transfer: The case of the Chinese photovoltaic industry, Working Paper 2010-12, CERNA, Paris, p. 2.

[12] Id.

[13] See United Nations Conference on Trade and Development (UNCTAD) (1985). "Draft International Code of Conduct on the Transfer of Technology, as at the close of the sixth session of Conference on 5 June 1985", TD/CODE TOT/47, Geneva.

[14] Id.

Further, para. 34.18 (d) of Agenda 21 explicitly recognized the existence of barriers for the transfer of 'privately owned technologies'. It indicated the need to adopt 'appropriate general measures to reduce such barriers while creating specific incentives, fiscal or otherwise, for the transfer of such technologies.'

The idea that IPRs may undermine access to technology and the development of a local technological base also underpins article 66.1 of the TRIPS Agreement. This provision exempted least developed countries (LDCs) from the implementation of the TRIPS Agreement's obligations during a transitional period that was already extended once, in 2005, until 2013. Article 66.2 of the same Agreement established an obligation for developed countries to provide incentives for to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to LDCs in order to enable them to create a sound and viable technological base. This obligation remains largely unfulfilled[15].

The stated concerns on the impact of IPRs have led to proposals to amend the TRIPS Agreement,[16] or to otherwise exclude or limit the applicability of IPRs in the field of ESTs[17].

It is sometimes argued that there is a lack of evidence on the blocking impact of IPR on access to ESTs and that such evidence should be produced and supplied by those holding this view. This unduly reverses the burden of proof. While there is increasing evidence on the impact of IPRs in the field of ESTs,[18] it would be up to those arguing that IPRs are conducive to transfer of technology to developing countries to show that this is actually the case. By their very nature, IPRs, notably patents, do create *barriers* to the use of the covered technologies in the countries where protection was acquired. Their main legal effect is to establish a *ius prohibendi* that can be exercised against any third party with a potential interest in using the protected technology.

The impact of the right to prohibit is particularly severe in a context of proliferation of patent grants, including in the area of ESTs, and of strengthening and expansion of enforcement measures. This context accentuates the asymmetric bargaining position of technology owners and would-be licensees who, if able to obtain the required technology, must generally pay a high price therefor via the tied purchase of inputs or spare parts, royalties and other forms of remuneration.

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[15] See, e.g. Correa, Carlos (2007), Intellectual property in LDCs: strategies for enhancing technology transfer and dissemination, study prepared for UNCTAD, 2007, available at www.unctad.org/Templates/Page.asp?intItemID=4316&lang=1; Moon, Suerie (2008), Does TRIPS Art. 66.2 Encourage Technology Transfer To The LDC's?: An Analysis Of Country Submissions To The TRIPS Council (1999-2007), ICTSD, available at http://ictsd.org/downloads/2009/03/final-suerie-moon-version.pdf.

[16] An early expression of such concerns can be found in the submission made by India to the Committee on Trade and Environment (1996) where it proposed to amend a number of provisions of the TRIPS Agreement, including the patent term and compulsory licenses.

[17] See, e.g., the debates and proposals by some developing countries submitted during the UNFCCC Conference held in Cancun, Mexico, from 29 November to 10 December 2010.

[18] See, e.g. UNEP, EPO, ICTSD, *Patents and clean energy: bridging the gap between evidence and policy. Final report*, 2010. Available from http://ictsd.org/downloads/2010/09/study-patents-and-clean-energy_159101.pdf.

Patents may also prevent technology diffusion, as they allow right-holders to control when, to whom and at what price a technology could be made available. High products prices may delay adoption of technologies relevant for climate change mitigation or adaptation. The entry of Chinese producers in the solar photovoltaic market, for instance, has shown how competition can lead to price reductions that improve the rate of diffusion of an important component of ESTs.

Finally, technical standards can reduce the cost of production and benefit consumers. However, technology diffusion may be slowed down or prevented when patents become part of technical standards. Innovation may be equally stifled. Right holders of patented technologies necessary to implement a specific standard may charge high royalties or impose other licensing terms, thereby negatively affecting competitors and users, and slowing down the diffusion of technologies needed to address climate change. Users may need to pay higher prices and become locked-in by high switching costs. If licenses are not readily available under reasonable and non-discriminatory terms, or the permitted users of the standard collude to set prices of standard- compliant goods, competition authorities can intervene to protect competition.

