Analysis of Technology Transfer in CDM Projects

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Abstract

Although the Clean Development Mechanism (CDM) does not have an explicit technology transfer mandate, it may contribute to technology transfer by financing emission reduction projects using technologies currently not available in the host countries. This report analyzes the claims of technology transfer made by CDM project participants in their project design documents. Roughly 39% of all CDM projects accounting for 64% of the annual emission reductions claim to involve technology transfer. Technology transfer is more common for larger projects and projects with foreign participants. Technology transfer is very heterogeneous across project types. Technology transfer usually involves both knowledge and equipment with equipment imports accounting for most of the remaining transfer. The technology originates mostly from Japan, Germany, the USA, France, and Great Britain. The rate of technology transfer is significantly higher than average for projects in Ecuador, Honduras, Mexico, Sri Lanka, Thailand and Vietnam and significantly lower than average for projects in India. Foreign participants have little impact on technology transfer. For most project types project developers appear to have a choice among a number of domestic and/or foreign technology suppliers. Based on data from six Technology Needs Assessments, countries that encourage technology transfer in CDM projects identify more technology needs and fewer barriers to technology transfer.

1. Introduction

Technology development and transfer is included in both the United Nations Framework Convention on Climate Change and its Kyoto Protocol. Article 4.1 of the Convention requires all Parties to promote and cooperate in the development, application and diffusion, including transfer, of GHG mitigation technologies.[1] Articles 4.3 and 4.5 stipulate that developed country Parties should provide new and additional financial resources to support the transfer of technology and take all practicable steps to promote, facilitate and finance the transfer of, or access to, environmentally sound technologies and know how to developing country Parties. Article 11.1 of the Convention further prescribes that financial resources shall be provided for the transfer of technology on a grant or concessional basis.

The Kyoto Protocol, in Article 10(c), reiterates the requirement of all Parties to cooperate in the development, application, diffusion and transfer of environmentally sound technologies that are in the public domain.[2] Article 11.2 of the Protocol repeats the commitment of developed country Parties to provide financial resources for technology transfer.

Initiatives to fulfil these commitments include creation of an Expert Group on Technology Transfer to provide advice to Parties, establishment the Technology Information Clearing House (TTClear) by the Climate Change Secretariat, and preparation of technology needs assessments (TNAs) by many developing country Parties.[3] A country TNA involves stakeholders in a consultative process to identify technology needs by sector, barriers to technology transfer and measures to address these barriers.

Although the Clean Development Mechanism (CDM) does not have an explicit technology transfer mandate and is not identified as a means of fulfilling the technology transfer objectives of the Protocol, it may contribute to technology transfer by financing emission reduction projects that use technologies currently not available in the host countries. This paper examines the technology transfer claims for CDM projects.

Section 2 provides background on technology transfer and the Clean Development Mechanism. Data sources are presented in section 3. The results of the analyses are presented in sections 4 through 13. Conclusions are provided in section 14.

2. Background

2.1 Technology Transfer

In its Special Report on Methodological and Technological Issues in Technology Transfer, the Intergovernmental Panel on Climate Change (IPCC) defines technology transfer “as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, non-governmental organizations (NGOs) and research/education institutions."[4]

This definition covers every relevant flow of hardware, software, information and knowledge between and within countries, from developed to developing countries and vice versa whether on purely commercial terms or on a preferential basis. The IPCC acknowledges that "the treatment of technology transfer in this Report is much broader than that in the UNFCCC or of any particular Article of that Convention."[5]

This paper analyzes the claims of technology transfer made by CDM project participants in their project design documents (PDDs). In Section A.4.3 of the project design document, "technology to be employed by the project activity", the project participants are requested to "include a description of how environmentally safe and sound technology and know-how to be used is transferred to the host Party(ies)."[6] The CDM glossary of terms does not define "technology transfer".[7]

Since our analysis covers 2293 registered and proposed projects, it is not practical to define "technology transfer" and then ensure that all claims are consistent with that standard definition. However, it can be inferred from the information in the PDDs that project participants almost universally interpret technology transfer as meaning the use of equipment and/or knowledge not previously available in the host country by the CDM project. The arrangements for the technology transfer, whether on commercial or concessionary terms, are never mentioned.

