13 Climate change investment and technology transfer in Southeast Asia

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Introduction

Technology transfer is crucial to international agreement on environmental policy and is seen by many developing countries as a prerequisite for adherence to treaties. Yet many investing countries see technology transfer as a lengthy and costly process with potential risk to intellectual property rights. This chapter argues such views need to be rethought, and that technology transfer instead needs to be understood by distinguishing between so-called "horizontal" transfer (including long-term sharing of technological expertise), and "vertical" transfer (in which technologies are relocated without sharing). The chapter illustrates how such vertical transfer may occur using evidence from Thailand, Vietnam, Indonesia, and the Philippines. The chapter's key argument is that integrating technology transfer with international investment offers a powerful way to overcome disagreements in the climate change negotiations, and is an important reflection of foreign policy relating to international economic competitiveness.

Foreign investment is increasingly a crucial component of domestic and foreign policy. With the onset of global investment and global production of commodities in the late twentieth century, governments are no longer seeking to achieve national technological competitiveness by developing domestically owned industries located within their own countries alone. Instead, national competitiveness may also occur through developing effective multinational companies that invest overseas, or through attracting and keeping investment from foreign companies at home. The location and ownership of investment therefore have immense significance for the development and control of technology production worldwide.

The new globalization of technology production offers different strategies to developing countries. On one hand, developing technology through domestic companies may give a country the chance to become internationally competitive in investment; but this may mean waiting years before success is achieved, and also success may never come if the market is already dominated by producers elsewhere. Alternatively, countries may allow foreign companies to produce new technology locally because it may accelerate the supply of useful technology to local users, and also provide associated benefits of investment. Yet the risk of this strategy is that it assumes local producers may never gain economic competitiveness in the production of that technology. Technology production and ownership therefore have immense implications for national and international economic competitiveness and rates of economic development. As such, they are relevant to foreign policy by affecting comparative growth of economies, and also the factors concerning foreign aid or assistance to other countries that may request technology transfer and technological development as part of their strategy to achieve economic development.

The role for international investment in environmental policy was made clear under the Kyoto Protocol of 1997. The establishment of joint implementation (JI) and the Clean Development Mechanism (CDM) as two so-called "flexible mechanisms" of climate change mitigation, allowed international investment in climate-friendly activities as a means by which Annex I countries (i.e. countries with specific targets for greenhouse gas [GHG] reduction) could achieve their targets. In particular, the CDM was established specifically for non-Annex I (or usually developing) countries, and was aimed to assist projects related to sustainable development in general in relation to the United Nations Framework Convention on Climate Change (FCCC). For East and Southeast Asia, all countries except Japan are classified non-Annex I, and therefore stand to receive CDM-related investments.

Yet, at the Sixth Conference of the Parties to the FCCC at The Hague in November 2000, and negotiations since, there was much disagreement between different Parties about how such flexible mechanisms were to be interpreted and implemented. The near-collapse of negotiations in 2000 was widely attributed to disagreements concerning the incorporation of "sinks" into measures to reduce concentrations of GHG concentrations. While the question of sinks – or the use of forests and other land-use activities to sequester carbon – raises important questions for political analysis and physical monitoring of GHG concentrations (Cullet and Kameri-Mbote 1998), the underlying causes of disagreements also lay in the perceived purpose of international investment for climate change mitigation, and the impacts on technological development.

Since the signing of the FCCC at Rio in 1992, technology development, and specifically "technology transfer" have been bitterly contested, and a major dividing line between Annex I countries and many developing countries. India, China, and Brazil, for example, have reiterated demands for agreement with the FCCC to be contingent upon the urgent and unconditional transfer of valuable technologies for climate change mitigation. Yet, for their part, many Annex I countries have resisted guaranteeing technology transfer, arguing that it is a long-term and complex process, and increasingly difficult for the state to organize because most environmentally sound technology (EST) is now owned by investors in the private sector. Discussions about flexible mechanisms, and the possibility of using these to enhance technology transfer, have often led to some of the most intractable disputes in the climate change negotiations.

This chapter considers the role of technology transfer and international investment under the FCCC in relation to recent experience in Southeast Asia. The aim of the chapter is to discuss how international investment may assist in overcoming some of the dilemmas faced in the negotiations concerning international climate change policy, and how such investment may also assist – or fail to assist – national strategies for economic development, and particularly electricity supply (see also Chapters 6 and 13). There can be fewer more important themes in domestic development, and in climate change policy, than in influencing the growth of power sectors toward more climate friendly technologies.

The chapter is divided into three main sections. First, the concept of "technology transfer" itself is discussed, in relation to the climate change negotiations and international investment. Second, the chapter assesses case studies of investment in renewable energy technologies from Thailand, Vietnam, Indonesia, and the Philippines to indicate how investment may assist the production and adoption of EST. Third, the implications for the climate change negotiations and dilemmas of foreign policy are discussed.

Technology transfer and the climate change convention

Technology transfer – or the transfer of EST from industrialized to industrializing countries – has long been identified as one of the most urgent ways to reduce global GHG emissions (TERI 1997). Indeed, at the 1992 Rio Earth Summit, China and India, speaking on behalf of other developing countries, insisted that developed countries commit themselves to technology transfer as a requirement for developing country support for the proposed agreements. The resulting wordings of agreements indicate the perceived urgency and responsibility for technology transfer. The FCCC (Article 4.5) stated that developed country Parties "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 the developing country Parties . . . ." And Chapter 34 of Agenda 21 suggested that the access to and transfer of EST should be promoted "on favorable terms, including on concessional and preferential terms, as mutually agreed, taking into account the need to protect intellectual rights as well as the special needs of developing countries for the implementation of Agenda 21."