C. INTERNATIONAL COOPERATION IN RESEARCH AND DEVELOPMENT AS A COMPONENT IN PROMOTING AN ENABLING ENVIRONMENT AND ADDRESSING BARRIERS TO TECHNOLOGY DEVELOPMENT AND TRANSFER

C1. Introduction

The 16th Conference of the Parties of the UNFCCC created a 'Technology Mechanism' and defined a number of priority areas for enhanced action on technology development and transfer.[19] Paragraph 10 of the Decisions adopted on the Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action defined as one of such actions:

> "(a) [the] [D]evelopment and enhancement of endogenous capacities and technologies of developing country Parties, *including cooperative research, development and demonstration programmes*;" (emphasis added).

In addition, one of the functions of the established 'Climate Technology Network' is to

> "(b) Stimulate and encourage, through collaboration with the private sector, public institutions, academia and research institutions, the development and transfer of existing and emerging environmentally sound technologies, as well as opportunities for North/South, South/South and triangular technology cooperation;"

These elements in the Cancun negotiated text reflect the importance attributed by the Parties to the UNFCCC, particularly by developing countries, to the implementation of effective cooperative mechanisms to develop and transfer environmentally sound technologies (ESTs).

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[19] Decisions adopted by the Conference of the Parties on the Outcome of the work of the Ad Hoc Working Group on Long-term Cooperative Action, FCCC/CP/2010/7/Add.1. Available from http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf#page=2.

Although the issue of technological cooperation in the area of ESTs was raised on several occasions by developing countries[20], little has been achieved so far. A report by the Expert Group on Technology Transfer (EGTT) established in the context of the UNFCCC in 2001[21], observed in this regard:

> "While there are a large number of climate-related international collaborative activities, a preliminary survey of the landscape indicates a number of large gaps. First, most existing initiatives are focused on enabling frameworks and facilitating deployment. Second, mitigation technologies (and within that, energy technologies) dominate; there is relatively limited focus on adaptation. Third, most of the collaborations between developed and developing countries are targeted at or take place with the major developing economies…
>
> "One particular observation relating to technologies for both mitigation and adaptation is that, while there are many international collaborative initiatives around technologies to address climate change, many of these involve processes for identifying needs and facilitating the sharing of knowledge and experiences rather than actually undertaking collaborative R&D."[22]

This section examines possible modalities of collaboration for *research and development* (R&D). It briefly discusses, first, the various sources of technology for adaptation to and mitigation of climate change. Second, the paper examines different elements relevant for fostering cooperation in R&D and the modalities that such cooperation may adopt, having in view experiences made in other areas of science and technology. Finally, an analysis of the cooperative model used to promote the development and diffusion of seeds in the 'green revolution' is presented, with the aim of exploring its possible applicability to the case of environmentally sound technologies.

C2. Problems facing developing countries in accessing technology

Countries may ensure the diffusion of technologies needed for adaptation to and mitigation of climate change through a combination of various sources: the application of technologies in the public domain (including by reverse engineering[23]), access - under licensing or other agreements - to foreign-owned technologies, and research and development (R&D) leading to the implementation of new technologies.

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[20] See, e.g., Decision 4/CP.7, 2001, paragraph 14(c), which urged all the Parties 'to promote joint research and development programmes, as appropriate, both bilaterally and multilaterally".

[21] The Conference of the Parties (COP) decided to terminate the mandate of the Expert Group on Technology Transfer (EGTT) at the conclusion of its sixteenth session.

[22] Report on Options to Facilitate Collaborative Technology Research and Development, Note by the Chair of the Expert Group on Technology Transfer, United Nations Framework Convention on Climate Change (FCCC/SBSTA/2010/INF.11). Available from http://unfccc.int/resource/docs/2010/sbsta/eng/inf11.pdf, pp. 4-5 and 26.

[23] 'Reverse engineering' consists of the evaluation of the technological features, function and operation of a device, object, or system in order to replicate it. Often the outcome of this process entails improvements on the evaluated matter.