In summary, the technology transfer claims are not based on an explicit definition but generally assume that technology transfer means the use of equipment and/or knowledge not previously available in the host country by the CDM project. Several of the projects reviewed claimed technology transfer for technology already available in the country. Since the focus of the Kyoto Protocol is on technology transfer between countries, those cases were classified as involving no technology transfer.

2.2 CDM Projects

The participants must complete a project design document that describes the proposed CDM project. An independent "designated operational entity" (DOE) must validate a proposed project to ensure that it meets all of the requirements of a CDM project. As part of the validation process the DOE must solicit public comments on the proposed project. Once public comments are requested for a project it is considered to be in the CDM pipeline. This paper analyzes the technology transfer claims in the project design documents of 2293 projects in the CDM pipeline as of September 2007, of which over 750 had been registered by the CDM Executive Board.

The 2293 proposed projects include 24 different categories of greenhouse gas emission reduction actions (project types). The analysis investigates whether the percentage of projects for which technology transfer is claimed varies by project type. A CDM project may be implemented by project participants from the host country alone – a "unilateral" project – or jointly with foreign participants. Small projects may use simplified baseline and monitoring modalities.[8] The analysis investigates whether the incidence of technology transfer claims differs for unilateral and small-scale projects.

The characteristics of the host country might affect the incidence of technology transfer for CDM projects. A larger (larger population or larger economy) host country might already use a technology and/or have the expertise for a given project type. Similarly, a richer host country, higher per capita GDP, might already use a technology and/or have the expertise for a given project type. The analysis investigates whether the incidence of technology transfer claims is affected by such host country characteristics.

A host country can incorporate technology transfer requirements into its criteria for approval of CDM projects. In addition, host country characteristics, such as tariffs or other barriers to imports of relevant technologies, perceived and effective protection of intellectual property rights, and restrictions on foreign investment, can have an impact on technology transfer. The analysis investigates whether technology transfer differs significantly across host countries.

Foreign participants might express a preference for technology they are familiar with or technology suppliers might agree to purchase/accept CERs from a project as a marketing strategy. Such practices would lead to technology transfers from buyer countries. The analysis investigates whether participation by specific countries is related to technology transfer and technology supply from by those countries.

The report analyses the origins of the transferred technologies – equipment, knowledge, or both – by project type. Technology transfer is found to be very heterogeneous across project types, varying significantly in terms of the reliance on imported technology, the mix of equipment and knowledge, and the source countries for the technology.

Potential market power on the part of technology suppliers is examined in terms of the number of countries that supply technology for each project type and the share(s) of the technology supplied by the largest supplier(s) for each project type.

Finally, technology transfer via CDM projects is compared with technology needs as identified by developing countries in their Technology Needs Assessment reports.

3. Data Sources

The primary source of data on CDM projects is the “CDM_Projects” sheet of *The CDM Pipeline* for September 2007 (Fenhann, 2007).[9] It lists, inter alia, the host country, the project type based on 26 categories,[10] the methodology used, the estimated annual emission reductions, and the countries that have agreed to buy credits generated by the project for each of 2293 registered and proposed projects covered by this analysis. Small-scale projects are identified from the methodology used.[11] Projects with no credit buyer are classified as “unilateral” projects.

Information about technology transfer had to be collected from the individual Project Design Documents (PDD). Statements relating to technology transfer were generally found in sections A.4.2, A.4.3 or B.3 of the PDD. To ensure that all statements relating to technology transfer were identified each PDD was searched for several keywords related to technology transfer.[12] In many cases the PDD explicitly states that the project involves no transfer of technology. For other projects, the PDD makes no mention of technology transfer.

Where claims for technology transfer are made, they were coded for the nature of the technology transfer activity (imported equipment, training local staff, etc.). The codes distinguish transfer of both equipment and knowledge from transfer of equipment or knowledge alone. In addition to the nature of the technology transfer, the source countries were recorded. If the source was not identified, the project's developers were contacted to determine the origins of the technology. Often the source is not known because the technology supplier for a proposed project has not yet been selected, so the source remains "unknown" for about 20% of the projects that claim technology transfer.

