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The Future of Technology Transfer Under Multilateral Environmental Agreements

by James Shepherd

Editors' Summary: A myriad of social, economic, and legal barriers stand in the way of transferring environmentally sound technologies from developed to developing countries. The international regime that could facilitate this transfer is, at the present time, nonbinding and vague. In this Article, James Shepherd explores the potential for technology transfer under multilateral environmental agreements. Using the United Nations Framework Convention on Climate Change and Montreal Protocol as case studies, he summarizes lessons learned and identifies the barriers standing in the way of technology transfer. He then focuses on the current role played by governments and industry, and he concludes with some suggestions to assist governments, private enterprise, and international organizations in facilitating transfer of environmentally sound technologies.

I. Introduction

It is becoming increasingly common for multilateral environmental agreements (MEAs) to address not only matters of global environmental concern, but also developmental issues requiring transfers of financial and technological resources from developed countries to developing countries.[1] To facilitate this transfer of resources, a number of MEAs, as well as bilateral and regional treaties, provide for the establishment of "technology transfer" regimes.[2] Such regimes focus on the transfer of specific environmentally sound technology (EST)[3] to tackle environmental and developmental concerns. Accordingly, it is only those environmental problems of a truly global nature such as ozone depletion and climate change, which present urgent threats to developed countries as well as developing countries, and are therefore conducive to the establishment of effective regimes for the transfer of EST.[4] The idea behind these regimes is that developed countries are to take the lead and that the actions taken by developing countries must be financially and technically supported.[5]

For example, the United Nations Framework Convention on Climate Change (UNFCCC)[6] and the subsequent Kyoto Protocol[7] compel developed countries to provide assistance to developing countries on the basis that international cooperation is required to enable developing countries to adopt EST for the dual purposes of mitigating against climate change and adapting to its impacts.[8] Similarly, the Montreal Protocol,[9] designed to phase out ozone-depleting sub-

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1. Jutta Brunnée, *The U.S. and International Environmental Law: Living With an Elephant*, 15 Eur. J. Int'l L. 617, 638 (2004).
2. More than 80 international instruments and numerous subregional and bilateral treaties contain measures related to the transfer of environmentally sound technology (EST). For more information, see United Nations (U.N.) Compendium of International Arrangements on Transfer of Technology: Selected Instruments (2001). Important MEAs containing provisions relating to technology transfer include the Convention on Biological Diversity, the Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal.
3. Calestous Juma, *Promoting International Transfer of Environmentally Sound Technologies: The Case for National Incentive Schemes*, *in* Green Globe Yearbook of International Co-operation on Environment and Development 137, 138 (Helge Ole Bergesen & George Parmann eds., 1994).
4. Gaëtan Verhoosel, *Beyond the Unsustainable Rhetoric of Sustainable Development: Transferring Environmentally Sound Technologies*, 11 Geo. Int'l Envtl. L. Rev. 49, 62 (1998).
5. Brunnée, *supra* note 1, at 630.
6. For more information on the UNFCCC, see U.N., *United Nations Framework Convention on Climate Change*, http://unfccc.int/2860.php (last visited Mar. 2, 2007).
7. Kyoto Protocol to the UNFCCC. For the text of the Kyoto Protocol, see http://unfccc.int/resource/docs/convkp/kpeng.html (last visited Mar. 2, 2007).
8. Joyeeta Gupta, *Evaluation of the Climate Change Regime and Related Developments*, *in* Yearbook of International Co-operation on Environment and Development 19, 20 (Helge Ole Bergesen et al. eds., 1999).
9. Montreal Protocol on Substances That Deplete the Ozone Layer. For the text of the Montreal Protocol, see http://hq.unep.org/ozone/Montreal-Protocol/Montreal-Protocol2000.shtml (last visited Mar. 12, 2007).

stances (ODS), also provides for the transfer of EST. Both of these conventions regard technology transfer as a critical method for achieving concrete environmental improvements[10] as well as assisting developing countries in achieving developmental goals. However, while the transfer of EST is clearly an important aspect of many MEAs, the regimes that have been established have had varying degrees of success.

This Article analyzes some of the features of the regimes established by the UNFCCC and the Kyoto Protocol, as well as the Montreal Protocol. It focuses on the lessons learned from those experiences, and suggests some measures that can be taken to address the barriers to the international transfer of EST. It argues that as the provisions for technology transfer in MEAs are soft law, the successful transfer of EST at the international level will depend upon the domestic measures taken by governments in both developed countries and in developing countries. Given that the private sector is the key player in technology transfer, such policies should focus on the promotion of technology transfer by private enterprise. The role of governments and of international organizations is to create an environment that is conducive to the transfer of EST. In particular, governments in developed countries need to implement domestic policy incentives in the form of tax relief and research and development grants to encourage the private sector to engage in the transfer of EST while governments in developing countries should engage in market and legal reform to encourage foreign investment. International organizations should continue to focus their attention on carrying out capacity-building activities in developing countries. This Article also suggests some actions that can be taken by private enterprise on the ground in developing countries to ensure that the transfer of EST is successful.

II. Background on Technology Transfer

The classic model of technology transfer, which originated in the 1950s, was based on large-scale foreign investment in developing countries, but included little domestic capacity-building[11] and focused almost exclusively on the procurement of hardware and machinery without regard for human resource development.[12] As identified below, the lack of technical expertise in developing countries is a significant impediment to the international transfer of EST. Accordingly, as significant capacity-building activities are required in developing countries, such as the work done by the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP), it is fortunate that since those early days, approaches have evolved to a broader socioeconomic view of development.[13] These days, and particularly since technology transfer has become an important aspect of MEAs, a more holistic view is taken incorporating the efforts of government, international organizations, and private enterprise. The transfer of EST is now a major theme in international relations,[14] and is considered critical for promoting sustainable development[15] in developing countries.

The starting point for any discussion of the issues addressed in this Article is to define technology, technology transfer, and EST. This is particularly important because the MEAs themselves do not provide definitions of such terms,[16] and commentators have proffered numerous definitions in many different contexts.

A. Definition of Technology

Historically, the idea that the concept of technology is limited to the flow of production capacity has engendered the false view that technology transfer is an inherently expensive process.[17] Accordingly, at the very least in the context of global environmental issues such as ozone depletion and climate change, and the MEAs addressing those issues, there can be no doubt that broad definitions are appropriate. To this end, in analyzing the Kyoto Protocol, Prof. Klaus Bosselmann defines technology extremely broadly as "the complete body of knowledge applicable to human endeavour (as well as the physical embodiments of this)."[18]

For the purposes of this Article, the more specific explanation suggested by Prof. Keith E. Maskus, writing about technology in the context of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs),[19] will be adopted. He considers that technology may include particular production processes, intra-firm organizational structures, management techniques, financing methods, marketing approaches, or a combination of these.[20] Clearly, this list is not exhaustive, and technology may take many other forms. Additionally, it may be documented in formulae, blueprints, or patent applications but generally also requires know-how on the part of personnel.[21]

B. Definition of Technology Transfer

Technology transfer, then, involves the diffusion and adoption of technology (including know-how) between parties such as private enterprises, governments, financial institutions, nongovernmental organizations (NGOs), and research bodies such as universities.[22] It can be direct or indirect, and may or may not involve formal market mecha-

10. Daniel C. Esty & Maria H. Ivanova, *Revitalizing Global Environmental Governance: A Function-Driven Approach*, *in* Global Environmental Governance: Options & Opportunities 16 (Yale Sch. of Forestry & Envtl. Studies 2002).

11. Gill Wilkins, Technology Transfer for Renewable Energy: Overcoming Barriers in Developing Countries 42 (The Royal Inst. of Int'l Affairs Sustainable Dev. Programme 2002).

12. Verhoosel, s*upra* note 4, at 63.

13. Michael Dutschke et al., *Risks and Chances of Combined Forestry and Biomass Projects Under the Clean Development Mechanism* 46 (CD4CDM Working Paper Series, Working Paper No. 1, 2006).

14. Juma, *supra* note 3, at 140.

15. Esty & Ivanova, *supra* note 10, at 16.

16. Verhoosel, *supra* note 4, at 62.

17. Juma, *supra* note 3, at 139.

18. Klaus Bosselmann, *Poverty Alleviation and Environmental Sustainability Through Improved Regimes of Technology Transfer*, 2/1 L. Env't & Dev. J. 19, 22 (2006).

19. For more information on TRIPs, see World Trade Organization, *TRIPs Material on the WTO Website*, http://www.wto.org/english/tratop_e/trips_e/trips_e.htm (last visited June 4, 2007).

