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Climate Action Network South Asia

Climate Technology Transfer Regime in South Asia
Fostering Regional Cooperation

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CONTENTS

CLIMATE TECHNOLOGY TRANSFER REGIME IN SOUTH ASIA: FOSTERING REGIONAL COOPERATION

Everyday we are reminded about the potential climate catastrophe waiting to devastate the living planet through a plethora of reports, research results, and events. According to experts, this is a result of unimpeded exploitation of natural resources to meet the economic imperatives of different countries in their efforts towards development. This model for development has given rise to an unsustainable mode of economic growth leading to the growth of GHG (greenhouse gas) concentration in the atmosphere. To tackle this overarching problem and to avoid the looming catastrophe, the UN Summit on Environment at Stockholm has urged the countries of the world to undertake enhanced cooperative actions through technology and financial support. The result of such an effort has been espoused in the framework of UNFCCC (United Nations Framework Convention on Climate Change), which came into force in 1992. The countries have come forward towards developing a paradigm that 'recognised the unique overriding objectives of poverty eradication and rapid economic growth of newly independent and post-colonial developing countries'. Under the convention, as part of the equitable sharing of the burden, the developed and industrialized countries are obliged with technology and financial support either directly as per the provisions of UNFCCC or through other relevant multilateral agreements.

The current hypothesis before us is not only limited to emissions reduction on an aggregate level but also to find ways and means of meeting the development goals. In this regard, technological solutions and development form the mainstay of addressing the challenge. It is a proven fact that, until now, majority of path-breaking technological benefits are accrued through exploitation of natural resources and fossil fuels. Although the current technological paradigm has resulted in the humongous growth of GHGs in the atmosphere, the future technological paradigm should play the role of solving this. Technological requirement in the realm of climate change is not limited to fixing the problem of emissions reduction, but it also has to address the imperatives of development. The problem gets more intense for developing countries owing to a gradual decrease in the availability of carbon space. This would mean that the current carbon-intensive development model needs to be transformed into a de-carbon model, wherein development is achieved with minimum utilization of the carbon space. To achieve this, the developing countries required access to strategic knowledge of soft and hard technologies that are climate-friendly. Issues such as direct access to technology, capacity of absorbing and modifying them to local needs and capital expenditure required to make a shift towards low/de-carbon development form the core of the technology discussion under climate change. The UNFCCC has recognized these imperatives for technology support and have obliged the developed countries with enhanced actions towards technology development, diffusion, transfer, and deployment of the same to the developing countries. For many developing countries, especially the LDCs (least developed countries) and the SIDS ((Small Islands Developing States), there is an immediate requirement for climate-friendly technologies to be diffused not only to meet the adaptation needs but also because they are directly linked to survival issues.

Development and Role of Technology under Climate Change

The science of climate change has long been suggesting that mankind is heading towards 'dangerous anthropogenic interference with the climate system' and is on the verge of committing to catastrophic interference. The core of such activity lies in the techno-economic development paradigm, which we have started since the Industrial Revolution. The challenge is therefore broadly two-folds. First, we need to come to a common ground in terms of taking actions towards preventing the catastrophic interference and, second, a 'consequent need for an emergency plan in a profoundly divided world characterized by both staggering levels of poverty and enormous (growing) wealth'. The pathways from poverty to prosperity can only be possible through a development process that entails increased usage of fossil fuels in terms of per capita and other non-renewable sources. The prosperous world has grown at the cost of the existing poor people of the world in terms of using of the carbon space and fossil fuel usage. Therefore, our emergency plan for the current situation must include two important components. First, the emergency plan of actions must be inclusive, and would entail equity in terms of development parameters, as well as in terms of sharing of the future burden of actions. Second, we must develop the pathways of development decoupled from a fossil-fuel-intensive paradigm, and also not locked in to the current disparity in the distribution of wealth. The core of both lies in the solutions obtained through technological advancements and their unimpeded deployment and diffusion across the world, irrespective of the geo-political relations among the countries.

At the core of the current techno-economic development paradigm, we see a phenomenon resulting in unsustainable rise in fossil fuel and non-renewable sources of energy for economic benefits. The energy–economy relationship for the countries is a crucial factor in such an unprecedented increase in GHG concentration in the atmosphere during the post-Industrial Revolution period. As mentioned earlier, de-coupling of economic development with the use of fossil fuel by the countries will address the looming threat of catastrophic interference. This is only possible through technological innovations, and their deployment, and diffusion within the different countries of the world. Within the UNFCCC arrangement, the parties had clearly recognized their commitment towards promotion and cooperation in the development of technology, application, and diffusion as per their common but differentiated responsibilities and national priorities (Article 4.1). More recently, at the 13th Conference of the Parties (COP13), 2007, the Bali Action Plan observed, 'technology development and transfer to support actions on mitigation and adaptation' has been developed as a specific activity for the countries. 'A robust technology transfer programme under the Convention is required to catalyze the transition to low-emission and climate-resilient development' (FCCC/SB/2009/3/Summary).

Thus the goal of such arrangements is to ensure that the development goals of the developing countries are not hampered due to the future shifts and changes in the techno-economic paradigm. The common but differentiated responsibilities of the countries in the context of climate change regime entail that emissions reduction be achieved globally, and enhanced effort be put in for the above by the developed countries. Because the world's wealthy minority has left precious little space for the poor majority (HBF, 2009), enhanced support in the form of technology should urgently flow to the developing world without any impediments as per the rules laid under the Convention. This, in turn, would be regarded as part of commitments fulfilled by the developed world. The core of this hypothesis is that enhanced actions are required for stopping the catastrophe from occurring. We must also note that, even if the developed countries are able to suddenly halt or stop their emissions, the growing need of energy in the developing world would ensure that the global carbon budget is exceeded in future. To remain within limits, the developing countries should also take upon the task of reducing emissions voluntarily and through enhanced support from the developed countries, although they are still combating poverty and struggling to meet the basic needs of sustaining life.

Technology arrangement under the UNFCCC covers the items of cooperation, absorption and utilization of technologies by the developing world. However, there has been lesser emphasis on measures that the governments of developed countries or supplier countries should take to facilitate and accelerate technology cooperation. Therefore, there has not been any established mechanism for technology support, so that there could be accountability established for the developed countries. This cooperation is central to addressing the climate change catastrophe in the developing world. As has been observed by GEP (Global Economic Prospects) (World Bank, 2008), there is lack of advanced technological competencies in the developing countries, and this can only be resolved through adaptation and adoption of new-to-market or new-to-the-firm technologies. The adoption and adaptation of these technologies in the developing world would depend on the extent of exposure to new technologies, and also on the ability of the developing world to absorb the above. The success of the first factor is dependent on the support and interest from the developed world. The second, however, depends on the overall macroeconomic conditions of the economy across the world, which influences entrepreneurs to take risks in new ventures and thereby into sustained process of deployment and management of new forms of technology. It has been observed that over the last 200 years of development, human progress has been inextricably linked to the increasing use of energy. Between 1800 and 2000, the use of energy was multiplied 30 to 100 times of GDP (gross domestic product). But this growth in energy usage has been extremely skewed. There is huge gap in the energy used by different regions.