Developing countries, in particular, may face three types of barriers in their efforts to incorporate technologies for the *production and goods and services*[24] suitable for adaptation to and mitigation of climate change:

1. Lack of skills and/or financial resources to utilize freely available technologies

Significant reductions in greenhouse gas emissions may be obtained without major technological breakthroughs, by diffusing technologies in the public domain, for instance, known techniques to improve carbon efficiency. The public domain comprises of technologies that have not been subject to intellectual property rights (IPRs), and those for which protection has expired; their use does not require any permission or compensation[25].

However, the effective use of production technologies, even if freely available, requires technical capabilities and investment. The fact that a technology is in the 'public domain' does not mean that it will be applied widely or without difficulty. Technological learning is neither automatic nor free of cost. In many cases, incorporating new technologies require plant lay-out changes, purchase of equipment, adaptation to local raw materials and conditions, and training of personnel. Many developing countries lack a broad pool of skilled personnel or the financial resources necessary to ensure the utilization of ESTs even if in the public domain. This problem may be addressed through national measures and through international cooperation.

2. Reluctance to or onerous conditions for the transfer of technologies

Despite the role played by the public sector in the development of technologies relevant to address climate change, a large portion of environmentally sound technologies is covered by intellectual property rights (IPRs)[26]. Barriers caused by IPRs to technology transfer have been described in the previous section of this paper.

3. Asymmetries in R&D capabilities

Domestic R&D capacity is not only necessary to develop new technologies and provide local solutions to local problems, but also to scrutinize scientific and technological developments that take place elsewhere and to generate capacity to absorb and adapt foreign technologies. This dual role is critical for technologies relevant to climate change, largely held by entities from developed countries. An R&D capacity permits institutions and companies to screen how the scientific and technological frontier evolves. They may, through 'gatekeeping' activities, benefit from technology spillovers and choose possible partners for cooperation. "Gatekeeping" refers to a permanent search for new sources of innovation, either within or outside the firm. It requires special skills in order to identify new sources of core information, interpret and assimilate it.[27]

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[24] The adoption/consumption by final users of such products and services also face a series of problems (e.g. higher cost vis-à-vis conventional solutions, reliability, etc.) that may be addressed with various policies (e.g. tax exemptions, subsidies). This paper does not address this set of issues.

[25] Secret know-how is not part of the public domain, since it is protected as 'undisclosed information', one of the categories of IPRs in accordance with articles 2 and 39 of the TRIPS Agreement.

[26] This reflects both the importance of the private sector in the development of such technologies and the growing trend by public institutions to claim IPRs on their research outputs.

[27] W. Faulkner, *Understanding industry-academic research linkages: towards an appropriate conceptualization and methodology*, Edinburgh, University of Edinburgh, 1992..

Developing countries account for a growing but still minor proportion of global R&D.[28] Developing countries excluding China only account for around 10% of global R&D expenditures[29]. Although this share is much higher than the estimated share (4 per cent) for such countries twenty years ago[30], the world distribution of R&D is indicative of one the most dramatic North-South asymmetries[31].

C3. Types and Examples of International Cooperation in R&D

As noted above, despite the commitment originally contained in article 4.1(c) of the UNFCCC and the perceived need of massive investments in R&D, deployment and diffusion of technologies [32], it is little what has been achieved in the area of technological cooperation, particularly in relation to the development of adaptation technologies. Given the limitations of technology transfer from developed countries, and the need for a global effort to generate new technologies, developing countries must participate in the creation, transfer and diffusion of new technologies suitable to their conditions and development objectives.

Despite the weaknesses and asymmetries in R&D capabilities in developing countries mentioned above, there is great potential for cooperation among developing countries and between them and developed countries. Several possible models for such cooperation exist. They can be categorized in accordance with a number of features, such as:

- whether they are ‘pull’ or ‘push’ mechanisms, based on incentives that operate on the demand (e.g. advance purchase contracts) or on the supply (e.g. subsidies for research);
- the type of R&D to be conducted (such as basic or applied research, development of pre-competitive or competitive technologies);
- the thematic fields selected for R&D;
- the type of cooperating parties (public, private, mixed);
- the policies regarding the generation and availability of R&D results for utilization or further research (intellectual property issues); and

[28] Defined in accordance with the OECD’s *Frascati Manual* (OECD, *The Measurement of Scientific and Technological Activities. Frascati Manual. Proposed Standard Practice for Surveys on Research and Experimental Development*, Paris, 2002).