20. Keith E. Maskus, *Encouraging International Technology Transfer* 9 (U.N. Conference on Trade and Development and International Centre for Trade and Sustainable Development Project on Intellectual Property Rights and Sustainable Development, Issue Paper No. 7, 2004).

21. *Id.*

22. Wilkins, *supra* note 11, at 42-43.

nisms,[23] but essentially involves transfer from one organization or institution (which developed the technology) to another (which adopts, adapts, and uses it).[24] A significant amount of technology transfer occurs between partners in market-based transactions, but a large amount of technology is transferred outside those parameters.[25] This is because of a number of factors including the internal flow of information within multinational companies, the fact that technical knowledge about production and management processes may be gained from processes such as reverse engineering, and also because certain technical information, albeit a limited amount, may be available in the public domain.[26]

The process of technology transfer is complex, particularly at the international level, and it is made up of many components with a number of interested parties,[27] including governments, international organizations and the private sector. It requires efforts from both developed countries and developing countries.[28] This multifaceted dynamic is reflected in the definition adopted by the Intergovernmental Panel on Climate Change (IPCC). In the context of the UNFCCC, the IPCC says that technology transfer is:

> a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, [NGOs] and research/education institutions . . . The broad and inclusive term "transfer" encompasses diffusion of technologies and technology cooperation across and within countries. It covers the transfer of EST processes between developed countries, developing countries and countries with economies in transition, amongst developed countries, amongst developing countries and amongst countries with economies in transition. It comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies.[29]

While this definition specifically relates to the UNFCCC, it accurately describes the process for the transfer of EST generally by drawing attention to the fact that it is a multifaceted phenomenon requiring the involvement of many parties and the existence of an enabling environment for it to occur successfully.[30] Additionally, it identifies the fact that for the transfer of EST to be successful, there must be effective absorption of the transferred technology, and so any workable definition is therefore functional rather than formal.[31] Attention must be paid to technical adaptation to local conditions, integration with existing technology and the development of the skills in developing countries needed to fund, manufacture, install, operate, and maintain EST.[32]

This Article will argue that the transfer of EST at the international level results from actions taken by governments and international organizations to create a favorable environment that facilitates activity in the private sector.[33] This is because private enterprise undertakes most activity in creating new technology, developing marketable products, and diffusing the relevant technology, and also because most capital comes in the form of direct investment by the private sector.[34] This is particularly the case in relation to EST, because very little EST-related knowledge resides in the public domain and most proprietary knowledge in relation to EST has been developed by multinational companies.[35] Accordingly, the transfer of EST is largely generated by market forces, and as the holders of the majority of knowledge in relation to EST, multinational companies are extremely important players in the process.[36] For example, significant amounts of technology flow within such companies and between joint venture partners. If a joint venture is established involving a multinational company and a local company in a developing country, technology transfer will be an ongoing process as further technical developments are made and implemented on the ground.[37] It is trite to say that private enterprise is driven by profit motive,[38] but the role of governments—in developed countries and in developing countries—is to introduce policy measures that create an environment conducive to the transfer of EST, that is to say that they must ensure that it is in the interests of the private sector to engage in technology transfer activities. This Article will suggest a number of measures that can be taken to create the necessary conditions, including, for example, the use of incentives in developed countries to nurture frontier technological development by multinational companies.[39]

C. Definition of EST

Agenda 21[40] sets out a number of elements that characterize EST. Among other things, Chapter 34 provides the following definition:

23. Maskus, *supra* note 20, at 9-10.
24. Bosselmann, *supra* note 18, at 22.
25. Maskus, *supra* note 20, at 9.
26. *Id.*
27. *Id.* at 7.
28. Verhoosel, s*upra* note 4, at 51.
29. Intergovernmental Panel on Climate Change Special Report Methodological and Technological Issues in Technology Transfer—Summary for Policy Makers 1 (2000).
30. Esa Puustjärvi et al., *Transfer of Environmentally Sound Technologies From Developed Countries to Developing Countries*, Background Document for the Ad Hoc Expert Group on Finance and Environmentally Sound Technologies, The Secretariat of the U.N. Forum on Forests, at 2 (Dec. 2003).
31. Verhoosel, *supra* note 4, at 64.
32. Wilkins, *supra* note 11, at 44.
33. *See, e.g.*, IPCC Working Group III Special Report, U.N. Environment Programme Division of Technology, Industry and Economics, Methodological and Technological Issues in Technology Transfer 5 (2001).
34. International Energy Agency, Technology Without Borders 11 (2001). However, this is not the case for adaptation technology as the market for adaptation technology is dominated by public finance and there is little private sector involvement. It is a task better undertaken by government.
35. Verhoosel, *supra* note 4, at 66.
36. *Id.* at 67.
37. Wilkins, *supra* note 11, at 45.
38. *Id.*
39. Jason R. Wiener, *Sharing Potential and the Potential for Sharing: Open Source Licensing as a Legal and Economic Modality for the Dissemination of Renewable Energy Technology*, 18 Geo. Int'l Envtl. L. Rev. 278, 303 (Winter 2006).
40. Agenda 21 is a comprehensive plan of action to be taken globally, nationally, and locally by organizations of the U.N. system, governments, and other major groups in every area in which human activity has an impact on the environment. Agenda 21, the Rio Declaration on Environment and Development, and the Statement of Principles for the Sustainable Management of Forests were adopted at the U.N. Conference on Environment and Development held in Rio de Janeiro in 1992. For more information on Agenda 21, see U.N. Depart-

> Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes.
>
> Environmentally sound technologies in the context of pollution are "process and product technologies" that generate low or no waste, for the prevention of pollution. They also cover "end of the pipe" technologies for treatment of pollution after it has been generated.
>
> Environmentally sound technologies are not just individual technologies, but total systems which include know-how, procedures, goods and services, and equipment as well as organizational and managerial procedures. This implies that when discussing transfer of technologies, the human resource development and local capacity-building aspects of technology choices, including gender-relevant aspects, should also be addressed. Environmentally sound technologies should be compatible with nationally determined socio-economic, cultural and environmental priorities.[41]

It is important to note that the benefits EST can bring will vary according to context. For example, the best available EST is not necessarily appropriate for a developing country that lacks the capacity required to use that technology effectively, and in such circumstances, technology that better fits that country's capacity may be more appropriate.[42] Similarly, the environmental impact of technology cannot be assessed in a vacuum, as ultimately, its success or otherwise will depend on how that technology is applied locally, because technology transferred from one country to another cannot be expected to perform in the same way or have the same environmental impact.[43] For these reasons, the environmental soundness of any particular technology can only be assessed on a case-by-case basis regarding factors such as the circumstances in the developing country concerned[44] and the resultant impacts of the technology there. However, this task is made significantly more difficult by the fact that, as yet, there are no widely accepted criteria for assessing the performance of EST, although the UNEP Expert Group on Environmentally Sound Technologies has drafted a preliminary set of generic guidelines that can be used in evaluating EST.[45]

Despite these problems, the Parties to certain MEAs have attempted to adopt a definition of the types of EST that should be transferred from developed countries to developing countries. For example, each year, the Parties to the UNFCCC meet at the Conference of the Parties to monitor its implementation and to continue negotiations on the best ways to address the problem of climate change. At the Second Conference of the Parties, held in 1996 in Geneva, the Parties adopted the following definition of EST for the purposes of technology transfer:

> [P]ractices and processes such as "soft" technologies, for example, capacity-building, information networks, training and research, as well as "hard" technologies, for example, equipment to control, reduce or prevent anthropogenic emissions of greenhouse gases [(GHGs)] in energy, transport, forestry, agriculture, and industry sectors, to enhance removals by sinks, and to facilitate adaptation.[46]

This description is interesting, because it reflects the enormous range of technology that can be considered EST under the UNFCCC. This has been a significant issue in the implementation of that treaty, particularly when compared with a treaty such as the Montreal Protocol, where the range of relevant technology is relatively small.

Nonetheless, there are a number of concrete historical examples of the successful transfer of EST from developed countries to developing countries, including a project to improve the water quality of the Kuang River in northern Thailand by treating domestic wastewater using an aeration process, the use of computer software to create long-term future scenarios of the Langat Basin in Malaysia by making policy choices and exploring the environmental, social, and economic consequences of the decisions, and the uptake and application of environmental management systems by local government authorities in China.[47]

D. Benefits of Transfer of EST

The benefits of the transfer of EST are well-documented. Numerous references to the transfer of EST in Agenda 21 reflect its importance to sustainable development. Not only are developing countries reliant on the transfer of EST to reduce the environmental stress caused by industrialization,[48] the transfer of EST is also critical to addressing global environmental issues such as ozone depletion and climate change.[49] The industrial expansion of developing countries depends on technological and financial assistance[50] as does sustainable economic growth.[51] This is a manifestation of the underlying conflict between environmental and developmental objectives that many MEAs seek to address through technology transfer regimes.

