

Chapter 6

Achieving Environmentally
Sound Development in Asia
through the Transfer of Low
Carbon Technology

Chapter 6

Achieving Environmentally Sound Development in Asia through the Transfer of Low Carbon Technology

Abdessalem Rabhi and Yuki Shiga

1. Introduction

Developing countries in Asia, led by China and India, are among the fastest growing economies in the world today. According to the International Energy Agency's (IEA) Outlook, economic growth in the region in the coming 20 years will exceed the average level of the world economy, boosting a continuous increase in primary energy demand (IEA 2009). While such economic development offers great opportunities for poverty eradication in the region, it would sharply increase greenhouse gas (GHG) emission levels unless properly designed in line with sustainable development. A sharp increase in GHG emission levels would result in a climate change outcome seriously endangering the future environmental quality and human well-being of the region and, eventually, of the earth. Climate change is already a tangible threat for Asian countries. As many as 1.2 billion people in the Asia-Pacific region face the prospect of freshwater shortages by 2020, while crop yields in Central and South Asia could drop by half by 2050 (ADB 2009). Many key coastal cities could also see increasingly serious flooding. Thus, achieving environmentally sound development in Asia is an important policy issue.

The chapter's clear message is that the transfer¹ of low carbon technologies to, and within, Asia can play a key role in achieving environmentally sound development in the region. It emphasizes that the deployment and diffusion of low carbon technologies to, and within, the region should be scaled up, since they are major contributors to CO₂ emission abatement. The chapter's objective is to provide several strategies on how to promote this process.

Key Messages

- The transfer of low carbon technologies, to and within, Asia can play a key role in achieving environmentally sound development in the region.
- Government and companies should focus more on promoting the deployment and diffusion of commercially available technologies which are associated with fewer barriers. This does not mean that R&D and demonstration of new technologies are not important, but emphasizes that deployment and diffusion are more urgent actions given the risk associated with current global environmental and economic conditions.
- Considering the shortcomings of current centralized mechanisms and bi/multi-lateral initiatives, three strategies are proposed to promote the deployment and diffusion of low carbon technologies to, and within, Asia including rewarding projects with low carbon technology transfer with credits, supporting the proactive involvement of the private sector and by promoting low carbon foreign direct investment (FDI) to, and within, the region.

Promoting low carbon technology transfer is widely considered a determinant factor to reduce GHG emissions that would contribute to climate change mitigation. At the global level for example, according to IEA's "Energy Technology Perspective," if governments worldwide introduce no new energy and climate policies, energy-related CO₂ emissions will increase from 28.8 Gt in 2007 to 34.5 Gt in 2020, and may reach 57 Gt in 2050. In contrast, through deployment and diffusion of existing and new low carbon technologies this amount may be reduced to about 14 Gt by 2050 (IEA 2010).

At the regional level for example, as indicated in Table 6.1, technologies related to energy efficiency are a major potential contributor to CO₂ emission abatement in the ASEAN region (Olz and Beerepoot 2010). They could contribute to a 319 Mt reduction in CO₂ by 2030. Technologies related to renewable energy (especially in power generation) are the next major contributors to possible CO₂ emission abatement in the ASEAN region, contributing to a 121 Mt CO₂ reduction by 2030.

Table 6.1 Energy-related CO₂ emission reduction by source in the 450 Scenario² relative to the reference scenario: ASEAN region

Measures	2020	2030
Efficiency	84	319
- End-use	82	308
- Supply	1	11
Renewable energy	2	121
Biofuels	9	20
Nuclear	3	33
Carbon capture and storage (CCS)	1	18

Note: Emission reduction is measured in Mt CO₂

Source: Olz and Beerepoot (2010)

The transfer of low carbon technology sounds simple, but in reality it is a process that is quite difficult to quantify. It is a highly complex process of sharing physical assets, technical knowledge and skills, influenced by domestic and international factors that hinder the application even of the most promising technology. Barriers and challenges to, and instruments for this process are very different depending on the level of maturity of the transferred technology. Thus, looking for the most appropriate strategies that could promote the transfer of low carbon technology to, and within, Asia will be addressed in the rest of the chapter.

The remainder of the chapter is arranged as follows. The second section defines the concept of low carbon technology transfer, and outlines the results of discussions on this issue under the United Nations Framework Convention on Climate Change (UNFCCC) process. The third section reviews the main current mechanisms and multilateral and bilateral initiatives regarding low carbon technology transfer. The fourth section proposes new and improved strategies on how to promote the process of low carbon technology transfer. The last section draws conclusions and provides several policy recommendations.

2. Technology transfer

2.1 Definition

The Intergovernmental Panel on Climate Change (IPCC) defines technology transfer as "...a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions" (IPCC 2000: 7).

In this chapter, technology transfer refers to the horizontal flow of technologies that enable GHG emissions reduction to Asian countries (north-south) and within developing Asian countries (south-south). The flow may involve materials and products, technical knowledge (theoretical ability) and technical skill (practical ability to execute technical knowledge). It is a process that occurs via a variety of pathways (foreign direct investment (FDI), direct purchases, government assistance programmes, licensing, joint ventures/collaboration, cooperative research agreements, public-private partnerships, etc.), and involves various stakeholders who play different roles including developers, owners, suppliers, buyers, recipients and users of technology, as well as financiers, donors, governments, international institutions, NGOs and community groups, among others.

It is possible to transfer a technology at any stage of its life cycle³ from one geographical location to another, and several specific barriers can be associated with each stage of maturity of technology (Table 6.2). Technologies which are at their deployment and diffusion stage may be much less affected by intellectual property right (IPR) issues compared to technology at earlier stages of development. Their environmental and economic impacts can easily be measured, reported and verified, and they are often less expensive than those which are still at the demonstration stage.

Table 6.2 Stage of technological maturity and barriers to technological transfer

Type of barrier	Stage		
	Research and development	Demonstration	Deployment and diffusion
Proof of concept	○	X	X
Intellectual property rights	○	○	X
Measuring, Reporting, Verification (MRV)	○	○	X
Financial	○	○	○
Social	○	○	○
Institutional	○	○	○

Note: ○: Technologies are affected by the barrier

X: Technologies are not or less affected by the barrier

Source: Authors, based on UNFCCC (2009)