Yet despite these statements, comparatively little has been achieved. First, experts now agree that the term "technology transfer" is extremely difficult to define, and is actually a long-term and complicated process (Baldwin *et al.* 1992; MacDonald 1992; Heaton *et al.* 1994; Martinot *et al.* 1997). Commonly, technology transfer is thought of as the simple relocation of "hardware" such as equipment or blueprints. In reality, "software" such as training, personnel, and financial support systems are also necessary in order to ensure long-term technical maintenance and full cost recovery for investors.[1] Similarly, companies do not use the term "technology transfer" but instead refer to "joint ventures" (JVs) or "contracting" as alternative descriptions of commercial relationships concerning technology. The statements above from the FCCC and Agenda 21 make no reference to this complexity, although later publications stressed this complexity (see IPCC 1996, 2000a).

Second, there are also difficult problems in defining "climate technology." Different technologies have varying impacts on GHGs. "Renewable energy," for example, includes biogas generation – which involves the emission of GHGs during use – but other forms that do not emit during use, such as photovoltaics or passive solar heating, also have various environmental effects during their manufacture (Philips and Browne 2000). Large renewable energy projects, such as dams and geothermal developments also have a variety of other social and environmental impacts that make their all-round contribution to environmental policy questionable. Nuclear energy is also in this category.

Third, it is also agreed that effective technology transfer requires incentives for private-sector participation. Most climate technology is owned and developed by commercial companies. "Transferring" technology therefore implies risking intellectual property rights and empowering competitors. Some negotiations about climate technology transfer, however, have not appreciated this problem. In 1996, for example, at the Second Conference of the Parties to the FCCC, the Chinese government published a booklet entitled *The List of Chinese Government Needed Technologies* (SPC 1996), in which it demanded equipment such as integrated gasification combined cycles, fuel cells, and rice husk energy transfer instruments as examples of required climate technology. This booklet did not discuss any compensation for technology producers, and consequently is yet to produce the impact the government wished for (Forsyth 1998). In conflicts such as these, the relationship between technology transfer and more general objectives of foreign policy become more obvious. The demands of China (and other developing countries) for technology is most linked to the desire to enhance industrialization and economic competitiveness, and accordingly such demands are often resisted by the more developed countries, leading to impasses in discussions about how to enhance the adoption of environmentally sound technology.

Fourth, there is much political opposition in Annex I countries to undertake any measure that may seem to threaten intellectual property rights, or competitive standing, of national companies through encouraging them to engage in technology transfer. There is a perception among many investors that "technology transfer" has to imply sharing technology with potential competitors, and consequently that requirements to conduct technology transfer would reduce the comparative advantage of investors. Such factors have contributed to the proposed use of the CDM for projects not directly related to industrial technological upgrading. Indeed, despite his active engagement in other environmental issues, it is also reported that then US Vice-President Al Gore was personally opposed to integrating the Climate Change Convention with measures that placed responsibility for technology transfer with US companies (Robert Frosch, Harvard University *pers. comm.* 2000).

And fifth, and related to topics of foreign policy, discussions in general about technology transfer and investment for climate change mitigation have been affected by deep divides between industrialized and industrializing countries about responsibility for world development and for addressing climate change. These divides have particularly affected negotiations concerning flexible mechanisms of climate change mitigation on the grounds that they reduce the need for developed countries to undertake GHG abatement within their own territories (see Box 13.1). Furthermore, the proposal to use JI (or its pilot phase entitled Activities Implemented Jointly (AIJ), from 1995 to 2000), and the CDM for sinks

Box 13.1 Flexible mechanisms for climate change mitigation under the Kyoto Protocol

Emissions Trading: Annex I countries may achieve emissions reductions targets by trading GHG emission permits with other members of Annex I. Countries who fail to achieve their targets (potentially the United States and Japan) may buy permits from those that have overachieved their targets (potentially Russia and the Ukraine). Critics claim that emissions targets, based on pre-1990 levels, offered to countries in industrial decline (such as Russia and the Ukraine) imply reduction in total emissions achieved via trading that would have occurred anyway (the so-called "hot air problem").

Joint Implementation: Annex I countries may achieve emissions reductions targets by investing in GHG abating activities in other countries of Annex I. Proponents argue JI provides fast and low-cost climate change mitigation. Critics claim JI's impact on climate change is difficult to measure and that JI will only address cheaper projects (such as sinks), leaving more expensive projects (such as upgrading industrial technology) to host governments. After the 1st Conference of the Parties to the FCCC in Berlin in 1995, a pilot phase of 1995–2000 for JI was agreed under the name "Activities Implemented Jointly". AIJ could take place throughout the world, but without crediting against emissions targets. At the Kyoto Protocol, JI with crediting was approved, but only within Annex I.

The Clean Development Mechanism: Annex I countries may achieve emissions reductions targets by investing in GHG abatement activities in non-Annex I (usually developing) countries. The CDM is different to JI by focusing on non-Annex I; by supporting "sustainable development" in general. The original text of the CDM made no mention of the word "sinks" but later conferences of parties to the FCCC agreed that some element of sinks could be permitted. However, there are no specific guidelines for enhancing technology transfer, and it is still unclear how far the CDM will adopt the same governance and monitoring structures of AIJ.