The impact of developing countries undergoing industrialization on the global environment cannot be overstated. For example, developing countries are expected to account for more than 75% of the increase in carbon emissions worldwide between 1990 and 2020,[52] and the carbon emis-

ment of Economic and Social Affairs, Division for Sustainable Development, Documents, http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm (last visited Mar. 12, 2007).

41. See Chapter 34 of Agenda 21, http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter34.htm (last visited June 4, 2007).

42. Pew Center on Global Climate Change, Beyond Kyoto: Advancing the International Effort Against Climate Change 49 (2003).

43. Verhoosel, *supra* note 4, at 64.

44. *Id.*

45. International Environmental Technology Centre, U.N. Environment Programme, Technology Transfer: The Seven Cs for the Successful Transfer and Uptake of Environmentally Sound Technologies 22 (Nov. 2003).

46. *See*, *e.g.*, *U.S. Government Activities: Technology Cooperation & Climate Change*, http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BVU68/$File/tech_coop.pdf (last visited Mar. 12, 2007).

47. International Environmental Technology Centre, *supra* note 45, at 1.

48. Bosselmann, *supra* note 18, at 24.

49. Wilkins, *supra* note 11, at 47-48.

50. Verhoosel, *supra* note 4, at 49.

51. Bernard M. Hoekman et al., *Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options* (World Bank Policy Research Working Paper No. 3332, at 1, 2004).

52. Ved P. Nanda, *The Kyoto Protocol on Climate Change and the Challenges to Its Implementation: A Commentary*, 10 Colo. J. Int'l Envtl. L. & Pol'y 319, 332 (1999).

sions of developing countries are projected to, at the very least, equal the emissions of developed countries by 2030.[53] Similarly, as developing countries continue to industrialize, their impact on other environmental problems will increase.[54] The transfer of EST is thus an extremely important mechanism to enable developing countries to undertake sustainable development, rather than repeating the mistakes that developed countries have made in the past.

A good way to illustrate the benefits of technology transfer is to assess the situation in a developing country that does not have access to the mechanisms of the UNFCCC and the Kyoto Protocol facilitating the transfer of technical and financial resources. Taiwan is such a country. It is not a member of the United Nations (U.N.) or the International Court of Justice, and so it is excluded from the operation of the UNFCCC by Article 20 and it is prevented, by its political status, from ratifying the Kyoto Protocol.[55] Taiwan is a developing country in Asia. As a result, its economy relies heavily on international trade and in particular fossil fuels, importing as much as 80% of its coal and crude oil.[56] Additionally, Taiwan has a particularly active industrial sector. In 2001, for example, its total GHG emission levels ranked as high as 22nd in the world, and constituted 1% of the world's total emissions.[57] The amount of GHG emissions in Taiwan is growing rapidly. Its average growth rate for emissions of, for example, carbon dioxide, between 1990 and 2000, was 6.3%.[58]

These statistics make it clear that Taiwan is facing critical environmental and developmental issues. However, it is unable to take advantage of the international regimes established to assist similar countries with addressing those problems. Due to the fact that it is a developing country with a unique political position, Taiwan lacks administrative capacity and economic resources, particularly those required to develop and implement the necessary environmental policies.[59] Similarly, Taiwan lacks technological know-how and experience in implementing GHG reduction policies and in policies to improve energy efficiency.[60] Most critically, its ability to obtain financial and technical support from developed countries is severely limited.[61] Instead, Taiwan can only procure the necessary technologies, techniques and equipment by itself, either through the public sector or the private sector.[62] Accordingly, it is in a position where it is forced to develop environmental solutions without assistance from developed countries,[63] and, as a result, it is extremely costly for Taiwan to achieve GHG emissions reductions. Certainly the costs faced by Taiwan will be much higher than in other developing countries.[64] Additionally, without the financial assistance of developed countries and access to shared knowledge and similar experiences, the process for achieving GHG emissions reductions will take significantly longer.[65] This delay not only wastes further resources, but also slows the development of domestic environmental policies and strategies[66] and diverts those resources from other much needed areas.

The example of Taiwan clearly illustrates the benefits of technology transfer. Taiwan, like other developing countries, is impaired by its lack of financial, technical, and professional capacity, which prevents it from evaluating development options and implementing the policies required to give effect to them.[67] Those other developing countries, however, are able to obtain the benefits of the international regimes established to facilitate technical and financial transfers. The most significant benefit of those regimes is that they enable seemingly competing objectives, namely the well-being of people, economic prosperity, and the protection of the environment, to be pursued at the same time.[68]

III. Provisions in MEAs on the Transfer of EST

The approach to technology transfer espoused in most MEAs is based on the concept of common but differentiated responsibility,[69] which presumes that while all countries share the duty of addressing global environmental problems, the unequal historical contributions of countries and their different capacities to take corrective action must be taken into account.[70] Accordingly, the provisions in MEAs providing for the establishment of international regimes to facilitate the transfer of EST from developed countries to developing countries aim to prevent developing countries following patterns of high-polluting, unsustainable industrialization that was commonplace in developed countries.[71]

Interestingly though, there is no universal framework for the transfer of EST under MEAs. Different mechanisms have been set up under different conventions and the wording of the relevant provisions vary significantly. Generally, however, MEAs provide for developed countries to make some effort to promote the transfer of EST to developing countries. As a result of these often quite vague, perhaps deliberately so, obligations, it is often difficult to determine their scope,[72] particularly as the MEAs themselves do not contain binding rules and are generally limited to "best ef-

53. Mark A. Drumbl, *Does Sharing Know Its Limits? Thoughts on Implementing International Environmental Agreements: A Review of National Environmental Policies, A Comparative Study of Capacity-Building*, 18 Va. Envtl. L.J. 281, 286 (1999).

54. *Id.*

55. Yi-Yuan Su, *The Effects of the Kyoto Protocol on Taiwan*, VI Sustainable Dev. L. & Pol'y 51, 51 (2006).

56. *Id.*

57. *Id.*

58. *Id.*

59. *Id.* at 52.

60. *Id.* at 53.

61. *Id.* at 52.

62. *Id.*

63. *Id.* at 54.

64. *Id.* at 52-53.

65. *Id.* at 54.

66. *Id.*

67. Alicia Bárcena, *An Overview of Follow-up of Agenda 21 at the National Level*, *in* Green Globe Yearbook of International Co-operation on Environment and Development, *supra* note 3, at 133.

68. Bosselmann, *supra* note 18, at 21-22.

69. For more information on this concept, see, e.g., *The Principle of Common but Differentiated Responsibilities: Origins and Scope* 1 (Centre for Int'l Sustainable Dev. Law Legal Brief, 2002). The principle includes two fundamental elements: the common responsibility of countries for the protection of the environment at the national, regional, and global levels; and the need to take into account each country's contribution to a particular problem and its ability to and control the threat.

70. Brunnée, *supra* note 1 at 628-29.

71. Bosselmann, *supra* note 18, at 24.

72. Verhoosel, *supra* note 4, at 49, 57-58.

forts" commitments.[73] Accordingly, the provisions regarding the transfer of EST are regarded as soft law[74] because they do not impose binding commitments on countries against which compliance can be assessed, and they rely on national measures for their implementation, leaving individual countries with considerable discretion.[75]

This lack of hard international environmental law is often seen as a major obstacle to global environmental protection,[76] and not just in the context of technology transfer. Currently, MEAs contain no penalty provisions for breaches, and the current system relies solely on ethics as the major enforcement mechanism for global environmental standards.[77] A further difficulty arises because private enterprise has a significant impact on global environmental issues. However, no mention is made of the private sector in the MEAs, or indeed in most international conventions.[78] The result of these two difficulties is that ultimately, the success of MEAs, and in particular the international regimes to facilitate technology transfer, will depend on the measures taken by governments, in both developed and developing countries, to facilitate and monitor the transfer of EST in the private sector.