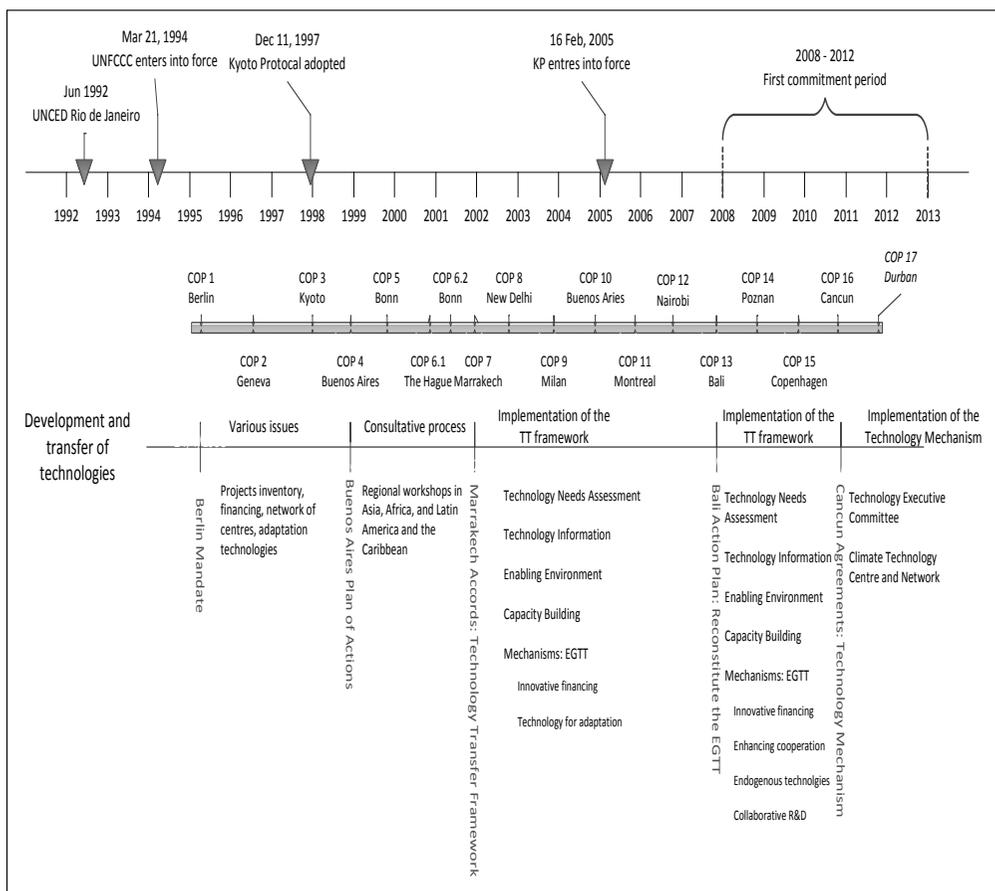
The technology transfer process may be evaluated as successful if the recipient of technology can effectively utilize the transferred technology and eventually assimilate it. This definition is valuable because it clarifies that technology transfer is not simply about the supply and shipment of technology: it is about the complex process of selecting the most appropriate technology available in the supplying country and adapting it to local conditions in the recipient country. It is a process of integrating several stakeholders to

overcome various economic, social, and institutional barriers related to the differences between the two countries. Hence, it is a process of technology application rather than simply technology transfer.

2.2 Review of discussion about technology transfer under UNFCCC processes

Since 1994, at each session of the Conference of the Parties (COP), parties have taken decisions on the development and transfer of environmentally sound technologies. Furthermore, the development and transfer of technologies is a standing agenda item of both the Subsidiary Body for Implementation (SBI) and the Subsidiary Body for Scientific and Technological Advice (SBSTA). The evolution of the issue over time and key decisions taken are illustrated in Figure 6.1.

Figure 6.1 Development and transfer of technologies under the UNFCCC process



Source: Technology Executive Committee (2011)

The negotiations on technology development and transfer under the UNFCCC did result in multiple areas of convergence. While this is certainly a significant step forward, these areas were where consensus among parties was relatively easy to reach (Table 6.3). The more challenging components of negotiations have not yet been settled and a number of areas of substantial disagreement still remain. Disagreements over the role

and treatment of IPR stand out in particular. Finance and the provisions for MRV and compliance with respect to technology transfer are other areas of contention. Evidence points to the likely continuation of these disagreements among UNFCCC parties for the near future.

Table 6.3 Result of negotiations on technology development and transfer under UNFCCC

Areas of agreement	Areas of controversy
■ Establishment of a technology mechanism	■ IPR
■ Enhanced strategic planning on technology and improved cooperation	■ Finance
■ Addressing the full technology cycle	■ MRV and compliance with respect to technology transfer
■ Creating enabling environments for private investment	
■ Overall efforts needed	

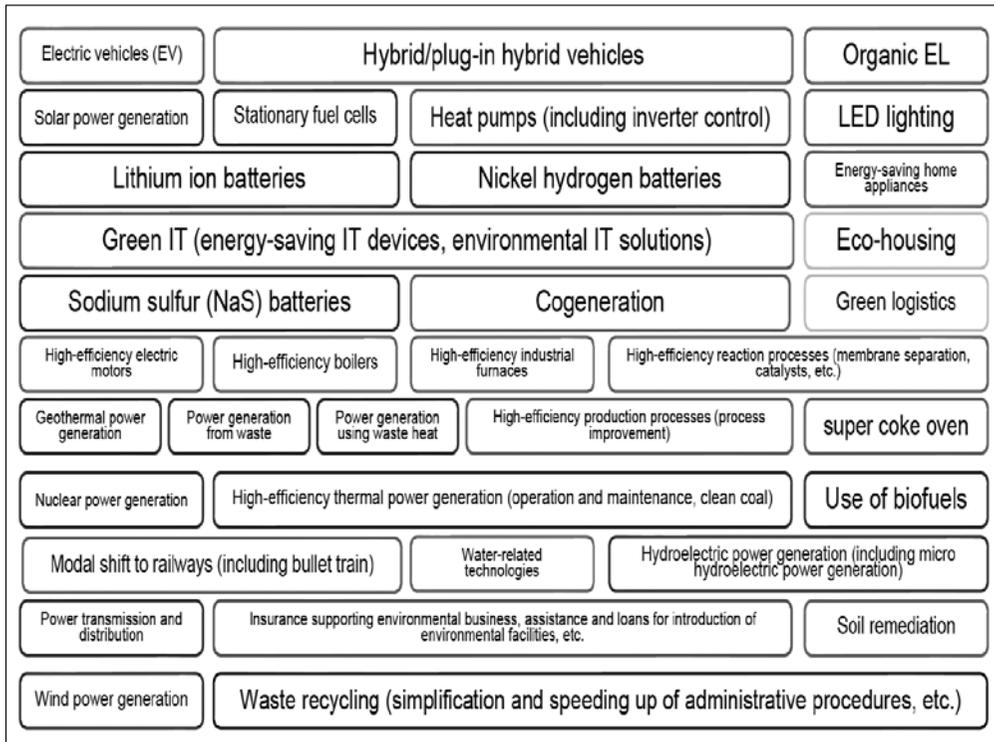
Source: Marcellino et al. (2010)

While the discussion among UNFCCC parties is ongoing, perhaps the most urgent action is to focus on promoting the horizontal transfer of low carbon technologies which are at their deployment and diffusion stage. These technologies are associated with fewer barriers, as explained above, in particular, the controversial barriers currently under UNFCCC discussion, namely IPR, MRV and finance. By focusing only on the deployment and diffusion of proven and commercially available low carbon technologies, a considerable amount of energy saving and CO₂ emissions reduction can be achieved. As indicated above, IEA (2010) estimated that through the deployment and diffusion of existing and new low carbon technologies, global CO₂ emissions from the energy sector may be reduced to about 14 Gt by 2050 compared to emissions levels in 2007.

