Climate change and technology: building capabilities

Introduction

For mitigating and adapting to climate change and achieving sustainable development, energy-efficient technologies are considered by policy-makers to hold the key. But the lack of technological capabilities in developing and least developed countries to develop advanced technologies necessitates the need for a flow of technologies from developed countries to developing and least developed countries (Elliott 2004). The technological capability includes, apart from required financial resources, the ability to select, assimilate, adapt, and improve upon a given technology (Lall 1985; Gonsen 1998). Therefore, in order to have a successful technology transfer, besides the financial resources, training to build adoptive capacity, along with complete transfer of technological know-how and know-why, is necessary. Moreover, the development of domestic technological capability is crucial because an endogenous technological change may lead to substantial reduction in carbon prices as well as GDP (gross domestic product) cost (IPCC 2007).

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Technological capability building, however, is a time-taking and path-dependent process, and the rate of advancement for different countries differs according to their existing technological and institutional capabilities (Bhaduri and Ray 2004; Salomon and Lebeau 1993). This makes the overall process of technology transfer complex and difficult. More so when the need for technology transfer is immediate, as is the case in the context of climate change. In order to combat climate change successfully, developing countries need to 'leapfrog' one or more generations of a broad technology portfolio (Tamura 2006).

In this context, the UNFCCC (United Nations Framework Convention on Climate Change) and the Kyoto Protocol require Parties to cooperate in the development and diffusion, including transfer, of technologies that control, reduce or prevent GHG (greenhouse gas) emissions and promote them. Towards this end, the Bali Action Plan declared an '[e]nhanced action on

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technology development and transfer to support action on mitigation and adaptation', which includes mechanisms and means to remove obstacles, along with provision for financial and other incentives to scale up the development, deployment, diffusion, and transfer of affordable environmentally sound technologies to developing country parties. It also includes considerations on 'cooperation on R&D (research and development) of current, new and innovative technology' and 'mechanisms and tools for technology cooperation in specific sectors.'[1]

Both aspects of the technology-related action in the Bali Action Plan – the development and the transfer of technology – are important, even though technology transfer, so far, has taken the centrestage for debate.

The objective of this paper is to contextualize the feasibility of technological solutions in light of the important role technologies can play in addressing climate change and the limitations that the development and transfer of technology have to deal with in general. On the basis of this analysis, this paper also makes certain recommendations for successfully achieving the goals outlined in the Bali Action Plan.

Issues with technology development and transfer

The Intergovernmental Panel on Climate Change (Metz, Davidson, Martens, *et al*. 2000) has listed various hurdles in technology transfer, including high capital cost, limited access to capital, poor access to information, institutional and administrative difficulties in developing technology transfer contracts, lack of infrastructure to absorb riskier technologies, absence of economic incentives, and IPR (intellectual property rights). A number of other studies have also examined the technology transfer scenario in the present climate change regime. According to Klein, Alam, Burton, *et al*. (2006), the nature and the need of the technology transfer in different sectors are different. Schneider, Holzer, and Hoffmann (2008) point out another kind of problem that hinders technology transfer. They argue that in the absence of a favourable institutional framework in the host country, technology transfer becomes difficult.[2] These studies are mainly based on the experiences of developing countries and confirm a number of theoretical propositions on technology transfer from developed to developing countries. The main issues that these studies have highlighted are discussed subsequently.

In the absence of a favourable institutional framework in the host country, technology transfer becomes difficult.

Rigid IPR system

The IPR protection on technologies held by the developed country firms causes two kinds of problems to technological acquirements of developing countries: (1) for the user firms, it makes the technology more expensive; and (2) it restricts developing countries from developing their own built of IPR-protected technologies. This process is further made difficult by the fact that the 20-year duration of patent protection makes the technologies obsolete when the protection is removed. Consequently, whatever technology transfer has taken place is more of financial transfer than knowledge transfer. Many stakeholders and commentators from developing countries, therefore, have argued strongly for a more favourable IPR regime for environment-friendly technologies (South Centre 2001; Tamura 2006).

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[1] Bali Action Plan. Details available at <http://unfccc.int/files/meetings/cop_13/application/pdf/cp_bali_action.pdf>.

[2] This argument is well established in the literature dealing with technology transfer. For a review of this literature, see Shrivastava (2007) and Gonsen (1998).

