Flexible Mechanisms of Climate Technology Transfer

TIMOTHY FORSYTH

Despite the recent adoption of "flexible" mechanisms for climate change mitigation, such as emissions trading and joint implementation, there has been little attention to the use of flexibility specifically for international climate technology transfer. This article proposes new flexible mechanisms of technology transfer that allow Annex I countries (or those with quantified targets to reduce greenhouse gas emissions) to achieve greenhouse gas abatement targets, and supply industrial environmental technology to developing countries. The article also discusses how such mechanisms may be used in conjunction with the Clean Development Mechanism (CDM), which was created under the Kyoto Protocol to promote climate-related investment in non–Annex I countries. It is argued that current approaches to technology transfer repel private investors by focusing too closely on long-term technology sharing rather than the potential benefits of the globalization of technology investment and ownership. However, simply subsidizing technology exports from Annex I countries may result only in damaging non–Annex I industries. It is, therefore, necessary to balance flexible mechanisms with strong national technological policies or governance by the CDM executive body.

This article assesses the difficulties in accelerating the transfer of technology between developed and developing countries for climate change mitigation and suggests mechanisms to overcome them. In particular, the article considers the problems of enhancing private sector participation in climate technology transfer and the potential application of the CDM to promote technology transfer.

Technology transfer has been associated with some of the most bitter disagreements between developed and developing countries in climate change negotiations. Negotiators have long acknowledged that transferring environmentally sound technology from developed to developing countries is necessary to reduce greenhouse gas emissions in countries undergoing industrialization. However, despite strong commitments to technology transfer from the UN Framework Convention on Climate Change (UNFCCC) and Agenda 21, many observers believe that little has been done. Indeed, according to the World Wide Fund for Nature, technology transfer has become the "forgotten issue" of the climate change negotiations.[1]

1. World Wide Fund for Nature (1997).

Journal of Environment & Development, Vol. 8, No. 3, September 1999 238-257
© 1999 Sage Publications, Inc.

In response to these criticisms, the major technology-exporting countries, such as the United States and Japan, have argued that technology transfer is a long-term and costly process that cannot be achieved quickly. Furthermore, they explain that technology is increasingly owned by private companies who are outside the control of the state and who need adequate compensation for the transfer of technology. Private investment between developed and developing countries now greatly outweighs official development assistance (ODA); yet, there are few mechanisms for harnessing this investment for development. For example, between 1990 and 1997, private sector foreign direct investment between developed and developing countries amounted to some U.S. $240-250 billion, whereas funding from the Global Environment Facility (GEF)—the body created in 1990 to address global environmental problems—amounted to just U.S. $5.25 billion.[2]

Accelerating technology transfer between developed and developing countries may therefore depend on creating the right commercial incentives to attract private sector participation. Commercial incentives have already been introduced for climate change mitigation in the form of "flexible" mechanisms, such as emissions trading and joint implementation, which allow Annex I countries[3] to offset their greenhouse gas abatement targets by trading with or investing in other countries (see Table 1). However, flexible mechanisms have also been bitterly contested by many developing countries. They are seen to reduce the responsibility of developed countries to reduce their own emissions, or to advance international development through actions such as technology transfer. There is, consequently, a need for new flexible mechanisms that can enhance technology transfer and provide incentives for private companies to take part.

This article fulfills this need by proposing new flexible mechanisms of climate technology transfer. Flexible mechanisms of climate technology transfer may be defined as investment opportunities that allow Annex I countries to offset their targets for greenhouse gas abatement by transferring environmentally sound technology to non–Annex I (usually developing) countries. In essence, such mechanisms propose uses for the CDM, which was created at the Kyoto Protocol in 1997 as a flexible mechanism focusing specifically on non–Annex I countries (see Table 1). Although the CDM represents a possible and mutually satisfactory

2. World Bank figures, cited in Forsyth (1998, p. 25); see also French (1998).

3. Annex I countries agreed to reduce greenhouse gas emissions by an average of 5.2% from 1990 levels by the years 2008-2012, although the targets agreed for individual countries varied between, for example, 8% for the United Kingdom and Germany, 7% for the United States, no change for Russia, and an increase of 8% for Australia (see Grubb, Brack, & Vrolijk, 1999).

flexible mechanism for both developed and developing countries, the CDM as yet has no guidelines or incentives particularly for technology transfer or private sector participation. This article suggests such guidelines.

The article is divided into two main sections. The first section analyzes the current approaches to technology transfer under the UNFCCC and the potential benefits of flexible mechanisms. The second section proposes practical steps for introducing flexible mechanisms of technology transfer, possibly through the CDM. The article's key argument is that climate technology transfer needs to be seen as a further example of economic globalization and international investment. Under this approach, the development of new climate technology via international investment may be better for both local development and climate change mitigation than traditional approaches to technology transfer that require investors to share technology with local producers. However, strong national policies and governance by the CDM executive body may be necessary to ensure that local industries are protected and that investors do not manipulate the flexible mechanisms by claiming to have mitigated climate change when all they have done is simply increase their own market share.

The UNFCCC and Technology Transfer

The transfer of EST to countries undergoing rapid industrialization is an urgent and necessary part of global efforts to mitigate climate change. However, approaches to technology transfer under the UNFCCC have reflected the bitter disagreements between developed and developing countries about responsibility for global development rather than an understanding of the mechanisms necessary for successful technology transfer. Indeed, the Earth Summit discussions about technology transfer were among the most protracted, and some developing countries, such as India and China, refused to sign agreements unless firm commitments were made by developed countries for technology transfer.