Data on the population and GDP of each host country were obtained from the Climate Analysis Indicators Tool (CAIT) (World Resources Institute).[13] The population and GDP are for 2000, with GDP being converted to international dollars using purchasing power parity (PPP) exchange rates. The data come from the 2003 *World Development Indicators* report prepared by the World Bank. The GDP is divided by the population to get the GDP per capita for each host country.

Host countries were grouped into size categories based on population. Host countries were also classified into the per capita income categories – Least Developed Countries, Other Low-Income Countries, Lower Middle-Income Countries, and Upper Middle-Income Countries – defined by the Development Assistance Committee (DAC) of the Organisation for Economic Co-operation and Development (OECD, 2005).

4. Technology Transfer by Project Type

Table 1 shows the number of projects and average project size (estimated annual emission reductions) by project type. It also shows the percentage of the projects and of the estimated annual emission reductions for which technology transfer is claimed. The distribution of projects is not uniform: about one-third of the project types have fewer than 10 projects while another third have over 100 projects each, with Biomass energy and Hydro dominating the totals. The average project size varies widely across categories from 8 ktCO_2e per year for Energy efficiency service to 1,038 and 4,563 ktCO_2e per year for N_2O and HFC reduction projects. The overall average is 164 ktCO_2e per year.

The percentage of projects that claim technology transfer averages 39% and ranges from 7% to 100% for different project types. That is easy to understand when a category includes only a single project, as in the case of Tidal. Only two of the 28 Cement projects and 45 of the 500 Hydro projects claim technology transfer claim, while 159 of the 170 Agriculture projects, 16 of the 18 HFC destruction projects and all 41 of the N_2O destruction projects claim to involve technology transfer.

Projects that claim some technology transfer represent 64% of the estimated annual emission reductions.[14] Since this is much higher than the 39% of projects that claim technology transfer, it indicates that projects that claim technology transfer are, on average, substantially larger than those that make no technology transfer claim. This is true for most project types as well. However, the Fugitive emission reduction, Solar and Transport projects that claim technology transfer are much smaller than similar projects that do not claim technology transfer, while the Agriculture, Geothermal and Reforestation projects that claim technology transfer are smaller, than the averages for those categories.

Technology transfer claims for unilateral and small-scale projects by project type are summarized in Table 2. Over 54% of all projects are unilateral projects, but they account for only about 29% of the annual emission reductions. This means that the average size of unilateral projects, 88 $ktCO_2e$/yr, is a little more than half that of all CDM projects. About 33% of the unilateral projects claim technology transfer as compared to 39% of all projects. The projects that do claim technology transfer are somewhat larger than the average for unilateral projects, accounting for 46% of the emission reductions.

Conversely, the projects that have foreign participants are more than 50% larger (253 $ktCO_2e$/yr) than the average for all CDM projects. Just under half of the projects that have foreign participants, representing 71% of the estimated emission reductions for those projects, claim technology transfer. Thus technology transfer claims are more common for projects that have foreign participants and the projects that claim technology transfer are larger than those that do not claim technology transfer.

Small-scale projects represent 44% of all projects. Small-scale projects, by definition, are much smaller than average (29 $ktCO_2e$/yr). About 33% of the small-scale projects claim technology transfer as compared to 39% of all projects. The average size of projects that claim technology transfer is only marginally larger than the average for projects that do not claim technology transfer.

In summary, technology transfer is more common for larger projects; 39% of all CDM projects accounting for 64% of the annual emission reductions involve technology transfer. Technology transfer varies widely across project types. Technology transfer is more common for projects that have foreign participants, possibly because those projects tend to be larger. Unilateral and small-scale projects involve less technology transfer, possibly due to their smaller size. Within any given group – foreign participants, unilateral, small-scale – technology transfer is more common for larger projects.

5. Technology Transfer by Host Country Characteristics

Do CDM projects in larger or richer countries draw upon a larger, more diverse stock of technology in the host country and so involve less technology transfer? The data in Table 3 address that question.

There doesn't appear to be a direct link between technology transfer and country size. Technology transfer claims, in terms of share of projects and share of annual reductions, are more common for CDM projects in countries with a population between 1 and 100 million. Projects in both smaller and larger countries claim less technology transfer.