Lack of financial resources for technology R&D and transfer

Developing countries find it difficult to arrange for funding for technology development and transfer. They have argued long for the subsidized transfer of technologies from developed countries, but due to private firms holding the IPR protection on technologies, the developed countries have expressed their inability to do so (Elliott 2004; Hagedoorn 1995). The funds currently available under the UNFCCC are not sufficient to induce the technological changes that need to occur in developing countries (Tamura 2006).

Restrictions on transferred technologies

It has been observed that even the transferred technologies cannot be utilized to their full extent in developing countries due to various severe restrictions placed on them by the provider firms. In terms of categorization of technologies, adaptation technologies face more barriers than mitigation technologies. Uptake of these technologies requires the involvement of an expanded stakeholder community, which is difficult to achieve. On top of that, there is a lack of willingness to promote the funding required to transfer adaptation technologies. Moreover, a large part of what has been accounted for as technology transfer constitutes only information networks and capacity-building activity (Lall 1985, Salomon and Lebeau 1993; Klein, Alam, Burton, *et al*. 2006).

Lack of domestic institutional capacity

Developing countries also lag behind in their institutional infrastructure, which is necessary to promote environment-friendly technologies. This includes the lack of skilled professionals, incentive structure to promote use and development of environment-friendly technologies, legal and administrative support system to facilitate the technology development and transfer, and so on (Chesnais 1995; Cohen 2004; Hagedoorn 1995).

To sum up, the development and transfer of technology cannot be achieved in the absence of sufficiently developed technological capability across countries. This can be achieved only if developed countries play a proactive role because (1) the developing countries lack technological capability to develop new technologies (Hagedoorn 1995); (2) technological capability building is a path-dependent learning process (Bhaduri and Ray 2004); therefore, it is important that the developing countries are imparted with learning opportunities; and (3) many developing countries don't have enough resources to finance their institutional and technological capability-building projects and, thus, need external assistance. This is also confirmed by various submissions made on technology-related issues to the UNFCCC by different countries, which highlight the need for (1) intensifying R&D to develop new technologies; (2) removal of barriers to technology transfer; (3) international cooperation; (4) capacity building; and (5) financial support to developing countries.[3]

The development and transfer of technology cannot be achieved in the absence of sufficiently developed technological capability across countries. This can be achieved only if developed countries play a proactive role.

What needs to be taken care of?

The major obstacle in the flow of assistance from developed to developing countries is rooted in the fact that most of the technologies in the form of know-how and tacit knowledge are owned by big private firms that are not willing to share them with other firms in order to maintain their competitive edge (Elliott 2004). Therefore, the major challenge in achieving the goals set in the Bali Action Plan with regard to technology development and transfer is to ensure the participation of private players. This would require providing incentives to those private players who own technologies

[3] See submissions by various countries on technology-related issues.

and are capable of undertaking R&D for developing new technologies. Some of the incentives are as follows.

IPR protection with compulsory licensing

The IPR protection, traditionally, has been seen as a major incentive for private firms to undertake R&D activities and develop new and better technologies. The IPR protection, however, is also considered as one of the major hindrances in technology transfer (Tamura 2006). Thus, the IPR protection, on the one hand, promotes development of new technologies and, on the other hand, blocks transfer of technology. Therefore, the issue of IPR needs to be dealt with very carefully while designing any technology development and transfer programme.

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To avoid the IPR blockage for technology transfer, one option that has been widely discussed in literature is compulsory licensing (Metz, Davidson, Martens, *et al.* 2000). Compulsory license is a statutorily created license that allows others to pay a royalty and use an invention without the patentee's permission, which is an important feature of IPR law. It also includes the government authorizing itself to use an otherwise protected intellectual property without obtaining the permission or authorization of a patent holder in cases of national emergency or towards a public good.

Alternatively, the IPR can be purchased by multinational agencies or governments to facilitate free transfer of technology either by licensing or by allowing it to become a public good.

Demand for technologies

If high demand for newer and environment-friendly technologies is expected, then also the private firms may undertake R&D activities towards developing new and advanced technologies. This can be done in many ways. For example, governments can make use of certain technologies in certain sectors/activities mandatory – for example, India has made the use of supercritical technology mandatory for all ultra mega power plants (Government of India 2003) – or they can set norms requiring the production or consumption activity to satisfy certain minimum environmental standards, for example, setting pollution norms for vehicles. Both these processes can be further complemented by various support measures such as exemptions from import/export duties on the whole and on relevant parts/material of the technical artifact, direct or indirect subsidies or cheap credit for availing identified technologies, and so on. Other options may include increasing awareness among consumers (for example, energy efficiency labelling programme of the BEE [Bureau of Energy Efficiency]) and developing market for promising technologies by setting up demonstration plants/projects, and so on for the users to see them actually perform.