Emissions, Development, and Role of Technology in South Asia

It has been observed that the energy needs of the global poor have been overlooked historically. Even now, the needs for provisioning the energy demand specific to the poor people of the world are overlooked. Improvements in the basic development parameters related to health, education, standards of living, and drinking water supply are closely correlated to the provisioning of energy to meet these services. As Figure 1 tells us, most of the high achievers of HDI (human development index) are intrinsically high users of electricity (which is used as proxy for energy usage). Given the fact that we are going to add at least 3 billion to the total population by 2050, provisioning of energy becomes a challenge for the developing countries as most of these people are going to be housed in the developing world. The situation is grim for the South Asian region because all member states rely heavily on the traditional sources of power, and the future scenarios of planning ensure that they continue to do so. This only adds to the increasing emission bill for the region, and this is going to be a major concern even if we try to avoid the immediate responsibility of reduction of GHGs as policy imperative.

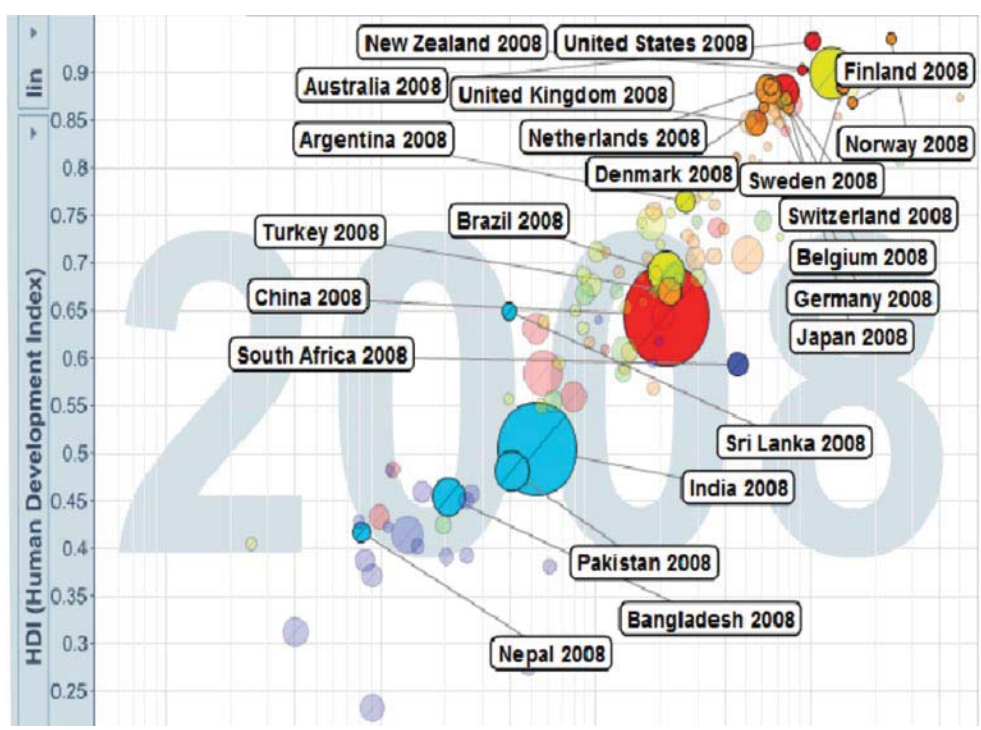

Figure 1 Electricity per-capita usage and human development index for select developed and South Asian countries
Source: www.gapminder.org

As per the estimates of the World Bank (2009a), more than 1.6 billion people of the world are currently without electricity, and they lie well below the poverty line. In South Asia, almost 570 million people are without electricity as per the latest available data of the World Bank (2009a) (Table 1). This also reflects the fact that they are going to be the future market for energy. Providing energy to these people of South Asia should not be seen as merely a 'long-term goal', but as a regional imperative. The other challenge we face in the region

Table 1 Number of people living without electricity	
Region	Millions without electricity
South Asia	706
Sub-Saharan Africa	547
East Asia	224
Other	101
Source: World Bank (2009a)	

is that the primary low-cost energy carriers are neither clean nor renewable. The imperative of provisioning energy to the people in the region would mean that the future emission bill is going to rise. When emissions reduction goals are intrinsically linked to a potential rise in future emissions, any global agreement on this as a region becomes extremely difficult from the context of political imperatives as well. The role of technology in such a context can be the elusive magic wand the policy makers of the region can bank upon. On one hand, the technology options for energy provisioning have the capacity to reduce the existing price of the generation of clean and renewable sources of energy and, on the other, it will make cleaner options for traditional sources possible. The net result would be the achievement of both development and emissions reduction in a targeted time. However, the two major assumptions in the whole context of technology are that (1) there is an unimpeded supply of cheaper technologies made available for the region, and (2) the support for the know-how has been institutionalized in the context of climate change and development. The global pact on technology cooperation could ensure that both objectives are achieved as part of the global commitment on climate change.

Technology Cooperation: Ways and Means

Traditional conceptualization of technology cooperation refers to supply of capital goods and equipment to the developing countries. A study by Evans (1999) showed that 80% of aid to China's energy sector was focused on funding the construction of new thermal and hydro power plants wherein the aid was to finance the export equipment supplied by the foreign firms. There is also one popular opinion that the transfer of plant and equipment to the developing countries has often been based on turnkey and product-in-hand contracts with restrictive terms of contracts between transnational companies and the firms of the developing countries, with the latter having limited scope for fostering innovation through reverse technology (Saad and Zawdie, 2005), and often technology transfer between technology suppliers and importers preludes knowledge sharing across the economic spectrum.

Comprehensive technology cooperation arrangements would involve the purchase and acquisition of the equipment, cooperation, and training wherever necessary for skill development; know-how sharing for operation and maintenance of the equipment; and to develop the understanding of the hardware of the technology, which will entail further adoption and adaptation by the recipient firms or countries as applicable. Therefore, it is essential that both soft and hard technologies are shared between the supplier and the recipients. Under the UNFCCC, technology cooperation and transfer involves the following elements: (a) technology needs assessment, (b) technology information, (c) enabling environment, (d) capacity building, and (e) mechanism to facilitate institutional mechanisms for operationalization of technology cooperation.

It is interesting to note that the UNFCCC paradigm of technology cooperation is built on the assumption that there will be a networked approach to technology development across the world. This is an important step in the evolutionary institutional theory. It essentially takes a systems approach to the issue of technology development, deployment, and transfer. The conceived technological system assumes an important role in social systems under the context of climate change, apart from the role of hardware and software systems involved in technology development and deployment. The technology cooperation mechanisms conceive a multi-layered approach for the operationalization of the technology mechanism to combat climate problems through technology solutions. On one hand, there is need for technology deployment and diffusion of existing and new commercial technologies across the world, especially in the developing countries, and, on the other, there is need for development of new technologies. In the current scenario, a networked approach will mean that both elements of the technology mechanism, development, and diffusion are carried out. This approach is built on the premise that the three strands of entities involved in research on technology, namely, the government, academia, and industry would play a joint coordinated role to fill each other's gap. Further, this approach is also designed to address the issue of lack of investments in the climate technology development by the private sector. The current approach is designed to ensure that the public sector play the role of facilitator in attracting investments on technology by the private sector, in areas like developing technologies for adaptation and technology for high risk mitigation sector. There has been in the past various attempts to close this gap in the international level and Box 1 would give an idea about the role of different entities.