A. Montreal Protocol

The Montreal Protocol seeks to protect the ozone layer by phasing out ODS. Article 10A, which establishes the regime for the transfer of EST, provides:

> Each Party shall take every practicable step, consistent with the programmes supported by the financial mechanism, to ensure:
>
> a. that the best available, environmentally safe substitutes and related technologies are expeditiously transferred to [developing countries]; and
> b. that the transfers referred to in subparagraph (a) occur under fair and most favourable conditions.[79]

The Parties have taken a number of important actions to administer this commitment. Those measures have included, for example, the engagement of UNEP to collect information for the purposes of preparing an inventory of EST conducive to the phaseout of ODS; seeking input from developing countries on their experience with impediments to the transfer of EST and identifying solutions to overcome those impediments; and the establishment of a reporting and monitoring mechanism which fosters compliance.[80]

UNEP has also been active in undertaking capacity-building activities at the national government level in developing countries to ensure that the correct technology choices are made. UNEP has undertaken a number of activities with governments in developing countries to strengthen capacity including assisting in the development of national ozone units to develop national policies regarding the phasing out of chlorofluorocarbons (CFCs) and assisting governments in developing countries to develop cost-effective strategies for phasing out ODS, especially in the refrigeration and air conditioning sectors.[81] Similarly, the UNDP has provided technical assistance through institutional strengthening, for example, in China's Project Management Office and demonstration phaseout projects in solvent cleaning, foams, and other activities, while the U.S. Environmental Protection Agency has also assisted in developing ozone-friendly refrigerators for the Chinese market.[82]

The types of projects for the transfer of EST implemented under the Montreal Protocol include, for example, efforts to replace CFC-based foam-blowing machinery with new non-CFC equipment and projects to initiate the recovery, recycling, and reuse of CFCs during equipment servicing in the refrigeration and air conditioning service industries.[83]

1. Indian Refrigeration Industry

One of the major success stories of the Montreal Protocol has been the transfer of EST to the Indian refrigeration industry to enable it to implement new technology. India signed the Montreal Protocol in 1992, and soon faced a major challenge in replacing the CFCs that were used in the refrigeration industry with new non-CFC equipment.[84] In response to that challenge, a significant amount of EST has been transferred to the Indian refrigeration industry under the auspices of the Ecofrig Project.

The Ecofrig Project involved collaboration among the German, Indian, and Swiss governments, with a view to promoting the transfer of EST in the field of refrigeration technologies to the Indian refrigeration sector.[85] Recognizing the importance of building capacity in developing countries, the Ecofrig Project focused on increasing technical expertise in India to assist appliance manufacturers in making technological choices.[86] As a result, most of the seven major refrigerator manufacturers in India have developed partnerships with multinational companies in Europe that manufacture similar appliances.[87]

Similarly, the availability of accurate and timely information to the relevant parties is of critical importance to technology transfer. Like any other global environmental issue, Indian refrigerator manufacturers required accurate infor-

73. Bosselmann, *supra* note 18, at 26.

74. *Id.* at 25. For a discussion of soft law, see, e.g., Hartmut Hillgenberg, *A Fresh Look at Soft Law*, 10 Eur. J. Int'l L. 499 (1999).

75. Bosselmann, *supra* note 18, at 25.

76. Itaru Nitta, *Proposal for a Green Patent System: Implications for Sustainable Development and Climate Change*, V Sustainable Dev. L. & Pol'y 61, 62 (2005).

77. *Id.*

78. David M. Ong, *The Impact of Environmental Law on Corporate Governance: International and Comparative Perspectives*, 12 Eur. J. Int'l L. 685, 694 (2001).

79. For the text of the Montreal Protocol, see http://hq.unep.org/ozone/Montreal-Protocol/Montreal-Protocol2000.shtml (last visited June 4, 2007).

80. Gilbert M. Bankobeza, Ozone Protection: The International Legal Regime 240-42 (2005).

81. *Id.* at 208.

82. O. Yoshida, *The International Legal Regime for the Protection of the Stratospheric Ozone Layer*, 6 Int'l L. Japanese Persp. 273 (2001).

83. David Strelneck & Peter Linquiti, *Environmental Technology Transfer to Developing Countries: Practical Lessons Learned During Implementation of the Montreal Protocol* 1 (ICF Consulting Working Paper, Presented at the 17th Annual Research Conference of the Association for Public Policy and Management).

84. International Energy Agency, *supra* note 34, at 21.

85. P. Bhatia & P. Pramanik, *Globalisation, Competitiveness and Flexibility: Case Study on Ecofrig Project*, Proceedings of the International Conference on Management of Technology (1997), *available at* http://static.teriin.org/division/eetdiv/ie/docs/ft01.htm.

86. Yoshida, *supra* note 82.

87. International Energy Agency, *supra* note 34, at 22.

mation on alternative technologies to assist in addressing the problem of phasing out CFCs.[88] The Ecofrig Project provided access to information and technical know-how to enable Indian manufacturers to make informed choices and to negotiate with technology suppliers in developed countries by facilitating visits by Indian scientists, industry representatives, and government officials to manufacturing plants in Germany and Switzerland.[89] It also served as an information clearinghouse on alternative technologies and in doing so has increased Indian expertise in the manufacturing of household appliances.[90]

Prior to the commencement of the Ecofrig Project, the Indian refrigeration industry, like many other industries in developing countries, was not in a position to absorb the transfer of EST from developed countries because it lacked technical expertise and know-how as well as product development capabilities and operating experiences with the new technology.[91] There was also a significant lack of proper facilities and equipment necessary for servicing the new refrigerators.[92] Accordingly, between 1992 and 1997, the Ecofrig Project also oversaw the establishment of two pilot plants involving leading Indian refrigerator manufacturers.[93] A German appliance manufacturer provided technical expertise in appliance engineering, particularly the safe design of refrigerators using non-CFC technology.[94] The development of strong partnerships between companies in developed countries and developing countries was a key element in the success of the Ecofrig Project, allowing the Indian refrigeration industry to gain the knowledge required to select and adopt suitable alternative technology.[95]

The Ecofrig Project highlights a number of issues that are significant in facilitating technology transfer in the private sector. Problems of access to information and lack of capacity are major impediments to technology transfer, and this project was particularly successful in addressing those obstacles.

2. Multilateral Fund

Another important aspect of the Montreal Protocol has been the establishment of the Multilateral Fund. Created by Article 10,[96] it is an unprecedented step in financing the implementation of MEAs,[97] and has been particularly important in the successful operation of the Montreal Protocol. Article 5(5) makes developing countries' obligations conditional upon the effective implementation of technology transfer pursuant to Article 10A and the effective implementation of the Multilateral Fund pursuant to Article 10.

The Multilateral Fund provides resources to assist developing countries with complying with their obligations under the Montreal Protocol to phase out the use of ODS. It is managed by an Executive Committee and funded by contributions from developed countries. Financial and technical assistance is provided in the form of grants or concessional loans delivered through the implementing agencies: the UNDP, UNEP, the U.N. Industrial Development Organization, and the World Bank.

A number of successful projects under auspices of the Multilateral Fund have been implemented in China. One of the largest projects implemented by the World Bank is the conversion of air conditioning compressor production from CFC-12 to hydrochlorofluorocarbon-22 at the Beijing Machinery Factory through an agreement providing for the transfer of EST negotiated with Arctic Circle Ltd. in the United Kingdom.[98]

The success of the Multilateral Fund can be attributed to the manner in which it is structured to address concerns long held by developing countries. First, there is often a tension in developing countries between environmental and developmental objectives, so the Multilateral Fund actively seeks not to promote environmental protection at the expense of economic development, primarily because the technology transfer regime is based on the transfer of EST that is affordable and attractive.[99] Secondly, the Executive Committee has sought input from developing countries regarding the impediments to the transfer of EST and the identification of solutions to overcome such impediments.[100] Thirdly, priority has been given to capacity-building in developing countries,[101] involving activities such as the Ecofrig Project. Fourthly, the Multilateral Fund is sensitive to political differences between countries as it utilizes a consensus-based decisionmaking approach with balanced representation that is acceptable to all countries.[102]

By encouraging the participation of developing countries internationally and sponsoring domestic capacity-building exercises, the Multilateral Fund has contributed to the sense of cooperation and commitment amongst the parties and has contributed to the phaseout of ODS and the international transfer of ozone-friendly technology.[103]

3. Success of the Montreal Protocol

China is the largest consumer and producer of ODS among developing countries.[104] Under the Multilateral Fund, as of November 1995, 155 projects had been implemented exclusively for China and it is estimated that 31,000 metric tons (t) of ODS would be eliminated, 1,700t having already been phased out.[105] Worldwide, it was suggested that between 1990 and 1995, 3,000t of ODS had been eliminated on an annual basis through implementation projects supported by the Multilateral Fund, although if approved projects had been implemented without delay, an estimated 2,500t could have been phased out.[106]

88. *Id.*
89. *Id.*
90. *Id.*
91. *Id.* at 23.
92. *Id.* at 22.
93. *Id.*
94. *Id.* at 23.
95. *Id.*
96. For more information on the Multilateral Fund, see Multilateral Fund for the Implementation of the Montreal Protocol, http://www.multilateralfund.org (last visited Mar. 2, 2007).
97. Bankobeza, *supra* note 80, at 205.
98. Yoshida, *supra* note 82, at 271-73.
99. Bankobeza, *supra* note 80, at 206.
100. *Id.* at 207.
101. *Id.* at 208.
102. *Id.* at 209.
103. Yoshida, *supra* note 82, at 274-75.
104. *Id.* at 271.
105. *Id.*
106. *Id.*

Although there have been delays in the implementation of some projects, technology cooperation partnerships under the Montreal Protocol such as the Ecofrig Project have been based on equality rather than dependence, which has engendered a sense of commitment among the parties.[107] The result has been the transfer of EST making a significant contribution to the reduction of ODS.[108] The Ecofrig Project in particular also benefited from the fact that the technology to be transferred is limited to a number of specific, identifiable substitute products and processes.[109] This is to be compared with the UNFCCC and the Kyoto Protocol, where the range of possible technology is much wider.