Based on research conducted by The Energy and Resources Institute (TERI) in 2008, the technologies most relevant for Asia and the Pacific are related to clean coal technologies, energy efficiency technologies, fuel cells, geothermal, micro-hydro, small wind turbines, and solar power (Srivastava 2010). Most of these technologies are at their deployment and diffusion stage of maturity and should be promoted in Asia and the Pacific.

Keidanren⁴ has listed various Japanese technologies according to their maturity stage. Those which have widespread practical introduction in Japan and have overseas expansion phases are shown in Figure 6.2 below. These technologies form the base of those that can be deployed and diffused to developing countries in the region.

Figure 6.2 Key technologies which have widespread practical introduction/overseas expansion phases



Source: Nippon Keidanren (2010)

Focusing on the deployment and diffusion of technology does not mean that R&D and demonstration are not important, but emphasizes that deployment and diffusion are more urgent given the risks associated with current world environmental and economic conditions. The mechanisms that should be used to promote this transfer process are addressed in the following sections.

3. Main mechanisms and initiatives focusing on low carbon technology transfer

This section reviews the main extant mechanisms and initiatives, focusing on low carbon technology transfer in order to draw lessons and assess the extent to which they can be used to deploy and diffuse low carbon technologies to, and within, Asia.

3.1 Main mechanisms and funding sources for technology transfer

3.1.1 Global Environment Facility (GEF)

To date, the GEF has been one of the most significant external funding mechanisms for accelerating the deployment and diffusion of climate-friendly technologies in developing countries. GEF has allocated USD 2.5 billion for climate-friendly technologies in more than 50 developing countries since its inception in 1991, generating roughly USD 15 billion in co-financing (Marcellino et al. 2010). About USD 250 million is invested each

year in projects related to renewable energy, low-carbon energy-generating technologies, energy efficiency, and sustainable urban transport (Marcellino et al. 2010). Compared to the magnitude of the technology transfer challenge posed by climate change, however, the efforts by GEF are still of modest significance (Sudo et al. 2006). GEF's technology transfer efforts have exhibited significant weaknesses and face continuing challenges. According to a study done by Porter et al. (2008), the key weaknesses identified in GEF climate-related work include: (i) its complex project cycle, particularly lengthy approval periods; (ii) its slow response to new opportunities; and (iii) its need for additional funding. According to the same study, the long and complex project approval process has been found to pose difficulties for recipient countries and discourages private sector participation. Also, the need to remedy legal and institutional rigidities has been emphasized in order for the GEF to become more adaptable, flexible and innovative.

Box 6.1 key conclusions to improve GEF's technology transfer efforts

GEF projects—especially those first approved—have struggled. Many have been cancelled or have remained for many years at the early stages of completion. The reasons for this disappointing performance have been examined in several formal reviews. The GEF's Scientific and Technical Advisory Panel (STAP) issued a report in March 2004 that included the following key conclusions:

1. Projects should focus more on creating an enabling environment for technology transfer rather than simply buying and shipping hardware to recipient country.
2. GEF should develop partnerships with the private sector and with developed and developing countries, as the challenge of commercializing new technologies is too great to be undertaken alone.
3. GEF needs to make longer-term commitments to country and private sector partners to provide the stability needed for investment and market development.
4. GEF should support a broader range of technologies, including smaller-scale applications and energy efficiency.
5. GEF should further analyze why so many projects have experienced lengthy delays, and set tighter deadlines to avoid continued slippage.

Source: Miller (2007)

The GEF experience suggests several important lessons for future efforts to promote the deployment and diffusion of low carbon technologies in developing countries (Miller 2007). First, the provision of subsidized funding, while helpful and even necessary in some cases, is insufficient to promote the deployment of new technologies. Second, strong local partners are important, preferably with a financial interest in the success of the programme and the capacity to replicate and learn from the project. Third, a portfolio approach with a range of partners, countries, and technologies may be advantageous. Finally, given the risks and uncertainties associated with long-term technology commercialization, a decision to make a relatively greater share of investment in near-term technologies and markets may be understandable.

3.1.2 Clean Development Mechanism (CDM)

CDM projects were not originally envisioned to be technology transfer projects. They were one of the flexibility mechanisms for international emissions trading under the Kyoto Protocol. In spite of the various criticisms of CDM, there are strong indications that CDM projects have contributed positively to technology transfer. CDMs are among

the strongest mechanisms for technology transfer under the UNFCCC, contributing to the transfer of both equipment and know-how. Table 6.4 presents findings from a recent study of technology transfers associated with CDM projects, showing international technology transfers in 29 of the 63 projects investigated, with such transfers being especially common in hydropower and landfill gas projects (Brewer 2008).

Table 6.4 Technology transfer in CDM projects

Technology	Number of projects	Number of projects with technology from outside country	Country origin of technology
Biogas	6	0	China, India
Biomass	10	0	India
Energy efficiency	1	0	South Africa
Fuel switching	1	1	Germany, USA
HFC-23	3	2	Germany, Japan, UK
Hydropower	22	12	China, Australia, France, India, Japan, Panama, Brazil, Peru, Spain, Sri Lanka, Switzerland, USA
Landfill gas	10	8	Belgium, Netherlands, Japan, France, Brazil, USA
Methane capture	3	0	Chile
Nitrous oxide destruction	2	2	France
Wind energy	5	4	Spain, Denmark
Total	63	29	

Source: Brewer (2008)

Box 6.2 includes the findings of another recent study on technology transfer associated with CDM projects. It indicates that roughly 36% of the 2,100 registered CDM projects claim to have involved technology transfer (Arquit et al. 2011). This technology transfer involves knowledge and equipment, and is more common for larger projects and projects with foreign participants. The pricing of GHG emissions was regarded as an efficient measure to facilitate the development and diffusion of low carbon technologies through CDMs (Sudo et al. 2006).

Box 6.2 Impact of CDM on technology transfer and investment

Analysis of the experience to date suggests that the CDM has stimulated additional low-carbon investment and technology transfer. Although the CDM does not have an explicit technology transfer mandate, it may contribute to technology transfer by financing emission reduction projects using technologies currently not available in the host countries. A study commissioned by the UNFCCC secretariat (Seres and Haites 2008), which analyzed the claims of technology transfer made by project participants in the project design documents, found that:

- Roughly 36% of the projects accounting for 59% of the annual emission reductions claim to involve technology transfer.
- Technology transfer is more common for larger projects and projects featuring the participation of foreign stakeholders. Technologies originate mostly from Japan,

Germany, the United States, France, and Great Britain. For most project types, project developers appear to be able to choose from among a number of domestic and/or foreign technology suppliers.

- Technology transfer is very heterogeneous across project types and usually involves both knowledge and equipment.
- The rate of technology transfer is significantly higher than average for some host countries (including Bolivia, Ecuador, Guatemala, Honduras, Indonesia, Kenya, Malaysia, Mexico, Pakistan, South Africa, Sri Lanka, Thailand and Viet Nam) and significantly lower than average for Brazil, China, and India.
- As the number of projects increases, technology transfer occurs beyond individual projects. This is observed for several project types in China and Brazil.