Under Article 4.1 of the UNFCCC (1992), parties were urged to

> promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases.[4]

Article 4.5 also stated that Annex I (or developed) parties

4. See Grubb, Koch, Munson, Sullivan, and Thomson (1993, pp. 64–65).

Table 1
Flexible Mechanisms of Climate Change Mitigation Agreed on Under the Kyoto Protocol

Emissions trading: Annex I countries may achieve emissions reductions targets[a] by trading greenhouse gas 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 Ukraine). Proponents argue that trading provides incentives for all countries to undertake greenhouse gas abatement. Critics claim that emissions targets, based on pre-1990 levels, offered to countries in industrial decline (such as Russia and Ukraine) imply reduction in total emissions achieved via trading that would have occurred anyway (the so-called hot air problem).

Joint implementation (JI): Annex I countries may achieve emissions reductions targets by investing in greenhouse gas abatement activities in other countries of Annex I. Proponents argue that JI provides fast and low-cost climate change mitigation. Critics claim JI's impact on climate change is difficult to measure (the baselines problem) and that JI will address only cheaper projects (such as sinks), leaving more expensive projects (such as upgrading industrial technology) to host governments (the cherry-picking problem). After the First Conference of the Parties to the UNFCCC in Berlin in 1995, a pilot phase of 1995-2000 for JI was agreed on under the name *activities implemented jointly* (AIJ). 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.

Clean Development Mechanism (CDM): Annex I countries may achieve emissions reductions targets by investing in greenhouse gas abatement activities in non–Annex I (usually developing) countries. The CDM is different from JI: It focuses on non–Annex I, supports sustainable development in general, and makes no mention of the word *sinks*. However, there are no specific guidelines for enhancing technology transfer, and the degree to which CDM will adopt the same governance and monitoring structures of AIJ is still unclear.

Source: Grubb et al. (1999), Bush and Harvey (1997), and Gupta (1997).
a. Emissions reductions targets are sometimes known as Quantified Emissions Reduction or Limitation Objectives.

> shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties.

A similar approach was adopted in Agenda 21. Chapter 34 stated that technology transfer should be encouraged

> on favorable terms, including on concessional and preferential terms, as mutually agreed, taking into account the need to protect intellectual

> property rights as well as the special needs of developing countries for the implementation of Agenda 21.[5]

These words set a precedent for approaching technology transfer as an urgent and unconditional commitment by industrialized countries as part of assistance to developing countries. However, since these agreements were signed in 1992, three theoretical and practical objections to this approach have emerged that have questioned the effectiveness of such direct transfer, or government-to-government assistance.

First, and most fundamentally, it is worth noting that despite mentioning the urgency of technology transfer, both the UNFCCC and Agenda 21 made only a general assumption that technology transfer implies the provision of environmentally relevant technology to countries that do not possess it. However, technology transfer is notoriously difficult to define, partly because the concept is of relevance only to public sector policy objectives for environmental and social development, but in reality is carried out by private sector operators who do not value such ambitions. Indeed, private companies define technology transfer in terms of joint ventures, licensing, and contracting, which indicates the commercial nature of technology sharing between different companies. The tendency for negotiations about technology transfer under the UNFCCC to become linked to arguments about international responsibility for development therefore reduces attention to the practical means by which technology transfer is most commonly undertaken.

Second, it is now widely recognized that technology transfer is widely misunderstood and very difficult to achieve. A common belief is that technology transfer is the transfer of new equipment, or "hardware," to countries or companies that do not possess it. More sophisticated approaches note that technology transfer requires "software," or the training, marketing, and local maintenance support necessary to maintain local demand for new technologies.[6] Indeed, MacDonald (1992) concluded that successful technology transfer depends on 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.

For example, in 1979, a UNICEF decision to locate two new biomass generators in Fateh-Singh-Ka-Purwa village in India failed because the project overestimated the supply of dung fuel on account of using national rather than locally gathered figures.[7] As a result, dung changed

5. See Grubb et al. (1993, pp. 144–145).

6. See MacDonald (1992), Baldwin, Burke, Dunkerley, and Komor (1992), Heaton, Banks, and Ditz (1994), and Martinot, Sinton, and Haddad (1997).

7. Butera and Farinelli (1991).

from a free good to a traded commodity, resulting in a shortage of dung and the decommissioning of the plant in 1985. Similarly, in the western Philippines in the 1980s, only one third of new charcoal gasifiers installed by the government were actually used for their intended purpose of pumping irrigation water. Farmers had agreed to accept the technology because it was offered free of charge, but in practice preferred to use rainwater because this was seen to be more reliable. In both cases, the simple transfer of new climate technologies failed because developers did not pay enough attention to the local socioeconomic factors that determined whether there was sufficient market demand and local support necessary for successful adoption.[8]

Third, it is now increasingly clear that the UNFCCC has assumed a largely outdated and static approach to technology transfer based on official aid rather than new thinking reflecting economic globalization of technology development.[9] Under the UNFCCC statements made 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 as part of an aid package. This approach reflects the conventional assumption that technology is a commodity that represents economic success and that the route to national or regional prosperity lies in building local expertise in technology.[10] This approach also makes the hidden assumption that technology transfer has to take place between developed and developing countries, which ignores the understanding that economic competitiveness may develop in several locations and that many useful innovations—particularly in local biomass technology—already exist within developing countries.[11]

In place of this orthodox approach, theorists are now acknowledging that technology markets and supplies are becoming global. The implications of global demand and supply are that some of the most advanced technologies may come from multinational companies, and that some countries may never develop their own companies with sufficient expertise to become competitive with such companies.[12] As a result, it may be more effective for some countries to invite international investment rather than attempt to build their own companies because they will benefit from employment and other advantages of

8. Butera and Farinelli (1991).

9. For example, see Howells and Michie (1997) and Dunning (1998). The aim of such new thinking is not to adopt uncritically neoliberal ideas in development thinking, or to suggest that technology transfer is no longer possible, but instead to enhance technology transfer and local economic development in an increasingly global world economy.