B. UNFCCC and the Kyoto Protocol

1. UNFCCC

The UNFCCC is the centerpiece of the international community's effort to combat global warming[110] and it recognizes that the transfer of EST is critically important to achieving the objective of stabilizing GHG concentrations in the atmosphere at a level that prevents dangerous interference with climate. The transfer of EST is designed to assist developing countries with responding to climate change through the diffusion and use of appropriate climate change mitigation and adaptation technologies.[111] The UNFCCC recognizes that developed countries' special responsibility of ensuring effective implementation of developing countries' commitments under the UNFCCC is to be achieved by the provision of financial assistance and technology transfer, but at the same time recognizes that developing countries need to encourage economic and social growth to eradicate poverty.[112]

Despite its objective, the UNFCCC sets no firm targets or deadlines, primarily due to the opposition of many countries.[113] Consequently, it contains only vague commitments regarding the stabilization of GHG emissions, and no specific commitments regarding reductions of GHG emissions.[114] The achievement of the objective of the UNFCCC will require considerable technological innovation in combination with rapid and widespread technology transfer and implementation which should also include transfer of information and skills development.[115] The technology transfer regime is established by Articles 4.5 and 4.7. Article 4.5 provides:

> The [developed countries] 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 [developing countries] to enable them to implement the provisions of the Convention. In this process, the [developed countries] shall support the development and enhancement of endogenous capacities and technologies of [developing countries]. [Organizations] in a position to do so may also assist in facilitating the transfer of such technologies.[116]

Article 4.7 provides:

> The extent to which [developing countries] will effectively implement their commitments under the Convention will depend on the effective implementation by [developed countries] of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the [developing countries].[117]

The exact meaning and practical consequences of these provisions is unclear.[118] It is also important to note an inherent difficulty in the UNFCCC, particularly in comparison with the Montreal Protocol, namely, the difficulty in establishing an effective regime for the transfer of EST because the range of technology to be transferred is much less specific.[119]

2. Energy Efficiency in China

Through financial and technology transfer to developing countries, developing countries can target climate change[120] to achieve the objectives of the UNFCCC. For example, in 2002, China was the second largest emitter of carbon dioxide in the world, with 13% of the world's total emissions.[121] The principle reason for China's high emission rate is its use of heavy coal combustion in outdated and inefficient facilities that is necessary to support the country's rapid economic growth.[122] Even though the Chinese government has offered initiatives to expand the use of EST, it lacks the technical capability and the capital necessary to effectively reduce GHG emissions.[123] In order for China to properly introduce EST, it relies on financial and technical aid from developed countries, such as Japan.[124]

While foreign aid has assisted in progressing China's environmental protection, there are still obstacles to introducing EST into China.[125] Nonetheless, since 2002, the Japanese International Cooperation Agency (JICA) has undertaken the Project for Improvement of Environmental Protection Technology for Metallurgical Combustion at Beijing

107. Helen Argalias et al., *Introduction: Environmentally Sound Technologies—An Overview*, *in* The Role of Publicly Funded Research and Publicly Owned Technologies in the Transfer and Diffusion of Environmentally Sound Technologies: U.N. Conference on Trade and Development Advance Technology Assessment 9 (2000).

108. Bosselmann, *supra* note 18, at 28.

109. Verhoosel, *supra* note 4, at 65.

110. Peter D. Cameron, *The Kyoto Process: Past, Present and Future*, *in* Kyoto: From Principles to Practice, International Environmental Law and Policy Series, Vol. 60, at 3, 8 (Peter D. Cameron & Donald Zillman eds., 2001).

111. Methods for Climate Change Technology Transfer Needs Assessments and Implementing Activities: Experiences of Developing and Transition Countries, Climate Technology Initiative Draft Report 1 (2001) [hereinafter Climate Technology Initiative].

112. Hoekman et al., *supra* note 51, at 321.

113. *Id.*

114. *Id.*

115. Wilkins, *supra* note 11, at 33.

116. For the text of the UNFCCC, see http://unfccc.int/resource/docs/convkp/conveng.pdf (last visited June 4, 2007).

117. *Id.*

118. Hoekman et al., *supra* note 51, at 284.

119. Verhoosel, *supra* note 4, at 65.

120. Nitta, *supra* note 76, at 64.

121. *Id.*

122. *Id.*

123. *Id.*

124. *Id.*

125. *Id.*

in order to improve the energy efficiency of China's steel industry.[126] The program's goal has been to improve China's energy efficiency in coal combustion by constructing a piole plant in the State Steel Research Institute of China.[127] JICA has also deployed equipment provisions, conducted joint exercises, invited experts, and held workshops in China to improve existing technology.[128]

3. Kyoto Protocol

The UNFCCC is a framework agreement that depends upon supplementary protocols and agreement for implementation.[129] Accordingly, the Third Conference of the Parties, meeting in Kyoto in 1997, adopted the Kyoto Protocol which sets specific targets and timetables for reducing overall global emissions of GHG from developed countries. It commits developed countries to achieving emissions reductions to levels averaging 5.2% below those of 1990.[130] Not only does it contain legally binding steps to achieving reductions in GHG emissions,[131] the Kyoto Protocol also contains important provisions about the transfer of EST. Indeed, technology transfer is mentioned in several places in the Kyoto Protocol.[132]

Pursuant to Article 11, developed countries are to provide financial resources, including for the transfer of technology, needed by developing countries. Article 13.4 acknowledges the need to minimize the adverse impacts of climate change in developing countries and notes that among the issues to be considered shall be the establishment of funding, insurance, and technology transfer. Article 10(c) provides for the transfer of EST to developing countries and that all Parties shall:

> [C]ooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programmes 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 the transfer of, and access to, environmentally sound technologies.[133]

Perhaps the most significant development under the Kyoto Protocol has been the development of the Clean Development Mechanism (CDM). The CDM is essential to achieving emissions targets because, as a market-based regulatory tool, it enables countries to achieve their targets in the most cost-effective manner possible.[134] The CDM can also play a significant role in facilitating the transfer of EST.

126. *Id.*

127. *Id.*

128. *Id.*

129. Climate Technology Initiative, *supra* note 111, at 9.

130. Wilkins, *supra* note 11, at 33.

131. Climate Technology Initiative, *supra* note 111, at 4.

132. Wilkins, *supra* note 11, at 50.

133. For the text of the Kyoto Protocol, see http://unfccc.int/resource/docs/convkp/kpeng.pdf (last visited June 4, 2007).

134. Scott J. Stone, *Comment on COP 11 to the UNFCCC*, VI Sustainable Dev. L. & Pol'y 45, 45-46 (2006).

4. Clean Development Mechanism

The CDM is designed to assist developing countries in achieving sustainable development through investment and the transfer of EST[135] and also to assist developed countries in achieving compliance with their GHG emission reduction commitments.[136] It seeks to achieve this objective by harnessing private capital and channeling it to developing countries[137] resulting in increased foreign investment in EST in developing countries.[138] It is expected that this approach will result in increased technology transfer.[139]

Under the CDM, emissions reductions from clean or renewable energy projects are given a market value in the form of certified emissions reductions that can be sold by energy producers.[140] Through this mechanism, the CDM encourages investment in EST projects in developing countries[141] while reducing investment risks.[142]

While in theory, CDM project activities should benefit developing countries via investment and technology transfer,[143] it is important to note that the CDM is not a mechanism for technology transfer. It is a mechanism for channeling foreign direct investment into developing countries. Indeed, the Kyoto Protocol does not make any explicit links between the CDM and technology transfer, but it does acknowledge that technology transfer is increasingly being integrated into policy debates about investment, and the problems of managing investment for better development are similar to those for increasing technology transfer.[144] Technology transfer may well be a side effect of that investment, but it is necessary to look at whether it will actually occur by analyzing whether the CDM will promote the development and diffusion of technology.