Likewise, there does not appear to be a systematic relationship between a host country's per capita GDP and technology transfer. The frequency of technology transfer claims is high for "Least Developed Countries" although the number of projects (14) is relatively small. The frequency of technology transfer claims is quite low for "Other Low-Income Countries". India accounts for almost 95% of the projects and over 84% of the annual emission reductions for this group.

In short, technology transfer does not appear to be systematically related to the host country population or per capita GDP. The characteristics of projects in some countries, such as Argentina, India and South Korea, affect technology transfer for the categories that include those countries. The next two sections examine technology transfer claims for projects in specific host countries in more detail.

6. Technology Transfer for Selected Host Countries

Each CDM project must be approved by the host country government. As part of its approval process the host country government may choose to impose technology transfer requirements. Table 4 presents data on technology transfer claims for every country that accounts for more that 2% of the number of projects or 2% of the total annual emission reductions. Four countries – Brazil, China, India and South Korea – dominate the totals, accounting for 72% of the projects and 80% of the annual emission reductions.

According to the *Brazilian Manual for Submitting a CDM Project to the Interministerial Commission on Global Climate Change*, the project developer shall include in the description of the project its contribution to sustainable development including its "d) contribution to technological development and capacity-building."[15] Technology transfer is not mentioned directly. Rather the project's contribution to technology development is assessed as part of its contribution to sustainable development. Technology transfer for Brazilian projects is roughly equal to the average for all CDM projects measured in share of projects (32% vs 39%) and annual emission reductions (68% vs 64%)(see Table 4).

In *Measures for Operation and Management of Clean Development Mechanism Projects in China*, the Government of China requires that "CDM project activities should promote the transfer of environmentally sound technology to China."[16] This is a general provision not a mandatory requirement for each project. Projects in China involve about the same rate of technology transfer as the average for all CDM projects measured in share of projects (37% vs 39%) and annual emission reductions (68% vs 64%) (Table 4).

In the *Eligibility Criteria* for CDM project approval established by the Indian Government, it is prescribed that the "Following aspects should be considered while designing [a] CDM project activity: … 4. Technological well being: The CDM project activity should lead to transfer of environmentally safe and sound technologies that are comparable to best practices in order to assist in upgradation of the technological base. The transfer of technology can be within the country as well from other developing countries also."[17]

The Indian Government has adopted a broad concept of technology transfer, similar to that of the IPCC special report, which includes technology transfer *within* the country. However, technology transfer within a country, claimed by seven Indian projects, is excluded from this analysis. India has a much lower rate of international technology transfer than average whether measured in terms of number of projects (14% vs 39%) or annual emission reductions (40% vs 64%) (Table 4). The projects that claim international technology transfer are larger than the Indian average.

The Korean Designated National Authority for the CDM requires that "environmentally sound technologies and know how shall be transferred."[18] Projects in Korea are much larger than the average for all CDM projects and are more likely to claim technology transfer. About half of the projects in Korea representing 81% of the annual emission reductions claim technology transfer (Table 4).

Clearly, a host country can influence the extent of technology transfer involved in its CDM projects. It can do this explicitly in the criteria it establishes for approval of CDM projects. Other factors, such as tariffs or other barriers to imports of relevant technologies, perceived and effective protection of intellectual property rights, and restrictions on foreign investment also can affect the extent of technology transfer involved in CDM projects. In most host countries technology transfer is more common for larger projects.

7. Regression Analysis with Project Type and Host Country

The tables introduced in the preceding sections examine the relationship between technology transfer and project characteristics, host country characteristics and the host country. Regression analysis can be used to examine relationships between technology transfer and combinations of these variables. Two approaches are used for the regression analysis; a logit model and a linear probability model. Relationships among the variables make it difficult to determine the statistical significance of individual variables. Similar results from the two approaches increases confidence in the results.

Technology transfer, dependent variable, takes a value of 1 when a project includes a technology transfer claim, regardless of the type of technology transfer claimed, and a value of 0 when technology transfer is not mentioned. With a dependent variable that has a value of either 0 or 1 the appropriate form of regression analysis is logit analysis. The results for three equations are presented in Table 5.[19]

Equation 1 includes a constant, the project size (kt CO_2e reduced per year), whether it is a unilateral project, host country population, and host country GDP measured in millions of constant US dollars.

