Chapter 5

Technology Development and Transfer

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5.1 Introduction

Energy demand in the Asia-Pacific region is accelerating rapidly because of expanding populations and swift economic and social transformations characterised by urbanisation and industrialisation. Consequently, GHG emissions from the region are expected to rise quickly (IEA 2005). Tackling climate change will require radical changes in socio-economic systems, which in turn necessitate further technology development, transfer and deployment.[1] Recent estimates by the IEA suggest that developing country emissions in 2050 could be reduced by 47-54% below the reference level if cost-effective technologies were to be adopted (IEA 2006). Discussions on the future climate regime, therefore, will have to include enhanced focus on technology issues. This chapter considers technology-related concerns and interests in the region, reviews major proposals to strengthen technology development, transfer and deployment under a future climate regime, and identifies a few options to move forward based on a full consideration of perspectives of various countries and stakeholders in the region.

5.2 Technology challenges and opportunities in Asia

The overriding priority for Asia is development, and technology is seen as a key element that helps to utilise limited resources to enable the development ladder to be climbed.

This section presents technology challenges facing the Asia-Pacific region from three angles: the technology-development nexus, the technology-climate stabilisation nexus, and adaptation technologies.

The overriding priority for Asia is development, and technology is seen as a key element that helps to utilise limited resources to enable the development ladder to be climbed. While many Asian countries have been experiencing rapid economic growth recently, there still remain considerable gaps in economic prosperity and social well-being between countries in the region and other developed countries (Table 5.1). Such economic disparities spur eagerness for further economic growth and improvement of the quality of life in Asia, which lead to an increase in energy demand. In addition, many Asian countries are anticipated to become more dependent on oil imports from distant, often politically unstable parts of the world, thereby raising concerns on energy security. Technological upgrades and diffusion of such upgraded technologies can alleviate concerns about implications of mounting energy needs in the region, while allowing them to pursue economic development.

Table 5.1 Economic development and infrastructure stocks in Asia

	Gross national income per capita (PPP in US$) 2004	Installed capacity per 1,000 persons (kW) 2001	Electricity consumption per capita (kWh) 2001	Average telephone mainlines per 1,000 persons 2001	Road density (km/sq, km of land) 2000	Access to improved water source (% of population) 2000
Developing countries	3,575	272	1,054	95	0.15	78
East Asia	4,589	223	921	59	0.15	71
South Asia	2,397	99	426	31	0.94	76
Developed countries	24,218	2,044	8,876	501	0.58	99

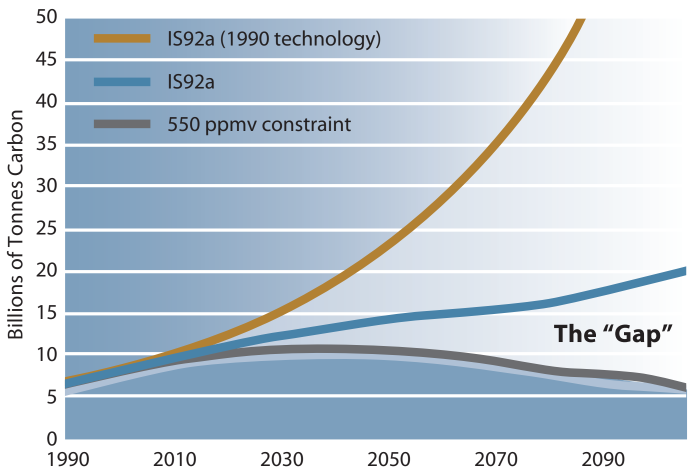
Source: World Bank 2004a

1. Technology development refers to the process of developing new technologies, while technology transfer refers to the diffusion of technologies across the border, and technology deployment describes the spread of a specific technology within a country.

For the world to attain the ultimate objective of the UNFCCC, all countries need to "leapfrog" over one or more generations of technology. The gaps in currently used technologies and technologies necessary to stabilise GHG concentrations are illustrated in Figure 5.1. The middle curve, denoted *IS92a*, shows the global CO_2 emissions associated with IPCC's middle-of-the-range scenario, which assumes a doubled world population and moderate economic growth by the end of the 21st century. The top curve assumes the same population and economic growth as *IS92a*, but it holds energy technologies constant at the 1990 level. The difference between the top and middle curves thus illustrates the technological improvement needed merely to achieve the *IS92a* emissions path. The lower curve describes an emissions path that would be necessary to attain a 550 ppmv GHG concentration target, which is twice the pre-industrial level. Achieving this stabilisation emissions path would require even greater use of advanced technologies than is assumed in *IS92a*. The key challenge here is how to enable countries in the Asia-Pacific region to employ such technologies through facilitating indigenous development or enabling transfer and deployment of climate-friendly technologies from developed countries.

For the world to attain the ultimate objective of the UNFCCC, all countries need to "leapfrog" over one or more generations of technology.

Figure 5.1 Technology gap and global CO_2 emissions

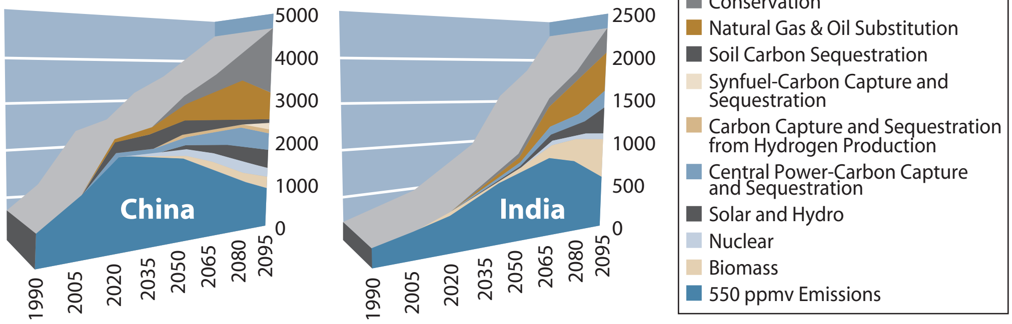


Source: Battele (2001: 30)

Another key point to recognise is that a broad portfolio of technologies would be required to meet the challenge, as no single technology alone can fill the gap between the future emissions based on the *IS92a* technologies and the 550-ppmv stabilisation path. Figure 5.2 shows a range of technologies that could allow China and India to move from the IPCC's *IS92a* scenario to a 550-ppmv stabilisation path. Note that technology needs vary. For example, energy conservation technologies can play a greater role in China while in India biomass technologies offer significant potential. Not to be overlooked though is that both countries need to maximise use of other low carbon technologies.

A broad portfolio of technologies would be required to meet the challenge.

Figure 5.2 Technology portfolios for China and India



Source: Battele (2001)

Agriculture, water resources, costal zone protection, and forest management, in particular, are very vulnerable sectors in Asia and the Pacific which particularly require development, transfer and deployment of adaptation technologies.

The high degree of vulnerability to impacts of climate change in Asia is well-known (IPCC 2001b). In particular, agriculture, water resources, costal zone protection, and forest management are very vulnerable sectors in Asia and the Pacific countries, which particularly require development, transfer and deployment of adaptation technologies. The nature of the technology required in each sector and the primary driving force behind the technology transfer also differ (Klein et al. 2006). In the agricultural sector, for example, both community-based endogenous technologies, such as floating agriculture and diversification of cropping patterns as well as modern biotechnologies to develop new varieties to cope with future changes in climate, are important in limiting negative effects of climate change. Given the uncertainty in local impacts of climate change, however, understanding the potential of both indigenous and introduced technologies and maintaining a broad range of technological options are critical.

The extent to which international initiatives will mobilise existing technologies and help in development of breakthrough technologies will ultimately determine if we can achieve the goal of stable climate.

5.3 Current status of technology cooperation

This section presents an overview of the various initiatives in technology research and development (R&D), transfer and dissemination at the multilateral and plurilateral levels with special reference to Asia.