The cooperation mechanism can be classified into four parts: (a) incremental, (b) radical, (c) changes of technological systems, and (d) changes in techno-economic paradigm. All of these are covered by the UNFCCC framework including supplier/recipient firm strategies, absorptive capacity, and intellectual property rights. Further, the soft and hard technology cooperation mechanisms would involve (a) hardware involving manufactured objects, (b) software that involves knowledge sharing, and (c) orgware—the institutional settings and rules for generation of technological knowledge for the use of technologies. The current paradigm of low-carbon technology is based on the framework of networked systems of innovation and diffusion. One of the reasons for this is the huge capital cost and opportunity cost to be foregone in replacing the existing ones. As most of the emissions reduction potential lies in the energy technologies to ensure a low-

Mechanism	Rationale	Issues to consider
Publicly-supported centres for technology development and transfer	Green revolution model of technology diffusion; makes technologies available to developing countries without IPR protection	Similar to proposal for innovation centres in section on 'public-private roles'; suitable for mitigation or only for adaptation technologies?
Technology funding mechanism to enable participation of developing countries in international R&D projects	Resultant IPRs could be shared; patent buyouts could make privately owned technologies available to developing countries	Is there sufficient incentive for participation by developed country private sector technology leaders?
Patent pools to streamline licensing of inventions needed to exploit a given technology	Developing country licensees won't have to deal with multiple patent holders	What are the incentives to patent holders? Would government regulation be needed?
Global R&D alliance for research on key adaptation technologies	Model of research on neglected tropical diseases	Is such an approach suited to mitigation technologies?
Global clean technology venture capital fund	Fund located with a multilateral financing institution which will also have the rights to intellectual property	Will new technology ventures be viable commercially if they don't own intellectual property?
Eco-Patent Commons for environmentally sustainable technologies	Approach initiated by the private sector to make certain ESTs available royalty-free on a "give-one, take-one" model	Voluntary; private incentives appear weak. What about those companies without a patent to contribute?
Blue Skies proposal of European Patent Office: differentiated patent system with climate change technologies based on a licensing of rights	Complex new technologies based on cumulative innovation processes need to be treated differently from, e.g., pharmaceuticals	Appears to address similar concerns to patent pool proposal: more specifics needed on implications for technology access
More favourable tax treatment in developed countries for private sector R&D performed in developing countries	More pro-active, technology-push approach by developed country governments	May face domestic political constraints
Technology prizes	Reward innovation without awarding IPRs to innovators	Require a well-specified research objective

Box 1 Ideas for collaborated technology development: role of public, private, and academia
Source: UNDESA (2008)

carbon pathway, the need for huge capital over a long time period increases the risk and therefore deters investments. Innovation at various stages requires a long time to get commercialized and the pace of diffusion is slow. Competition in the energy technologies focuses on price rather than product differentiation (Garibaldi, 2008). Under the climate change regime, emissions reduction has been the main purpose of innovative actions. As most of the emissions are sourced out from the energy sources, the innovation activities for reduction have been directed towards this sector. Despite efforts ranging from institutional mechanisms to international investment flow being enhanced for R&D in this sector, the success rate is very less compared to the demand and scale for new technologies. Further, the problem is compounded because the capital-intensive energy sector operates in a risk-averse market and in power sector, a highly regulated one, while the end products, that is, electricity is homogenous or potentially transformable from one source to other. These constraints lead to the development of a centralized sector, occasionally leading to a small number of players, thereby diminishing competition pressure and innovation incentives (Garibaldi, 2008). As a result, the path of innovation and activities related to the above are limited for this sector. This results in much less diffusion of technologies from the developed to the developing world.

As Garibaldi has observed, in such situations, problems arise mainly from lack of sustained financial support at the stages of innovation. Public sector funding is definitely needed for supporting new technology research; however, the relationship of the public sector with the private sector and its investments might at some point become complex, and play a hindering role. This is especially the case when a technology moves from a public-funded demonstration level to a commercially viable level. The public sector views its commitments as being limited to the early stages of innovation, whereas the venture capitalists typically fund when solid initial sales have been established; however, they rarely fund the intermediate steps.

Therefore, to tackle the above situation, first we require efforts at the global scale for new technology innovation to move the world towards a low-carbon economy. Thus, the continuous decline in R&D funding at the global level in the recent decades should be reversed. Deployment of incentives will have to be increased two- to fivefolds globally. It has been noted in the UNCTAD report that, between 2010 and 2030, there is going to be an increase in energy demand for meeting development imperatives, and if the world is to meet the demand in a low-carbon way, it would need an investment to the tune of 27 trillion USD during this period. A substantial policy shift is therefore needed to ensure that the required technologies are diffused in the developing countries, and that the markets expand in size and reach a scale so that the cost reductions and economies of scale are attained. This has to be operational along with the financial mechanism. This will reduce the gap between the public and private sector investments in the technology development cycle.

Conceptual Model of Technology Cooperation

The technology cooperation conceived under a climate regime assumes that a networked mechanism be developed across the world for international sharing and cross learning on climate-friendly technologies. The current situation demands collaboration of public and private research and support to be crucial in meeting the demand for new technologies as well as to get them diffused to the sites across the world. The catalytic role of collaborative efforts in the history of technology cooperation can be noticed in twentieth-century innovations such as aviation, electronics, and nuclear-power. The network system of innovation has been extended to other advanced areas such as particle physics research, the human genome project, and so on. It must be explained here that these collaborations are mostly in fundamental research areas of science. But for climate change, we need collaboration from inception to the commercialization stage of a particular technology, and for existing technologies collaboration is required for diffusion (Figure 2).

Sustained diffusion mechanisms across different markets and

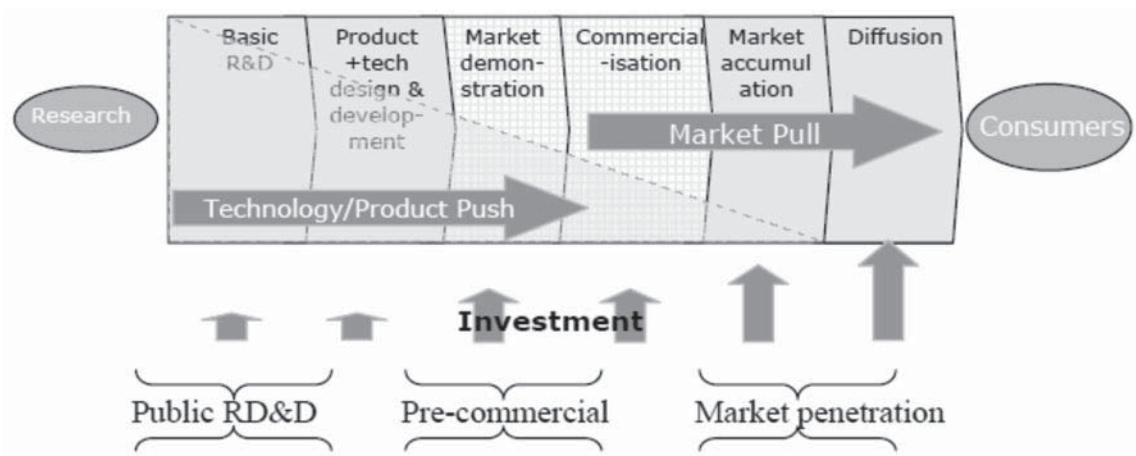

Figure 2 Major steps in the innovation chain
Source: Grubb (2004)