10. See Porter (1990).

11. Indeed, the role of developing countries in developing climate technology is commonly underrated (see Reid & Goldemberg, 1997; Tata Energy Research Institute, 1997).

12. For example, see Howells and Michie (1997), Dunning (1998), and Dunning and Narula (1996).

investment, even if the ownership of the technology produced remains in foreign hands.[13]

The implication of this approach to technology transfer for the UNFCCC is that discussions about "technology transfer" per se may decline in importance relative to "technology development" in new locations. Some theorists have already made this distinction by referring to vertical and horizontal forms of technology transfer. Vertical transfer refers to the point-to-point relocation of technology, where ownership remains in foreign hands. Horizontal transfer refers to the more complex, longer term embedding of technology through education and sharing with local users generally referred to in the UNFCCC.[14]

Under the orthodox approach of the UNFCCC, companies are expected to undertake both vertical and horizontal forms of technology transfer, which represents high costs for investors. However, under new thinking reflecting economic globalization, this orthodox approach may no longer be achievable if it implies that host countries can achieve economic competitiveness in their own industries. Furthermore, the orthodox approach avoids the potential benefits of vertical technology transfer in both the acceleration of global manufacture and the dissemination of climate technology, and in enhancing local development in host countries through employment and associated benefits. Using international investors to supply new climate technology may also lead to a longer term adoption of environmental technology.

Two examples of international investment in climate technology illustrate the need to incorporate global competitiveness in certain high-technology markets. In Brazil, an indigenous investor created Heliodynamica during the 1980s as a local producer of photovoltaics (PV). The company was vertically integrated, undertaking both manufacturing and distribution of PV, and absorbed much investment at the outset, leaving little finance available for subsequent reinvestment or upgrading of equipment. Over time, the company was not able to compete with international PV companies because its products became outdated, and the company became unprofitable.[15] In comparison, the

13. Indeed, economic theorist Robert Reich (1991) in particular has supported this view: "Well trained workers and modern infrastructure attract global webs of enterprise which invest and give workers relatively good jobs; these jobs, in turn, generate additional on-the-job training and experience, thus creating a powerful line to other global webs" (p. 264).

14. See Leonard-Barton (1990). The term *vertical transfer* also reflects the process of vertical integration between companies, in which a large investor may diversify economic activities by merging with another company or creating a subsidiary. Under vertical integration, ownership of technology remains within the larger company and is not shared with other companies through actions such as joint ventures (see Dunning & Narula, 1996).

15. J. Gregory, IT Power Limited, personal correspondence (1997); see also Gregory et al. (1997).

Municipal Solar Infrastructure Project in the Philippines was established in 1997 partly through support of the Australian Export Finance and Insurance Corporation and the Australian aid agency, AusAID, using PV technology from BP Solar (Australia). The project aims to design, supply, and install 1,003 solar-powered electricity generators for more than 400 villages in Mindanao and the Visayas in the southern Philippines at a total cost of some U.S. $36 million. Under this scheme, technology is updated by the investor and funding from AusAID and the Philippine government covers the local installment and initial administration costs of implementation. As a result, the technology adopted is unlikely to become outdated and the local costs of horizontal technology transfer (embedding) are not left to the company alone.[16]

These three criticisms of the original statements concerning technology transfer in the UNFCCC have pointed to the dynamic, private-sector-oriented nature of technology development. However, official approaches to technology transfer since 1992 have largely been state led and reflective of orthodox linear assumptions about technology dissemination. Agenda 21, for example, urged further communication between developed and developing countries and public and private sectors through the creation of "a collaborative network of research centers" and "programs of cooperation and assistance." The creation of technology assessment panels by the UNFCCC secretariat after 1992 failed to provide adequate incentives to harness private international investment and did not settle arguments between developed and developing country participants about the responsibility for action.

Another network, the Climate Technology Initiative, was launched by the government of Japan and the International Energy Agency (IEA) to offer advice on national technological plans, international collaboration on technology research and marketing, and incentives such as prizes for technological development. The IEA also created the Global Remedy for the Environment and Energy Use—Technology Information Exchange initiative in 1997, aiming to enhance the use of climate-change-mitigating technology in ODA and private investment. Other initiatives including the establishment in 1994 of an Ad Hoc Group on Technology Transfer and Cooperation by the UN Commission for Sustainable Development and ongoing work by the UN Commission on Trade and Development build capacity for technology transfer, training, and learning in developing countries. The UNFCCC Subsidiary Body on Scientific and Technical Advice is primarily responsible for the negotiation and identification of technology needs under the UNFCCC.[17]

Such schemes, however, have failed to provide adequate incentives for private sector participation in climate technology transfer and have