Source: Arquit et al. (2011)

Factors that have been singled out as decisive for the technology-transfer content of CDM projects include (i) the country's general institutional framework; (ii) capacity to adopt new technologies and/or produce them domestically; and (iii) investment condition in the recipient country, the project's size and the particular technology (Schneider et al. 2008).

If implemented well, CDM projects should promote low carbon technology transfer. However, the administrative complexity of a project-based mechanism seems to restrict the inherent ability to bring about major change (Bell and Drexhage 2005). In the Asian context, the predominance of unilateral CDM projects and their limitation to specific projects that produce a large amount of certified emission reductions (CERs) (especially biomass, hydropower, and wind power projects) indicate limited prospects for the transfer of a greater number of low carbon technologies to, and within, the region through CDMs. Furthermore, the skewed distribution of CDM projects toward a small group of developing host countries (China and India) also indicates limited prospects for the transfer of low carbon technologies toward a wider number of countries in the region through CDMs (Table 6.5).

Table 6.5 Number of CDM projects in pipeline in selected Asia-Pacific countries

Type \ Country	Biomass	Coal bed/ mine methane	Geo-thermal	Hydro	Landfill gas	Solar	Tidal	Wind	Total projects
Bhutan	0	0	0	3	0	0	0	0	3
China	138	96	1	1231	107	78	0	1097	3311
India	381	0	0	191	31	59	0	764	1998
Indonesia	20	1	11	21	19	1	0	0	165
Lao PDR	1	0	0	6	0	0	0	0	10
Malaysia	45	0	0	5	15	0	0	0	170
Nepal	0	0	0	1	0	0	0	0	9
Philippines	14	1	2	9	8	0	0	3	96
South Korea	3	0	1	26	7	42	2	14	123
Thailand	37	0	0	6	8	13	0	4	181
Viet Nam	13	0	0	200	7	0	0	1	251

Source: Authors (based on data from UNEP Risoe Centre on Energy, Climate and Sustainable Development as of 1 February 2012)

3.2 Multilateral and bilateral initiatives for low carbon technologies transfer

Table 6.6 lists several multilateral and bilateral initiatives focusing on low carbon technology transfer. Asian countries, in particular China, India, Indonesia, Japan and Republic of Korea, are participants in many of these initiatives.

Table 6.6 Example of initiatives focusing on development and transfer of technologies

	USA	EU	Japan	China	India	Indonesia	S.Korea
Gleneagles Dialogue (2005)	○		○	○	○	○	○
G8 Gleneagles Plan of Action (2005)	○	○	○				
Asia-Pacific Partnership for Clean Development and Climate (APP) (2005)	○		○	○	○	○	
Methane to Market (M2M) Partnership (2004)	○		○	○	○	○	○
Carbon Sequestration Leadership Forum (CSLF) (2003)	○	○	○	○	○	○	○
International Partnership for the Hydrogen Economy (IPHE) (2003)	○	○	○	○	○	○	○
World Bank Global Gas Reduction Flaring Reduction Partnership (CGFR) (2002)	○	○				○	
Generation IV International Forum (GIF) (2001)	○	○	○				○
Climate Technology Initiatives (CTI) (1995)	○		○				○
International Renewable Energy Agency (ERINA) (2009)	○	○	○		○		○
Greenhouse Gas R&D Programme (1991)	○	○	○		○		○
Clean Coal Centre (1975)	○	○	○	△	△		○

△ indicates Industrial Sponsors

Source: Authors (based on Table 5.2 in Sudo et al. 2006)

Some of these initiatives could provide Asian participants with valuable opportunities to shift their development towards a low carbon approach. They have significant potential for facilitating technology transfer by promoting private participation in the technology transfer process. For example, private sector participation in the M2M Partnership in Table 6.6 above is promoted through a mechanism called the Project Network, which is considered essential to build capacity, transfer technology and promote private direct investment. Through the M2M Partnership (of which all the major GHG emitting countries in Asia, namely China, Japan, India, and Republic of Korea, are members), an American company secured a USD 58 million contract to supply all the power generation equipment for a 120 MW coal bed and coal mine methane power plant in China (Sudo et al. 2006). In addition, through the APP in Table 6.6 above, eight public-private sector task forces were established, covering (i) cleaner fossil energy; (ii) renewable energy and distributed generation; (iii) power generation and transmission; (iv) steel; (v) aluminum; (vi) cement; (vii) coal mining, and (viii) buildings and appliances. As climate change has become an agenda item for the Group of Eight (G8) summit, the 2005 summit 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, in Asia and elsewhere, to enhance private investment in, and the transfer of, clean technologies.

Though the listed initiatives have significant potential for facilitating technology development, transfer and deployment, implementation is more complicated. The levels of bilateral and multilateral ODA to fund international technology transfers are still modest. Technology-oriented cooperation, which is usually seen as the most feasible option for U.S. international leadership, is not immune to the credibility problem of its international commitments (Tamura 2006). Similarly, the G8 summit has launched many new initiatives only to abandon them later (Tamura 2006). Too many initiatives focus only on collecting and sharing information relevant to technology transfer (i.e., acting as an information hub) and not on knowledge and capacity building and feasibility assessment. Thus, while these initiatives may enable Asian countries to access low carbon technologies, it is important to first demonstrate the value of such centralized initiatives by effective implementation.

3.3 Foreign direct investment (FDI)

The FDI in low carbon technologies is already large. According to the United Nations Environment Programme (UNEP), private investment in energy efficiency and low carbon technologies has increased rapidly from USD 33.2 billion in 2004 to USD 148 billion in 2007, and asset financing (i.e., investment in new renewable energy, energy efficiency and low-carbon energy technology assets) has increased from USD 12.4 billion in 2004 to USD 84.5 billion in 2007 (UNEP 2008). In addition, private investment in clean energy in developing countries has also grown rapidly, reaching USD 22.3 billion in 2007 (UNEP 2008).

The potential of FDI in low carbon technologies is also huge and an appreciable share of it will be borne by the private sector (Box 6.3). The continuing transition to a low carbon economy requires huge additional investments in all sectors. By 2030, additional investments to maintain GHG emissions at current levels are estimated to be about USD 1 trillion per annum (Zhan 2010), and a large share of these additional investments will be carried by the private sector, and more specifically, by trans-national companies (TNCs) in low carbon investment abroad. In the Asian context, China is considering pouring USD 1.7 trillion into the so-called "strategic sectors" over the coming five years. Targeted sectors include alternative energy, biotechnology, new-generation information technology, high-end equipment manufacturing, advanced materials, alternative-fuel cars and energy-saving and environmentally friendly technologies. Foreign firms were assured of the same opportunities as Chinese firms to take part in the growth of these sectors (Buckley 2011).