climatic zones are one of the key concepts of technology cooperation under a technology cooperation regime to address climate change. It has been found throughout the technological cycle that there is a constant feedback relationship established at the stages of development of technology and its commercialization. This feedback on technology often leads to further improvement of the product itself or sometimes gives rise to a specific new product altogether. Under the climate change regime, when a mature technology is taken from one climatic zone to the other, it requires substantial changes and modification before entering into the market. Therefore, for successful technology innovation, it is required that they be appropriately modified for different market and climatic situations. A successful technology development strategy should also incorporate the linkages between the front and back ends of innovation. As seen in Figure 3, the front end mainly consists of supply factors of technology and the back ends of the cycle are mainly the demand side. In a networked model of technology development, the supply and demand factors play the role of determination of the size and scale of the market for the technology. While the need factors determine the demand for the technology, the supply side factors determine the availability of technology in the market. The supply side gives various options to the consumers to meet the particular demand for the technology, and the demand side factors send signals to the innovators about the potential market for the technology.

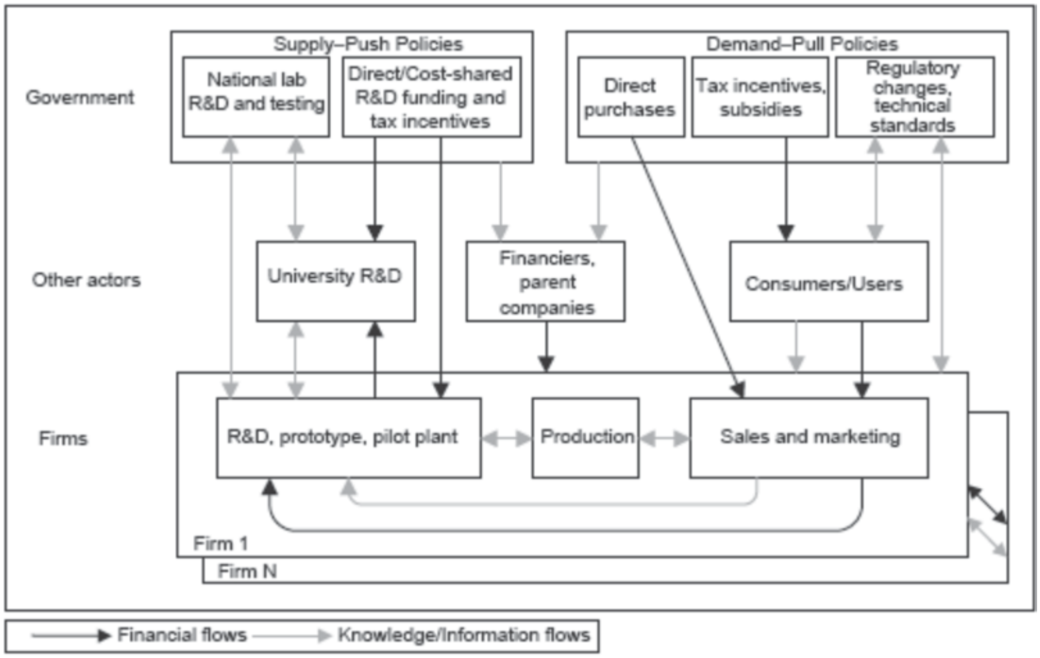

Figure 3 Supply push and demand pull for technology development
Source: Margolis (2002)

The role of government in such an arrangement is to provide an enabling environment to the industry through incentives (both regulatory and monetary), and also to provide direct funding to universities and research institutes. On the demand side, the government can create a market for a particular technology, or set standards for other technologies so as to promote the use of new technology if the new one is better than the existing ones. As mentioned above, the gap to be filled in the development of a particular technology has to be through both public and private sources. Therefore, PPP (public–private partnership) models are required to address this. As there is still lack of adequate scale of investments in the low carbon and clean energy technologies, further actions are needed. The carbon market alone cannot provide adequate incentives for upscaling the investments from the private sector. For a collaborative effort, we need to keep in mind the following issues:

a The climate problem is a global problem, but it requires local and global solutions to be in place and to be modified as and when required to meet specific needs. Therefore, any mechanism under climate change should be able to develop global solutions, as well as local innovation systems so that it meets the needs specific to local problems, as well as redesign the global solution to make it fit the local conditions.

b As viewed by Hodge and Greve (2005), there are diverse opinions on technology development related collaborations among private and public players; therefore, the issue of governance has to be resolved before operationalizing such collaborations.

It is therefore important to find out successful models of international cooperation for technology development and transfers. Successful models such as CERN, IEA technology implementation, and so on can form the basic understanding of such technology related networked innovation systems, but probably the most successful of these from the operationalization perspective is the CGIAR model in agriculture.

On the basis of the precedents of such arrangements, the current proposal on technology mechanism suggests developing technology network centres in the form of energy and climate technology innovation centres (or low-carbon energy technology innovation centres) in developing countries. This would be a new combination of public–private, north–south and south–south partnerships, intended to advance the development and availability of suitable technologies (i.e. support 'technology push'), underpin the creation and development of markets (i.e. support 'demand pull') and carry out other enabling activities to overcome implementation barriers in developing countries (Sagar, Bremner, and Grubb, 2009; Carbon Trust 2008).

Particular functions being recognized to be performed by the centres are to (a) accelerate the transition to low-carbon technology development by using multilateral and plurilateral funds to be deployed cost effectively at the national and regional levels wherever applicable through PPP, (b) address the issue of climate resilient technology development and diffusion, while addressing the mitigation technology needs, and create an enabling environment through the network to address the problem of energy access to the poor and (c) support climate adaptation programmes by developing local technology and know-how. In the meantime, these centres should also prevent the exploitation of local and traditional knowledge. The main function of these centres would be to expedite technological innovation towards these three goals by the following approaches (Figure 4).

- Working in partnership with the private sector, which would involve using public money to reduce the risks of private sector investment, and promoting technical collaboration between public- and private-sector researchers on specific projects.
- Focusing resources and activities towards the development and/or adaptation of the most appropriate energy and climate technologies for a country, given its capabilities, resource base, and needs.
- Proactively identifying and addressing technology and market barriers to move technologies up the adoption curve; this includes helping create a favourable national political and regulatory framework for the deployment of these technologies, providing information and raising awareness nationally, and exploring innovative delivery models that promote local entrepreneurship and employment.