Sources: Forsyth 1999a; Grubb *et al.* 1999; Gupta 1997.

projects has been criticized by some developing countries. Some have claimed these projects overlook the scientific difficulties in monitoring carbon sequestration through land use (Cullet and Kameri-Mbote 1998). Others have argued that simple sequestration projects reduce the need to discuss industrial technology transfer as a means of climate change mitigation (Gupta 1997).[2] Indeed, when the CDM was created under the Kyoto Protocol of 1997, the original wording of the agreement did not mention "sinks," and this was taken to indicate a potential use of the CDM for investment relating to industrial technology. Such disagreements reached a head in at the Sixth Conference to the Parties (COP6) of the FCCC in The Hague in 2000, when it seemed that divisions on "sinks" threatened to undermine the entire implementation of the FCCC. But further meetings in Bonn (the so-called COP6 bis) and then at Marrakesh (COP 7) both in 2001 led to the Marrakesh Accords that allowed a framework for allowing the CDM to enable both investment in sinks (to specified levels), and in the provision of an "adaptation fund" to support longer-term support of technology and adaptive capacities. Supporters of the Accords suggested that they allowed rapid mitigation of greenhouse gas emissions, as well as helping to address developing-country objections to the FCCC. Critics suggested that the Adaptation Fund acted as a tax on investments, and that there should not be a line drawn between CDM projects and long-term capacity building, as ideally both should be integrated.

As a result of these disagreements and problems in incorporating private investment, most discussions about technology transfer since the Earth Summit have remained largely deadlocked, and focusing on the different responsibilities of states rather than the mechanisms that may allow companies to participate. For example, the Technology Assessment Panels set up by the FCCC secretariat quickly reached an impasse in discussions on the grounds of identifying which countries should attend, and who should have responsibility for undertaking technology transfer. Similarly the Climate Technology Initiative (CTI), set up by the International Energy Agency (IEA) and the government of Japan, has sought to lessen investors' costs by establishing international seminars and offering prizes for product development, but has not produced the transfer of EST demanded by developing countries. The CTI is still ongoing, and in 1997 the IEA launched the Global Remedy for the Environment and Energy Use – Technology Information Exchange (GREENTIE) initiative, aiming to enhance the use of climate change mitigating technology in official aid and private investment. Other initiatives include the establishment in 1994 of an Ad Hoc Group on Technology Transfer and Cooperation by the UN Commission for Sustainable Development (UNCSD), and ongoing work by the UN Commission on Trade and Development (UNCTAD) to build capacity for technology transfer, training and learning in developing countries. The FCCC Subsidiary Body on Scientific and Technical Advice (SBSTA) is primarily responsible for the negotiation and identification of technology needs under the FCCC.

Seeking new forms of technology governance

Despite the deep disagreements in the meaning and urgency of technology transfer in the climate change negotiations, academic debates about technology transfer have illustrated a variety of alternative means of looking at the subject, and which may offer insights into integrating climate technology transfer with new investment from the private sector. Under the statements from Agenda 21 and the FCCC above, technology transfer is seen to be a linear process in which technology may be developed by particular companies or countries, and then disseminated to other users. This approach reflects conventional assumptions that technological competence lies in developing expertise within indigenous companies (Porter 1990).

Alternative thinking, however, has stressed that national economic progress may not necessarily depend upon the development of indigenous technological expertise, but may rely instead on the attraction of investment in general, even if it is foreign owned (Howells and Michie 1997; Dunning 1998). This thinking partly reflects the belief that some indigenous companies may never be able to compete successfully with more powerful transnational corporations under current trade regimes. Yet, in addition, it is likely that the short-term investment from foreign companies in these relatively more advanced technologies will create associated benefits for host countries such as employment (Reich 1991). As Howells and Michie (1997: 30) wrote:

> Globalization of technology does not imply the need for the abolition of national or regional policies, or an attempt to create a protectionist barrier around an economy's technology base; rather it requires sensitive policies that seek to engage the major economic base of the nation or region with both indigenous and foreign technological capabilities.

Accordingly, some theorists have argued that it is possible to identify two forms of technology transfer (Leonard-Barton 1990). The first is the relocation, or point-to-point transfer of new manufacturing or sales of technology, in which ownership of production remains in foreign hands. The second is the traditional embedding or education about technology manufacture that is usually the subject of discussion about technology transfer under the FCCC. The first may also be likened to vertical integration of companies through the creation of subsidiaries, and the second is similar to the formation of joint ventures or other contractual relationships between different firms (Williamson 1996). Advancing "vertical" or point-to-point technology transfer via international investment may therefore provide climate technology to new locations quicker than conventional, "horizontal" forms of embedding. But the cost of this approach is that the host country may not gain long-term economic success in this particular technology, and that its own competing technologies may lose competitiveness in relation to the imported varieties (Forsyth 1999a).

In addition, there is a need to understand better ways of ensuring private investment may be harnessed in order to lead to technology transfer. Past experience from North America and Europe has indicated that certain market interventions at the same time as private-sector investment into new forms of renewable energy technology have resulted in greater adoption of new technologies. In the United Kingdom, the Non-Fossil Fuel Obligation (NFFO) (ironically introduced to support the nuclear industry) and the Public Utilities Regulatory and Policies Act (PURPA) in the United States greatly increased investment in renewable energy technologies, and also consequently reduced the development and operating costs of renewable energy (Grubb 1995). One unseen impact, however, was to increase sales of Danish wind turbines in the United Kingdom, and decrease the market share of British-made turbines, because the Danish technology was considered more efficient (and hence more competitive) than British technology (Gregory *et al.* 1997). Encouraging investment through mechanisms such as the NFFO/PURPA may therefore enhance "vertical" or point-to-point technology transfer rather than just boosting the performance of indigenous technology manufacturers.