Box 6.3 Public and private role in promoting low carbon FDI

Stern (2006: 60) states, "Most of the development and deployment of new technologies will be undertaken by the private sector; the role of governments is to provide a stable framework of incentives." The World Bank also indicates that "the large amounts of financing that will be required for an effective transition to a low-carbon economy will only be available via efficient mobilization of private capital" (WB 2006: 28). However, the necessary investments will not take place without a supportive enabling environment; "Unless the policy framework changes and appropriate instruments are in place to facilitate investments in new technologies, developing countries are expected to follow a carbon intensive development path similar to that of their developed country counterparts" (WB 2006: 16).

Low carbon technologies are projected to cover 36% of the energy demand of Southeast Asia, with the most spectacular increases for solar, wind and geothermal technologies which together could satisfy almost 11% of regional energy demand by 2030 (Olz and Beerepoot 2010). In this regard, many governments in the region have introduced various favourable policy frameworks and targets to fully benefit from the potential FDI to promote low carbon technology to, and within, the region. However, substantial hurdles continue to be a major impediment to achieve this potential (Box 6.4).

Box 6.4 Major impediments to promote low carbon FDI

Governments in the region⁵ have introduced various favorable policy frameworks and targets to promote low carbon technologies penetration into the market. However, investment certainty is affected by a widespread absence of specific regulations to flesh out these frameworks.

Furthermore, maintaining non-cost reflective energy prices and substantial fossil fuel subsidies in the region dampens the enthusiasm of prospective private sector investors to finance the necessary expansion of the energy sector generating and transmission capacity. As well, information needs to be disseminated on the available and most appropriate technologies and the direct environmental economic and social benefits they can offer.

Source: Olz and Beerepoot (2010)

Drawing on various observations, these hurdles can be categorized into those that are (i) relevant to corporate capability in the recipient country; (ii) relevant to the operating environment in the recipient country; and (iii) relevant to the provider of technology in the supplying country.

Issues for corporate capability in recipient countries

- Limited information about what alternative technologies are available.
- Lack of visible and committed top management support for adopting new low carbon technology (corporate governance).
- Inability to adopt new low carbon technology due to financial, technical and industrial restrictions.
- Absence of incentive systems for investigating new technologies.
- Language barrier which inhibits effective communication between personnel and restricts effective transmission and assimilation of relevant information.

Issues in operating environment

- Low and poor physical infrastructure.
- Weak and inadequate institutional infrastructure to provide support in terms of finance, information, skill development, and technology brokering.
- Inadequate investment policies which are not developed according to specific needs and situations, but rather adhere to conditions of an external entity in order to receive aid funding.
- Ineffective policies supporting overseas investment in low carbon production (such as IPR protection, tax holidays, tariff adjustments, and industry parks to promote technology transfer).
- Bureaucratic delays at various levels of government in obtaining approvals and clearances for finalizing technology transfer agreements.
- Excessive government intervention and regulation.

- Foreign exchange restrictions.

Issues for providers of technology in supplying country

- Limited information on the needs of recipients.
- Lack of trust in the technology recipient, especially regarding IPR for technologies which are considered to be cutting-edge.
- The technology often needs considerable adaptation to suit local conditions in the recipient country.
- High cost of technologies to be transferred.
- Language barriers that inhibit effective communication.

4. Proposal of new strategies to promote low carbon technology transfer

4.1 Which technology has to be transferred?

One of the messages of this chapter is that the focus should be on the horizontal transfer of low carbon technologies which are already at their deployment and diffusion stage. These technologies are associated with fewer barriers, especially those which continue to be controversial under the UNFCCC process (namely IPR, MRV and finance). These technologies are also easier modified to local conditions in recipient countries. Special focus should be on low carbon technologies that match the needs of recipients; this is a process of technology application, not only a process of technology transfer. Furthermore, the focus should not only be on transferring hard technologies, but should also include transferring technical knowledge and skills.

4.2 Through which mechanism?

4.2.1 Rewarding technology transfer with emission reduction credits

The CDM process seems to be more effective compared to other centralized mechanisms, such as the GEF, and bilateral and multilateral initiatives focusing on technology transfer, probably because it generates financial incentives through CER credits. Thus, the first option to promote low carbon technology transfer to, and within, Asia could be through generating financial incentives by rewarding low carbon technology transfer with credits, for example, Technology Transfer Credits (TTC). Projects which result in low carbon technology transfer could receive such credits, which could be used for payment of IPR holders. Of course, this is a challenging process which necessitates worldwide agreement on various issues, for example, the selection of the agency to implement this reward scheme, determining the format for registering projects, and methods for MRV.

This proposed mechanism could be discussed under the Ad Hoc Working Group on the Durban Platform for Enhanced Action established at the COP17. However, while waiting to finalize this new mechanism, it may be possible to start with the currently existing CDM process under UNFCCC (which will still run for a few more years). It suggests that, in addition to the CERs, any CDM project should be rewarded with TTCs if it results in low carbon technology transfer. This strategy will lead to the dissemination of currently available low carbon technologies throughout developing countries faster than a business-as-usual case, while also generating credits. In addition, the TTC value should vary according to the transferred low carbon technology and recipient country. This measure will help promote the transfer of various types of low carbon technologies, as well as towards a wider number of countries, hence, overcoming some of the current criticisms to CDM projects mentioned earlier.

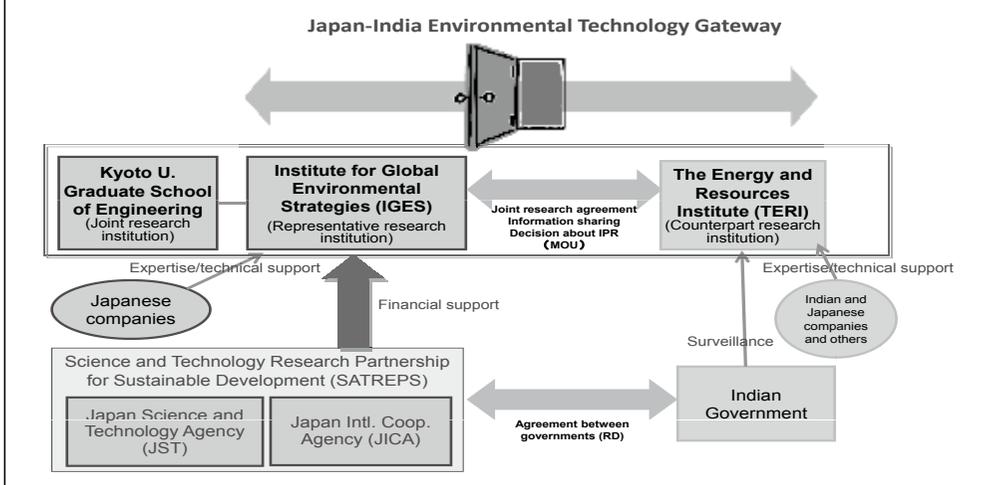
MRV of a project to determine if it resulted in low carbon technology transfer is a challenging task, especially if the transfer process is in the form of technical knowledge and skills, or if the technology is still in an early stage of maturity. To overcome this challenge, as a first step, it would be better to start by rewarding the transfer of hard technologies which are at their deployment and diffusion stage, since these technologies can more easily be quantified.