The intuitive model for such collaboration and specific activities can be developed in the form of the above schematic arrangement. The centres mostly follow the actions of the PPP areas marked. Their mandate

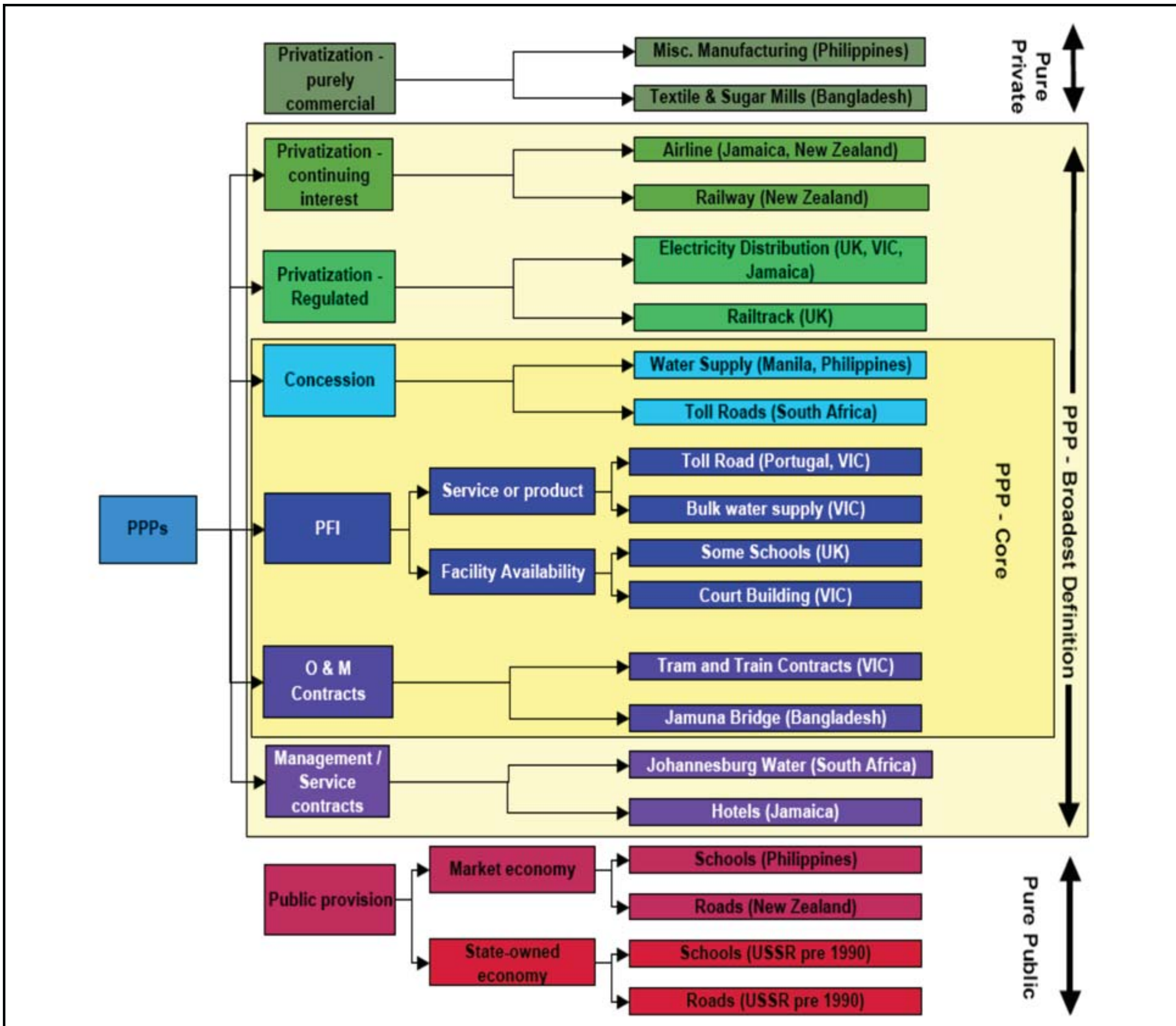

Figure 4 Schematic arrangement of public-private collaboration in technology development and diffusion.
Source: World Bank/ PPIAF (2007)

would be to provide appropriate, sustained, and significant support to promote development and deployment of low-carbon technologies, particularly meeting the needs of energy security through proper energy access, enhancing services pertaining to low-carbon technologies. The current proposal also identifies the reporting line for these centres so that a structured system of accountability and transparency is developed. The local capacity building and developing local entrepreneurs and markets are important functions of these centres. Therefore, it has been perceived that these centres would help in developing technical policies, market analysis, and implementation strategies at the regional level. All of these have to be carried out in tune with the national priorities, while not suppressing the national imperatives of country. It is quite obvious that the functions of the centres would differ depending on the respective capacities of the countries or the regions. Therefore, a broad set of functions is particularly important for countries with limited technological capability, which, unfortunately, are also often the countries with the greatest energy challenges. There is also the likelihood that technology transfer is increased for a recipient country that has stronger technological capabilities (Dechezleprêtre, Glachant, and Ménière, 2008).

Regional Technology Cooperation and South Asia

Success in technology cooperation is judged on the ability of positive transformational changes that could be ushered in to meet the overarching goals for the region. In this regard, South Asia has a number of goals under the aegis of climate change and development. On one hand, the region is one of the poorest in the world, with constantly increasing population, a majority of them being deprived of the basic necessities of life; and on the other hand, the region has been experiencing a secular increase in economic wealth, led by India, over the last few decades. The region is bestowed with rich natural resources, which are the sources of income for a substantial number of people. Agriculture is the most important employment-generating sector for the region, although it is mostly dependent on monsoons as major input to the production. Most of the economic activities are derived out of traditional sectors, and are labour-intensive in nature.

These factors add to the vulnerability of the region, as has been projected by the IPCC (Intergovernmental Panel on Climate Change) in their recent report in 2007 (IPCC, 2007). As per Figure 5, it has been observed that South Asia is one of the most vulnerable regions as the incidences are multifarious. Owing to a variety of vulnerability incidences, technological support has to be streamlined accordingly.