5.3.1 UNFCCC initiatives

Several articles of the UNFCCC and its Kyoto Protocol refer to promoting international cooperation in development, transfer and deployment of technologies. For example, Article 4.1(c) of the Convention states that all Parties shall "promote and cooperate in the development, application and diffusion, including transfer of technologies, practices and processes that control, reduce or prevent anthropogenic emissions" of GHG. Likewise, Article 4.5 stipulates that the developed country Parties included in Annex II shall "take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally-sound technologies and know-how to other Parties, particularly developing country Parties". Article 4.7 acknowledges that the extent to which developing country Parties will effectively meet their commitments will depend on the effective implementation by developed country Parties of their own commitments on finance and technology transfer.[2]

2. Other relevant UNFCCC Articles include Articles 4.1, 4.3, and 4.4. The Kyoto Protocol Articles 3.14, 10(b), (i) and (c), and 11.2 are also pertinent.

The Conferences of Parties (COPs) to the UNFCCC made several decisions on technology development and transfer (Decision nos. 13/CP1, 7/CP2, 9/CP3, 4/CP4, 5/CP4, 9/CP5, 4/CP7, 5/CP7, 10/CP8, 1/CP10 and 6/CP10). In particular, the decision 5/CP7 adopted at COP7 in 2001 is particularly significant as it provided a "framework for meaningful and effective actions" to enhance the implementation of Article 4.5, covering five themes: technology needs assessments, technology information, enabling environments, capacity building, and mechanisms for technology transfer. The Expert Group on Technology Transfer (EGTT) was established in 2001 to analyse and identify ways to facilitate and advance technology transfer activities. In parallel, a technology information system, TT: CLEAR, was developed. The COP7, through the adoption of various decisions called the Marrakesh accords, also established the Special Climate Change Fund (SCCF) to address technology transfer as one of the four priorities, and the LDC Fund to support adaptation activities (including adaptation technologies). Decision 1/CP10, which includes the Buenos Aires Programme of work on adaptation and response measures, also refers to the promotion of the transfer of technologies for adaptation on an urgent basis in priority sectors, including agriculture and water resources.

The Global Environment Facility (GEF) is the operating entity of the UNFCCC Financial Mechanism. Between 1995 and 2005, GEF in its climate change focal area provided around US$ 1.75 billion in grants, of which 20% was allocated to Asian countries to support many projects, including 23 in China, 13 in India and 10 in the Philippines (GEF 2005). As of April 2006, 11 developed countries had contributed or pledged a total of US$ 45.4 million to SCCF, but only US$ 2.7 million was made available for allocation to projects related to technology transfer and its associated capacity building activities (GEF 2006). Likewise, in the LDC Fund, very little of the 11.8 million allocated by GEF has actually ended up in adaptation technologies. Compared to the magnitude of the technology transfer challenge that climate change poses, the efforts by the UNFCCC and the GEF are of modest significance at best.

Compared to the magnitude of the technology transfer challenge that climate challenge poses, the efforts by the UNFCCC are so far of modest significance at best.

Through its flexibility mechanisms, such as the CDM, the Kyoto Protocol was assumed as a means to facilitate transfer of technologies from developed to developing countries. Indeed, the pricing of GHG emissions was regarded as an efficient measure to facilitate the development and diffusion of low carbon technologies. As of November 2006, as many as 421 projects were registered by the CDM Executive Board (CDM-EB) with an estimated issuance of 680 million tCO_2eq by 2012. If implemented well, these projects should promote extensive transfer of technologies. However, the administrative complexity of project-based mechanisms seems to restrict the ability to bring about major changes, in particular technology shift, in developing countries (Bell and Drexhage 2005). It was also noted by Sandén and Azar (2005) that the Kyoto Mechanisms are basically designed merely to provide Annex-I Parties with cost-efficient tools to meet their near-term emissions reduction targets, thereby resulting in only weak incentives to develop more advanced technology on a long-term basis. In the Asian context, the predominance of unilateral CDM projects (especially in India), and HFC destruction projects that produce a large amount of CERs (especially in China and the Republic of Korea) also indicate very limited prospects for effective technology transfer from developed countries.

The Kyoto Mechanisms seem to provide only weak incentives to develop advanced technologies on a long-term basis.

Since many UNFCCC initiatives have so far focused on technology needs assessments, identification of barriers, and capacity building, rather than technology development and transfer per se, there was a broad agreement among stakeholders in the Asian-Pacific region that much remains to be done (IGES 2005a). One senior Malaysian participant to our consultations pointed out that convention-driven technology R&D and transfer has a dismal record in Asian countries. Indeed, at COP9, the Indian delegation expressed concern that the only concrete outcome of calls for technology transfer was TT:CLEAR (ENB 2003). The need for finding innovative ways to facilitate technology development and transfer in a post-2012 climate regime is, therefore, significant.

5.3.2 Non-UNFCCC initiatives

Technology development and transfer is a cornerstone of several non-UNFCCC initiatives.

Outside the UNFCCC, there are several plurilateral and bilateral initiatives focusing on low carbon technology development and transfer. Asian countries, in particular China, India, Indonesia, Japan and Republic of Korea, are members in many of these initiatives (Table 5.2). For example, implementing agreements (IAs) of the International Energy Agency (IEA) included more than 40 international collaborative energy R&D and demonstration projects, such as the Clean Coal Centre, the Greenhouse Gas R&D Programme, and the Climate Technology Initiative (CTI). Leading nuclear technology nations, including Japan and Republic of Korea, also established the Generation IV International Forum to develop next generation nuclear energy systems. In 2002, the World Bank launched the Global Gas Flaring Reduction (GGFR) Partnership in which Indonesia is a member.

Despite the rejection of the Kyoto Protocol in 2001, the USA launched a series of international initiatives for energy technology R&D and transfer, including three multilateral agreements: the Carbon Sequestration Leadership Forum (CSLF), the International Partnership for the Hydrogen Economy (IPHE), and the Methane to Markets Partnership (M2M).[3] All the major GHG emitting countries in Asia (China, Japan, India, and Republic of Korea) are members of these new initiatives, and some positive results are evident. Through the M2M Partnership, for instance, a USA company secured a US$ 58 million contract to supply all the power generation equipment for a 120 MW coal bed and coal mine methane power plant in China.[4] Private sector participation in M2M is promoted through a mechanism called the Project Network, which is considered essential to build capacity, transfer technology and promote private direct investment.

In July 2005, a new international voluntary programme for developing and deploying cleaner and more efficient technologies, the Asia-Pacific Partnership on Clean Development and Climate (APP), was established.[5] Its member countries, including China, India, Japan and Republic of Korea from the region, besides the USA and Australia combine to produce nearly half of the world's GDP while producing and consuming more than 65 percent of the world's coal. The APP established eight public-private sector task forces, covering: (1) cleaner fossil energy; (2) renewable energy and distributed generation; (3) power generation and transmission; (4) steel; (5) aluminium; (6) cement; (7) coal mining, and (8) buildings and appliances. Various initiatives under these task forces can potentially provide the Asian participants with many opportunities to shift their economies towards low carbon ones.

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3. For more details on each programme, see http://www.cslforum.org/ for CSLF; http://www.iphe.net/ for IPHE; and http://www.methanetomarkets.org/ for M2M.
4. Press release is available at http://yosemite.epa.gov/opa/admpress.nsf/4d84d5d9a719de8c85257018005467c2/8ec89e33e48a863f852571720063e8d7!OpenDocument
5. For more details, see http://www.asiapacificpartnership.org/.