Model results of the CDM suggest annual revenue of about $10 billion per year, assuming U.S. participation.[145] This represents only about 10% of current foreign direct investment in developing countries, but it is likely that a significant share of the investment would be in the energy sector, and would influence the technology choices made.[146] Unfortunately, while total investments may be large, the CDM value of most projects would be relatively small, and so the CDM by itself may not promote market penetration of expensive options without price supports.[147]

Accordingly, for the CDM to reach its full potential in terms of technology transfer, a number of issues need to be

135. Wilkins, *supra* note 11, at 39.

136. Climate Technology Initiative, *supra* note 111, at 16.

137. Wilkins, *supra* note 11, at 51-52.

138. Secretariat of the UNFCCC, Caring for Climate: A Guide to the Climate Change Convention and the Kyoto Protocol 29 (2005).

139. Sara Standish, *Business and Climate Change: Examining Drivers for Action*, V Sustainable Dev. L. & Pol'y 9, 12 (2005).

140. *Id.*

141. *Id.*

142. *Id.*

143. Wilkins, *supra* note 11, at 39.

144. *Id.* at 51.

145. Organization for Economic Cooperation and Development and International Energy Agency, Technology Innovation, Development and Diffusion 29 (2003). Clearly, without U.S. participation, the annual revenue figure will be much lower.

146. *Id.*

147. *Id.* at 29-30.

addressed. First, significant uncertainties regarding the ongoing value of credits have undermined the market's development. To address this concern, long-term policy signals are needed, or many projects will not attract financial capital.[148] Secondly, steps need to be taken at the domestic level in developing countries to attract foreign investment, including setting emissions abatement targets and defining a strategy to meet policy objectives; connecting energy policy, strategy, and targets with climate policy; solving problems of lack of coherence and coordination and making the necessary adjustments to regulations to create adequate investment conditions; and overcoming incomplete and inefficient information resources.[149] Similarly, developed countries will have to develop policies supportive of private investment in EST.[150] Despite these issues, however, in June 2006 it was reported that the CDM is estimated to generate more than one billion metric tons of emission reductions by the end of 2012.[151]

5. Adaptation Technology

Historically, the debate in relation to climate change has focused on the development of clean energy supply alternatives, perhaps at the expense of adaptation technology.[152] Indeed, comparatively little consideration has been given in a systematic way to what is required for adaptation to climate change.[153] Nonetheless, technology transfer for adaptation to climate change is important to reducing vulnerability to climate change.[154] Governments have a special role to play in the development and transfer of adaptation technology that assists vulnerable areas in adapting to the adverse effect of climate change, because such measures are undertaken for the public good, not in response to market forces, and so the task is better suited to government.[155]

In 1997, in one of the early projects to address adaptation technology, the United States funded an initiative to assess how farmers in Burkina Faso could use climate forecasts to enhance agricultural sustainability and food security.[156] The project involved a study of local forecasting knowledge, adaptive strategies to climate variability, farmers' information networks, and the experimental dissemination of seasonal rainfall forecasts based on surface temperature in selected communities, monitoring of farmers' responses, and the circulation of information throughout the community.[157] However, a number of problems were experienced in the implementation of the project. Institutional barriers, such as village politics, ethnic identity, and gender roles contributed to exclusion of certain groups.[158] Social norms for appropriate social interaction hindered outreach.[159] There were obstacles in village dissemination as some participants downplayed the probability aspect of the forecast.[160] This project provided a number of lessons for future adaptation projects and also lessons for implementing the transfer of EST generally.

IV. Barriers to the Transfer of EST

As there are no performance indicators to assess the extent of the transfer of EST to developing countries under MEAs, it is difficult to evaluate the success of the initiatives that have been undertaken.[161] However, it is clear that developing countries are not entirely satisfied with the assistance being provided.[162] For many developing countries, the anticipated improvements in levels of development and sustainability have not eventuated.[163]

One of the most significant impediments to the transfer of EST is the inability for developing countries to properly assimilate technology.[164] Exacerbating this problem is the fact that in many developing countries, international environmental issues, such as climate change, are barely on the national political agenda[165] as there is often a more pressing need to address immediate local environmental concerns[166] such as safe drinking water, providing arable land, indoor air quality, and accommodating growing populations.[167] Direct and indirect costs associated with developing national standards, including the expense of enacting and enforcing domestic laws, also contribute to the problem.[168] Some developing countries fear that increased environmental regulation will result in deceleration in industrial development.[169]

It is widely accepted that there are a number of barriers that have prevented the transfer of EST in the private sector. Some of these, as identified by Professor Bosselmann, are: legal and political conditions in developing countries increasing risks for foreign investment; social conditions in developing countries including cultural differences, lack of awareness of EST, and lack of confidence in new EST; market conditions in developing countries, including the failure of government agencies to promote the use of EST; low technical capabilities and lack of adequate infrastructure; and insufficient investment in research and development, particularly technology adaptation, in developed countries.[170] These barriers prevent individual companies from investing and undertaking projects in developing countries that include the transfer of EST.[171]

148. Standish, *supra* note 139, at 12-13.

149. Yoshida, *supra* note 82, at 21.

150. Verhoosel, *supra* note 4, at 70.

151. Press Release, Secretariat of the UNFCCC, Emissions Reductions From Kyoto Protocol's Clean Development Mechanism Pass the One Billion Tonnes Mark (June 9, 2006).

152. UNFCCC Technical Paper, Application of Environmentally Sound Technologies for Adaptation to Climate Change 91 (2006).

153. International Energy Agency, *supra* note 34, at 105.

154. *Id.* at 100.

155. *Id.* at 95.

156. UNFCCC Technical Paper, *supra* note 152, at 81.

157. *Id.*

158. *Id.*

159. *Id.*

160. *Id.* at 81-82.

161. Gupta, *supra* note 8, at 22.

162. *Id.*

163. International Environmental Technology Center, *supra* note 45, at 5.

164. Juma, *supra* note 3, at 141.

165. Gupta, *supra* note 8, at 25-26.

166. Mark A. Drumbl, *Northern Economic Obligation, Southern Moral Entitlement, and International Environmental Governance*, 27 Colum. J. Envtl. L. 363, 364 (2002).

167. *Id.* at 365.

168. *Id.*

169. *Id.*

170. Bosselmann, *supra* note 18, at 23.

171. Juma, *supra* note 3, at 147.

V. Lessons Learned to Assist in Overcoming Barriers

There is a need for more extensive governmental intervention at the national and international level.[172] Governments can play key roles in facilitating the transfer of EST in the private sector by adopting policy measures such as the establishment of institutional infrastructure, the promotion of research and development activities, the maintenance of adequate industrial standards, and the creation of flexible market mechanisms.[173] International organizations also have an important role to play in promoting access to EST and facilitating international research and development collaboration.[174]

A. Domestic Actions

1. Taxation Relief and Research and Development Promotion in Developed Countries

Under MEAs, the onus is on developed countries to provide financial and technical assistance to developing countries. The success of those regimes requires developed countries to implement measures domestically to encourage and facilitate the private sector transfer of EST. For example, governments can provide incentives for private enterprise to invest in developing countries through the CDM.

While taxes are widely used as incentives and disincentives in domestic environmental policies, including for EST development, they could also be an instrument to promote the international transfer of EST to developing countries.[175] One suggestion is to grant tax relief, reduction, or rebate on the income or sales tax of domestic companies in developed countries for revenues from the export of EST to developing countries.[176]

Providing taxation relief for companies actively engaged in the transfer of EST to developing countries is an obvious incentive. Less obvious is the fact that inadequate government support for research and development is a significant impediment to the transfer of EST. Recognizing this problem, the European Union has provided public support for moving research and development from knowledge generators to potential users because small- and medium-sized enterprises often require financial assistance to turn research results into marketable products.[177] There are a number of other steps that can be taken by developed countries to improve research and development. They include supporting sustainable development culture in business, developing national environmental policy frameworks for the stimulation of EST, promoting innovations in EST, developing joint research and development activities, encouraging the sharing of the results of collaborative research and development activities, encouraging pilot and demonstration projects, developing innovative mechanisms for the transfer of EST, and encouraging technology needs assessments.[178]

2. Export Policies and Export Credit Agencies

Export policies in both developed and developing countries are significant impediments to the transfer of EST.