Enhancing public R&D

Innovation is understood as a strategy of a firm to maintain its competitive edge over other firms (Cantner, Gaffard, and Nesta 2008). Therefore, one way of indirectly forcing private R&D in environment-friendly technologies could be to strengthen and enhance public R&D in clean technologies. This would not only make transfer of technologies cheaper for the receiving firms – both user and producer of the technology – but would also give a direction to the overall R&D agenda towards clean technologies. Another way could be to extend public–private cooperation in technology development and promotion. The development of wind turbine in Denmark is a good example. This technology was developed through public R&D, and after its demonstration, it was subsequently passed on to the private

sector, which marketed and sold it not only locally but also globally. Now this is a globally thriving industry. The private sector has now made further R&D and upgraded this technology significantly. The method is narrowly followed in the USA.

Institutional capacity building

For developing countries, it is of vital importance that an appropriate institutional infrastructure in terms of providing training, education, scientific temperament, laboratories, and R&D centres is in place (Salomon and Lebeau 1993). In the absence of these facilities and skilled human resources, developing countries can neither develop new technologies on their own nor successfully absorb transferred technologies. It is certainly not in the interest of developing countries to remain the user-only of a technology. They must be able to meet their technological requirements domestically.

Collaborative R&D

For building same level of technological capabilities across countries, bilateral and multilateral collaborative R&D efforts may prove to be vital. Such collaboration have huge scope for South–South and North–South cooperation in technology development and transfer. Such initiatives can help in reducing the cost of R&D significantly and also in leveraging technical capabilities of various countries and organizations.

Developed countries must take initiative

Developing countries have been arguing from the beginning of the climate change negotiations that they would need efficient technologies to meet their development goals as well as environmental objectives, and it is the responsibility of the developed countries to provide them with these technologies at a cheaper price (Elliott 2004). However, except for the recent submissions by G-77, China, India, and Brazil, developing countries rarely argued for the developed country support in developing technological capability.

Given that the technological capability building process is a path-dependent learning process, it becomes imperative that developed countries ensure that their technological knowledge – know-how and know-why – is imparted to developing countries in such a manner that the developing countries are able to build their own capacity to identify appropriate technologies, along with the ability to use, adapt, repair, and improve upon them. The developed country support, therefore, would also include helping the developing countries set up R&D centres, laboratories, and educational institutions, and organize training programmes. This would require, along with financial and technical assistance, providing opportunities to the scientists and engineers from developing countries to work with R&D laboratories in developed countries.

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Institutionalized technology development and transfer programme at global scale

Many country submissions on technology-related issues, particularly by developed countries, have highlighted the importance of national plans in addressing climate change. However, with few exceptions, almost all national initiatives to protect global environment have followed a global endeavour (Shrivastava 2007). Thus, the initiatives to enhance technology development and transfer at national level need to be guided and supported

by a global initiative. Some of the issues identified above can only be addressed at global level, for example, compulsory licensing for clean technologies. It would also be impractical to expect one or few developed countries to provide for means and support to help developing countries enhance their technological capabilities. In fact, in the absence of a multilateral framework, any bilateral initiative aiming at enhancing technological capability and facilitating technology transfer between two countries may be counter-productive to the larger objective of technology development and transfer, as it might aggravate regional disparity of technological capabilities. The global initiative must be guided by two main objectives: (1) to develop new technologies and enhance associated technological capabilities in all countries; and (2) to facilitate the flow of technologies from developed countries to developing countries. To achieve these two objectives, we propose establishment of a global R&D system and a global financial mechanism, respectively, as discussed subsequently.

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The global R&D system

In the light of above discussion, we recommend that a global R&D system be institutionalized for the development and production of advanced technologies. Such a global R&D system is qualitatively different from the various proposals on international technological collaborations.[4] For instance, the idea of international collaboration on technology aims at making technologies available to developing countries and, thus, does not necessarily address the root of technological differences between developed and developing countries. On the contrary, the objective of a global R&D system that we are suggesting is to bridge the gap in technological capabilities among countries in the context of yet-to-be-developed technologies.