Table 5.2 Non-UNFCCC initiatives focusing on development and transfer of technologies

		Gleneagles Dialogue	G8 Gleneagles Plan of Action	Asia-Pacific Partnership for Clean Development and Climate (APP)	Methane to Markets Partnership (M2M)	Carbon Sequestration Leadership Forum (CSLF)	International Partnership for the Hydrogen Economy (IPHE)	World Bank Global Gas Flaring Reduction Partnership (GGFR)	Generation IV International Forum (GIF)	Implementing Agreements (IAs) under the International Energy Agency (IEA): Climate Technology Initiative (CTI)	Implementing Agreements (IAs) under the International Energy Agency (IEA): Greenhouse Gas R&D Programme	Implementing Agreements (IAs) under the International Energy Agency (IEA): Clean Coal Centre	GHG Emissions in 2000* ($MtCO_2$)
		2005	2005	2005	2004	2003	2003	2002	2001	1995	1991	1975	
Selected Annex I countries	USA	○	○	○	○	○	○	○	○	○	○	○	6,928.10
	EU		○			○	○	○	○		○	○	4,724.90
	Russia	○	○		○	○	○	○**					1,915.20
	Japan	○	○	○	○	○	○		○	○	○		1,316.70
	Germany	○	○		○	○	○			○	○	○	1,009.40
	Canada	○	○		○	○	○		○	○	○	○	680.2
	UK	○	○		○	○	○	○	○	○	○	○	653.7
	Italy	○	○		○	○	○					○	531.1
	France	○	○			○	○		○		○		513.4
	Australia	○		○	○	○	○				○	△	490.9
	Ukraine				○								481.9
	Spain	○											381.1
	Netherlands					○					○	△	215.1
	Greece					○							120
	Austria									○		○	80.4
	New Zealand						○				○		72.9
	Finland									○	○		68.5
	Denmark					○					○	△	66.5
	Sweden										○	○	61.9
	Norway					○	○	○		○	○		53.8
	Switzerland								○		○		51.5
	Iceland						○						2.8
Selected non-Annex I Asian countries	China	○		○	○	○	○					△	4,937.70
	India	○		○	○	○	○				○	△	1,884.10
	Republic of Korea	○		○	○	○	○		○	○	○	○	520.9
	Indonesia	○						○					502.6
Other non-Annex I countires		6	0	0	6	5	1	8	3	0	1	0	-
Total		20	9	6	18	22	17	15	11	9	18	9	-

Note: * Excluding LULUCF and international bunker fuel, WRI 2006.
** Participation of Khanty-Mansijsysk province.
△ means industrial sponsors.

Climate change has recently become an agenda item for the Group of Eight (G8) summit. The summit of 2005 adopted the Gleneagles Plan of Action on Climate Change, Clean Energy, and Sustainable Development in order to promote the deployment of cleaner technologies and to work with developing countries to enhance private investment and transfer of technologies. The summit also decided to review the progress in its summit in 2008. Informal sources indicate that the G8 summit planned for 2007 in Germany would again include climate change as an agenda item. With such recognition at the international level of G8, climate change seems to have finally left the sidelines of political agendas.

Though the non-UNFCCC initiatives have significant potential for facilitating technology development and transfer, it is another thing for countries to actually implement them.

Though the above non-UNFCCC initiatives have significant potential for facilitating technology development, transfer and deployment, it is one thing to reach an agreement but another for countries to actually implement it. For example, while the APP stands at the forefront of the USA efforts to address climate change through involving major Asian developing countries, it remains to be seen if the USA congress will fully approve its financial commitment to the APP (US$ 52 million as seed capital). Technology-oriented cooperation, which is usually seen as the most feasible option for USA international leadership, is not immune to the credibility problem of its international commitments (Tamura 2006b). Similarly, there are many examples of the G8 summit launching new initiatives only to abandon them later.

In summary, both UNFCCC and non-UNFCCC initiatives may enable Asian countries to access climate-friendly technologies. However, it is first important to demonstrate the value of such initiatives by effective implementation. The launching of the Gleneagles Dialogue, bringing together 20 major emitting countries to informally discuss new measures to tackle climate change and to monitor the implementation of the Gleneagles Plan of Action can be a departure point. The extent to which these initiatives will mobilise existing technologies and help in development of breakthrough technologies to achieve much steeper reductions in GHG in future will ultimately determine if we can achieve the goal of stable climate.

5.4 Asian aspirations and concerns over climate-friendly technologies

Several Asian countries expressed strong aspirations for technology R&D and transfer in both rounds of our consultations. For those countries that are experiencing accelerating economies, and therefore increased energy demands, and where modern energy services such as electricity are still not available to large poor populations, technology development and transfer remain a key policy focus.

Recently, the IEA estimated the potential of various technologies for reducing global CO_2 emissions from the energy sector and concluded that the greatest GHG reductions in the year 2050 are projected to come from improvements in end-use efficiency, power generation and carbon capture and storage (CCS) (IEA 2006). In view of the high reliance of several Asian countries on traditional fossil fuels, as well as the high potential for renewable sources of energy, participants showed a keen interest in a wide range of both conventional (e.g. energy efficiency, renewable energy, technologies for adaptation) and advanced (e.g. clean coal technologies, Integrated Gasification Combined Cycle [IGCC], CCS, nuclear energy) technologies.

National preferences for low carbon technologies, however, vary, reflecting economic size, developmental stage, and geographical location. For example, China, India and Viet Nam have coal-based energy structures, and are expected to continue to rely on coal in their energy mix over the following decades (IEA 2004). Countries such as Indonesia, which have recently become net oil importers, have begun to consider depending on coal again. Hence, clean coal technologies are very important for these countries to reduce GHG emissions without compromising their development goals. Put another way, merely to maintain the current level of emissions would require installing IGCC and CCS technology in over three-quarters of all new coal-fired power stations for the next 30 years (IEA 2004). In addition, in many Asian countries, technologies for energy efficiency improvement and energy conservation are important in terms of achieving energy security and minimising local air pollution.

Notwithstanding the national aspirations of technology development and expectations for international technology cooperation, participants expressed serious concerns on the ability of the current international regime in facilitating technology development and transfer. Many participants were concerned about severe restrictions in place even on technologies already transferred to the countries. For example, Table 5.3 shows the degree to which restrictive conditions are imposed upon various technologies introduced into Thailand.

Notwithstanding the national aspirations of technology development and expectations for international technology cooperation, there are many concerns over the current international regime.

Table 5.3 Restrictions on technology transfer (e.g. Thailand)

Item	USA	Japan	Germany	UK	France	Others	Total
Technologies introduced	209	168	37	28	20	61	523
Technologies introduced accompanied by patent rights	122	82	28	18	4	31	280
% of technologies with restrictions	58.4	48.8	62.2	64.3	20.0	50.8	53.5

Source: Chantanakome, 2003

Many participants noted that under Annex I National Communications, only "soft" technology transfer including information networks and capacity building was often listed as transfer of technologies. Some participants argued that the poor record of technology transfer so far implied that the use of market mechanisms such as CDM was a failure. The transfer of technologies for adaptation faces additional barriers when compared to mitigation technologies; the uptake of such technologies is dependent on the buy-in and involvement of an expanded stakeholder community, and there is unwillingness at present to provide the funding required to transfer these technologies (Klein et al. 2006).

The rigidity of intellectual property rights (IPR), including the long duration of protection, was considered as another barrier to collaborative technology development projects and technology transfer. Some participants claimed that the 20-year protection period for patented technologies under the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement of the World Trade Organisation (WTO) makes climate-friendly technologies obsolete by the time they are transferred to developing countries.

Although the potential of renewable energy sources is widely known in many Asian countries (especially in China, India, Indonesia, the Philippines and Viet Nam), renewable energy as a means of GHG mitigation has limitations in terms of both technology and economics. The technologies are not commercially competitive yet, and are burdened with high costs and high capital intensity, which stunts wider dissemination. A few participants (e.g. LDCs and SIDS) expressed that technologies for adaptation did not receive much attention in the current regime and sought for fair sharing of knowledge, technology and tools in future. They also expressed that effective transfer of technology should not be confined only between north and south but also between south and south. Some participants (e.g. India) noted that technology transfer in practice has become more of a financial transaction rather than a knowledge transaction.

Climate-related funding under the current regime is both inadequate and unpredictable.