Yet, simply inviting further private investment in new technologies may not be sufficient for enhancing technology transfer. On the one hand, host countries may lack the capacity to ensure that imported technologies are appropriate for local development (e.g. the "dumping" of outdated technologies at low cost by importers is common). Yet, on the other hand, countries may insist upon so many regulations for joint ventures and long-term sharing of technology, that they repel investors and also avoid the potential benefits of point-to-point relocation of technology. Experts have therefore agreed that the key requirement of privatization in developing countries is to build the associated incentives and regulatory bodies before privatization, in order to ensure that investment both proceeds and also addresses local concerns. As Ranganathan (1992: 173) wrote concerning electricity privatization in Africa: "a bane of all African countries constrained by a shortage of funds is that … they look to donors or lenders whose preferences come to disrupt and dictate power sector planning … in other words, foreign financial assistance has failed to promote technology transfer." Similarly, Bruggink (1997: 87) wrote:

> To privatize the generation business without fundamentally strengthening the regulatory bodies and the transmission and distribution segments of the sector involves substantial risks for both private and public interests. If developing countries wish to attract substantial and continuous inflows of private capital, they must avoid the dangers of having to change the economic rules of the game at subsequent stages of restructuring. Otherwise the availability of foreign capital will drastically decrease and its price will move up inexorably.

Under the CDM, exports in climate technology will effectively be subsidized between Annex I and non-Annex countries, and therefore a new wave of investment in climate technology may be expected. The experiences of electricity privatization so far suggest that successful technology transfer may be achieved first by the creation of legislation similar to the NFFO/PURPA ("vertical," or point-to-point technology relocation), and second by the establishment of new capacity – possibly including organizations such as Renewable Energy Project Support Offices (or REPSO) – that can effectively bypass the bureaucratic state mechanisms and integrate foreign investment and technology into new locations ("horizontal" technology transfer or sharing). Yet it is also important to note that many successful renewable energy technologies already exist in developing countries that are cheaper and more appropriate to local needs than many imports (e.g. biogas generators in India) (Reid and Goldemberg 1997; TERI 1997). It is therefore important for both climate change mitigation and local economic development that new subsidized exports do not threaten the competitiveness of indigenous technology companies.

Case studies from Southeast Asia

The role of renewable energy in Southeast Asia is still generally currently small, but it is growing in size. In particular, national statistics generally refer to electricity

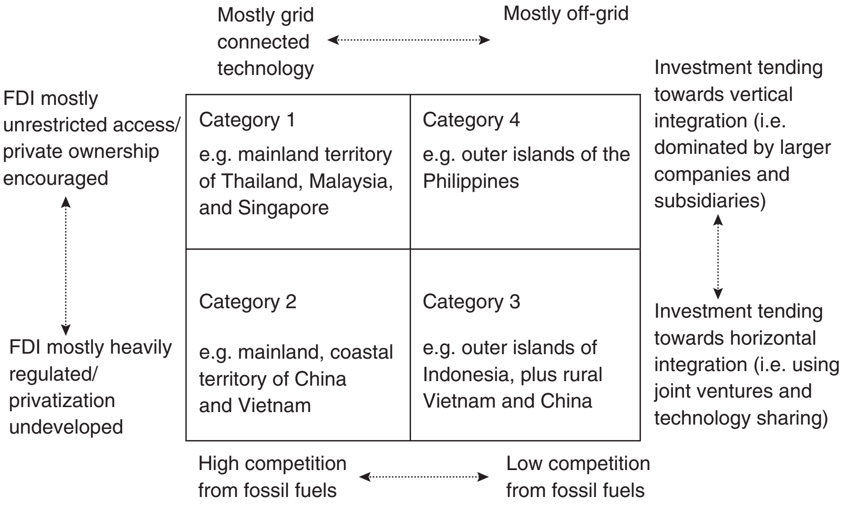

Figure 13.1 Southeast Asia: classification according to business and regulation structures for renewable energy investment.

from national grids rather than for the potential size of markets that exist in areas that are currently off-grid, and for whom new, renewable energy technologies may provide sources of decentralized electricity generation. Large proportions of Southeast Asia's 500 million people live in locations that are not supplied by grid electricity, particularly in Vietnam and Indonesia, and these areas may prove the most likely sites of renewable energy development.

The following case studies aim to present information about how *national* policies concerning electricity privatization have affected new investment in renewable energy technologies. The four countries are selected in order to reflect different investment regimes and physical circumstances for renewable energy development (see Figure 13.1). Thailand, for example, has few opportunities for off-grid investment because it has few islands and is already supplied with an extensive grid. Indonesia and the Philippines, by contrast, are suitable for off-grid technology because they are archipelagos comprising thousands of islands. All countries vary in terms of government incentives for inviting foreign investment and privatization, as well as per capita income and energy growth. It is not possible in this chapter to provide all details of privatization and liberalization regimes in each case study (Forsyth 1999b), but the case studies do highlight which political and economic reforms impacted most on the adoption of renewable energy technologies.

Thailand

Thailand is by far the most electrified of the case studies, with some 95 percent of rural population grid connected, and also highly dependent on centralized fossil fuel-based generation. Nevertheless, the Thai government has been particularly active in energy sector reform, and instigated demand-side management (or energy cost-saving measures) from the fifth Five Year Plan (1982–1986) that established the first Energy Conservation Program and an Energy Conservation Center of Thailand in order to educate companies on energy use. The 1992 Energy Conservation Act defined targets for industry, and established a fund for promoting energy efficiency by applying a tax on petroleum products (at less than one US cent per liter). The seventh Five Year Plan (1991–1996) reduced peak electricity demand by an estimated 238 MW (Lefevre and Bui Duy Thanh 1996; TEI 1997).