Results for Equation 1 indicate that the probability of technology transfer increases with project size and the GDP (positive coefficients) and declines for host countries with larger populations (negative coefficient). The results also show that the odds of a technology transfer claim are reduced for unilateral projects, which means it rises if the project includes foreign participants. The equation has a pseudo R^2 of 14% and correctly classifies 68% of the observations demonstrating a good fit to the model.

Equation 2 includes the same variables as equation 1 and adds variables for the different project types; for example, the Agriculture variable has a value of 1 for each agriculture project and 0 for any other project type. As part of the estimation procedure the statistical package drops any variable for which prediction is perfect. This will happen if there is only one project in a category or all projects in a category claim (or do not claim) technology transfer. For Equation 2 it dropped the N_2O and Tidal project types because all of these projects claimed technology transfer.

Regression analysis assumes that the independent variables are not related to one another; for example, that host country size is not related to its GDP, and other variables. Since this not true, the independent variables are linearly related (collinear). When the variables are linearly related, regression results may show that a variable is not related to technology transfer when it actually is. To analyze this possibility an equation that includes only project size, the unilateral variable and the project type variable was estimated for each of the remaining 22 protect types. The project type variables that yield perfect predictions and those that have very little statistical significance were isolated. As a result, the project type variables for Energy efficiency Households, EE Industry, and EE Service, as well as Geothermal, HFCs, PFCs, and Wind were dropped in addition to the two project types (N_2O and Tidal) that yield perfect predictions.

The insignificance of the HFC project type is a surprising result given that 89% of these projects claim technology transfer (Table 1). Insignificance suggests that technology transfer is neither more nor less likely for this project type than for all CDM projects (39%). Further testing revealed a strong interdependence between the project size and HFC project variables, rendering the tests for significance of the HFC variable unreliable. Once isolated, the HFC project type shows a strong positive relationship with technology transfers, confirming the results in Table 1.

Results for Equation 2 with the remaining 15 project type variables indicate that all but the Energy efficiency supply, Solar and Transport project types are all significant at the 0.05 level or higher.[20] Technology transfer is *more* likely for Agriculture. Although the variables are not included in Equation 2, technology transfer also is more likely for HFC, N_2O, and possibly Tidal, projects. All of these project types have technology transfer claims for a large share (89% to 100%) of the projects (Table 1).

Technology transfer is *less* likely for Biogas, Biomass energy, Cement, Coal bed/mine methane, Energy efficiency own generation, Energy distribution, Fossil fuel switch, Fugitive, Hydro, Landfill gas, and Reforestation. Some of these project types, including Cement, Hydro, Reforestation, Fugitive and Biomass energy, have low rates of technology transfer (Table 1). These results can be interpreted as a preference for local technology for these project types.

Foreign participation and GDP continue to increase the probability of technology transfer, while population continues to decrease it. Equation 2 has a pseudo R^2 of 31% and correctly classifies almost 79% of the observations demonstrating that the addition of the project type variables has improved the model.

Equation 3 adds variables for the host countries. Host country population and GDP were dropped from equation 3 due to the collinearity between those variables and the host country variables. The initial estimation (not shown) dropped 27 of the country variables due to perfect prediction, mostly countries with only one project. When the remaining countries were tested individually the variables for Bolivia, Chile, Colombia, El Salvador, Morocco, Panama and Peru were found to have very little statistical significance. Equation 3 was estimated with variables for the remaining 25 countries.

The coefficients for eight of the countries in equation 3 are statistically significant, at the 0.05 level or higher. Technology transfer is *more* likely for projects in Ecuador, Honduras, Mexico, Sri Lanka, Thailand and Viet Nam. Technology transfer is *less* likely for projects in Brazil and India. The results are consistent with the high rate of technology transfer for Mexico and the low rate of technology transfer for India noted in Table 4. The significant negative coefficient for Brazil, whose rate of technology transfer is roughly equal to the average for all projects is a surprise.