Some participants noted that climate-related funding under the current regime is both inadequate and unpredictable. They noted, for example, that only US$ 2.7 million was allocated for technology transfer out of nearly US$ 45 million available for allocation under SCCF (GEF 2006). A further obstacle is the lack of domestic funds for technology development and deployment: China, for instance, has its own environmentally-sound technologies, but not the financing to localise and commercialise them (Peng et al. 2005). Many participants argued, therefore, for more proactive involvement of the private sector in technology initiatives in Asia and the Pacific, considering the fact that the private sector makes enormous investments in the energy sector. Striking the balance between publicly-funded R&D and private sector investments in terms of their appropriate roles in developing new technologies is a major challenge to be addressed in the future regime.

Developing countries would only be able to be effective partners in technology transfer if they were able to choose, absorb, use and improve the technologies acquired.

Participants (e.g. Nepal) noted that the lack of capacity in domestic institutions for dissemination of low carbon technologies was another barrier. Inadequacy in enabling environments in general, and lack of incentive mechanisms to reward the adoption of clean technologies in particular, were often considered as missing components of such domestic institutions. Participants observed that developing countries would only be able to be effective partners in technology transfer if they were able to choose, absorb, use and improve the technologies acquired.

In summary, Asian stakeholders expressed many concerns over the current international regime:

(1) limited collaborative R&D and slow pace of the transfer of "hard" technologies

(2) lack of sufficient technology transfer under the current Kyoto Mechanisms

(3) rigidity of the international IPR system

(4) high costs and capital intensity of renewable energy technologies

(5) limitation of domestic and international fund availability and,

(6) lack of domestic incentive mechanisms and enabling environments.

To enable each developing country in Asia to have a sense of ownership and confidence in the evolving climate regime, these concerns should be addressed thoroughly.

5.5 Proposals for promoting technology development and transfer

Based on the recognition that technologies hold the central key to the success of future climate regime, several researchers and policy makers made proposals to strengthen technology development, transfer and deployment. The proposals are grouped into five areas:

(a) Promoting collaborative technology research, development and transfer

(b) Restructuring of the CDM

(c) Securing financial resources for technology development and deployment

(d) Improving the flexibility of IPR regime

(e) Enhancing "market-pull" mechanisms through setting technology targets and standards

5.5.1 Collaborative R&D and technology transfer as part of commitments

The future climate regime can provide incentives for technology development and transfer, through enabling collaborative R&D and/or transfer as part of commitments by Annex I countries. Dasgupta (2004) suggested that developed countries could comply with their legally-binding commitments by either meeting their emission reduction targets and/or through providing financial and technology transfer to developing countries. While preserving the basic structure of the Kyoto Protocol, this proposal would give Annex I countries a greater flexibility to achieve their commitments, as each developed country could determine its own mix of emission reductions and financial/ technology transfer commitments. In practice, however, optimisation of the two types of commitments remains a challenge.

While preserving the basic structure of the Kyoto Protocol, this proposal would give Annex I countries a greater flexibility to achieve their commitments, as each developed country could determine its own mix of emission reductions and financial/ technology transfer commitments.

Gupta (2003) proposed setting-up of numerical targets for technology transfer in relation to national income. This idea is part of a broad proposal with the aim of gradually involving developing countries in a commitments-based regime, with the countries being placed into 12 categories based on GNP per capita, CO_2 emissions per capita, and Human Development Index. High and upper-high income countries with medium to high GHG emission levels would be required to transfer technology at a rate equivalent to a minimum percentage of national income. However, several challenges, such as the categories and the agreement on specific numerical targets for technology transfer, would need to be overcome for implementation of this proposal.

The Ministry of Economy, Trade and Industry (METI) of Japan also proposed technology transfer as well as collaborative R&D with developing countries as part of commitments by developed countries, but on a non-binding, pledge and review basis (METI 2004). While arguing that an international climate regime should be based on the UNFCCC, the

The idea of enabling technology development and transfer as part of numerical commitments has spread at the conceptual level, but further studies on definition, quantification and modalities of implementation of such commitments are necessary.

proposal explored the possibility of bringing new initiatives among a smaller group of countries, and suggested multiple forms of commitments, besides quantitative emission reduction targets. This proposal suggested that international collaborative R&D and technology should be included in such multiple forms of commitments. Considering the poor record of non-binding commitments (technology transfer is a "commitment" under the Convention Articles 4.5 and 4.7), however, it is not clear how another non-binding agreement can really work.

In our consultations, participants repeatedly emphasised that developed and developing countries should conduct mutually-beneficial technology development and demonstration projects as well as technology transfer and deployment projects. The idea of enabling technology development and transfer as part of either legally-binding or pledge-and-review-based commitments has spread to some extent at the conceptual level, but further studies on definition, quantification and modalities of implementation of such commitments are necessary.

5.5.2 Restructuring of the CDM

Participants in our consultations repeatedly mentioned that the nature of project-based mechanisms in the current regime remains as an obstacle to enable effective technology transfer through the CDM. To overcome this limitation, several proposals were made to strengthen the CDM through widening the scope of activities that are eligible for the CDM. Such proposals include the following:

(a) Policy-based CDM, which allows public policies aimed at reducing GHG emissions to be eligible for the CDM without pre-established limitations in terms of geographical coverage (e.g. entire cities or regions); and,

(b) Sectoral CDM, where GHG emissions reduction activities along the lines of a sector or sub-sector are made eligible for the CDM project regardless of the type of enabling instruments (i.e. either private initiatives or public policies).[6]

A derivative of the policy-based CDM, Technology Transfer CDM, where a policy that promotes the adoption of a certain low-carbon technology within a single sector or across many sectors is eligible for CDM, was proposed at our consultations (IGES 2005a). However, the feasibility of implementing such proposal remains a grey area.

The METI of Japan proposed that a wider range of activities, including CCS and nuclear energy projects, be eligible for the CDM (METI 2004). While the eligibility of CCS projects for the CDM is now under consideration (UNFCCC 2006f), nuclear energy projects are still controversial in terms of both political, environmental and safety concerns.

Although all these approaches to expand the scope of the CDM are expected to contribute to sector-wide technological transformation in developing countries, it is still not clear how the expansion of the CDM scope alone can contribute to promoting technology transfer. Perhaps sector-CDM would facilitate technology deployment

6. The terms "sector-based", "sectoral" and "policy-based" CDM are used differently in the literature (see Bosi and Ellis 2005, Michaelowa 2005, Samaniego and Figueres 2002, Sterk and Wittneben 2005).

within a developing country rather than technology transfer from developed countries. In addition, such approaches face many problems: e.g. the establishment of a credible baseline, the treatment of additionality, the maintenance of the environmental integrity, and the reliability of emission monitoring (Sterk and Wittneben 2005).

It is still not clear how the expansion of the CDM scope alone can contribute to promoting technology transfer.

5.5.3 Securing financial resources for technology R&D and transfer

Currently, funds available under the UNFCCC are not large enough to finance the costs associated with the technological changes that need to occur in developing countries. Therefore, several new ideas were put forward for securing financial resources for technology R&D and transfer. Barrett (2003), for example, proposed the establishment of a protocol for a global R&D fund, as such protocol would aid the development of new technologies. In this scheme, developed countries contribute funds based upon the principle of ability and willingness, as in the UN scale of assessments, or historical responsibility for climate change. He also proposed a similar financing mechanism for technology transfer. Reliance on the principle of ability and willingness or historical responsibility, however, poses a challenge to political feasibility of implementing this proposal.

Shelling (2002) proposed the "Climate Marshall Plan"—an assistance programme for low carbon technology dissemination in developing countries in return for their commitment to mitigate GHG emissions. In this proposal, massive financial transfers to developing countries are expected to occur, and simultaneously satisfy some notion of equity. Developed countries would make financial contributions to an institution that would finance energy-efficient and decarbonised technologies in developing countries. The process of allocation of resources made available by the scheme is based on ad hoc agreements between donor and recipient countries on how to spend grants, as well as "multilateral reciprocal scrutiny" of emission-reduction actions of the latter. As the proposal aims to attain twin objectives of GHG reduction commitments from developing countries and technology transfer, it needs to be further explored. However, implementation of this approach has, at least, two problems. First, its environmental effectiveness is not certain. Second, as Shelling himself recognises, "the burden on the rich countries will undoubtedly be more political than economic" (Shelling 2002).