The contribution of small-scale renewable energy to electricity supply, however, has been small, and is also difficult on account of the large percentage of villages connected to the central grid. Much development of renewable energy technology has been from international development agencies. For example the Australian Center for Application of Solar Energy (CASE) had four projects in Thailand in 1997 using advanced PV, micro-hydro and wind technology. Two projects are grid connected and two are off-grid. For example, Ban Khun Pae is a village in the northern Chiang Mai province, inhabited by the Karen nationality, and uses 7.2 kW of PV in conjunction with diesel and batteries (a hybrid fuel source) to power refrigerators and lighting in homes and a school. In Ban Den Mai Sung in Tak province, in the far west, a similar PV system was installed in 1986 and then connected to the grid in 1990 (Woravech 1997).

Privatization of electricity supply has brought opportunities for renewable energy technology through the Small Producers Program (SPP). The SPP was introduced in 1992 as a means in which factories that generate their own electricity may sell surplus amounts back into the grid, and usually refers to producers of about 50–90 MW a year. By August 1997, there were officially twenty SPPs supplying the national grid, with the total supply rising from 1.3 MW in 1994 to 1,215 MW in 1996 (Lefevre *et al.* 1997b: 85). The SPP particularly favors biomass electricity generation, as factories using woodchips or vegetation can use waste material to fuel generators. For example, the TRT Parawood rubber-wood sawmill in southern Thailand constructed a 2.5 MW cogeneration plant for internal use in the early 1990s at the cost of $2.2 million. The company can now expect to save $840,000 per year in reduced energy costs, and also earn income from electricity sales at an estimated $48,000 per year (Green 1997: 114).

Privatization, however, may also limit the ability of state agencies to adopt and demonstrate renewable energy technologies. For example, since 1976, government bodies such as the Ministry of Public Health and the Telephone Organization of Thailand have adopted PV systems to power rural clinics and relay stations often with the help of US Agency for International Development (USAID). By 1997 about 2.5 MW of PV was installed in Thailand, of which about 90 percent was government funded. Despite the progress made under the SPP legislation, the privatization and liberalization of state bodies may reduce their ability to adopt and demonstrate renewable energy technologies (see Table 13.1 for summary).

Table 13.1 Different investment niches for technology transfer

	Expertise and economic base in technology exists locally	*Expertise and economic base in technology does not exist locally*
Vertical technology transfer (ownership remains with investor)	1 High competition and low profit margins	2 Most attractive to new foreign investors
Horizontal technology transfer (ownership is shared with local producers)	3 Least attractive to new foreign investors	4 High transaction costs and potential loss of competitiveness

Source: The author's case studies described in this chapter. See Forsyth 1999a for more detail.

Vietnam

By contrast with Thailand, Vietnam has both a poorly developed electricity supply industry and privatization program (IPP). Indeed, "privatization" in Vietnam to date is generally the invitation of IPPs to build new power plants while the State Electricity Board (SEB) remains centralized. Installed capacity in Vietnam in 1995 was just 4,485 W, of which hydro comprised 63 percent, coal 14.4 percent, diesel 9.7 percent, gas 8.5 percent, and fuel-oil 4.4 percent (Toan 1997: 3). Invitations to international investors have been characterized by long and protracted negotiations that have caused much resentment from some well-known companies. For example, negotiations between the government and IPPs such as Oxbow and Enron of the United States on private-sector participation (PPAs) have also been characterized by bureaucracy and uncertainty, and the ruling Communist party has stated at party conferences that private-sector participation in crucial industries like power remains sensitive (Birchall 1997; Quinn 1997).

The most immediate impact of privatization on renewable energy relates to large hydro schemes, where a combined 3,764 MW of extra capacity is planned (World Bank *et al.* 1996: 37). Such schemes, however, were planned with Russian assistance that is unlikely to materialize. Also, some large dams, such as the proposed 2,300 MW Son La project in the far northwest, would involve relocating thousands of villagers. Smaller renewable energy development, however, has been encouraged through the cooperation of international agencies and local citizens organizations. For example, the Vietnamese Women's Union (VWU) and the Solar Electric Light Fund (SELF)[3] started the so-called "Solar Project in Support of Rural Women and Children" project in 1994 in three provinces in northern and southern Vietnam. The project supplies Solar Heating Systems (SHS) manufactured by the United Solar Systems Corporation of the United States to villages for lighting and refrigeration. Households were required to make an initial downpayment of 20 percent and then pay monthly contributions for four years. The long-term aim of the project is to provide SHS to one million households before 2010, although initial results suggest that more investment needs to be made in providing local maintenance skills and availability of spare parts.

Other approaches include the use of build-operate-transfer (BOT) schemes for urban waste treatment in Vietnam's large cities. In 1995, one BOT of 20 years' duration was approved with an Indian consortium for using urban waste in Ho Chi Minh City to generate electricity and manufacture organic fertilizer (*Vietnam Investment Review*, March 27–April 2, 1995). The contact with India is a good example of technology transfer between developing countries, rather than simply between developed and developing countries.

There are also government schemes to advance renewable energies. The Institute of Energy has established the Solar Laboratory of Ho Chi Minh City, which has installed PV battery chargers in villages in the Mekong delta. The Ministry of Agriculture and Rural Development has also undertaken joint work with EVN to invest $28 million in 150 micro-hydro stations in mini grids in the mountainous regions of Vietnam before 2000. Micro-hydro systems have also been supported by the Vietnam Bank for Agriculture and Rural Development and the Vietnam Bank for the Poor in collaboration with the VWU, the Veteran Association, and Farmer Association (Toan 1997: 11). The Council on Renewable Energy in the Mekong Region (CORE) was also established in 1996 to create "focal points" on disseminating renewables in cooperation with neighboring countries (Rakwichian *et al.* 1996). These small, yet focused organizations have therefore allowed progress on renewable energy development despite the government emphasis on fossil fuels and large hydro schemes.