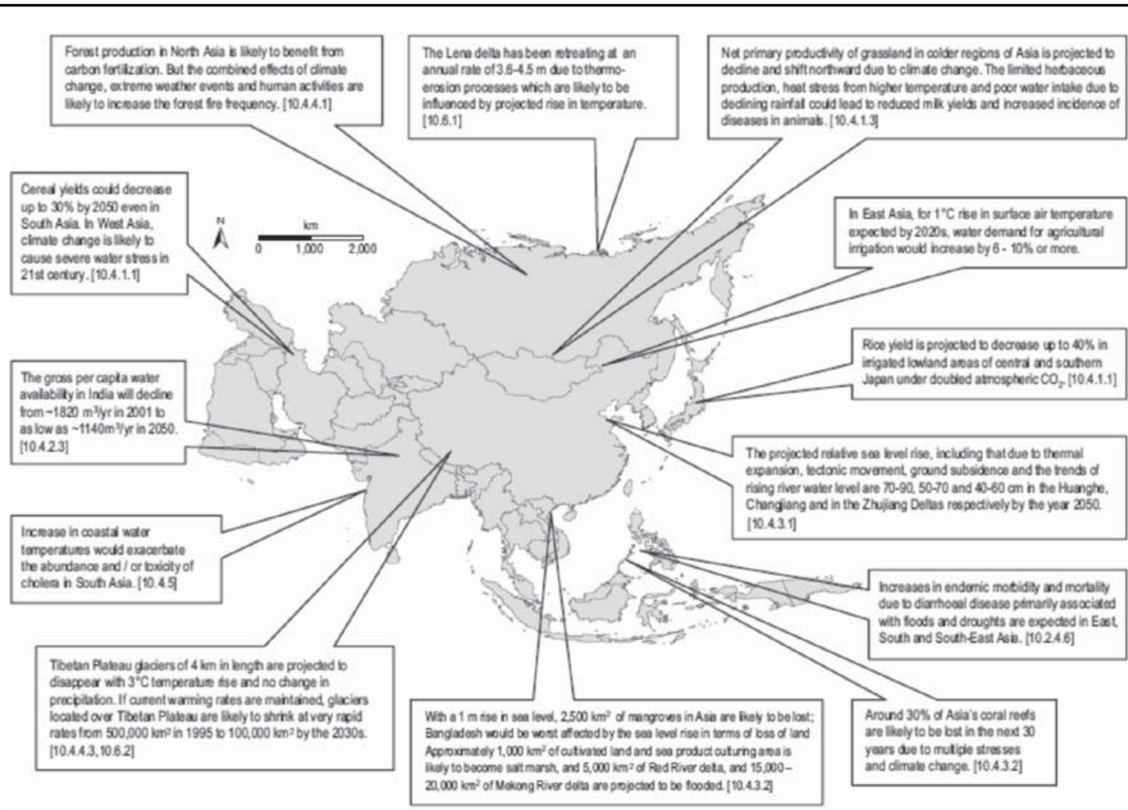

Figure 5 Vulnerabilities of the region
Source: IPCC (2007)

Owing to the potential physiographical impacts, we need specific technologies or best practices designed for the region. The cooperation on technology and best practices requires to be prioritized according to potential impacts and availability of technologies/best practices. In the region, the threats from sea level rise, extreme incidents and glacial melts are some of the key areas of concern, which concerns the policy makers. While in each of these, mapping existing technologies for addressing these issues are available, the problem lies in contextualizing them for the South Asian context. For example, due to the peculiarity of the region and its coasts, we have to develop technologies that will ensure that the coastlines are minimally damaged due to sea level rise, the mangrove resources are preserved, and the agricultural and other challenges emanating out of the rise in sea level in the region are also addressed. It is generally observed that, within the region, primarily the following dimensions need to be addressed: the physical loss, the economic loss, and the biodiversity loss. Technological cooperation should take into account the following aspects.

Ability and capacity to use technologies by collaboration

A major criterion for successful collaboration on technology lies in the intrinsic capability of the region to absorb the technologies that are developed outside the region by modifying them according to their use in the region. For example, specific irrigation technologies can be modified for use in South Asia, although they are made for use in the Middle East, as the soil conditions and nature of crops are different in different regions.

Scale of operation and market sensitiveness

Apart from the issue of making these mechanisms rooted to the local context, yet fulfilling the global cause, they should also help in the development of the market in the region. Many technologies simply could not be incorporated into the region because of lack of proper market mechanisms and scale of the demand. For example, despite being one of the first countries of the world to have a renewable energy policy put in place, India's solar sector did not grow to meet the scale required for closing the gap in prices. Thus, the technology centres would help in designing innovative delivery models, entrepreneurial support systems and clean-tech service companies, which would develop an information network in the region on technologies and their sources, different stages of development, appropriate policy framework, and so on.

One of the other major issues to be considered is the scale of operation and size of the firms. As there are many SMEs (small and medium enterprises) in the region in various industrial sectors, technological cooperation is required to address the specific needs of SMEs. For this, there should be collaboration with regions that have technological experience in SME sectors. Further, the policy makers developing the technology collaboration roadmap should identify those areas that have the maximum potential in reducing emissions and minimum negative effects on the livelihoods of people. Literature on technology collaborations suggests that displacement of labour from the sectors is a major implication and challenge in such developments. The UNFCCC framework has not addressed this aspect of collaboration mechanism fully. We in South Asia should set a model before the world in this respect.

Regional Cooperation Model within South Asia

Regional cooperation has been identified as the core strategy for developing climate-proof South Asia. A coordinated policy for mitigation and adaptation has been envisaged through regional agreements. While the core focus has been on the adaptation issues, the region has to reduce emissions on an aggregate. Challenged by huge population and resources constraints, the region depends on exploitation of green sources for meeting its energy demands. The region should also shift to a low-carbon pathway for development. Independent of the international climate regime and technology agreements coming through, the region has proposed for enhanced collaboration between the countries in the SAARC declaration of 2008. This ranges from development of an information bank, sharing of expertise on climate science, establishing centres for excellence, and also developing coordinated adaptation strategies. This region is on the verge of stepping into higher levels of understanding, which has already begun with the trade cooperation. Well-defined action points and proposals have been made in the areas of climate technology and information sharing. Countries such as Bangladesh have moved forward in establishing national centres for undertaking enhanced research and dissemination of adaptation-related technologies. India has made huge plans for voluntary reduction of GHG emissions in the next decade, and is also moving towards establishing research centres on glaciers, meteorological data analysis, and technology diffusion and so on. The linkage and impacts of climate change on the society is to be studied at the newly established SAARC University for which the Government of India has agreed to be the secretariat. Special emphasis has been laid on research related to the socio-economic aspects of climate change in this University.

Low-carbon Development and Technology Cooperation

With a prevalence of labour-intensive industrial sector across the region, shift towards low-carbon pathways will entail a critical choice of maintaining employment and moving on to advanced stages of the technological ladder. This according to the existing literature is a challenging ask. One of the ways to develop such pathways is to strengthen the services sector. The South Asian potential for developing energy services is substantial. There are many reasons for such an assessment. This region boasts of having a large number of educated people within the working age, low cost of trained labour, and almost all clean technology potential still remains under-utilized. For this potential to be exploited, we need a coordinated effort and thereby we would be able to reduce the vulnerabilities of the region being mapped by the IPCC through developing capacities in the region (IPCC, 2007).

Potential Areas for Technology Cooperation and Issues to Deal with

The composition of the GHG profile of the region suggests its emergence as a major contributor of emissions. In various reports, the region is recognized as a potentially high emitter. The main reason for getting this unwanted tag, despite having resources for alternative development pathways, is the lack of capacities for developing them, as well as lack of proper policies towards addressing the issues of sustainable growth. As per the World Bank (2009b) study on South Asia, the countries are currently keeping significant portion of their annual budgets for disaster risk management, and building resilient policies to protect humans and ecology (Figure 6). However, we need to identify the problems of designing an efficient policy towards tackling climate change.