As funds available under the UNFCCC are not large enough to finance the costs associated with the technological changes that need to occur in developing countries, several new ideas were put forward for securing financial resources for technology R&D and transfer.

Benedick (2001) proposed that revenues from a harmonised carbon tax among like-minded countries (including both developed and developing countries) might be used to finance an R&D fund and promote technology transfer. Potential difficulties with this approach are many. First, taxation is at the core of sovereignty of nation-states, thereby sparking off political obstacles to the harmonisation process. Secondly, developing countries may not be willing to participate as they might consider it unfair to adopt the same amount of tax as developed countries, given the unequal historical responsibility for climate change; and, thirdly the governments may be tempted to neutralise the effect of a carbon tax, especially during a period of economic recession or stagnation.

Aldy et al. (2001) proposed a hybrid international emissions trading programme that combines an international emissions trading scheme, not unlike that founded in the Kyoto Protocol, with a safety-valve or price cap mechanism. Under the safety-valve mechanism, when a permit price hits a certain level, additional permits would be sold without any upper limit.[7] One variation of this approach involves the creation of an international body that would sell additional permits and use the proceeds from the sale of such for mitigation efforts in and technology transfer to developing countries. The merit of this proposal is that the mechanism can be built upon the Kyoto Protocol, thereby reducing the long negotiation process. However, setting the price of an international safety valve may very well result in another political battle. In addition, creating a new powerful international financing body might not be acceptable to some groups (e.g. the USA Congress) and some countries.

Sugiyama et al. (2004) examined the role of international treaties in securing domestic financial sources, rather than financial resources at the international level. They proposed the Zero-Emission Technology Treaty (ZETT) and the Climate-wise Development Treaty (CDT) as part of a "nested" international climate regime. Under ZETT, participating countries would make non-binding pledges of zero-emissions from energy-related CO_2. Such symbolic goal of ZETT could send a strong signal to both domestic political arenas as well as markets. Countries participating in the CDT would agree to modify the flows of financial assistance so that it mainstreams such climate issues as transfer of low carbon technologies, mitigation and adaptation, into development policies.

Further work is necessary to identify ways to overcome specific instances of IPR related barriers to acquisition of existing proprietary technologies.

5.5.4 Improving the flexibility of intellectual property rights on low carbon technologies

The rigidity of the current international IPR regime is considered a major barrier for promoting transfer of low carbon technologies, which require significant up-front investment and have patented production processes. Many participants in our consultations recommended further work to identify ways to overcome specific instances of IPR related barriers to acquisition of existing proprietary technologies.

Ogonowski et al. (2004) proposed policy options that address IPRs according to the stage of technology development. For technologies under development, they proposed creation of an international association that coordinates and develops new technologies and hold IPRs in a pattern similar to that of the Consultative Group on International Agricultural Research (CGIAR). An international organisation could then be founded for developing advanced low carbon technologies and all participating countries would have access to the technologies developed. However, the CGIAR, as an informal association, has no formal role in the ownership and control of the gene collections under its umbrella, and the legal status of such collections has always been problematic (Blakeney 2002). Furthermore, the increasing use of modern biotechnology has caused a series of IPR-related problems under the CGIAR system. The development of advanced climate-friendly technologies that usually contain a number of technology components and processes subject to IPR protection may lead to similar problems that the CGIAR is facing now.

For technologies beyond the primary development stage, Ogonowski et al. (2004) suggested that IPR options could be either based on compulsory licensing or bilateral negotiations. Following the case of compulsory licensing for AIDS medicine under the Doha Declaration of the TRIPs, governments could grant domestic manufacturers

7. For more details on a safety-valve mechanism, see Pizer (1999).

licence of advanced technologies, who must then pay royalties to IPR holders over time, not up-front.[8] Alternatively, governments and IPR holders could bilaterally negotiate an agreement on potentially non-financial terms. For low carbon technologies a similar arrangement can be made for an exchange of, for instance, CERs.

Compulsory licensing, however, does not automatically solve the problems of access to technology in developing countries, and the aggressive use of compulsory licences as an instrument of technology transfer may rather eliminate prospects for effective technology transfer (Correa 2005). Compulsory licensing may even discourage aggregate investments of foreign companies in the developing countries. Furthermore, the transfer of hardware through compulsory licensing does not compel the transfer of know-how and expertise necessary for generating and managing technical change, which many observers see as an indispensable element of effective technology transfer (Bell 1990, Watson 2002). For hybrid drivetrains (which are subject to strict IPRs), for example, the firms owing the IPRs would have to train mechanics in the recipient country in fitting and maintaining the drivetrains, which raises a skilled manpower issue. To avoid such negative consequences, policy-makers seeking compulsory licensing should take into account the summation of social costs that may, in the end, outweigh short-term benefits of this action (Reichaman and Hasenzahl 2003), and find a way through which foreign and local interests could be mutually satisfied.

Another way to improve the flexibility in the IPR system for low carbon technologies is to shorten the duration of IPR protection. This idea was raised on many occasions throughout the first round of our consultations (IGES 2005a). Two basic ideas lie behind the proposal: one is that since climate-friendly technology retains the nature of public goods, IPR protection rules should be liberally applied to it; and, the other is that the 20-year duration of patent protection makes technologies obsolete when the protection is removed. From the viewpoint of patent holders, however, simply shortening the duration of patent protection may not be so favourable, since they need to recuperate the costs for R&D. Thus, a more balanced approach, such as the establishment of a funding mechanism for purchasing licenses by developed and developing countries so that low carbon technologies could be used in the developing countries, would be necessary.

5.5.5 Enhancing "market-pull" mechanisms through international cooperation

Internationally agreed technology targets and standards can help participating countries to establish or enhance such "market-pull" mechanisms at the national level. However, this approach has the difficulty in achieving a political consensus.

Internationally agreed technology targets and standards can provide a "pull" incentive to commercialise new, low carbon technologies, and help participating countries to establish or enhance such "market-pull" mechanisms at the national level. Although Barrett (2003) stresses the self-enforcing nature of technology standards (if enough countries adopt the standards, others will follow due to economies of scale in production), adoption and implementation of such standards would actually help to gear domestic institutions towards the dissemination of low carbon technologies. Benedick (2001) suggested two such policies and measures (vehicle fuel-economy standards among auto-producing countries, and technology targets for power generation and fuel refining), while Ninomiya (2003) proposed an international agreement on appliance efficiency in the residential and transportation sectors in major GHG emitting countries.

8. Ockwell et al. (2006) also points out the possibility of drawing on the experiences of the Doha Declaration in the climate context.

Most of the proposals discussed focus more on technologies for mitigation than on adaptation technologies. A few proposals specifically refer to the need for supporting adaptation technologies.

Edmonds and Wise (1998) proposed medium- and long-term technology targets for Annex I, as a "backstop" in the case of failure of the first-best option, i.e. efficient policies such as tax or tradable permits. Here, technology targets can, for example, require all new power plants to capture and store all the carbon from their waste streams after 2020, and require new fossil fuel refining capacity to capture and sequester carbon from fuels after 2050. The proposal is also equipped with a graduation provision in that non-Annex I countries would be subject to the targets when their per capita income, in Purchasing Power Parity terms, equalled the average for Annex I countries in 2020 or 2050. This provision addresses the equity issue to some extent.

A major drawback of the above approach would be the difficulty in achieving a political consensus. The failed attempt to make all countries to commit themselves to reach some degree of renewable energy sources in their primary energy supply, and the fact that negotiations over certain provisions of the Kyoto Protocol remain locked in a stalemate clearly demonstrates how difficult it is to harmonise such domestic policies. Reaching some form of consensus on standards and targets even within a limited range of technologies through a multilateral environmental agreement such as that of the UNFCCC requires considerable efforts by both developed and developing countries.