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Indonesia

The potential for decentralized renewable energy development in Indonesia seems high. There are some 13,000 islands within the archipelago, and in 1995, it was estimated that unelectrified rural populations amounted to 82 percent of the population in Irian Jaya (arguably the least developed island), 59 percent for west Sumatra, 36 percent for west Java, and 18 percent for Bali.

Renewable energy development in Indonesia has been largely undertaken through the activity of a specialist government office on renewable and alternative energy sources created in the late 1970s, the Baden Pengkajian dan Penerapan Teknologi (BPPT). This has overseen much research and development of indigenous renewable energy such as, for example, a $7 million ocean and wave technology project on the southern coast of Java near Yogyakarta (Symon 1997: 129). Another large-scale project, the so-called "One Million Homes PV Rural Electrification Scheme" was launched in 1997 with a long-term goal of providing SHS to one million household, or 10 percent on non-electrified households by 2007, at an estimated cost of $450 million. The scheme uses PV technology built indigenously within Indonesia, and is assisted by the World Bank, AusAID, and the governments of France and Bavaria. The scheme aims to transfer ownership of the SHS gradually to households through a process of part payment, offering the most attractive terms to households furthest from the grid (Djojodihardjo *et al.* 1997).

This scheme, however, has been criticized for relying almost exclusively on indigenous technology (which may not be competitive in relation to imports); for overlooking long-term cost recovery mechanisms in remote areas; and for a long supply chain for spare parts from Jakarta. Winrock International, the US-based non-profit making development agency, in eastern Indonesia, has adopted an alternative approach. In 1995, it installed ten wind turbines of between 10 and 1.5 kW in small rural villages for water pumping and power generation, using imported technology from Bergey Windpower of the United States. A key difference between this project and the "one million homes" scheme is that the dissemination of technology is accompanied by the creation of new governance systems (or "distributed utilities") to ensure technical maintenance and financial cost recovery. Local utilities were effectively created through building a tri-partite agreement between Winrock, the new utility (commonly the village committee), and a local NGO. Each was assigned duties concerning finance, training, and maintenance, which enabled each party to ensure the utility was performing its duties (Winrock International 1997).

AQ: Is it 1.5 kW or 15 kW

In addition, the government has enabled existing producers of electricity to adopt renewable energy sources through a small producer scheme similar to Thailand. The Pembangkit Skala Kecil dan Korporasi (PSKSK) was introduced to encourage developers to use fuels besides oil. Under the PSKSK, SPPs may generate and sell electricity to Perusahaan Listrik Negara: the State Electricity Utility of Indonesia (PLN) in amounts of up to 30 MW to the Java–Bali grid, and up to 15 MW for other systems. The tariff is prioritized by fuel type, in which wind, solar, and mini-hydro is given priority over oil, coal, and gas. Biomass fuel, including vegetable and animal waste, is given second priority. The PSKSK scheme has enabled many small manufacturers who have constructed their own "captive" power supplies to sell excess production to grid systems. In northern Sumatra for example, the PT Asahan Aluminum smelting works is a Japanese–Indonesian JV that has constructed two power plants of 268 MW and 317 MW on the Asahan River to benefit from this scheme. In southern Sulawesi, a similar Canadian–Indonesian JV has built a 165 MW plant on the Larona River to service a local nickel plant (Symon 1997: 123).

However, negotiations with international investors remain bureaucratic. The Bronzeoak company of the United States, for example, sought to establish a biomass generating facility in Java in 1997 that could produce 8–12 MW of electricity using palm oil waste. The approach to the government was made in association with the US Export Council for Renewable Energy and the Environmental Business Support Foundation of Jakarta. The request of Bronzeoak to negotiate a PPA based on 70 percent debt finance using the project itself as collateral was refused by the government, leading to deadlock (Walden 1997).

The Philippines

The Philippines are arguably the most likely location for renewable energy development because of the coincidence of some 7,000 islands and a government policy that actively supports investment. The New and Renewable Energy Program (NREP) was implemented in 1990 by the Department of Energy through its Non-Conventional Energy Division. This has sub-programs to address technology development, commercialization, promotion, and localized implementation. The Philippines Council for Industry and Energy Research and Development of Science and Technology has also integrated research on renewables with business development.

Small renewable energy technologies are expected only to contribute 4 percent of planed additional capacity during 1996–2005, but this amounts to 4,000 MW. Under the NREP, $30 million has been made available for biomass and mini-hydro projects through low interest funds. The Development Bank of the Philippines offers similar low interest loans to solar projects undertaken in villages. In 1991, RA 7156 (the Mini-hydropower Incentives Act) included special tax rates for importing equipment, and deferring or crediting VAT and income tax (Lefevre *et al.* 1997a: 118).

Two much larger schemes were launched in 1997. The so-called "Pole Vaulting" program aims to utilize the Philippines domestic ocean, solar and wind resources, where it is estimated there is a potential 266 million MW of supply. The program aims in general to employ domestic renewable technology with a budget of $30 million in 1997–2001. A second project is the Municipal Solar Infrastructure Project, which aims to supply 1,003 PV generators to more than 400 villages in Mindanao and the Visayas at a cost of $36 million, using PV from BP Solar (Australia). The PV will be used for a variety of applications including lighting, water pumps, and refrigeration.