We propose that this global R&D system would take resources from as many countries and in as many forms as possible. For instance, the research team must have experts from many countries, and the laboratories must be established in different countries, particularly in developing countries. Those who are able to provide funds for these research programmes should contribute in terms of money, while those who lack financial resources should contribute in terms of providing land, and administrative and other logistic support. Thus, this global R&D programme must be initiated through a global pooling of intellectual and logistical resources. The emerging technologies from such an endeavour must be owned, in the form of IPRs, by global agencies like the United Nations and made available to all countries at cheaper rates.

The objective of a global R&D system that we are suggesting is to bridge the gap in technological capabilities among countries in the context of yet-to-be-developed technologies.

In this case, we envisage a situation of increased private participation in two different ways. One possibility is that the increased competition in technology development would ensure that the private players also earmark huge amounts of money for development of newer technologies and make them available at relatively lower costs. The second and most preferred option is that the private players also become part of such a global R&D project by pooling in their expertise and resources (finance or required equipment).

What makes this global R&D system unique is the mandatory participation of scientists, engineers, and technicians from all countries. A global research team would ensure that the emerging new technological know-how would not constitute a barrier to technology transfer. It would

[4] For a brief discussion on these proposals, see Tamura (2006).

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allow each country to have at least one expert or a team of experts possessing the required technological capabilities in order to be able to develop and modify that technology further, without having to rely on any other country. From developing countries' point of view, it would allow them to leapfrog various technological stages and achieve a more self-reliant position in terms of technological capabilities, which would help them greatly realize their development objectives. Most importantly, it would enable developing countries to take up additional mitigation responsibilities. At least it would ensure that the world as a whole is almost uniformly equipped with technological options to face the climate change challenge.

Global financial mechanism to support developing countries

It is likely that for a long time, the bulk of technologies would be concentrated with the private enterprises. Therefore, it is important that all those concerns that hinder the transfer of privately owned technologies are addressed. The most critical issue is the higher cost arising from using clean technologies. It may be due to IPR protection or the initial establishment cost. The purpose of the global financial mechanism would, therefore, should be to assist developing country firms in acquiring technology, and technical know-how and know-why. It can also be used to promote the establishment of production units for identified sectors and technologies therein.

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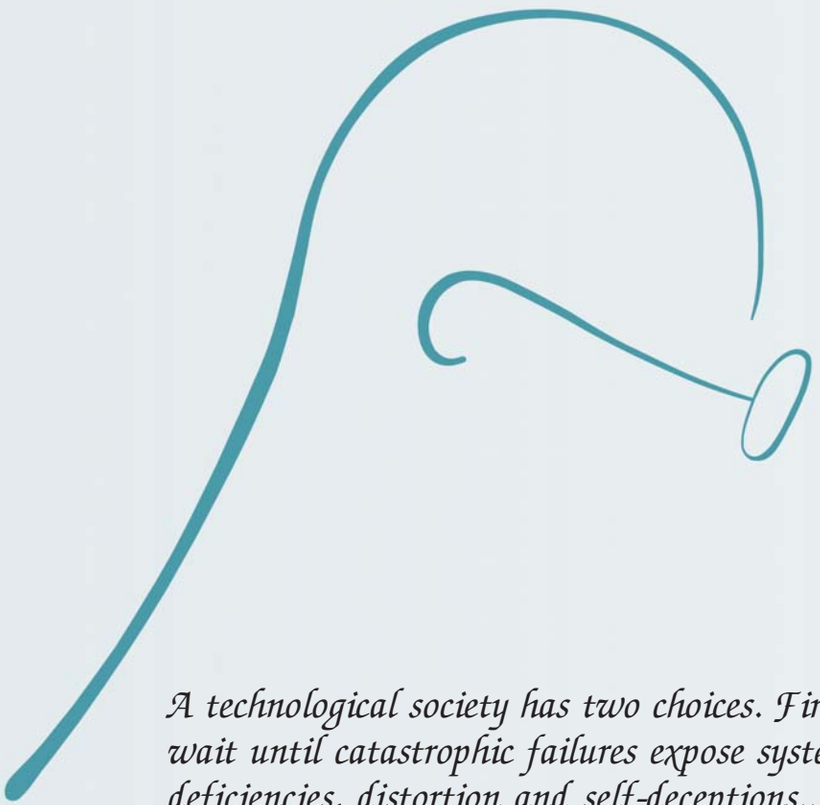

A technological society has two choices. First it can wait until catastrophic failures expose systemic deficiencies, distortion and self-deceptions...

Secondly, a culture can provide social checks and balances to correct for systemic distortion prior to catastrophic failures.

Mahatma Gandhi

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