Developed countries should not only lift existing export restrictions on EST, but they should also actively encourage such exports.[179] Similarly, developing countries could make efforts to lower tariffs on the import of EST[180] and undertake reform of markets and policies which impede investment in EST.[181]

Nearly all governments in developed countries have an export credit agency that provides insurance and guarantees against certain risks in order to promote exports.[182] About 80% of export credits from the G7 countries go to just 10 developing countries.[183] Export credit agencies often finance large infrastructure projects, and their involvement in a project can attract large amounts of private capital.[184] Export credit agencies could be encouraged to promote EST transfer specifically, along with the general export promotion that they do now.[185]

As most energy-related export credit agency activities in developing countries still promote carbon-intensive projects, several international campaigns are underway to introduce common environmental criteria for these projects.[186] For example, an electricity company in China recently built three clean coal-fired power plants with assistance from the Export Credit Agencies in the United Kingdom and the United States.[187]

3. Market Reform in Developing Countries

Technology transfer happens primarily through private sector investment, but investment in developing countries is impeded by lack of transparency in business transactions and uncertainty in recovering loans and equity investments.[188] While many potentially profitable projects can be identified, prospects for return on investment are made uncertain by unclear policies regarding ownership, pricing, and contract enforceability.[189] Often the perceived risk is so high that would-be investors are unwilling to finance even a feasibility study, which industries and governments in developing countries frequently cannot undertake on their own.[190]

For example, an inhospitable investment climate in India has made it difficult to attract foreign investment and the transfer of EST.[191] In India, and in many other developing

172. Bosselmann, *supra* note 18, at 31.
173. Wilkins, *supra* note 11, at 43.
174. Bosselmann, *supra* note 18, at 31.
175. Verhoosel, *supra* note 4, at 71.
176. *Id.*
177. Argalias et al., *supra* note 107, at 34.
178. *Id.* at 12-13.
179. Verhoosel, *supra* note 4, at 71.
180. *Id.* at 72.
181. Roebymen Heintz, Key Challenges in Stimulating Diffusion of Clean Technologies in Latin America (2000), *available at* http://www.climatetech.net/pdf/RHLAENG.PDF.
182. International Energy Agency, *supra* note 34, at 79.
183. *Id.*
184. *Id.*
185. *Id.*
186. *Id.*
187. *Id.*
188. Pew Center on Global Climate Change, Climate Change Mitigation in Developing Countries 54 (2002).
189. *Id.*
190. *Id.*
191. W. David Montgomery & Sugandha D. Tuladhar, Impact of Economic Liberalization on GHG Emission Trends in India 2 (2005).

countries, government action needs to be taken to address issues such as a lack of infrastructure, corruption, and regulatory burdens which are significant obstacles to foreign investment.[192] In addition to the establishment of a proper framework, targeted fiscal incentives can stimulate the adoption of EST by local enterprises in developing countries.[193]

Also, developing countries often lack effective governmental institutions. Even when such institutions have been developed, and succeed in setting national standards, such as the case of China and Korea, they may not exercise effective control.[194] Public control of energy resources and public subsidies for certain types of energy use often stand in the way of carbon mitigation.[195] In many countries, public control of resources has prevented the emergence of private actors more likely to promote energy efficiency.[196] State-owned institutions play major roles in supplying energy in China, Mexico, and South Africa, for example.[197] Especially when extraordinary events occur, such as the Asian downturn after 1998 or the drought in Brazil in 2001 that curtailed that country's hydroelectric supplies, foreign investors found agreements were abrogated by state-owned utilities or public regulators.[198]

Financial considerations are perhaps the most pervasive obstacles facing projects with climate change benefits, particularly in Latin America.[199] The origin of the problem lies in the project specifics as well as in the nature and availability of financing sources.[200] Climate change projects tend to have characteristics that make it difficult to secure financing, such as high development costs, high transaction costs, and a large number of "soft" components including feasibility studies, energy audits, the use of foreign and local consultants, and conducting training programs.[201] In several financial markets, such as Mexico for example, liquidity restrictions have compounded the reluctance of banks to consider lending for certain projects.[202] Similarly, payback periods tend to be relatively short, which is problematic in the case of renewable energy and land use projects.[203]

By contrast, Honduras has created an investment climate that discourages investments in fossil fuels by introducing an incentive to invest in renewable energy.[204] Such policies should be supported by policies in developed countries that encourage private enterprise to make use of the CDM, which will in turn encourage private investment in EST transfer.[205]

192. *Id.* at 3-4.

193. Bosselmann, *supra* note 18, at 23.

194. Hoekman et al., *supra* note 51, at 289.

195. Pew Centre on Global Climate Change, *supra* note 188, at 54.

196. *Id.* at V.

197. *Id.* at 54.

198. Pew Center on Global Climate Change, *supra* note 42, at 121.

199. Heintz, *supra* note 181.

200. *Id.*

201. *Id.*

202. *Id.*

203. *Id.*

204. *Id*.

205. Verhoosel, *supra* note 4, at 70.

4. Legal Reform in Developing Countries

Similarly, law reform is required in developing countries to stimulate foreign investment and the transfer of EST. For example, a major barrier to the transfer of EST is the fear that intellectual property rights will not be protected in developing countries. Intellectual property rights are an important barrier to market-led EST transfer[206] because the evidence suggests that improvements of the protection of intellectual property rights will result in real increases in the transfer of EST.[207]

Proprietary licensing schemes prevent developing countries from using renewable energy technology—which is vital in order for them to meet their accelerating energy demands in a sustainable manner—largely because such schemes only enable use of that technology in regions where capital is most aggregated and profit margins are abundant.[208] Intellectual property rights stimulate research, development, diffusion, and transfer of new technologies by multinational companies in the developed world.[209] There is no doubt that the enhanced protection of intellectual property rights in developing countries is an important tool to increase the influx of new technologies.[210]

B. Private Enterprise Actions

As the importance of multinational business to development finance and technology transfer has increased, so have the transaction costs and business risks of investing in developing countries.[211] In the energy sector, for example, the negotiating and financial carrying costs of licensing and contracting have been high, with median elapsed times of four to six years between initiating a project and beginning construction.[212]

Companies engaging in technology transfer can take a number of steps to minimize the investment and political risk that they face. Many companies have found that forming partnerships with local communities is a useful tool. For example, between 1996 and 1998, a U.S. investor sought to establish a methane-recovery and electricity-generating plant in the Philippines.[213] The project failed, in part because local landowners increased the rent payable on the power plant's land.[214] Also, the company discovered that the stream of recyclable waste was much smaller than anticipated because waste pickers and transporters were removing the most valuable elements.[215] In other projects in

206. *Id.* at 67.

207. Lee G. Branstetter et al., *Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence From U.S. Firm-Level Panel Data* (World Bank, Policy Research Working Paper No. 3305, at 2, 2004).

208. Jason R. Wiener et al., *Sharing Potential and the Potential for Sharing: Open Source Licensing as a Legal and Economic Modality for the Dissemination of Renewable Energy Technology*, 18 Geo. Int'l Envtl. L. Rev. 277, 278 (2006).

209. Verhoosel, *supra* note 4, at 67.

210. *Id.*

211. Pew Center of Global Climate Change, *supra* note 42, at 121.

212. *Id.*

213. Tim Forsyth, *Partnerships for Technology Transfer: How Can Investors and Communities Build Renewable Energy in Asia?* 6 (Chatham House Briefing Paper, 2005).

214. Branstetter et al., *supra* note 207, at 6.

215. *Id.*

the Philippines, local waste pickers have been hired to segregate waste because it allows investment projects to be accepted by local people rather than seen as a threat to their livelihood.[216]

Between 2000 and 2001, Enron sought to develop an energy plant using rice husks in the Philippines.[217] The large quantity of rice husks produced offered an important opportunity for using efficient incineration method to convert these to energy.[218] However, the project failed when the rice millers discovered that Enron had no other suppliers of rice husks and so were able to increase the price, thus eroding Enron's profitability.[219] In Thailand, however, an investor, faced with a similar situation, made contracts with 20 to 30 rice millers per power plant and sought to use just 10% to 15% of their total husk production, rather than 100% as was the case in the Philippines.[220] The plants experienced lower transactions costs and did not rely on each miller's total rice husk production.[221] Furthermore, millers were contracted to produce a guaranteed quantity of husks and they were fined if they failed to deliver and rewarded with a yearly bonus if they achieved their target.[222]

The lessons learned by companies engaging in the transfer of EST in developing countries include maximizing assurance mechanisms, namely, ensuring that devices such as contracts are in place to keep the partners together, minimizing transaction costs by understanding what aspects of the partnership are the most important for the parties, and being aware of local political issues.[223]

C. International Actions

1. Building Capacity

The ability of developing countries to assimilate technology can be enhanced by capacity-building. Significant capacity-building activities in developing countries have already been carried out. For example, under the Montreal Protocol, the Multilateral Fund has provided institution-strengthening grants to several developing countries to establish government ozone protection units.[224]