Smaller-scale schemes have also been adopted by village-based organizations known as electricity cooperatives or *barangays*. In 1995, total sales from ECs amounted to 4,315 GWh, or 16 percent of national sales, and are now identified to be part of government plans to increase grid supply and renewable energy usage. Other nongovernmental organizations involved in electricity development are Affiliated Non-Conventional Centers (ANECs) mostly comprised of twenty state universities in different regions. However, perhaps most significantly, the organization Preferred Energy Incorporated (PEI) was established by Winrock International with assistance from UNDP to operate at the national level to coordinate foreign investment and local renewable technology development. For example, the US biomass generating company, Silk Roads, has invested in biogas anaerobic digestion plants in Baguio City, north of Manila, using local municipal and farm waste.

Rethinking technology transfer and investment under the FCCC

This chapter has outlined various themes relating to the rethinking of technology transfer under the FCCC. They include:

- Much debate on climate change mitigation that has avoided the need to consider, first, the role of international private investment within environmental policy; and second, how international investment relating to environmental policy may also influence national economic competitiveness and technological development.

- Instead, much discussion concerning technology transfer under the FCCC has reflected a conventional approach to international investment and technology transfer by assuming that the process must involve sharing intellectual property rights between local and international investors, and is a long-term, costly process. This has been reflected to some extent by the creation of the "Adaptation Fund" under the CDM, which has implied that outright investment to mitigate climate change may be separated from projects that can build long term technological and adaptive capacity.
- Newer thinking relating to technology development and transfer, however, has argued that technology transfer may be conducted through both "horizontal" transfer (involving long-term capacity building and sharing of technology); and "vertical transfer" (referring to the relocation of technology construction or usage, without sharing ownership of the technology process itself). It may be possible, therefore, for "vertical" investment to achieve both rapid climate change mitigation and some forms of technology transfer in ways that do not require the usual perceived costs to investors. These differences radically alter the debate about technology transfer by indicating ways in which it may be achieved without necessarily challenging the foreign policy dilemmas associated with international competition and technological development.
- This approach, however, implies that Government intervention may be needed to ensure such vertical transfer is both attracted to a region, and then successfully adopted by local users. Examples of government interventions from the United Kingdom and the United States include measures such as the Non-Fossil-Fuel-Obligation (NFFO) and PURPA, which encouraged new investment into small, renewable energy technologies. These measures, however, were occasionally associated with challenges to domestic technology industries whose products were considered less attractive than international investors.
- New mechanisms are necessary to bypass cumbersome state bureaucracies in the case of renewable energy technologies, and to allow decentralized electrification beyond centralized national grid systems.

Rethinking technology transfer

The case studies of Southeast Asia have shown varieties of success in achieving technology transfer through international investment. In Thailand and Indonesia, similar mechanisms to the NFFO/PURPA have been achieved via respectively the SPP and the PSKSK legislation. Each of these government interventions have provided incentives for renewable energy development. In the case of Thailand, the SPP has also demonstrated that renewable energy investment can still be encouraged as a feed into grid supplied electricity, and where there is high level of existing grid supply.

Further assistance has been supplied by a variety of intermediary organizations that have acted as negotiators and go-betweens for international investors, state agencies, and end-users. These organizations (or REPSOs) include Preferred Energy Investments of the Philippines, subsidiaries of Winrock International, and local organizations such as SELF in Vietnam. The success of such organizations in creating distributed utilities in locations such as Eastern Indonesia suggest that they can provide a form of regulation for private investment during electrification. Critics of electricity privatization in developing countries (Berg 1997; Bruggink 1997; Ramani 1997) have argued that too much attention is usually given to electricity generation rather than transmission and distribution, and that the independent regulation of electricity supply needs to be developed in advance of investment. Creating distributed utilities through private investment is, in effect, creating generation, transmission, and distribution simultaneously with local regulation.

Yet, the forms of privatization described in Southeast Asia have not necessarily indicated a total absence of state regulation during the process. Some state agencies (such as Indonesia's BPPT) have remained influential in both technology development and dissemination. But it is also clear that large-scale schemes such as the Indonesian "One-Million Homes PV Rural Electrification Scheme," or the Philippines' "Pole-Vaulting" scheme have been probably too dependent on both subsidies: outdated indigenous technology and complicated supply chains for successful technology transfer. As an alternative, the Philippines' "Municipal Solar Infrastructure Project" may be more successful because it combines ambitious large-scale local development with the use of up-to-date technology supplied by a transnational company, and consequently there is less chance of the scheme failing because the technology supplied may be unable to remain commercially competitive long enough to allow cost recovery or long-term adoption by users.

The implication of these case studies is that international technology transfer may be achieved by a cautious integration of technology investment and national development programs. Such combinations integrate national public-policy objectives with the supply and maintenance of technology from specialized (if not domestically owned) suppliers. This kind of technology transfer is clearly different from the conventional ("horizontal") form of transfer, which implies a lengthy commitment from investors to share technology with local producers. But, given new thinking about the possibility for local technological expertise in some globally competitive industries (see Reich 1991), such an objective may be both more feasible, and also quicker.

Implications for the climate change convention

It may be possible to enhance technology transfer under the FCCC by providing incentives under the CDM. Table 13.1 shows a preliminary classification that may assist in the identification of which industries may be best suited to vertical or horizontal forms of technology transfer. Categories 1 and 3 of the diagram refer to those industries where hosts – or companies within developing countries – already have a competitive basis, and may provide the basis for future technology transfer between developing countries. Category 2 is the niche most likely to attract rapid foreign investment via CDM crediting as it refers to technology not currently produced in host countries, but where there is little competitive risk from sharing technology. Examples of technology in category 2 might include high-value photovoltaics, which are from a globally competitive market, and which need to be updated regularly in order to remain competitive. Examples of categories 1 and 3 may include passive solar heating, which is relatively low technology.