16. See Forsyth (1999, chap. 9).
17. See also Martinot et al. (1997).

not addressed the bitter divides between developed and developing countries on the topic of technology transfer. Indeed, proposals about technology transfer from developing countries have often resulted in response to other climate change discussions about flexible mechanisms such as joint implementation (JI) and emissions trading. Developing countries have considered flexible mechanisms such as these to be concessions to Annex I countries; therefore, they have responded by requesting the direct transfer of technology as both an assistance to development and a means to undertake climate change mitigation. At the Second Conference of the Parties to the UNFCCC in Geneva, 1996, and subsequent meetings, for example, the Chinese government declared that Annex I countries were in breach of Agenda 21 and the UNFCCC by not taking direct steps to transfer technology. The Chinese also issued a document called *The List of Chinese Government Needed Technologies*,[18] which referred to technologies such as integrated gasification combined cycles, fuel cells, and vapor emission control systems as examples of required technology. However, despite the urgent need for such technologies in industrializing countries, this confrontational approach reflected little understanding of the mechanisms necessary for successful long-term technology transfer and avoided any discussion of incentives or compensation for producers of technology.

As a result of these problems in achieving successful agreements about climate technology transfer, climate change negotiators have increasingly begun to discuss "technology cooperation" rather than "transfer" to indicate that technology development may not mean transferring ownership. This was reflected in the Kyoto Protocol of 1997, which also indicated for the first time a distinction between public and private sectors. In Article 10(c), it states:

> [Parties should] cooperate in the promotion of effective modalities for the development, application and diffusion of . . . environmentally sound technologies . . . in particular to developing countries, including the formulation of policies and programs for the effective transfer of environmentally sound technologies that are publicly owned or in the public domain and the creation of an enabling environment for the private sector to promote and enhance access to, and transfer of, environmentally sound technologies.[19]

However, the Kyoto Protocol listed no clear incentives or rewards for technology transfer and limited its statements to broad commitments in qualitative terms. This was in stark contrast to the flexible mechanisms of emissions trading, JI, and the CDM (see Table 1), which provided clear commercial incentives for Annex I countries to achieve emissions

18. State Planning Committee of the People's Republic of China (1996).
19. Kyoto Protocol, Article 10(c). See also Grubb et al. (1999).

targets. The next section of the article considers ways that similar incentives may be developed for technology transfer.

Implementing Flexible Mechanisms of Technology Transfer

The previous section argued that the UNFCCC has adopted an orthodox and costly approach to technology transfer that has placed the most emphasis on official development assistance rather than on the dynamics of private sector investment. It was argued that adopting a more dynamic approach based on global investment in technology may accelerate the dissemination of climate technology and provide benefits for local economic development.

However, adopting commercial incentives to investors in climate technology may result in further controversy because of general opposition within developing countries to flexible mechanisms such as joint implementation and emissions trading. Winning support for flexible mechanisms may, therefore, depend on indicating that mechanisms can also provide benefits to developing countries such as technology transfer.

Before the Kyoto Protocol, there was much debate about the potential to combine JI (or, historically, Activities Implemented Jointly [AIJ]) with technology transfer.[20] However, using JI/AIJ for technology transfer was opposed by Annex I investors who saw this as adding to costs. In addition, JI/AIJ was criticized by developing countries for being difficult to measure, or for providing too few benefits to developing countries.[21] In particular, countries argued that too few countries benefited from AIJ and that too many projects focused on forestry or sinks projects that either had exaggerated environmental benefits or avoided assisting developing countries with more costly upgrading or investment in industry.[22] Indeed, part of the attraction of sinks-based AIJ projects is that they can provide profits from sustainable logging enterprises.

The creation of the CDM at Kyoto, however, was an apparent attempt to address the concerns of developing countries by providing an instrument of flexibility that aimed to provide sustainable development in non–Annex I (usually developing) countries. The defining text of the

20. See Goldberg and Stilwell (1997), Bush and Harvey (1997), and Jepma (1995).

21. Gupta (1997), Parikh (1995), and Jepma (1995).

22. Reforestation is often suggested as a form of JI/AIJ investment but has been criticized because carbon sequestration may not be as rapid as suggested, and there are risks that burning trees may actually add to atmospheric carbon. Furthermore, reforestation may also be opposed by local agricultural communities (see Reimer, Smith, & Thanbimuthu, 1997; Cullet & Kameri-Mbote, 1998). However, there has been much support for forest-based forms of AIJ by the government of Costa Rica.

Kyoto Protocol stated that the CDM was "to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the [Climate Change] Convention, and to assist Parties included in Annex I in achieving compliance with their [emissions reduction targets]."[23] The text also did not mention the word *sinks* and, thus, implied that the CDM may be used for technological development.

However, the Kyoto Protocol made no comments about how to harness private investment from Annex I countries for technology transfer. At the Fourth Conference of Parties at Buenos Aires in 1998, most debate about the CDM referred to the extent to which it may adopt similar guidelines to those already existing for AIJ. There is, consequently, a need to indicate how the CDM may be used to accelerate technology transfer in order to ensure that this new mechanism will achieve its full developmental objectives.

The following subsections describe suggestions for building flexible mechanisms for technology transfer and their potential effects on non–Annex I countries.