[29] While R&D investments in USA, Europe and Japan countries are generally between 1.5 per cent and 3 per cent of the gross domestic product (GDP), most developing countries invest much less than 1 per cent of GDP in R&D. See GAILLARD, op. cit. p. 96.

[30] Jean-Jacques Salomon, Francisco R. Sagasti and C. Sachs-Jeantet (eds.), *The uncertain quest: science, technology, and development* , United Nations University Press, The United Nations University, 1994. Available from http://archive.unu.edu/unupress/unupbooks/uu09ue/uu09ue0d.htm.

[31] In comparison, developing countries account for around 45 per cent of world exports.

[32] The EGTT report mentioned above estimated that ‘current financing for mitigation technologies needs to increase by USD 262.670 billion annually until 2030 (to a total of USD 332.835 billion annually)’ (UNFCCC, 2009, p. 3).

- the organizational structure of the R&D activities.

These aspects are briefly explored in more detail below.

1. Push-pull mechanisms

The use of *push* and *pull* mechanisms to promote technological development critically depends on the kind of outputs sought (scientific knowledge, prototypes, etc.) and on the prospective market for new products. Pull mechanisms are particularly suited to overcome insufficient markets, which they may help to create or secure. Push mechanisms, such as subsidies, essentially aim at reducing the cost or risk of R&D[33].

An example of a 'pull' mechanism is the offer of a prize that may be awarded for reaching specified results (e.g. a product with certain characteristics) or some defined milestones in the R&D process. So far, prizes have been successful in encouraging mechanical inventions, electronic systems, and engineering; they have also been proposed to encourage the development of health products needed to address diseases prevailing in developing countries. This is the case, for instance, of the Health Impact Fund (HIF). Some non-profit and for-profit organizations have experimented in recent years with this approach.

Another 'pull' mechanism is the 'advance market commitment' (AMC), which has also been broadly discussed to overcome market failures in health. For instance, in 2009 a pilot project was launched to supply 2 billion doses of pneumococcal vaccine by 2030. The funding for this pilot project is a cooperative effort among many international stakeholders, including the governments of Canada, Italy, Norway, Russia, and the UK. Other parties are the Bill & Melinda Gates Foundation, the World Bank, the GAVI Alliance, and UNICEF[34].

2. Type of R&D

Regarding the *type* of R&D, there is potential for cooperation in basic research and in different forms of applied research and technological development. The funding and organizational structure of such cooperation will significantly vary, however, depending on what their specific object is.

Scientific cooperation in climate change-related areas is not only desirable but needed to avoid unnecessary duplication, and to share skills and resources to address difficult issues, especially those demanding an interdisciplinary approach.

Technological cooperation generally requires a more complex governance structure than that centered on science. Since the main *locus* of technological innovation is the firm, such cooperation is generally sought to enhance the competitive advantages of the

[33] It is worth noting that there has been considerable scholarly debate on whether innovation is primary driven by market demand (i.e. market needs) or by technological shifts (e.g. changes in technology). See, e.g., Chidamber, Shyam R., and Kon, Henry (1994) , 'A research retrospective of innovation inception and success: the technology-push, demand-pull question', *International Journal of Technology Management*, Volume 9, Number 1 , pp. 94-112.

[34] See http://ghtcoalition.org/incentives-pull.php.

cooperating parties. However, public sector entities also play an important role in the development of ESTs.

Such cooperation may be crucial for developing countries in the area of climate change-related technologies. Development is generally more costly than research, except when it focus on incremental changes or adaptations; the pooling of funds and human resources may be the only option for developing countries to undertake large-scale or complex technological projects.

Typical objectives of technological collaborations are sharing limited resources, minimizing costs, reducing risks and achieving economies of scale and/or rationalization. However, they may be more *strategic* in nature and seek a number of indirect effects, such as strengthening the partners' capacity to undertake R&D, as well as keep open *options* that may be foreclosed in the absence of the cooperation.