4.2.2 Enhancing private sector participation in bilateral and multilateral initiatives

The participation of the private sector in several bilateral and multilateral initiatives focusing on technology transfer has contributed to their effectiveness. Thus, a second option to promote low carbon technology transfer to, and within, Asia could be through more proactive involvement of the private sector in bilateral and multilateral initiatives. Participation of the private sector is crucial since they are the main providers of technology. The mobilization of human capital and financial capital from the private sector is a determinant factor in the low carbon technology transfer process. For instance, private sector experts can help in the evaluation and analysis of the feasibility and applicability of a specific technology in specific conditions. They can also analyze the benefits (environmental and economic) that can be generated from applying a particular technology in a specific site (Box 6.5).

Box 6.5 Importance of private sector participation in projects related to technology transfer

On 17 May 2010, the Kansai Research Centre of the Institute for Global Environmental Strategies (IGES-KRC) officially launched an international joint research project with TERI and Kyoto University to promote the application of Japanese low carbon technologies in India. The project is being implemented as a Science and Technology Research Partnership for Sustainable Development (SATREPS) project in collaboration with the Official Development Assistance (ODA) programme by the Japan Science and Technology Agency (JST) and Japan International Cooperation Agency (JICA). The joint research also involves private sectors in both countries. It covers a variety of aspects, including identification of promising low carbon technologies, implementation of pilot projects to measure, monitor and demonstrate the effects of technology application, capacity building of technical experts and managers, and establishment of a cooperation framework between the public and the private sectors.



Private sector participation in this research partnership is tremendously important. Experts from private Japanese companies have participated in various meetings to identify promising Japanese low carbon technologies to be transferred to India, and were dispatched to identify potential candidate sites where these technologies could be implemented. Private sector experts also analyzed data and provided reports about the potential benefits (energy saving, CO₂ emissions reduction and cost savings) and the feasibility of implementing selected technologies in India. A preferential price for their technologies was provided to encourage implementation in India. Of the proposed technologies, the gas heat pump for industrial use was one type of Japanese low carbon technology investigated under this project. Based on a preliminary assessment by experts from the company manufacturing gas heat pumps, the benefits from implementing this technology in three Indian candidate sites (namely A, B, and C) are indicated in the table below:

Site \ impact	A	B	C
Primary Energy Saving	547 MWh/year (56%)	742 MWh/year (50%)	1,684 MWh/year (58%)
CO₂ Emission Reduction	116 t-CO ₂ /year (57%)	158 t-CO ₂ /year (51%)	356 t-CO ₂ /year (59%)
Cost Saving	451,335 INR/year (32%)	275,855 INR/year (15%)	1,419,671 INR/year (35%)

Source: Authors

The success of this option largely depends on what incentives have to be provided to enhance private sector participation in bilateral and multilateral initiatives. Although many of the largest private companies and multi-national corporations (MNCs) are voluntarily contributing, the participation of others still needs to be encouraged with appropriate incentives. A stable framework of incentives should be provided by governments, as well as from regional and international organizations, to leading companies willing to play a more proactive role in transferring low carbon technology. These incentives should include material incentives (financial, IPR protection, increase in market share, etc.) as well as non-material incentives (honorariums, public awards, etc.).

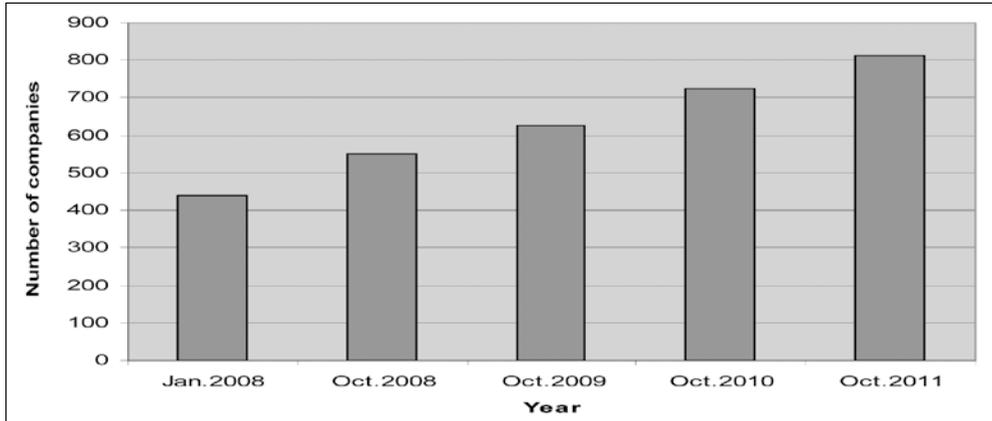
4.2.3 Promoting low carbon foreign direct investment (FDI)

As low carbon FDI in Asia is already soaring, the potential for further low carbon FDI is huge. Furthermore, additional FDI is most likely to be redirected to the region given the risk associated with the ongoing economic and financial crises in the U.S. and Europe. As the Japanese economy is strained by its soaring national currency, it is possible that a number of Japanese companies may move outside Japan and relocate to other Asian countries (Figure 6.3). This additional FDI should not encourage exports of highly polluting “brown” sectors to the region, but should be oriented to low carbon technologies in order to ensure sustainable economic development. Thus, a third option to promote low carbon technology transfer in Asia could be through promoting low carbon FDI in the region.

The effectiveness of this decentralized mechanism largely depends on the willingness and commitment of various stakeholders to attain certain emission targets (under Nationally Appropriate Mitigation Actions (NAMAs)), as well as to overcome the main hurdles that continue to impede the transfer of low carbon technology to the region.

More specifically, it depends on the willingness and commitment of various stakeholders to shift from current governance mechanisms toward green governance. Green governance should be streamlined at company and government levels. Regional and international organizations should provide the necessary support to private companies and governments in the region to make this transition.

Figure 6.3 Number of Japanese companies present in India



Source: Authors (Based on data from Embassy of Japan in India 2012)

Green governance at the corporate level: Companies in technology receiving countries should develop green governance. For example, top managers should attend, and enable other workers to engage in, various education and training programmes relevant to low carbon technology. They should continually search for alternative low carbon technologies available in the market, and assess the co-benefits of applying them in their companies. They should encourage initiatives regarding energy saving and low carbon emission reduction in their company by developing a specific rewarding system for good initiatives of workers. They should also respect their commitments to national regulations and standards, as well as their commitments in term of IPR. Furthermore, these activities should be disseminated through environmental and corporate social responsibility reports (CSR) to attract socially and environmentally responsible investors. Top managers in developed countries should also continuously search for opportunities for low carbon FDI, and assess the co-benefits of applying their low carbon technologies overseas.

Green governance at the government level: Capacity building and awareness raising activities for top managers in supplying and recipient countries may be not enough to engage them in corporate green governance processes needed for low carbon FDI. Further supporting activities and incentives from the government may be needed. This will be among other initiatives that can be included as part of government green governance to promote low carbon technology transfer through low carbon FDI.

Technological advances alone likely will not be sufficient to ensure the transfer of low carbon technology through low carbon FDI. Political will for large scale economic transformation toward green governance to create a rewarding enabling environment will be equally crucial. Green governance at the government level should be promoted and may include the following measures.