1. IDENTIFY THE OBJECTIVES OF INVESTMENT

A key objective of flexible mechanisms of technology transfer is that they satisfy the objectives of both developed and developing countries by enhancing technology transfer and by counting toward emissions reduction targets of Annex I countries. It must, therefore, be made clear that investment should be for sustainable development in general rather than the cheapest and most accessible way to mitigate climate change, such as simple reforestation, which has been opposed by both national governments and local communities in many developing countries.[24] Discussion of the objectives for investment under the CDM or similar structures therefore continues the Kyoto Summit debate on the purpose and nature of investment under JI/AIJ. As discussed above, such debates questioned how far JI/AIJ could enhance technology transfer and local economic development rather than simply provide low-cost means for Annex I countries to achieve emissions reduction targets. Table 2 shows 10 suggestions originally made for JI that may also be used to guide investment under the CDM.

23. Article 12.2.

24. At a conference at the Royal Institute of International Affairs before the Kyoto Summit, one African climate change negotiator summarized this position graphically by angrily telling a representative of an Annex I country: "Our countries are not toilets for your emissions!" (see Grubb et al., 1999).

Table 2
Ten Proposed Principles to Guide Investment Under the CDM for Technology Transfer in the South

1. A comprehensive legal framework should be in place before crediting begins.
2. Cost savings from investment should produce net climate change benefits, enabling greater emissions reductions and lowering costs.
3. Projects should produce significant local environmental and socioeconomic cobenefits.
4. The role of sequestration (e.g., forestry) projects should be limited.
5. Investment must be flexible and dynamic and must promote full participation in the Kyoto agreement.
6. Emissions-saving estimates should be conservative in the face of uncertainty.

In addition, investment must:

7. Take account of the time scale over which emissions reductions/savings are expected to endure.
8. Promote capacity building in the host country.
9. Promote the transfer of appropriate technology.
10. Be conducted with a high degree of transparency and public participation.

Source: Adapted from Goldberg and Stilwell (1997).

2. IDENTIFY KEY INDUSTRIES FOR SUPPORT

The next stage is to identify which industries and technologies will be best supported by flexible mechanisms for technology transfer. This article argues that the UNFCCC has adopted an outdated and somewhat static approach to technology transfer based more on public aid than on the harnessing of global investment by private companies. One key way to enhance technology transfer by private investment is to separate activities into vertical (point-to-point relocation of technology by foreign investors) or horizontal (sharing technology with local producers). Vertical investment occurs in industries where multinational producers have global competitive advantage. Horizontal transfer occurs in industries where there is less competition between domestic and international producers or where upgrading standards of domestic industry is essential for reducing emissions. Flexible mechanisms may be more suitable to accelerate vertical technology transfer, but ODA may still be necessary to enhance horizontal technology transfer. Figure 1 suggests a preliminary classification of industries and technologies where vertical and horizontal technology transfers may have different attractions.

In Figure 1, categories 1 and 3 refer to those industries in which countries receiving foreign investment are already economically competitive because of the success of indigenous companies. In the future, categories 1

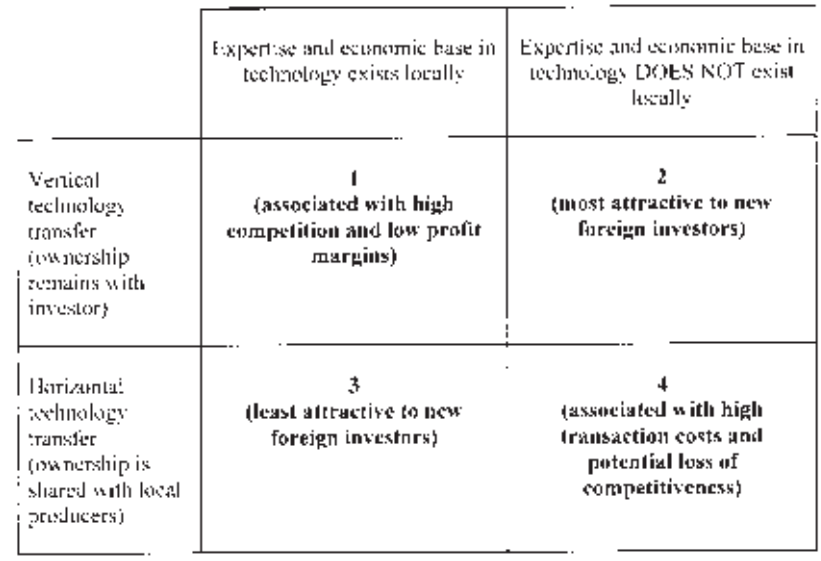

Figure 1: Different Investment Niches for Technology Transfer

and 3 may also refer to those industries in which technology transfer occurs not just from developed to developing countries but also between developing countries. Category 2 in Figure 1 refers to industries in which the most new investment in climate technology under the CDM may take place. Category 2 is likely to attract most investment because there are currently no indigenous competitors and because foreign investment may be undertaken without the commercial risks associated with sharing technology. Examples of technology in category 2 might include high-value PVs, which are from a globally competitive market and need to be updated regularly in order to remain competitive. Examples of categories 1 and 3 might include passive solar heating, which is a relatively low technology. Category 4 broadly represents the type of technology transfer currently discussed in the climate change negotiations, but it is unlikely to attract as much investment as category 3 because of the extra costs required in sharing technology.[25] Technology transfer may therefore be accelerated if flexible mechanisms are used to encourage investment in category 2. However, technology transfer may still be achieved via category 4 but only if costs are covered by

25. See Kozloff (1995) for a full discussion of the technology transfer problems of renewable energy investment in developing countries and the implications for technology choice.