Technological cooperation may, among other advantages, shorten research duration, reduce transaction costs, make it possible to reach the critical threshold necessary for undertaking large-scale projects, and spread a new technology more rapidly.[35]

Finally, cooperation schemes between R&D entities may differ depending on the resources that each of the partners bring thereto. They may be classified as 'symmetrical' when partners bring together similar resources to generate economies of scope, rationalize capacity, transfer knowledge, or share risk; and 'complementary' where partners contribute different assets and build on their respective strengths and advantages.

3. Thematic fields

Establishing the *themes* for scientific and technological cooperation is one of the greatest challenges from a technical, economic and political point of view. As noted above, the private sector accounts for a great portion of investment in R&D; as a consequence, a large part of resources will be oriented by the expectation of profit gains. The extent to which the public sector may influence (through incentives of different type) the patterns of private R&D is an open question.

The UNFCCC Secretariat noted that

> "Many developing countries have undertaken detailed assessments of their technology needs. A synthesis of technology needs in 69 developing countries was prepared in 2009…The most commonly identified technology needs for mitigation were renewable energy technologies, technologies for improved crop management, energy-efficient appliances, waste management technologies, forestry-related technologies and more clean and efficient vehicles. The most commonly identified technology needs for adaptation were related to crop management, efficient water use, improving irrigation systems, technologies for afforestation and reforestation, and technologies to protect against and accommodate rises in sea level."[36]

[35] Arranz and Fdez. de Arroyabe, op. cit., p. 8 (references omitted).

[36] Ibid. (references omitted).

On the other hand, the EGTT report mentioned above found a ‘weak coverage on technologies for adaptation’ and that

> “the portfolio of existing R&D programmes are strongly focused on energy technologies, in particular on renewable energy. There are far fewer collaborative R&D activities in industry, transport and energy efficiency in buildings, and forestry, agriculture and waste are covered only within more general programmes.”[37]

4. Type of cooperating parties

Technological cooperation may involve different *parties* both from the public and private sectors. There are abundant examples of public-private cooperation in various fields for the development of technologies and in scientific research. A large number of public-private-partnerships (PPPs) have been established, for instance, with the objective of developing drugs and vaccines. One example is the *TB Alliance* financed by public agencies and private foundations which, in association with research institutes and private pharmaceutical companies, aims at developing novel treatments for tuberculosis that are affordable and accessible to the developing world[38]. The Asia-Pacific Partnership on Clean Development & Climate, established in 2005 by Australia, Canada, India, Japan, the People's Republic of China, South Korea, and the United States, is an example of governmental cooperation to accelerate the development and deployment of clean energy technologies.

5. Policies regarding availability of R&D results and IPRs

R&D creates intangibles that, by their very nature, are public goods, that is, goods that are non-rival and non-excludable[39]. Non-rival goods have the property that they can be available for public use[40]. Knowledge may become excludable by action of its possessor (limitations to access, secrecy) or by legal means (e.g. patent protection).

Technological cooperation may be based on different models regarding the appropriability of the results obtained. They may include the generation of results for which IPRs are not claimed or asserted, that is, they remain freely available without prior authorization or compensation. Such results, however, may be protected by IPRs, such as patents, and its utilization by third parties subject to different conditions such as:

- licensing agreements with payment of a compensation;
- licensing agreements without compensation or with special conditions for utilization by certain categories of parties, in certain countries or for

[37] UNFCCC (2009), p. 26.

[38] See www.tballiance.org/.

[39] See, e.g., Joseph Stiglitz (1999), “Knowledge as a global public good”, Kaul, Inged, Grunberg, Isabelle and Stern, Marc, (Eds.), *Global public Goods. International Cooperation in the 21 ST Century*, New York, p. 309.

[40] Once knowledge has been created, its use by one agent does not reduce the amount or quality of the knowledge available for use by others.

specific purposes.

An example of a cooperative R&D arrangement designed to produce freely available R&D results is the case of the Consultative Group on International Agricultural Research (CGIAR) which will be reviewed in more detail below.

The negotiation of licensing agreements with payment of a compensation could be necessary to recover R&D costs and to finance further R&D, and to avoid 'free riding' by others. Many public R&D institutions have adopted this approach in the last two decades. In the area of agricultural research, for instance, some institutions in developing countries started to request plant variety protection to be able to obtain compensation from private companies that utilized their improved varieties.