- Governments of recipient countries should assess local technology needs in terms of low carbon technologies. They should establish a supportive institutional infrastructure as well as introduce investment policies that respond to country's specific needs and situation (such as strengthening IPR, tax holidays, tariff adjustments, industry parks, making markets more transparent, etc.) to stimulate markets for low carbon technologies.
- Governments of recipient countries should reduce or eliminate subsidies for fossil fuels as well as include environmental costs in the overall price of energy services.
- Furthermore, governments should develop product standards, instituting industry codes and certification procedures. In addition, they should foster research in low carbon technologies as well as adapting technologies transferred from other countries to suit local needs.
- Governments of recipient countries also should introduce low carbon technologies in state-owned companies, through public procurement, which will provide a showcase for the private sector to follow.
- These governments should also create a public database on low carbon technology investment potential and foster dissemination of such information, e.g., through a national low carbon technology development plan.

Box 6.6 Efforts of the Government of Thailand to collect and disseminate technology information

Thailand places emphasis on awareness-raising and information support, establishing publicly accessible databases on renewable energy potential and equipment manufacturers on the Ministry of Energy website. The Ministry has also founded a one-stop service centre for renewable energy and energy efficiency to provide information and guidance to investors, companies active in these sectors and private individuals.

Source: Olz and Beerepoort (2010)

Promoting low carbon transfer through FDI is not the responsibility of governments of recipient countries alone. A lack of willingness and awareness in supplying countries is also considered a fundamental reason for the limited progress of technology transfer. Governments of supplying countries should develop and introduce appropriate policies and incentive measures to support the deployment and diffusion of available and promising low carbon technologies overseas.

Support measures from regional and international institutions: Current national and international policy frameworks are not effective in promoting low carbon technology transfer in Asia. Low carbon technology transfer to the region can be better leveraged through the support of regional and international organizations. While their support should include financing, they have a more important role in information sharing and knowledge building and technical assistance. Financial support can be ensured through efficient mobilization of private sector funds by promoting private sector participation in bilateral and multilateral initiatives, explained in the second option above, and by promoting green governance at the corporate and government level. Information sharing and knowledge building, however, is quite difficult without the support of regional and international organizations with experience in the field. These organizations should collect and disseminate the information available from each country regarding low carbon FDI, build knowledge within countries and provide technical assistance, where necessary. Comprehensive technology needs and feasibility assessments/technology availability

assessments are quite difficult to develop without their participation and support.

Information sharing: National preferences for low carbon technologies vary among countries in Asia reflecting economic size, developmental stage, and geographical location. For example, energy conservation technologies can play a greater role in China, while in India, biomass technologies may offer more significant potential. Thus, information about the needs of each country should be compiled and disseminated. Similarly, available and promising low carbon technologies vary among countries. Thus information about the available technologies in each country should also be collected, listed and disseminated. To this end, the Durban Platform process for information dissemination regarding technology transfer, established at COP17, should develop and disseminate a comprehensive database relevant to technology transfer that will be useful for both recipient and technology-supplying countries. This database should provide an overview of the global status on low carbon technologies as well as country specific profiles, which will meet the increasing demand from policy makers, researchers, investors, and the general public for accurate, timely, and easily accessible information on low carbon technology transfer policies and measures. The importance of information sharing is explained further in chapters 2 and 3.

Knowledge building: Regional and international support should be provided for conducting technology needs and feasibility assessments, technology availability assessments, identification of risks and opportunities for technology transfer, and capacity building of various stakeholders involved in the technology transfer process, rather than focusing on technology development and transfer. They should match “seeds” (technology available) with “needs” (technologies needed). In this regard, they can focus on:

- i) analyzing the perspectives of businesses and government, both in recipient and supplying countries regarding the opportunities, risks, and obstacles relating to technology transfer;
- ii) listing the candidate low carbon technologies for transfer, from the perspective of businesses and governments of both recipient and supplying countries, and assess their GHG reduction potential; and
- iii) drawing a map (matrix) that best matches “seeds” with “needs.” Sharing, and facilitating access to this map will help investment decision makers effectively allocate low carbon FDI, and hence, minimize the risks and maximize the benefits (environmental, social and economic) of transferring low carbon technologies.

5. Conclusion and recommendations

Asia is the world's fastest growing economic region. This gigantic economy will require increasing amounts of natural resources, particularly energy and raw materials for production and urbanization. Thus, energy demand and CO₂ emissions in this region are expected to increase sharply. Unless economic development in the region is properly designed and targeted at sustainable development, it will seriously endanger the future environmental and human resources of the region and, eventually, of the earth. The main message of this chapter is that achieving environmentally sound development in Asia can be assisted by promoting the transfer of low carbon technologies to, and within, the region.

However, the transfer of low carbon technology is not an easy task. It is a highly complex process influenced by domestic and international factors that hinder the application even

of the most promising low carbon technology.

Given the risks of the current global environmental and economic situation and the need for urgent action, governments and companies should focus on promoting the horizontal transfer of proven and commercially available technologies which are at their deployment and diffusion stage of maturity. These technologies can be relatively easy to transfer since they are associated with fewer barriers. Special focus should be on low carbon technologies which match the needs of recipients and which have large local spillovers. A process of *technology application* is needed, not only a process of *technology transfer*. Furthermore, the focus should be on transferring combined packages of hard technologies, technical knowledge and skills. Technology transfers should not be limited to north-south but also carried out within the south, where widely different capacities exist.

Given the shortcomings of current centralized mechanisms under the UNFCCC, as well as bilateral and multilateral initiatives focusing on technology transfer, several decentralized mechanisms to promote the deployment and diffusion of low carbon technologies in Asia are proposed as follows:

1. Through rewarding low carbon technologies transfer with technology transfer credits (TTC);
2. Through enhancing a more proactive involvement of the private sector in bilateral and multilateral initiatives; and
3. Through promoting low carbon FDI in the region.

Each of these options is a challenging task unless other complementary measures are taken. For the first option, it may be best to start with using the currently existing CDM process under UNFCCC. In addition to the CERs, any CDM project should be rewarded with TTC if it results in low carbon technology transfer. This strategy will lead to the dissemination of currently available low carbon technologies throughout developing Asian countries faster than business-as-usual, while also generating credits. In addition, it is better to start by rewarding technologies which are at their deployment and diffusion stage, since these technologies can more easily be quantified.

For the second option, a stable framework of incentives should be provided by governments as well as regional and international organizations, to leading companies willing to play a more proactive role in transferring low carbon technology in Asia. This stable framework of incentives should include material incentives as well as non-material incentives.

For the third option, green governance processes should be streamlined at company and government levels to attract low carbon FDI. Regional and international organizations should provide the necessary support to private companies and governments in the region in this regard. Their role should not be limited to information sharing, but should be extended to knowledge building and technical assistance.