Table 3
Flexible Mechanisms for Climate Technology Transfer

1. Allow emissions reduction crediting activities to be undertaken by individual companies as well as by countries.
2. Allow different levels of crediting for varying kinds of investment.
3. Allow crediting for environmentally sound technology (EST) research and development at the national level and disseminate technology through an EST bank or clearinghouse.
4. Allow crediting for actions that build horizontal technology transfer.
5. Create voluntary qualitative targets of EST research and development in non–Annex I countries.

Source: Forsyth (1999), Chung (1998), and Corraru et al. (1994).

international organizations such as the GEF, local or bilateral aid organizations, or the companies themselves.

3. ESTABLISH REWARDS FOR DIFFERENT ACTIONS

One of the key arguments of this article is that current approaches to climate change mitigation through flexible mechanisms have made no distinction between those desired by developing countries (such as technology transfer) and those most feasible and cheapest for investing countries (such as simple reforestation). It is therefore essential to overcome this lack of interest in development projects by offering higher rewards for certain investments over others.

Table 3 suggests a number of different incentives for both public and private investors to undertake such actions in return for different levels of rewards. The first suggestion is the pragmatic need to allow private companies rather than national governments to be credited for undertaking carbon abatement activities. Crediting emissions reductions at the level of the company provides incentives for investment in climate change mitigation by companies. Carbon abatement activities would then need to be traded or exchanged in return for concessions such as tax crediting with governments.

The second suggestion is to allow different levels of crediting for activities with different levels of impact on carbon abatement or local development. Differentiating rewards would provide incentives for companies to undertake activities currently considered to be more costly, such as technology upgrading rather than low-cost cherry-picking options such as reforestation that have received opposition from developing countries because they do not address developing countries' concerns for sustainable development.

The third mechanism is to reward countries or companies that invest in climate technology and then disseminate findings through so-called

technology clearinghouses or banks. This mechanism may therefore provide incentives for individual companies to share new technological findings and to gain a fast return on research and development without risking intellectual property rights. The mechanism may also provide incentives for governments to invest in research in environmentally sound technology and to develop a publicly owned store of technology that may be used for horizontal technology transfer. A technology bank or clearinghouse may also develop a measurement system of the different greenhouse-abating potentials of different technologies (possibly using the existing certified emissions reduction units already used in the context of the CDM) as a way to indicate the varying contributions of technologies.

Fourth, Table 3 suggests providing rewards, or credits against national emissions reduction targets, for horizontal technology transfer. Such rewards would provide incentives for long-term capacity building in technology development and education in developing countries; hence, they would address the commitments made in UNFCCC and Agenda 21.

Finally, the fifth suggestion is to create voluntary qualitative targets of climate technology research and development in developing countries. This mechanism would acknowledge that many useful climate technologies already exist in developing countries and call attention on the actions necessary to build these industries. Technology designed and produced in developing countries may also be more appropriate for local communities and technical support. Enhancing industries in developing countries may also protect indigenous companies against the loss of market share possible following imports from Annex I countries.

The ability to credit climate-change-mitigating activities at the level of individual companies (suggestion 1) is perhaps the most urgent task, and one that is necessary before incorporating the private sector fully into public policy on climate change. However, this, of course, is also controversial. Grubb (1998) has suggested that integration of company investment into national targets could be achieved on the basis of exchanges and trading between different governments and companies, following the authorization of requests from individual companies to be credited for activities and the establishment of monetary compensation to companies for this action. In essence, this would also depend on creating measurements of the varying contributions of different technologies used.

4. ESTABLISH GOVERNANCE AND MONITORING RESPONSIBILITIES

Finally, there is a need to ensure that flexible mechanisms of technology transfer are governed and monitored so that success in both political

and practical terms is guaranteed. Governance and monitoring may take place at local, national, or international levels.

Locally, there is a need for specialist organizations that provide local knowledge of markets to international investors and assistance in maintenance and financial management to end users of technology. One example of this kind of organization is Preferred Energy Investments in the Philippines, which was established with the assistance of UNDP and Winrock International. This organization aims to reduce the transaction costs of investment by creating links between investors, local authorities, and nongovernmental organizations.[26] Similar duties may also be undertaken by governmental offices such as the Costa Rica office for AIJ, which has been successful in attracting AIJ investment at the national level. Internationally, the executive body of the CDM is one obvious contender for the agency responsible for ensuring that investment in technology is encouraged and made compatible with local development and competitive objectives.

Successful governance, however, does not imply letting the transaction costs of administration rise to a level that repels investors.[27] The costs of technology transfer and investment in the CDM have to be assessed alongside alternative climate investment opportunities. The World Bank Global Carbon Initiative, for example, was established in 1997 to facilitate international investment in carbon-abating activities. The initiative is not an official flexible mechanism under the UNFCCC; yet, investments under the initiative may rival the CDM because they are low cost and allow investors the right to claim political credit for undertaking "climate friendly" activities.[28] Indeed, some investors have even suggested that activities under the Global Carbon Initiative should be included in emissions reduction targets. There is also a need to differentiate the role of the CDM with regard to the Global Environment Facility, which was created in 1990 to address global environmental problems including technology transfer. One solution is for the CDM to support climate-change-related investment (possibly enhancing vertical technology transfer) and for the GEF to focus on nonclimate-related technology transfer, or long-term horizontal forms of technology transfer.