Similarly, between 1990 and 1994, six energy-efficient centers were created in Bulgaria, China, the Czech Republic, Poland, Russia, and Ukraine to promote energy-efficient products, techniques, and services. The establishment of such institutions have had pronounced roles in shaping energy-efficient policy in their countries and in raising public awareness.[225] The centers have enhanced the host nations' ability to improve energy efficiency by disseminating information to potential project developers and the public, assisting in initiating projects, conducting market analyses, and identifying options for projects and partners.[226] They link companies in their region with those in developed countries and help clients negotiate contracts.[227] They help companies analyze existing and potential markets and advise on how barriers can be overcome.[228] The centers are staffed by economists, engineers, and energy specialists.[229] They have promoted energy-efficient technologies and practices through policy reform efforts, private sector assistance, demonstration projects, training programs, and public education.[230] Investors require information and expertise when considering business opportunities.[231] The centers have met this need by providing market analyses and overviews of business opportunities.[232]

Although startup funding has run out, the centers have become financially self-sufficient by working for multilateral lending institutions, energy and environmental agencies, and national and local governments.[233] The centers have implemented a range of locally driven projects aimed at supporting business endeavors that led to energy savings.[234] They have worked with more than 250 companies to promote business opportunities that produce energy-efficient equipment, such as basic controls, thermostats, energy-efficient windows, steam traps, lighting, and a broad range of other technologies.[235] They have assisted in establishing the first energy service company in the Czech Republic, developed efficiency projects with Ukrainian companies, established a Chinese-U.S. joint venture to produce high-efficiency steam traps in China, and located a Russian partner for a U.S. firm that distributes equipment for mitigating sulfur dioxide emissions from factories.[236]

In other capacity-building activities, a project sponsored by the UNDP and the Global Environment Facility in Morocco is strengthening the country's technical capabilities in the field of solar water heaters.[237] Government agencies and private firms are being trained to promote, evaluate and install hot-water systems.[238] To promote their adoption, the value-added tax and duties on imported equipment for these systems have been reduced.[239] A UNDP project in the Ivory Coast and Senegal is training architects and builders to design and build more efficient buildings using foreign know-how and technologies.[240] An energy efficiency code for air conditioned buildings is in the works.[241] In the projects demonstration component, representative buildings undergo energy audits and are retrofitted, with an emphasis on air conditioning and lighting.[242] The project also facilitates

216. *Id.*
217. *Id.*
218. *Id.*
219. *Id.*
220. *Id.*
221. *Id.*
222. *Id.*
223. *Id.* at 7-8.
224. Bankobeza, *supra* note 80, at 7-9.
225. UNFCCC, *Capacity-Building in the Development and Transfer of Technologies* 12 (UNFCCC Technical Paper, 2003).
226. International Energy Agency, *supra* note 34, at 18.
227. *Id.*
228. *Id.*
229. *Id.* at 26.
230. *Id.*
231. *Id.* at 31.
232. *Id.*
233. *Id.* at 26.
234. *Id.* at 29.
235. *Id.*
236. *Id.*
237. *Id.* at 46.
238. *Id.*
239. *Id.*
240. *Id.* at 47.
241. *Id.*
242. *Id.*

the implementation of building codes. Affected parties are consulted and construction firms are trained to understand and apply the code.[243]

In-country capacity-building is an effective driver for policy reform in developing countries.[244] However, capacity-building efforts to support energy efficiency must be multifaceted if they are to succeed.[245] The focus has been on supply-side aspects and on activities involving governments and international organizations,[246] and, despite the extensive efforts already made, attention should now be paid to the business needs of companies that distribute EST and the demand-led aspects of the transfer of EST.[247]

2. Public-Private Cooperation

Cultural obstacles and a lack of awareness of EST are significant barriers to the international transfer of EST. One way of addressing this issue is the establishment of mechanisms to facilitate public-private cooperation. This is an important issue for the implementation of the CDM. It could involve partnerships between transnational corporations and governments in developing countries or between governments in developed countries and companies in developing countries. A good example is the Technology Partnership Initiative in the United Kingdom. The Initiative was established to promote technology cooperation in EST with firms in developing countries by expanding existing channels of communication and making information on EST more readily available.[248]

3. Information Availability

There is no sense in having transparency of information if there is no documentation or source of information to begin with.[249] In Nigeria, for example, comprehensive statistical data on the state of the environment is not available.[250] Similarly, a failed attempt to introduce vertical-shaft brick kilns in Bangladesh demonstrated the critical role of advice and training.[251] In one case, an entrepreneur attempted to build one of these kilns without adequate technical or financial assistance, but made basic mistakes in the kiln's construction resulting in its failure.[252] The technology was later successfully introduced in India, where an NGO set up a pilot project for the kilns in a controlled environment.[253]

There is no longer a lack of information on EST or of systems and sources that provide such information.[254] Problems that exist today in information access and dissemination are related to the ability of EST suppliers and users to know about and gain access to these sources and the level of compatibility among these information systems.[255]

Given the complex nature of new technologies and of international regimes for the transfer of EST, accurate, timely, and authoritative information is critical to project success.[256] It is critical to establish whether particular technologies are appropriate for certain environmental conditions.[257] For these reasons, the UNFCCC Secretariat has established a technology information clearinghouse known as TT:CLEAR. It is a web-based system that enables government, business, intergovernmental organizations, and other users to find information on technology transfer projects, EST and know-how, organizations and experts, methods, models, and tools to assess mitigation and adaptation options and strategies.[258]

VI. Conclusion

The international transfer of EST is hampered by economic, social, and legal barriers, including lack of definition, nonbinding character and vagueness of obligations, and ineffective compliance mechanisms.[259] Equally constraining is the lack of adequate institutional and professional capacities to choose and use them in developing countries.[260] Removing these barriers requires great political and regulatory efforts both domestically and internationally, but it is critical for realizing the role of the transfer of EST in environmental sustainability and poverty alleviation.[261] Internally, developing countries should focus on accumulating the ability to generate and manage technical change, undertaking necessary market and legal reform, and establishing the infrastructure required to encourage foreign investment.[262] National policies in developed countries should focus on the creation of incentives for the private sector to engage in the transfer of EST, including taxation relief and programs to fund research and development.[263] Multilateral initiatives should focus on creating an environment that is conducive to the transfer of EST, as the private sector relies on governments in both developed and developing countries to implement policies that stimulate demand for, as well as the supply of, EST.[264] The future of international cooperation arrangements depends to a large extent on what countries do to promote local technological initiatives,[265] such as implementing policies to sustain incentives for human capital formation and to reduce the cost of technology adoption.[266] The

243. *Id.*

244. *Id.* at 31.

245. *Id.*

246. In June 2004, the Expert Group on Technology Transfer called for a more diverse approach to the transfer of EST, observing that formal approaches to capacity-building under the UNFCCC have tended to emphasise actions by governments, especially in innovation and technology development, rather than ways in which non-State actors can implement technology diffusion.

247. Branstetter et al., *supra* note 207, at 2.

248. Maskus, *supra* note 20, at 32.

249. Hoekman et al., *supra* note 51, at 298.

250. *Id.*

251. International Energy Agency, *supra* note 34, at 18.

252. *Id.*

253. *Id.*

254. Verhoosel, *supra* note 4, at 71.

255. *Id.*

256. Bankobeza, *supra* note 80, at 7-9.

257. Bosselmann, *supra* note 18, at 31.

258. Information Services of the UNFCCC Secretariat, United Nations Framework Convention on Climate Change: The First Ten Years 60 (2004).

259. Bosselmann, *supra* note 18, at 32.

260. Su, *supra* note 55, at 133-34.

261. Bosselmann, *supra* note 18, at 32.

262. Juma, *supra* note 3, at 139.

263. Hoekman et al., *supra* note 51, at 1.

264. Bosselmann, *supra* note 18, at 26.

265. Juma, *supra* note 3, at 148.

266. Jörg Mayer, *Globalization, Technology Transfer and Skill Accumulation in Low-Income Countries* (U.N. Conference on Trade and Dev. Discussion Paper No. 150, at 27, 2000).

emphasis should be on technology cooperation in which externally developed technologies are adapted to local conditions and needs and are integrated with traditional technologies and experience.[267]

Ultimately, however, meeting climate change objectives alone is not a strong enough driver to ensure the transfer of EST from developed countries to developing countries, as both groups are motivated more by objectives of economic development and international competitiveness.[268] Accordingly, successful regimes for the transfer of EST will not be driven solely by their environmental benefits, but also by their ability to meet other economic needs.[269]

267. Su, *supra* note 55, at 133-34.

268. WILKINS, *supra* note 11, at 51.

269. Bosselmann, *supra* note 18, at 32.