Given the long history of emphasis on mitigation efforts by the international community, most of the proposals discussed above focus more on technologies for mitigation than on adaptation technologies. One proposal by Torvanger et al. (2005), however, specifically refers to the need for supporting adaptation technologies through establishment of a separate adaptation protocol, as part of the broader framework for mitigation commitments.

5.6 Perspectives on technology R&D and transfer

Diagnoses of the problems related to technology R&D and transfer vary depending on particular positions held by stakeholders and technologies concerned, and prescriptions accordingly differ. This section examines various perspectives on technology R&D, transfer, and deployment as revealed through our consultations.

From the view point of Asian developing countries, participation in international technology collaboration is seen as a good vehicle to access knowledge and build capacity.

5.6.1 Perspectives on R&D

There are various motivations for governments to participate in technology cooperation: knowledge creation; cost sharing; access to facilities and resources; strengthening of domestic capabilities through the exchange of information and experience; pursuit of specific economic, technological, political objectives, and creation of goodwill through science (Justus and Philibert 2005). Indeed, many participants to our consultations saw participation in such collaboration as a good vehicle to access knowledge and build capacity. Perhaps this is the reason why countries with a coal-based energy structure, like China and India, have a keen interest in collaborative R&D in clean coal technologies and CCS technologies, for example, through taking part in the APP and the CSLF.

The slow development of technology R&D cooperation under the current climate regime has led to frustration among many Asian developing countries. One Chinese participant, for instance, noted that developing countries may become less and less interested in the APP if no substantial joint technological development is demonstrated soon. A few participants (e.g. India) noted that international technology collaboration must not be a pretext for exploitation of human and other resources in developing countries. Another typical problem concerns the imbalance in information among collaborators, where they are exposed to a temptation to engage in strategic behaviour to take advantage of the situation. For instance, technology collaborators may make less than full disclosure of their ongoing research and progress until they know what their relative position is in relation to that of others.

Technology developers in developed countries express concerns about IPR protection in countries with a history of weak enforcement. They also express concerns about possible loss of existing competitive advantage against recipients. One case of a clean coal technology programme in China showed that the weak IPR protection in developing counties would depress the willingness of domestic companies to adopt new technology due to the fear that competitors in their own markets could freely copy such technologies (Watson 2002, Justus and Philibert 2005, Liu and Vallentin 2005). Strengthening the infrastructure of information gathering on technology development alliances, and effective capacity building and institutional strengthening for technology development and adaptation are, therefore, crucial.

Participants in Southeast Asian consultations (e.g. the Philippines) expressed the need for establishing national R&D funds for low carbon technologies using local resources, rather than solely depending on international mechanisms.

5.6.2 Perspectives on technology transfer

There are sharp disagreements between developed and developing countries with regard to causes for ineffective technology transfer to the latter.

There are sharp disagreements between developed and developing countries with regard to causes for ineffective technology transfer to the latter. Developed countries often attributed the slow progress in technology transfer to deficiencies in domestic institutions of developing countries. A presumption here is that private firms own climate-friendly technologies, and that the firms only transfer their technologies if it is in their commercial interest to do so. At COP3, for example, the Australian delegation noted that "the bulk of environmentally-sound technologies are privately developed and owned. Governments can create enabling conditions for technology development and recipient countries must have appropriate policies for successful transfers" (ENB 1997). The USA proposed at COP4 that "GEF supports programmes to assist developing countries in altering their policy and legal frameworks in support of technology transfer" (ENB 1998), for example.

Many developing country participants of our consultations, however, emphasised that developed countries have an obligation to transfer technologies under the current regime. Participants insisted that the governments of developed countries must enhance technology transfer by stimulating the supply of technologies via mechanisms such as government-to-government programmes or increasing financial and technical support. They noted that the lack of willingness and awareness in developed countries as the fundamental reason for the limited progress of technology transfer. Throughout international climate negotiations, developing countries repeatedly expressed their frustration over the failure of Annex I parties to fulfil their commitments, as well as their limited transfer of technologies. At COP3, the Chinese delegation expressed their view: "developed countries are only interested in transfer of technical information, while developing countries deem technology transfer on non-commercial and preferential terms most important" (ENB 1997).

Asian developing countries have proposed several ideas to realise technology transfer. Participants in South Asian consultations recommended linking technology transfer to commitments by developed countries, and suggested that nations with commitments should buy the necessary IPRs and freely transfer relevant technologies to developing countries. They also suggested that the future climate regime should consider allowing technology transfer to earn CERs on a case-by-case basis. Several such ideas were proposed in past negotiations of the UNFCCC. For example, at COP3, the Indian delegation proposed the operationalisation of FCCC provisions relating to state-of-the-art environmentally-sound technologies in a new legal instrument. At COP4, a G-77/China proposal set forth the establishment of a "technology transfer mechanism" to assist developing country parties to obtain environmentally sound technologies and know-how on non-commercial and preferential terms, which would thus contribute to the ultimate objective of the convention (ENB 1998). However, the USA opposed the G-77/China proposal since it would be difficult to agree on its terms of reference. It also opposed to the reference to "non-commercial, preferential terms," recalling that the reference was rejected when the convention was being negotiated (ENB 1998).

In climate negotiations, south-south technology transfer is frequently overlooked, but it has far-reaching implications for developing countries. Many developing countries have already established new forms of renewable energy supplies, and technologies in these countries are more suited to local technical and financial demands in developing countries than transfer from developed countries (TERI 1997). South-South technology transfers would be preferable because such mode of technology transfer can present a less malignant commercial threat to indigenous industries than transnational corporations (Forsyth 1999). Furthermore, among developing countries there is a greater prospect for south-south cooperation regarding the transfer of technologies and techniques for adaptation, rather than relying on developed countries. Such technologies and techniques are based locally, thereby being more suited to south-south cooperation. Participants suggested that the future climate regime should consider establishing a separate funding mechanism for south-south technology transfer together with a strategy to establish partnerships.

Whilst developing countries have taken several domestic measures to enhance technology deployment, they are sceptical about linking such domestic measures to international commitments in numerical terms.

5.6.3 Perspectives on technology deployment

Most participants of our consultations agreed that effective deployment or diffusion of low carbon technologies in developing countries is crucial to achieve the goals of the UNFCCC. For example, METI (2004) estimated that if 20% of energy is conserved in developing countries as a whole, which is possible by using currently available technologies, the increase in CO_2 emissions from developing countries from 2000 to 2020 would decline to roughly half of what it would be without such measures. Therefore, the EGTT urged in 2004 that technology "diffusion" should be recognised as an important process alongside innovation and development (UNFCCC 2004a,b), although EGTT discussions tended to focus on the supply of technologies and the roles of governments and international organisations (Forsyth 2005). Participants noted that domestic policies and measures in developing countries define national institutional conditions, which largely influence the deployment of low carbon technologies.

Several participants (e.g. China, India, the Philippines, Viet Nam) noted that developing countries have taken several domestic measures to conserve energy. Participants from China, for example, reported that the 11th Five-year Plan (2006-2011) called for overall consumption of energy per unit of GDP to be cut by 20% in five years. Recently, the Chinese government published a national list of energy efficiencies by region, which in turn offers a baseline for energy efficiency (*China Daily*, 4 July 2006). The Renewable Energy Law, with a target of 10 percent electricity generation from renewable energy, was also taken into force in China. India also enacted the Energy Conservation Act of 2001 and Electricity Act of 2003 in order to issue conservation measures.[9] Chandler et al. (2002) estimated that efforts already undertaken (including those related to technology deployment) by six developing countries (China, India, Brazil, Mexico, South Africa and Turkey) reduced their combined emissions growth by 288 million tons of carbon a year. It is worth noting that many Asian countries have begun to set targets for renewable energy utilisation, which again involves considerable technology deployment within those countries.