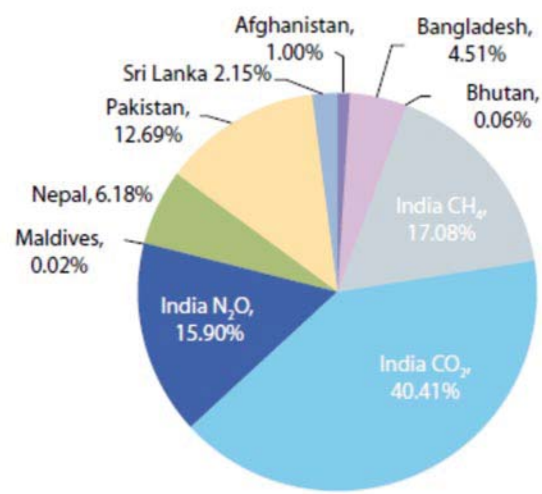

Figure 6 Contribution of emissions by countries in South Asia
Source: World Bank (2009b)

The primary challenge is to tackle the population and to address the climate change issue. Being one of the high density areas of the world, the region is poised to be in high demand for basic services. Owing to the bias towards energy produced from non-fossil fuel sources, there is going to be huge reduction in the agricultural output from the region, and this would be coupled with scarcity of water and erratic behaviour of the monsoon and the overall climate pattern. As the region depends highly on coal-based energy resources for meeting the energy demand, the shifting or replacing the coal-based energy to a sustainable mode would be a major challenge. In particular, the above is true in a context where renewable energy is still a high-cost venture for the region. Thus, we need a cooperation framework that will ensure easy and quick dissemination of these technologies. In the South Asia Report, World Bank (2009b) has proposed four strategic areas of regional cooperation, and the development of new technologies in the region forms a key strategy to resolve the problem of access to clean power. In the Asian Development Bank strategy, it has been identified that renewable energy deployment would be the focus of its strategy for energy access (ADB 2009). Therefore, the issue of clean sources of technology for energy production and its access at a cheap price will be the key for the region.

The region is abundant with agricultural resources, and this sector has emerged as a major contributor to the GDP of the countries. However, it has been observed that the current input incentive for agricultural practices will have to be changed to efficient-input-based agricultural practices. In this regard, a cross-country learning mechanism needs to be established. Heavy reliance on monsoon and Green Revolution-based practices has already been pushing the agricultural sector to the brink of collapse. An analysis by the World Bank (Table 2) shows that the region is going to experience reduced agricultural produce due to climate-related adversities. However, the problem is that who will bear the cost of these changes. The other important factor we need to discuss is the effectiveness of the proposed models as climate-resilient agricultural practices. Most of the current documents have proposed the use of capital-intensive practices, such a bio-technology and genetically modified variants of crops, and have not focused on an input-efficient production process.

Table 2 Estimates of climate-change-related effects on agricultural sector in South Asia

Country	Farm Area (1000 ha)	Output per Hectare (US$)	Output (US$ mil)	% Change (Ricardian)	% Change (crop models)
Afganistan	7827	313	2448	-9.5	-32.1
Bangladesh	8429	1355	11421	-14.3	-25.3
India	170115	777	132140	-49.2	-27.0
Nepal	3294	728	2399	-0.9	-25.3
Pakistan	22120	856	18935	-17.9	-36.6
Sri Lanka	1916	1808	3465	-935	-25.3

Source: World Bank (2009b)

As projected by the IEA (2009), the future demand for energy in the region is going to rise. A major portion of the energy demand is going to be generated if we are to meet the targets of MDGs (millennium development goals) for the region. During the last decade, the region has experienced an increase in energy consumption by 52% (Chary et.al. 2010). It has been found that the energy-sector-based emissions are going to grow during the next few decades due to the dependence on fossil fuel. To change this, the exploration of renewable energy resources would be the key strategy. This potential growth is constrained by price effect and policies on renewable energies. Current policies on renewable energy show that the region is still doing its energy planning on short timelines.. For a sustained reduction scenario, medium- and longer-term policies have to be introduced, which can only be facilitated through regional cooperative arrangements between countries.

Industrial cooperation on clean technology is another area where the region needs a coordinated approach. There are numerous bilateral treaties being undertaken in the region between the trading partners. Most of these are based on the traditional manufacturing sectors, which are energy intensive. A future cooperative mechanism based on technology and know-how exchange would be the key for an aggregate reduction in emissions for the region. As a SAARC region, there is need for developing such cooperative mechanism. The recent SAARC declarations do not feature these regional cooperative areas, and these should be included.

Potential Technology Requirement and their Mapping

A technology mapping exercise based on the current economic and physiographic constraints would reflect a complex matrix. The region is bestowed with agricultural resources, marine resources, and is regarded as a major exporter of agricultural products. Further, the economic liberalization has resulted in growth of manufacturing activities in the region, leading to both energy demand and emissions. Therefore, the policies concerning technology transfer need to ensure that they are being appropriately transferred to the region.

First and foremost, a recent study by WRI (2009) and World Bank (2009b) explains that the high-emitting sectors are also the ones with high economic activities (Figure 7). According to the above figure, the agricultural and the energy sectors remained key contributors to the emissions in the region. However, attempts to reduce emissions without holistic approach will result in catastrophic results. Further, as mentioned above, the development imperative requires an immediate expansion of energy services to the region, which is assumed to be the most energy poor region. To reduce emissions, there have to be attempts to expand energy resources, which would lead to almost zero or substantially less emission. The approach to such a solution should not be a one-time effort; it has to be step-by-step approach. There have to be mid- and longer-term approaches to resolve the problem, guided by the best available technologies. Currently, it has

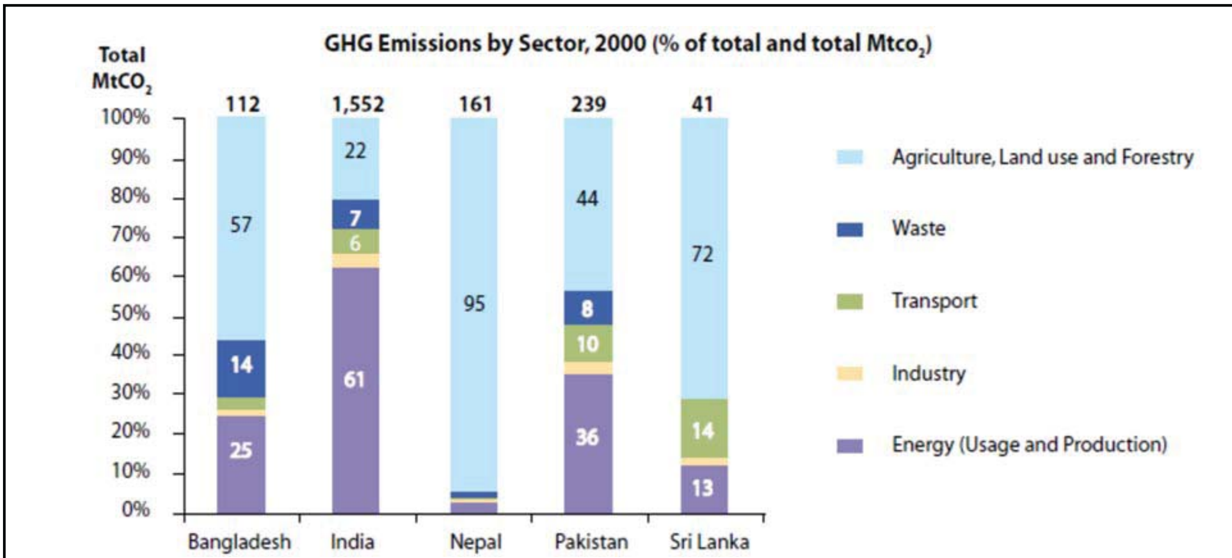

Figure 7 GHG emissions by sector, 2000 (percentage of total and total $MtCO_2$
Source: WRI (2009)

been observed that there are mainly three streams of technological solutions available at any given timeframe. The first set of technologies are those that are available in the market at certain prices, the second set of technologies are high-end technologies with high market prices and other non-price barriers attached to it for transfer and the third type of technologies are the ones that are yet to be developed and are mostly the next generation of available technologies. Under such a situation, mapping of the technology requirement would essentially mean a matching exercise of the demand side of the technology with the supply side, which is a complex matrix, and time is an important parameter in such a matrix.