An example of the model based on licensing agreements without compensation or with special conditions for utilization by certain categories of parties, in certain countries or for specific purposes, is provided by the 'humanitarian license reservation' (or 'equitable access license') proposed by a number of institutions and universities[41], whereby title-holders leave open the possibility of sharing their technology with third parties for the benefit of people in need. An example is the case of the 'golden rice', a genetically engineered rice rich in Vitamin A, where certain 'humanitarian uses' are allowed.

6. Organization of the R&D activities

One of the most critical issues for cooperation in R&D is its organization and governance, including funding, coordination, relationship between partners and third parties, sharing of costs and benefits, and the management[42] of the agreed upon activities.

There is a variety of models that may be applied, ranging from the conventional schemes of inter-institutional relations governed by agreements where the participants, objectives, fund allocation, tasks, etc. are defined, to the creation of a an institutionalized network of research institutions, resorting to a common pool of resources and services[43].

An interesting example of an innovative cooperative organization for R&D is the Open Source Drug Discovery (OSDD), inspired in the Open Source model for software development and the Human Genome Project.[44] OSDD was launched by the Council of Scientific and Industrial Research (CSIR) of India, with a vision to provide affordable healthcare to the developing world by providing a global platform where the best minds can collaborate & collectively endeavor to solve the complex problems associated with

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[41] See, e.g., Brewster, Amanda L., Chapman, Audrey R., Hansen Stephen (2005), 'Facilitating Humanitarian Access to Pharmaceutical and Agricultural Innovation', *Innovation Strategy Today*, Vol. 1, 3 (2005), available at http://www.biodevelopments.org/innovation/ist3.pdf.

[42] Although most literature on technological cooperation focuses on issues related to cooperation formation, adequate management is essential to achieve a satisfactory performance. See, e.g., Chen, Hung-hsin (2003), *Cooperative Performance. Factors Affecting the Performance of International Technological Cooperation*, University of Manchester, Manchester.

[43] The example of the CGIAR is considered in a separate section below.

[44] See http://www.osdd.net/about-us.

discovering novel therapies for neglected tropical diseases like Malaria, Tuberculosis, Leshmaniasis, etc. It is a concept to collaboratively aggregate the biological and genetic information available to scientists in order to use it to hasten the discovery of drugs…The OSDD consortium launched in September 2008 has more than 4500 registered users from more than 130 countries around the world, and has emerged as the largest collaborative effort in drug discovery. Launched on the three cardinal principals of Collaborate, Discover & Share, it is a community driven open innovation platform to address the unmet need of research and development of drugs for diseases that affect the developing world. Its objective is affordable health care.[45]

OSDD aims at accelerating research and reducing its cost; all the projects and the research results are reported on the web based platform http//sysborg2.osdd.net. [46]. In addition, 'to ensure affordability, the drugs that come out of the OSDD platform will be made available like a generic drug, without Intellectual Property encumbrances'. [47]

C4. Example of International Technology Cooperation: the CGIAR model

Several proposals have been made to foster climate change R&D and ensure a broad availability of their results. They include the establishment of specialized international funds, such as a 'multilateral technology fund', and the setting up of 'regional R&D networks of existing indigenous research institutions in developing countries for climate change technology development and commercialization that permit sharing of resources and cost for innovation infrastructure and expensive equipment'.

At the Delhi High Level Conference on 'Climate Change: Technology Development and Transfer', held on 23rd October 2009, a proposal was made to create a network of international research institutes inspired by the CGIAR. In accordance with the Chair's summary of the Conference:

> "The second lesson we will take away from here is what President Nasheed called a Green Power Revolution, learning from the lessons of the Green Revolution in which India led the way, with international cooperation, in the 1960s and 1970s, to address what was then the most formidable threat faced by developing countries, the threat of famine and food insecurity. Several speakers alluded to the CGIAR network as a model for addressing the challenge of climate change as well as energy poverty…The CGIAR network provided international support and cooperation in research and education (paragraph 9) [48.] A CGIAR type of global network could provide international support for research and cooperation and ensure that they become centers of excellence (paragraph 10)."

[45] Ibid.

[46] Ibid.

[47] Ibid.