The question is whether or not such domestic measures and targets should be linked to international climate regime and, if so how. As discussed in Section 5.5.5, international technology standards can help participating countries establish or enhance domestic measures. In addition, if such common standards are established in sectors of internationally tradable goods, they provide a level playing field, thereby easing concerns held by developed countries about industrial competitiveness. The World Business Council for Sustainable Development (WBCSD), for example, has long worked on setting non-binding international sectoral standards or benchmarks in the cement sector.[10]

Participants from Asian developing countries are, however, highly sceptical about setting international technology standards or targets. Their view partly reflects a fear that such commitments on the sectoral basis may lead up to national emissions control targets in the future. Another drawback is the difficulty of negotiations over the selection of sectors and the setting of targets or standards.

Unilateral CDM could be another mechanism to link domestic technology deployment and international climate regime, subject to the availability of finance to operationalise CDM activities. Subsequent to the decision on procedures on unilateral CDM by the CDM-EB in February 2005, the number of unilateral CDM activities in Asia, especially in India, increased dramatically. While unilateral CDM does not lead to technology inflow from developed countries, it helps the dissemination of existing technologies throughout developing countries faster than a business-as-usual case, while also generating CERs. Most of the ongoing CDM projects in India are small-scale, such as biomass, which are carried out on a unilateral basis. However, the proliferation of unilateral CDM projects may increase the risk of a "lock-in" to less efficient technologies. An objective assessment of unilateral CDM in facilitating technology deployment is, therefore, urgently warranted. In the case of bilateral CDM projects, developing countries can facilitate technology transfer by focusing on the kinds of technology they wish to promote through their approval of CDM projects and programmes, and policies (Ockwell et al. 2006).

The proliferation of unilateral CDM may increase the risk of a "lock-in" to less efficient technologies.

9. IEA (2006) provides a concise review of domestic energy policies and measures of major developing countries, such as China and India. IGES (2005a) provides a brief review of climate change-related policies and measures taken in selected Asian developing countries.
10. See http://www.wbcsd.org for more details.

5.7 Three priorities for strengthening technology development and transfer

This section examines three areas where future climate regime discussions can make a difference to achieve the goal of rapid uptake of climate-friendly technologies. These include building synergies between the UNFCCC and the non-UNFCCC initiatives, enhancing the flexibility of IPRs, and improving financial mechanisms.

5.7.1 Building synergies between UNFCCC and non-UNFCCC initiatives

Technology development and transfer is a cornerstone of several new non-UNFCCC initiatives (such as the APP) which have the potential to provide the necessary paradigm shift in technology to reduce GHG emissions in selected industries. Given the growing energy demand, such shift needs to be especially accelerated in China and India. Therefore, it is crucial to build synergies between the UNFCCC and non-UNFCCC initiatives in order to address Asian concerns on technology comprehensively.

One example of synergy can be found in a process though which the M2M Partnership facilitates better access for coal mine methane project developers to markets in China. The climate regime provides unique CDM opportunities in methane recovery, and additional income for project developers. Of late, many providers of coal mine and coal bed methane recovery technology, who are members of the M2M Partnership, recognised the potential for carbon revenue (Point Carbon 2006a). While it remains to be seen if M2M-sponsored projects contravene the CDM additionality rules, the example shows a positive leverage point for building synergies between UNFCCC and non-UNFCCC initiatives.

Durable mechanisms to create incentives for CCS are not yet established at the international and domestic levels.

A similar approach is possible in the case of CCS technologies, which are subjects of interest in both UNFCCC and non-UNFCCC initiatives. CCS is a significant GHG mitigation option, although further studies on its health, safety and environment risks are necessary. As Figure 5.3 shows, many CCS components are mature enough for deployment (IPCC 2005). While considerable uncertainty remains, as Table 5.4 Shows it was estimated that Asian developing countries would have some potential for geological carbon storage (Hendriks et al. 2004). Assuming that capacity is sufficient and storage sites can be planned close to emission sources of CO_2, CCS could reduce overall mitigation cost significantly in Asian developing countries.

Figure 5.3 Current maturity of CCS system components
(the highest level of maturity for each component)

CCS Components	CCS Technology			
	Research phase [a]	Demonstration phase [b]	Economically feasible under specific conditions [c]	Mature market [d]
Capture		Oxyfuel combustion	Post-combustion Pre-combustion	Industrial separation
Transportation			Shipping	Pipeline
Geological storage		ECBM [f]	Gas or oil fields Saline formations	Enhanced oil recovery [e]
Ocean storage	Direct injection			
Mineral storage	Natural silicate minerals	Waste materials		
Industrial uses of CO_2				Industrial uses

Notes: a Research phase means that the basic science is understood, but the technology is currently in the stage of conceptual design or testing at the laboratory or bench scale, and has not been demonstrated in a pilot plant.
b Demonstration phase means that the technology has been built and operated at the scale of a pilot plant, but further development is required before the technology is ready for the design and construction of a full-scale system.
c Economically feasible under specific conditions means that the technology is well understood and used in selected commercial applications, for instance if there is a favourable tax regime or a niche market.
d Mature market means that the technology is now in operation with multiple replications of the technology worldwide.
e CO_2 injection for EOR is a mature market technology, but when used for CO_2 storage, its is only economically feasible under specific conditions.
f ECBM stands for enhanced coal bed methane recovery, and is the use of CO_2 to enhance the recovery of the methane present in unminable coal beds through the preferential absorption of CO_2 in coals.
Source: Adapted from IPCC 2005

Table 5.4 Potential for geological carbon storage in Asia

	ONSHORE (Gt CO_2)					
	Oil fields*			Gas fields*		
	Low	Best	High	Low	Best	High
East Asia	1.2	4.5	25	4	11.7	31.3
South East Asia	0.7	1.9	7.2	2.9	9.8	24.9
South Asia	0.1	0.5	2.3	4.1	13.4	33.5
	OFFSHORE (Gt CO_2)					
	Oil fields*			Gas fields*		
	Low	Best	High	Low	Best	High
East Asia	0.4	1.7	5.6	0.3	0.4	1.1
South East Asia	1.4	5.2	17.6	18.1	34.9	65.7
South Asia	0.5	1.9	5.3	1.9	5.2	14.1
	ECBM**			Aquifers		
	Low	Best	High	Low	Best	High
East Asia	0	158	840.7	1.7	13.4	60.3
South East Asia	0	19	113.9	0.8	6.4	28.8
South Asia	0	2	11.9	2.7	21.2	95.5

Notes: * Oil and gas fields include both remaining and depleted fileds. All future oil is assumed to be produced with CO_2-enhanced oil recovery.
** ECBM stands for enhanced coal bed methane recovery.
Source: Adapted from Hendriks et al. 2004

In spite of the high potential in terms of both technological and storage capacity, there remain significant gaps in knowledge in the non-technical aspects (e.g. legal, regulatory, economic and social acceptability issues) of CCS, which need to be addressed before it can be broadly deployed (Coninck *et al.* 2006). In response to the G-8 Gleneagles Plan of Action, the CSLF has been working on these issues and plans to provide policy recommendations by 2008 (McKee 2006). However, durable mechanisms to create incentives for CCS are not yet established at the international and domestic levels.

If CCS projects become eligible as CDM project activities, the UNFCCC process may establish an international framework for CCS to provide the necessary incentives. The UNFCCC and its Kyoto Protocol do not expressly include or exclude CCS as an emission reduction mechanism. Since publication of the IPCC Special Report on CCS (IPCC 2005), discussion on applicability of CCS in CDM has started in the UNFCCC.[11] The CDM-EB stated that the issues of project boundaries, leakage, permanence, *inter alia*, need to be considered (UNFCCC 2006f). While it is necessary to carefully examine whether market mechanisms are an appropriate form of incentive to address risks in CCS investment, CCS is worth considering.[12]

Linking UNFCCC and non-UNFCCC initiatives more closely through information sharing could offer a platform for synergies.

Establishing a mechanism that functions as an intermediary conduit for knowledge on successful technology-development and -acquisition programmes could be another approach. The UNFCCC has developed an information clearing house, TT:CLEAR, but its technology information network is still limited. The success of TT:CLEAR partly depends on how far national governments engage with it, for example, through the submission of relevant information. More information on the outcomes of various technology programmes undertaken by governments through both UNFCCC and non-UNFCCC initiatives is expected to promote synergies. Such information can serve as a foundation for concerted actions in the future climate regime.