However, the most important task is to find the political will necessary to achieve flexible mechanisms of technology transfer on a basis that is acceptable to both developed and developing countries. There is no doubt that effective technology transfer to developing countries will affect future emissions of greenhouse gases. Yet, much debate within the climate change negotiations has been on finding the quickest short-term

26. Forsyth (1999, chap. 8).

27. See Collamer and Rose (1997).

28. For example, the Japanese manufacturer Nissan has expressed interest in producing a climate friendly car partly through offsetting carbon emissions by investing in tree plantations in eastern Russia.

route to achieving emissions reduction targets of Annex I countries rather than on ways to satisfy both Annex I and developing countries' objectives, as well as climate change mitigation in its own right. In meetings before and during the Fourth Conference of the Parties at Buenos Aires in 1998, both the World Bank and the United States called for the CDM to adopt the existing guidelines for AIJ and to incorporate existing AIJ projects into CDM investments, which can then be credited against national emissions reduction targets.[29] These proposals are controversial because there are currently no universally agreed-on baselines for establishing the contribution of these projects to carbon abatement and because AIJ was not originally intended for crediting against targets.[30]

Agreeing on baselines is also crucial in order to avoid creating new "hot air" problems associated with flexible mechanisms. As described in Table 1, the hot air problem is expected if emissions trading is allowed to take place with countries (such as Russia) that have undergone industrial decline since 1990. Under flexible mechanisms of technology transfer, a new form of "investment hot air" may result if countries can claim to have mitigated climate change when all they have done is take market share from local manufacturers rather than increase the total volume of climate technology adopted. There is a need for monitoring mechanisms to ensure that new investment does actually contribute to climate change mitigation. National technology development policies or protection against foreign investment, however, may also run counter to proposals for a multilateral agreement on investment, which may in time form a resistance to these proposals.

Conclusion

This article has looked critically at current approaches to technology transfer under the UNFCCC and sought ways to address present deadlocks between developed and developing countries through the use of flexible, market-oriented mechanisms of technology transfer. The article argues that current approaches to technology transfer under the UNFCCC place too much responsibility on private investors to incur the costs and commercial risks of technology transfer. An additional problem has been to overlook the benefit of existing technologies already developed in the South.

29. For example, Pershing (1998).

30. For this reason, some developing country activists are arguing that the CDM will result in no added benefits for industrializing countries. In 1999, for example, Anil Agarwal (1999), director of the New Delhi Center for Science and the Environment, stated: "To developing countries who see a great future in the (un)Clean Development Mechanism, we would say get over your salivating syndrome. You are drooling over peanuts."

In response to these problems, this article has argued that approaches to technology transfer need to acknowledge the increasing globalization of technology ownership and investment, as well as the benefits these offer to both private investors and host countries. It is important to acknowledge different types of technology transfer and the different roles for public and private sectors. Encouraging vertical or point-to-point transfer of technology may result in local developmental benefits without the need for long-term horizontal technology transfer or the need to share with local manufacturers. This is especially true where local companies are unlikely to gain regional or global competitiveness in high-technology industries. Crediting such activities against national greenhouse gas emissions reduction targets, on a differentiated rate for different acts of technology development and transfer, should provide commercial incentives to gain private sector participation.

However, this is neither an argument for a free market in technology nor a step away from the demands of developing countries for technology transfer. Instead, it is a plea for greater integration of international climate technology transfer into national and regional industrial and technology policies. According to Howells and Michie (1997), "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" (p. 30).

The major challenge for climate change policy on technology transfer in the future lies in developing successful national and regional strategies that allow Annex I countries to invest in climate technology in developing countries but do not erode competitiveness of local industries or add so significantly to the transaction costs of investment in which few investors take part. If such flexible mechanisms of climate technology transfer succeed, the potential impact on climate change mitigation will be immense. However, incorrectly applied, flexible mechanisms could damage competing industries in developing countries by rewarding the growth in market share rather than all-around adoption of climate technologies. In effect, this would be a new form of investment hot air in which the introduction of a flexible mechanism provides commercial benefits to some but makes no overall impact on climate change. Governance structures have to ensure that the benefits promised by flexible mechanisms are actually matched by the achievement of their aims.

Manuscript submitted September 21, 1998; revised manuscript accepted for publication February 1, 1999.

Acknowledgments

The work leading to this article was conducted at the Royal Institute of International Affairs, Chatham House, St. James Square, London. The research was sponsored by the New Energy and Industrial Technology Organization of Japan.

References

Agarwal, A. (1999, February). *Climate politics, technology transfer and the Clean Development Mechanism*. Paper presented at the Conference on Climate, Biotechnology and Food and Water Security, Chennai, India.

Baldwin, S., Burke, S., Dunkerley, J., & Komor, P. (1992). Energy technologies for developing countries: U.S. policies and programs for trade and investment. *Annual Review of Energy and the Environment*, *17*, 327-358.

Bush, E., & Harvey, L. (1997). Joint implementation and the ultimate objective of the UNFCCC. *Global Environmental Change*, *7*, 265-286.

Butera, F., & Farinelli, U. (1991, October). *Successes and failure in energy technology transfers to developing countries*. Paper presented at the International Symposium on Environmentally Sound Energy Technologies and Their Transfer to Developing Countries and European Economies in Transition, Milan, Italy.