It has been overwhelmingly accepted that adaptation actions on ground will minimize the cost of climate change impacts in the region. While we concentrate on the adaptation issues, the region is challenged by the biggest threats of rising of sea level. The coastal South Asia is probably one of the most densely populated coasts of the world and, therefore, any rise in sea level for the region would result in tremendous threats to human and biodiversity resources for the region. Therefore, coastal technologies would be vital for the region. The UNFCCC had come up with a matrix of types of coastal technology available currently.

On the mitigation side, the cooperation will mostly feature strategies to reduce the emissions in the energy sector. The key to this strategy is to design and promote the renewable energy sector in the region. There have been estimates that the region has high potential of renewable energy growth. In particular, in the wind and solar resources, however, the problem of evacuation of energy produced from the production sites to the sites of usage remains to be resolved. Therefore, technologies addressing these issues would be a key mapping issue to be dealt with.

Future of Technology Cooperation: Suggestions

Evidently, multifarious issues are currently in practice at different levels of engagements towards technology cooperation across the countries. The goals of regional collaborations on technology have to be a mix of bottom–up and top–down approaches. While for adaptation, we need specific technologies that suit the local conditions and best practices, the mitigation efforts might be a top–down one. In this regard, as identified before, there should be sector-specific goals and priorities for coherent technology cooperation within the region.

As noted earlier, as agriculture forms the backbone of the region's economy, most of the actions have to be taken considering that they have minimum impact of climate change on agriculture. Scholars have identified that the region should focus on two main points on agriculture. First, the region should move away from input-intensive to input-efficient agricultural practices. Under this scheme of things, soft technologies such as creation of information bank for a variety of seeds that are input efficient and short-duration crops would be very useful. Traditionally, there were seed varieties that contributed to both the criteria mentioned above. In Bangladesh specifically, the frequently flooded regions have been cultivating short-duration crop varieties. But with the development of the input-intensive practices, those crops have been phased out. The scope of hard technology is to create variants that would meet the quality of the produce and the yield. The collaborative efforts with the different crop research institutes of the regions, such as the Indian Council of Agricultural Research (ICAR), Indian Agricultural Research Institute (IARI) of India,Bangladesh Agriculture Research Institute(BARI) of Bangladesh, Risce Research and Development Institute (RRDI), Horticultural Research and Development Institute (HORDI) of Sri Lanka, Pakistan Agricultural Research Council (PARC) of Pakistan, would be an initiative that can be built under the recent initiatives of SAARC. Such collaboration should be from within the public sector, as research and other activities would be focusing on the basic research area in agriculture.

The role of civil societies would be important in implementing the benefits of agriculture research and development of the region, and also for replicating the best practices across the regions. For example, the recent initiatives of growing crops in the submerged areas would be important for the Gangetic plains of India, which have been flooded frequently. Further, based on climatic and soil conditions, traditional seed varieties can be interchangeably used. Most of the civil societies work at the grass-roots level, and they already have the expertise and the network with the people for dissemination of the above. Hence a strong civil society network needs to be developed. The role of network organizations will be important as they bring with them an association of experts in the field of agriculture and practices.

The region houses three large rivers of the world. They carry huge volumes of water during the monsoons, creating a threat of flooding. The Pakistan floods are the best example of such devastations. Had the rains occurred a few hundred kilometres eastwards, then the effect of such devastations would have happened in India and Bangladesh. So what we need for such a situation is to create an information-sharing mechanism that would facilitate the knowledge of dealing with the floods. For example, issues such as creation of seed bank at villages, flood shelters, and so on would be useful and should be utilized in other regions. Although much has been written about in the media, there has to be someone who will take the work to the last mile. Moreover, water-sharing agreements are also going to be an important issue. And, in this regard, the new methods and technologies for developing such mechanisms would be useful. India–Nepal, India–Pakistan and India–Bangladesh technology sharing mechanisms on floods would be an area where we need enhanced actions through the SAARC climate change initiatives.

A regional IPCC type of an institution should be developed for knowledge sharing on climate change and development. With India as one of the super powers of current knowledge and information, it should take lead in creating such a network with the leading institutes of the region. Some of the best research and technical institutes such as the IITs, the IISc Bangalore and the research institutes of

Bangladesh and Sri Lanka should collaborate between themselves and work towards such development. In fact, the satellite-based imagery and information-sharing network of the ISRO should be widely used for such knowledge and information sharing. There could be regional workshops on how to collate and synthesize their developing capacities for climate impact analysis.

The social and economic impacts of climate change should also be studied. This can be initiated through the South Asian University. Basically the regional institutes can play nodal roles in creating networks of learning and dissemination of knowledge and technical know-how.

South Asia is a region through which the network of south–south technology cooperation could be developed to its fullest extent, primarily because the region as a whole has similar industrial patterns and its needs overlap. In this regard, the focus should be on the core sectors of manufacturing, wherein exports take place. While India is a major exporter of cement to the region, there can be cross-learning on the development of iron and steel, textiles, and chemicals within the region. Further, one can cross-learn from the policies that are undertaken in different sectors within the region. There has been an increasing volume of commodities traded within the regions. Through SAARC, it is appropriate to develop common standardized norms for trading based on emissions and energy efficiency. This will help the region to reduce GHG emissions and force the sectors to come up with innovation and demand for energy-efficient, best-in-class technologies, which can be sourced out from the technology mechanisms.

Regional collaboration on technology development and transfer can happen broadly in two respects. First, by developing regional R&D. The future of the global climate technology cooperation model envisaged huge benefits accrued to the disadvantaged regions through these collaborative models. Given the technical capacities of the region, there is ample scope for developing such models of cooperation and then reap its benefits. The global technology cooperation mechanism has been designed to foster technology diffusion and develop south–south cooperation. With India being a powerhouse of technical capabilities in the region, the country should come forward and take a leadership role in developing such collaborations. Multilateral banks, development institutions, and international development organizations are keen on these aspects of technology cooperation in this region. The main concern is to resolve the issues of IPR (intellectual property rights) and other NTBs (non-tariff barriers) in technology diffusion. By developing such a coordinated approach for the region, a region-specific cooperation model can be made.

Collaboration can also occur by implementation of best practices. Because South Asia is rich in agricultural resources, there has to be replication of best practices. This would address the socio-economic challenge put forward by climate change.

Thus, it is observed that technology cooperation in the region can be a fruitful way of de-coupling the needs for emissions reduction and economic performance of the countries in the region. A coordinated approach to climate problem will be the core of technology development and diffusion in the area. This should occur in various sectors and at various levels, based on the local needs of the region. The current analyses are at a nascent stage and the recent declaration at the SAARC on climate change would be a good way to start and extend cooperation in the key areas mentioned above. It is important that the regions identify technology cooperation as means for attaining emissions reduction in a climate-smart way.

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