Category 4 broadly represents the type of technology transfer currently discussed in the climate change negotiations, but is unlikely to attract as much investment as category 3 because of the extra costs required in sharing technology. Technology transfer may therefore be accelerated fastest if the CDM credits companies that invest in category 2. Longer-term, or horizontal technology transfer, may still be achieved, but at higher costs to private investors. One possible solution is to enable international bodies such as the GEF, or local, and bilateral aid organizations to fund the long-term capacity building associated with successful horizontal technology transfer.

The identification and support given to different industries will, inevitably, require strong governance systems at the international, national, and local levels in order to highlight which industries may be best supported by different forms of investment. The international governance may be best achieved by the CDM Executive Body, which was created under the 1997 Kyoto Protocol, but which has yet to be defined in detail (Stewart *et al.* 2000). The national governance may be achieved by new agencies within government.

One possible solution is for the CDM to provide a variety of incentives for international investment to invest in climate technologies. Box 13.2 suggests some incentives – or "flexible mechanisms of climate technology transfer" – in which individual companies are rewarded for investment by the amount they contribute to national GHG abatement targets (Forsyth 1999a). Under this scheme, the CDM may be used most effectively for vertical technology transfer, while the existing aid mechanisms such as the GEF might best assist with horizontal transfer, or long-term capacity building that is less attractive to companies.

Yet, all such incentives and mechanisms have to be applied with caution. In effect, the CDM will provide a subsidy for investors from Annex I countries to export EST to non-Annex I (usually developing) countries. As such, there is a chance this investment may undermine existing sales from indigenous companies. In theory, this may also allow Annex I countries to claim such investment as leading toward their national commitments for GHG reductions when in fact no overall increase in EST usage has been achieved (because the Annex I investors will have simply taken market share from companies in host countries). There is consequently a need for monitoring international investment under the CDM to ensure that new investments in technology actually do achieve an incremental impact on GHG abatement.

Box 13.2 Flexible mechanisms for climate technology transfer for potential adoption by CDM

1 Allow emissions-reduction crediting activities undertaken by individual companies as well as by countries

provides incentive for investment in carbon abatement, without risking intellectual property.

2 Allow different levels of crediting for varying kinds of investment

provides incentives for technology transfer projects of the greatest value to host countries or for climate change mitigation. Examples of preferred projects could include those assisting sustainable industrialization and capacity building rather than low-cost, low-risk ventures, or provide carbon sinks without transferring industrial technology.

3 Allow crediting for EST development at the national level, and disseminate technology through an EST bank or clearinghouse

provides incentive for governments to invest in EST research, plus a store of publicly owned technology which may then be shared or relocated by public or private bodies (horizontal transfer); also allows private companies to be credited for depositing technology, thus lessening risk to intellectual property rights. The clearinghouse may also develop "climate saving technology units" as a way to quantify the value of each new technological application.

4 Allow crediting for actions that build horizontal technology transfer

provides incentives for companies or organizations which undertake more costly, long-term education and inculcation of technology use among new communities.

5 Create voluntary qualitative targets of EST research and development in non-Annex I countries

allows integration of carbon abatement with economic growth (reversing the image that reducing GHGs implies decreasing GDP). Also forms basis of future technology relocation/transfer between developing countries.

Sources: Adapted from Chung (1998); Forsyth (1999a).

Conclusion

In conclusion, it is hoped this chapter has illustrated ways in which international investment may be integrated with the transfer of technology related to climate change mitigation. The chief argument within the chapter has been that technology transfer must be seen increasingly as a function of international investment and national and regional technology policy. If technology development is still seen in conventional terms as a linear process, to be controlled by indigenous companies, then there is little prospect for enhancing international climate technology transfer, because the process will be seen as costly and a risk to competitiveness.

Yet, if it is seen as a chance to invite new technology investment from international companies that do not expect to give up intellectual property rights, then it is possible to have a win–win situation in which EST is increased; local development is assisted through the introduction of new investors; and investors are allowed into new markets.

Technology transfer can therefore fully complement both international environmental agreement, and international private-sector investment. Redefining technology transfer from the conventional view that it can only assist potential economic competitors has ensured that foreign policy objections have acted against moves to enhance technology transfer in the past. Yet seeing technology transfer in terms of "vertical transfer," or the relocation of economic activity without the sharing of intellectual property rights, may mean integrating foreign policy objectives with activities to mitigate climate change. Seeing the relationship of technology transfer to these other, important aspects of foreign policy, may lead to a more optimistic and successful negotiations under the Climate Change Convention.

Notes

1 Indeed, MacDonald (1992) concluded that successful technology transfer depends upon local demand for new technology; availability of information for users; supporting infrastructure such as transportation and education; economic viability and a lack of dependency on subsidies; sufficient capital for initial investment; and appropriateness of technology for the underlying needs of end-users.

2 Indeed, the CDM originated partly from a Brazilian proposal for a "Clean Development Fund" which would seek to fine Annex I countries for *not* achieving targets, rather than being a *mechanism* by which Annex I countries can achieve them. It is worth noting, though, that since 1997, many developing countries have stated they would accept "sinks" projects through the CDM (notably Costa Rica and Bolivia), whereas others have insisted that they should be excluded (such as China, India, and Thailand).

3 SELF is now entitled "Solar Electric Company" (SELCO) and is a commercially oriented development organization.

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