[48] Chair's Summary of the Delhi High Level Conference on 'Climate Change: Technology Development and Transfer', 23rd October 2009. Available from http://moef.nic.in/downloads/public-information/Chair%27s%20summary-FINAL.pdf

The 2010 World Development Report - Development and Climate Change- has also raised the question about the CGIAR as a model for climate change[49], while a report by the Clean Energy Group and the Meridian Institute has suggested that the CGIAR's 'Challenge Programs' [50] may provide a good model for technology sharing and cooperative research to foster open and distributed innovation. [51] Similarly, the already mentioned World Economic and Social Survey 2011 also suggested the CGIAR as an example of a successful mechanism to achieve the rapid worldwide diffusion of new technologies.

The CGIAR was born in 1971 as a result of the joint initiative of a number of international and bilateral agencies, supported by the Ford and Rockefeller Foundations. The CGIAR emerged as a loose network of international agricultural research centres that, although independently managed, worked together to create and disseminate improved plant varieties [52] in the context of what has been termed the 'Green Revolution', with the goal of alleviating hunger and poverty. The CGIAR is a strategic partnership with 64 Members that include 21 developing and 26 developed countries, four co-sponsors as well as 13 other international organizations. Most of the funding is provided by development assistance agencies of developed countries.

The existence of the CGIAR has permitted the Centers to share resources and coordinate policies at the system level, and thereby generate economies of scale and of scope that enhance the Centres's capacity to perform their missions.

Despite the proposal of a system wide IPRs policy elaborated in 2000 [53] and the establishment of a Central Advisory Service for Intellectual Property (CAS-IP), defining a common approach to IPRs has posed a complex challenge to the CGIAR Centres. The Genetics Resources Policy Committee (GRPC) elaborated a new proposal on the subject. In accordance with this proposal, the Centres might only exceptionally seek or assert intellectual property rights, such as when it is indispensable to ensure further development of a research result, or to get access to technologies under the control of private companies that are needed to fulfill the CGIAR mission.[54]

1. Can the CGIAR model be applied in the area of climate change?

While the CGIAR´s experience may provide useful lessons, the possibility of establishing a similar network of institutions for the coordinated development and broad

[49] *The 2010 World Development Report - Development and Climate Change*. Available from http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTWDRS/EXTWDR2010/0,,menuPK:5287748~pagePK:64167702~piPK:64167676~theSitePK:5287741,00.html, p.306.

[50] See below.

[51] See Clean Energy Group and the Meridian Institute (2009), *Accelerated Climate Technology Innovation Initiative (ACT II):A New Distributed Strategy to Reform the U.S. Energy Innovation System*, available at http://www.cleanegroup.org/Reports/ACTII_Report_Final_November2009.pdf.

[52] As mentioned below, the CGIAR later adopted a more holistic view of agriculture and expanded its activities to other areas of biodiversity.

[53] See GRPC (2002), *Guiding Principles for the Consultative Group on International Agricultural Research Centers on Intellectual Property Relating to Genetic Resources,* Report of the 11th Meeting of the GRPC for ICW2000, Appendix 3, available at http://www.cgiar.org/corecollection/docs/icw0009.pdf.

[54] See the proposal by the CGIAR Genetics Resources Policy Committee for a 'Policy of the Alliance of CGIAR Centres on Intellectual Assets', available at http://cgiar.org/pdf/grpc_25th_meeting_minutes.pdf.

diffusion, as public goods, of climate change adaptation and mitigation technologies, poses a large number of political, strategic and managerial challenges.

Science is normally more amenable to cooperative work and dissemination as a public good than technology, which generally requires adaptation to particular needs and circumstances. In an international scenario dominated by the private development and appropriation of technologies, a set of public institutions of excellence in research would be a useful mechanism to undertake a common program of activities. Existing national institutions may welcome additional international funding, but governments may be reluctant to lose control over them. Given the vast array of fields where research is needed to generate adaptation and mitigation technologies, defining a set of priorities would require scientific competence and political commitment. A mechanism of monitoring and evaluation should also be put in place. As the CGIAR experience shows, such a mechanism would be essential to define priorities, ensure an efficient utilization of resources and to achieve the concrete results that are urgently needed.