Chung, R. K. (1998). The role of government in the transfer of environmentally sound technology. In T. Forsyth (Ed.), *Positive measures for technology transfer under the Climate Change Convention* (pp. 47-62). London: Royal Institute of International Affairs.

Collamer, N., & Rose, A. (1997). The changing role of transaction costs in the evolution of joint implementation. *International Environmental Affairs*, *9*, 274-288.

Corraru, C., Lanza, A., & Tudini, A. (1994). Technological change, technology transfer, and the negotiation of international agreements. *International Environmental Affairs*, *6*, 203-222.

Cullet, P., & Kameri-Mbote, P. (1998). Joint implementation and forestry projects: Conceptual and operational fallacies. *International Affairs*, *74*, 393-408.

Dunning, J. (Ed.). (1998). *Globalization, trade and foreign direct investment*. Oxford: Pergamon.

Dunning, J., & Narula, R. (Eds.). (1996). *Foreign direct investment and governments: Catalysts for economic restructuring*. London: Routledge.

Forsyth, T. (Ed.). (1998). *Positive measures for technology transfer under the Climate Change Convention*. London: Royal Institute of International Affairs.

Forsyth, T. (1999). *International investment and climate change: Energy technologies for developing countries*. London: Earthscan and the Royal Institute of International Affairs.

French, H. (1998). *Investing in the future: Harnessing private capital flows for environmentally sustainable development* (Worldwatch Paper 139). Washington, DC: Worldwatch Institute.

Goldberg, D., & Stilwell, M. (1997, October). *Twelve principles to guide joint implementation*. Center for International Environmental Law, Washington/Geneva.

Gregory, J., Silveira, S., Derrick, A., Cowley, P., Allinson, C., & Paish, O. (1997). *Financing renewable energy projects: A guide for development workers*. London: Intermediate Technology Publications, in association with the Stockholm Environment Institute.

Grubb, M. (1998). Implementing the trading mechanisms of the Kyoto Protocol. *Review of European Community and International Environmental Law*, *7*, 140-146.

Grubb, M., Brack, D., & Vrolijk, C. (1999). *The Kyoto Protocol, a guide and assessment*. London: Earthscan and the Royal Institute of International Affairs.

Grubb, M., Koch, M., Munson, A., Sullivan, F., & Thomson, K. (1993). *The Earth Summit agreements: A guide and assessment*. London: Earthscan and Royal Institute of International Affairs.

Gupta, J. (1997). *The Climate Change Convention and developing countries: From conflict to consensus?* London: Kluwer.

Heaton, G., Banks, R., & Ditz, D. (1994). *Missing links: Technology and environment implications in the industrializing world*. Washington, DC: World Resource Institute.

Howells, J., & Michie, J. (Eds.). (1997). *Technology, innovation and competitiveness*. Cheltenham: Edward Elgar.

Jepma, C. (Ed.). (1995). *The feasibility of joint implementation*. Dordrecht: Kluwer Academic.

Kozloff, K. (1995). Rethinking development assistance for renewable energy sources. *Environment*, *37*(9), 6-32.

Kyoto Protocol. (1997). *Text of the Kyoto Protocol*. Bonn: UNFCCC Secretariat.

Leonard-Barton, E. (1990). The intra-organizational environment: Point-to-point versus diffusion. In F. Williams & D. Gibson (Eds.), *Technology transfer: A communication perspective* (pp. 43-62). London: Sage.

MacDonald, G. (1992). Technology transfer: The climate change challenge. *Journal of Environment and Development*, *1*(1), 1-39.

Martinot, E., Sinton, J., & Haddad, B. (1997). International technology transfer for climate change mitigation and the cases of Russia and China. In R. Socolow, D. Anderson, & J. Harte (Eds.), *Annual review of energy and the environment, 22* (pp. 357-402).

Parikh, J. (1995). Joint implementation and North–South cooperation for climate change. *International Environmental Affairs*, *7*(1), 22-41.

Pershing, J. (1998, February). *The Clean Development Mechanism: Some issues for clarification*. Paper presented at the International Workshop on Environmentally Sound Technology and the Clean Development Mechanism, Tokyo.

Porter, M. (1990). *The competitive advantage of nations*. New York: Free Press.

Reich, R. (1991). *The work of nations: Preparing ourselves for 21st–century capitalism*. London: Simon & Schuster.

Reid, W., & Goldemberg, J. (1997, July). Are developing countries already doing as much as industrialized countries to slow climate change? *World Resource Institute Climate Notes*.

Reimer, P., Smith, A., & Thanbimuthu, K. (Eds.). (1997). *Greenhouse gas mitigation: Technologies for activities implemented jointly*. Oxford: Pergamon.

State Planning Committee of the People's Republic of China. (1996). *The list of Chinese government needed technologies*. Beijing: SPC Energy Research Institute.

Tata Energy Research Institute. (1997). *Capacity building for technology transfer in the context of climate change*. New Delhi: Author.

UNFCCC (United Nations Framework Convention on Climate Change). (1992). *Text of the United Nations Framework Convention on Climate Change*. Bonn: UNFCCC Secretariat.

World Wide Fund for Nature. (1997, October). *The forgotten issue: Technology transfer and cooperation* (Leaflet). Godalming, UK: Author.

Timothy Forsyth is fellow in environment and development at the Institute of Development Studies, Falmer, Sussex. His work focuses on constructions of science and technology in environmental policy and mechanisms to reflect these constructions in public–private partnerships.