In short, combining facilitative roles played by public-private partnerships of various non-UNFCCC initiatives with incentive mechanisms of the UNFCCC is useful to create further synergies. Linking these initiatives more closely through information sharing could offer a platform for synergies.

5.7.2 Enhancing flexibility of intellectual property rights for low carbon technologies

By pursuing collaborative R&D initiatives at an early stage of technology development, both developed and developing countries could potentially enter into joint ownership of IPRs.

Many participants of our consultations emphasised the need for treating critical low carbon technologies as global public goods and for enhancing the flexibility of the IPR regime. However, it is necessary to first identify the critical technologies needed by the various Asian countries, and examine how IPRs are acting as a barrier to transfer of technology. It is also critically important to understand whether and how IPRs as a barrier to technology transfer might differ in importance depending on the stage of technology development or the nature of the technology itself. A case study of an IGCC programme between India and the UK, for example, identified that the key barrier for IGCC use in India was not the IPRs per se but the lack of knowledge on whether IGCC could work

11. The IPCC Special Report on CCS was developed in response to an invitation of COP7 in 2001. In the Marrakech Accords, clear mention was made of CCS.
12. Other than the issues raised by the CDM-EB, the price of CERs might be simply too low to be an incentive for CCS. IPCC (2005) pointed out that for CCS to be deployed in the power sector, the price of CO_2 reductions would have to exceed 25-30 US$/t$CO_2$.

even with the low quality of Indian coal and the technology's lack of a track record (Ockwell et al. 2006).

Several routes are available to move forward in dealing with IPRs. One approach recommended by participants of IGES consultations is to pursue collaborative R&D initiatives at an early stage of technology development so that both developed and developing countries could potentially enter into joint ownership of IPRs. They noted that such collaborative activities help developing country participants improve their capacity to absorb new technologies. Another option is to create a Multilateral Technology Acquisition Fund, as recommended by the South African Ministerial Indaba on Climate Action in 2006 (http://unfccc.int/files/application/pdf/20060626_indaba.pdf), which could be structured to buy-out IPRs and make privately-owned, climate-friendly technologies available for deployment in developing countries.

Collaborative R&D initiatives need to feature IPR-related capacity building programmes.

For achieving joint ownership of IPRs with developed country parties, Asian developing countries need to build the capacity to formulate their negotiating positions and become well-informed negotiating partners (Muller et al. 2003, Pengelly 2005). Such capacity is a minimum requirement for them to fully enjoy the fruits of international technology cooperation. Indeed, in most of the ongoing international initiatives on technology R&D in which Asian developing countries are taking part, the treatment of IPRs is left to their implementation agreements and is to be addressed on a case-by-case basis. [13] It also partly mitigates the concern expressed by the Indian participants of the possibility of collaborative initiatives being used by developed countries to exploit the human resources of developing countries. Thus, collaborative R&D initiatives need to feature IPR-related capacity building programmes.

It would be worth considering the establishment of an international code of compulsory licensing procedures with special reference to technologies for climate change.

Another approach to enhance the flexibility of the IPR regime for climate-friendly technologies is along the lines of approaches taken to combat HIV/AIDS (e.g. compulsory licensing) (Ockwell et al. 2006; Ogonowski et al. 2004). However, many participants felt that the global community has not yet recognised the problem of climate change as being as serious as that of AIDS. Furthermore, the aggressive use of compulsory licensing might result in negative consequences.[14] In this context, it would be worth considering the establishment of an international code of compulsory licensing procedures with special reference to technologies for climate change. Such an international code may offer benefits in terms of reducing costs, enhancing certainty, and saving time. In this process, it is important for the climate policy community to achieve consensus on the list of critical technologies to be subject to the international code of compulsory licensing procedures. Simultaneously, Asian countries should try to enforce a well-defined national IPR legal structure so that developed countries could more proactively encourage their firms to disseminate low carbon technologies.

13. See Charter for the APP, available at http://www.asiapacificpartnership.org/Charter.pdf, also Terms of References for the IPHE, available at http://www.iphe.net/ and Charter for the CSLF at http://www.cslforum.org/.
14. There is some confusion about the grounds for granting compulsory licences. Under the TRIPS Agreement, which does not specifically list the reasons that might be used to justify compulsory licensing, governments can establish compulsory licences on grounds of protecting the environment, or for reasons of "public interests", depending on the provisions of national legislation (Correa 1999).

International funding mechanisms, like those under the UNFCCC, could be utilised to buy down the IPRs of such technologies and improve their access.

5.7.3 Improving financial mechanisms to accelerate technology deployment

Ensuring additional finance through innovative public and private support mechanisms is critical to make the currently available technologies commercially competitive in the market. Energy efficiency and renewable technologies in particular need such support in Asian developing countries. If such technologies are covered by existing IPRs, international funding mechanisms, like those under the UNFCCC, could be utilised to buy down the IPRs of such technologies and improve their access – as has happened in the case of the Montreal Protocol dealing with ozone depletion. The Montreal Protocol initially provided no mechanism to support developing countries in meeting ODS (Ozone depleting Substances) reduction measures. In order to address developing country concerns, however, the London Amendment in 1990 revised the Protocol and established the Multilateral Fund for the implementation of the Montreal Protocol (MLF). The MLF is used to finance incremental costs (additional costs incurred when a company switches from an ODS technology to a non-ODS technology) and several clearing-house functions relating to technical co-operation, information exchange or training programmes. Incremental costs are defined in the Indicative List of Categories of Incremental Costs, developed by the MLF Executive Committee. Similar efforts are necessary in the case of clean energy technologies. Although the MLF should only cover incremental costs in principle, Zhao and Ortolano (1999) reported that grants from the MLF typically cover a significant proportion of funds needed by enterprises to shift to non-ODS technologies. Likewise, for projects producing net benefit through changing non-ODS technology, financing is provided through concessionary loans. Again, provision of such loans is not originally stipulated by the MLF; it was made possible after making necessary modifications to the rules (De Sombre and Kauffman 1996). Therefore, several lessons can be learnt from the implementation of the Montreal Protocol in facilitating deployment of clean energy technologies. It must be noted, however, that incremental costs for technologies utilised in implementing the Montreal Protocol and the UNFCCC vary quite widely. The World Bank estimates that the incremental cost of decarbonising the power sector alone in developing countries could reach US$ 30 billion per annum between now and 2050 depending on the level of decarbonisation and the assumed baseline (World Bank 2006a).

In the case of emerging technologies, the future climate regime could play a facilitative role in documenting the success stories of various policy instruments that can offset higher overall costs of such technologies. For example, with the introduction of the feed-in-tariff law to promote renewable energy in Germany in 1990, the cost of wind energy declined rapidly between 1990 and 2003, as the technology improved and became more fully deployed (CCAP 2006). Discussions on new technologies at the UNFCCC can also facilitate decision making at the multilateral financing institutions such as the World Bank, which has recently proposed a new investment framework for clean energy and development to foster the development of innovative but less competitive technologies.

5.8 Concluding remarks

Our consultations confirmed that optimal utilisation of low carbon technologies in Asian developing countries is central to tackling climate change, and that there is no single recipe for successful development, transfer and deployment of technologies. Further, it is worth bearing in mind that, due to both domestic and international barriers, the diffusion of new technologies has historically been a slow process, and that Asian developing countries have strong concerns about the pace and quality of support from developed countries for development, transfer and deployment of climate-friendly technologies. On the other hand, participants in our consultations made several constructive suggestions, implementation of which is certain to aid in achieving the future goals of the UNFCCC. The consultations emphasized the need for encouraging synergies between UNFCCC and non-UNFCCC initiatives and for enhancing the flexibility of IPR regime by treating critical low carbon technologies as global public goods. The future regime should also facilitate innovative options for financing of technology development and transfer.