In designing a possible international network of research institutions to work on climate change technologies, the following issues should be considered:

- selection of participating institutions or establishment of new ones;
- funding mechanism and plans;
- governance of collaborating institutions and capacity to engage in joint research;
- mechanisms to determine research priorities, distribute tasks, monitor progress and evaluate the achievement of the defined objectives;
- conditions for cooperation with and use of technologies held by the private sector;
- establishment of common policies on diffusion of research outputs and use of the IPRs system;
- participation of developing countries´ institutions in research and means for facilitating access by developing countries to all relevant research results.

C5. Conclusion

Since the adoption of the UNFCCC, technological cooperation has been on the agenda, but little action has been taken. There seems to be, however, an increasing recognition, at least by developing countries, that such cooperation must be effectively implemented. There are different models to do so and, understandably, delicate decisions to be made. But there are useful experiences and many options open for policy makers to put in practice what has so far remained a mere aspiration.

D. TECHNOLOGY ASSESSMENT

In order to promote the development and transfer of technologies, it is also important to assess the appropriateness of the technologies that are selected for development, transfer, and diffusion.

This is to ensure that the technologies that are so promoted are in accordance with the objectives of the UNFCCC, as well as in line with national needs and goals.

The TEC should establish principles and criteria for the assessment of appropriate and relevant technologies that meet general acceptability as well as national conditions, needs and objectives. A mechanism can then be established on applying these criteria when selection of technologies takes place.

It is proposed that the following are among the principles/criteria to be considered:

1. Relevance to the objective of addressing the climate change problem;

2. Environmental soundness;

3. Safety to the environment and to human health and safety;

4. Affordability, especially for developing countries;

5. Social acceptability and effects, including in relation to employment, equity, and cultural norms; and

6. Economic efficiency and cost-effectiveness.

It is clear that there could be trade-offs between and among some of the principles and criteria mentioned above. The methods for making choices in the context of trade-offs is therefore also important to consider and determine.

E. ROLE THAT THE TEC COULD PLAY

The following are roles that the TEC could play in the context of issues raised in this submission:

- Establish a work programme including studies to identify technology needs of developing countries, barriers to the transfer and diffusion and development of the required or desired technologies, and ways to overcome the barriers.

- As part of the above, initiate a discussion and a mechanism for the assessment of technologies including criteria for appropriate technologies, in order to assess the suitability of the technologies for selection for promotion and transfer. The criteria would take into account environmental soundness, climate friendliness, social and cultural aspects, affordability, economic cost and efficiency.

- With the goal of enabling developing countries to have affordable access to technology, the TEC could propose and promote measures for the regulation of the markets for climate-related technologies including through the development of guidelines for competition authorities that, *inter alia*, deal with refusals to transfer technology, restrictive practices in licensing agreements and the incorporation of patented technologies in technical standards. Besides proposing measures that can be undertaken by national authorities, the TEC could establish mechanisms of international cooperation and coordination in this regard.

- The TEC could take measures to promote an effective implementation of Article 66.2 of the TRIPS Agreement (that relates to obligations of developed countries to take measures to promote technology transfer to LDCs) with regard to climate related technologies

- TEC could initiate a programme to map patented technologies relevant to mitigation of and adaptation to climate change, and identify areas where the proliferation of patents, particularly may block innovation and technology transfer;

- TEC could support the improvement of patent examination through the development of guidelines for a rigorous application of patentability standards to climate-related technologies.

- TEC can arrange for studies and measures to assist developing countries to understand the use of flexibilities in the IPR regime in the context of access to technologies.

- Promote the development of relevant technical standards in a way that ensures the participation of developing countries' firms, avoid the incorporation of patented technologies or ensure access thereto on reasonable and non-discriminatory terms.

- TEC could take measures to assist developing countries in increasing their capacity for research and development with regard to climate-related technologies, in accordance with the objective of the development of endogenous technology by developing countries.

- Promote initiatives of open innovation schemes for the development of climate-related technologies.

- TEC could initiate a work programme on considering and establishing measures and mechanisms for international cooperation for research and development in climate related technologies, including financing of such schemes. Such a programme could start with a detailed study of existing cooperation schemes and programmes in other areas such as health, agriculture and industrial technology, and drawing lessons from them.