Notes

1. The horizontal flow of technologies that are at their deployment and diffusion stage of maturity.
2. The IEA's ambitious 2009 World Energy Outlook 450 Scenario analyses measures to force energy-related CO₂ emissions down to a trajectory that—taking full account of the trends and mitigation potential for non-CO₂ greenhouse gases and CO₂ emissions outside the energy sector—would be consistent with ultimately stabilizing the concentrations of all greenhouse gases in the atmosphere at 450 ppm of CO₂ equivalent.

3. During its life cycle, technology moves from the research and development (R&D) stage to the demonstration stage and then to deployment and diffusion stages, respectively. This is also known as vertical technology transfer. The R&D stage is when the basic science of a problem is understood, but the associated technologies are at their testing and laboratory stage. The demonstration stage refers to the stage when technologies are gradually implemented in a limited number of commercial facilities or research institutions. The deployment and diffusion stage refers to the stage where technology is generally competitive with alternative ones (Marcellino et. al 2010).
4. Keidanren (Japan Business Federation) is a comprehensive economic organization established in May 2002 by a merger between Keidanren (Japan Federation of Economic Organizations) and Nikkeiren (Japan Federation of Employers' Associations).
5. The region here refers to ASEAN+6. ASEAN countries include Indonesia, Malaysia, Philippines, Singapore, Thailand and Viet Nam. The other six countries are China, Japan, South Korea, Australia, New Zealand and India.

References

- Asian Development Bank (ADB). 2009. *The Economics of Climate Change in Southeast Asia: A regional review*. Manila: Asian Development Bank.
- Arquit, Anne, Jonathan Gage and Raymond Saner. 2011. *Levers to Enhance TNC Contributions to Low-carbon Development—Drivers, Determinants and Policy Implications*. Geneva: CSEND, Diplomacy Dialogue.
- Bell, Warren, Aaron Cosbey, Deborah Murphy, Jo-Ellen Parry, John Drexhage, Anne Hammill and John Van Ham. 2005. Climate Change and the International Carbon Market. In *Which Way Forward?: Issues in developing an effective climate regime after 2012*, edited by Warren Bell and John Drexhage, 41-56. Winnipeg: International Institute for Sustainable Development (IISD).
- Brewer, Thomas L. 2008. "International Technology Transfers for Climate Change Mitigation: What, who, how, why, where, how much...and the implication for international policy institutional architecture." Draft of discussion paper prepared for CESifo Venice Summer Workshop Europe and Global Environmental Issue, Venice, Italy, 14-15 July 2008.
- Buckley, Chris. 2011. "China Confirms \$1.7 Trillion Spending Plan: U.S." *Reuters*, November 21. <http://www.reuters.com/article/2011/11/21/us-china-us-idUSTRE7AK0MT20111121> (accessed 22 November 2011).
- Embassy of Japan in India. 2012. Japanese Business Establishments in India. <http://www.in.emb-japan.go.jp/Japan-India-Relations/list2011.pdf> (accessed 12 March 2012).
- Global Environmental Facility (GEF). 2009. *Technology Transfer for Climate Change*. Washington, DC: GEF.
- Haites, E. 2007. *Carbon markets*. Bonn: UNFCCC.
- International Energy Agency (IEA). 2010. *Energy Technology Perspectives*. Paris: IEA/OECD. 2009. *World Energy Outlook 2009*. Paris: IEA/OECD.
- IPCC. 2000. *Methodological and Technological Issues in Technology Transfer*, Cambridge, UK and New York, Cambridge University Press.
- Marcellino, Dominic, Christiane Gerstetter, Elena von Sperber and Michael Marble. 2010. *Technology Transfer in the International Climate Negotiations*. Washington DC: Ecologic Institute.
- Miller, Alan S. 2007. "The Global Environment Facility Program to Commercialize New Energy Technologies." *Energy for Sustainable Development* 11, No.1: 5-12.
- Nippon Keidanren. 2010. *Achieving Growth through Green Innovation-Proposals for Japan's New Growth Strategy and Other Initiatives in the Environmental Sector*. Tokyo: Nippon Keidanren. <http://www.keidanren.or.jp/english/policy/2010/019.html> (accessed 16 March 2012).
- Olz, Samantha and Milou Beerepoot. 2010. *Deploying Renewables in Southeast Asia: Trends and potentials*. Paris: OECD/IEA.
- Porter, Gareth, Nanki Kaur, Leo Peskett and Neil Bird. 2008. *New Finance for Climate Change and the Environment*. Washington, D.C.: WWF/Heinrich-Böll-Foundation.
- Schneider, M., A. Holzer and V. Hoffmann. 2008. "Understanding the CDM's Contribution to Technology Transfer." *Energy Policy* 36:2930-2938.
- Srivastava, Leena. 2010. "Need for Technology Transfer—An Indian perspective." Presentation at the International Forum for Sustainable Asia and the Pacific 2011 (ISAP2011), Yokohama, Japan, 26-27 July. Hayama: Institute for Global Environmental Strategies.
- Stern, Nicholas. 2006. *The Economics of Climate Change: The Stern Review*. Cambridge: Cambridge University.
- Sudo, Tomonori, Tamura Kentaro, Jung Tae Yong, Ancha Srinivasan, Watanabe Rie, Shimada Kunihiko and Kimura Hitomi. 2006. Technology Development and Transfer. In *Asian Aspirations on Climate Regime beyond 2012: Concerns, interests and priorities*, edited by Sudo Tomonori, pp. 31-38. Hayama: Institute for Global Environmental Strategies.
- Tamura, Kentaro, Jung Tae Yong, Ancha Srinivasan, Sudo Tomonori, Watanabe Rie, Shimada Kunihiko and Kimura Hitomi. 2006. Technology Development and Transfer. In *Asian Aspirations on Climate Regime beyond 2012: Concerns, interests and priorities*, edited by Kentaro Tamura, pp. 53-76. Hayama: Institute for Global Environmental Strategies.
- Technology Executive Committee. 2011. Briefing note on the development and transfer of technologies under the UNFCCC process. TEC/2011/1/2, UNFCCC.
- UNEP. 2008. *Public Finance Instruments for Climate Mitigation: Options document*. Paris: UNEP-SEFI.
- UNEP Risoe Centre. 2012. UNEP Risoe CDM/JI Pipeline Analysis and Database, March 1st, 2012. <http://cdmpipeline.org/> (accessed 20 February 2012).
- UNFCCC. 2009. Strategy paper for the long-term perspective beyond 2012, including sectoral approaches, to facilitate the development, deployment, diffusion and transfer of technologies under the Convention. FCCC/SB/2009/3.

- World Bank. 2006. *An Investment Framework for Clean Energy and Development: A progress report*. [http://siteresources.worldbank.org/DEVCOMMINT/Documentation/21046509/DC2006-0012\(E\)-CleanEnergy.pdf](http://siteresources.worldbank.org/DEVCOMMINT/Documentation/21046509/DC2006-0012(E)-CleanEnergy.pdf) (accessed 17 February 2012).
- Zhan, James. 2010. Presentation based on “*World Investment Report 2010: Investing in a low-carbon economy*” published by UNCTAD WIR. http://www.unctad.org/en/docs/wir2010_presentation_en.pdf (accessed 22 March 2012).