All the project types continue to show the same influence on the odds of a technology transfer except for Energy Distribution and Landfill gas. Both of these project types have lost their significance with the addition of country variables suggesting that the latter have more explanatory power than those project types. The addition of the host country variables improves the overall model which now has a pseudo R^2 of 37% and correctly classifies 81% of the observations.

As noted the logit analysis drops countries for which there is “perfect prediction”. This provides results for less than half (25) of the 58 host countries. The linear probability model has the advantage of not having to drop variables where predictions are perfect. With this approach the country coefficient indicates the change in the probability of technology transfer due to the host country given the project characteristics. The linear probability model was estimated for the same variables as Equation 3. The results are presented in Table 6.

The project type variables, with the exception of Energy efficiency supply side and Landfill gas, have the same sign as in the logit analysis. More of the project type variables lose their statistical significance when the country variables are added, but Agriculture, Biogas, Biomass energy, Cement, Coal bed/mine methane, Energy efficiency own generation, Energy distribution, Fossil fuel switch and Hydro all remain significant, with Agriculture being the only project type with a positive coefficient.

The results show 7 countries with statistically significant (0.05 level) negative coefficients and 22 countries with statistically significant positive coefficients. But many of these countries have only a small number of projects, so the results may not be meaningful. When countries with at least 5 projects are considered, only India has a significantly negative coefficient while Ecuador, Honduras, Mexico, Sri Lanka, Thailand and Viet Nam have statistically significant positive coefficients.

The only difference between the logit and linear probability analyses is the statistical significance of the result for Brazil, which seems anomalous. Both analyses indicate that India deters technology transfer while Ecuador, Honduras, Mexico, Sri Lanka, Thailand and Viet Nam encourage technology transfer.[21]

8. Regression Analysis with Project Type and Foreign Participant

Do foreign participants affect technology transfer? The Project Design Document identifies foreign participants, but does not specify the nature of the participation. By far the most common form of participation is believed to be a commitment to purchase certified emission reduction credits (CERs) generated by the project. A buyer country could affect technology transfer if, for example, a technology supplier agrees to purchase/accept some of the credits from the project.

This question is analysed using both the logit and linear probability approaches. The results are presented in Table 7. In both cases the project type and other variables found to be statistically significant in Equation 2 are included because they affect the frequency of technology transfer claims. Some of the projects have more than one credit buyer and some credit buyers are organizations, such as the World Bank, that would not be technology suppliers.

The results of the two analyses are basically the same when countries with more than 5 projects are considered. Projects for which Finland, France and Switzerland are buyers are significantly (0.05 level) more likely to involve technology transfer. Figure 1 indicates that for Finland and France credit purchases and technology supply are not related. In contrast, Switzerland is a buyer for 54% of the projects (based on estimated annual emission reductions) for which it is a technology supplier and a technology supplier for 62% of the projects for which it is a credit buyer.

In summary, although Finland and France are buyers for projects with a significantly higher rate of technology transfer, this is not associated with technology supplied by those countries. Switzerland is a technology supplier and credit buyer for over half of the projects it participates in.

Figure 1
Relationship between Technology Supply and Credit Purchases for Finland, France and Switzerland
(estimated annual emission reductions, $ktCO_2e$)

Credit Buyer	Technology Supplier				
	Finland	France	Switzerland	Other	Total
Finland	12			57	69
France		2,149	71	9,346	11,566
Switzerland			930	553	1,482
Other	474	15,877	725	165,684	182,760
Total	486	18,026	1,725	175,640	195,876

9. Nature of the Technology Transfer

Determining the nature of a technology transfer from a wide variety of written statements inevitably involves judgments. We tried to reflect the written statements in the PDDs as accurately as possible and, when a technology transfer occurred, assign it to one of the four categories in Table 8, that is the transfer of equipment only through import, the transfer of knowledge only through training and the engagement of foreign experts, the transfer of both equipment and knowledge, and other. The first three categories are self evident and the nature of the technology transfer from individual statements within the PDDs fell into one of those three quite readily. There were seven projects, however, that involved the development of a new technology under a domestic and foreign partnership. These were classified as “Other”.

Several PDDs claimed a technology transfer from one region to another within the same host country. These are fair claims since there is no guidance on what constitutes a technology transfer. But the focus of this analysis is international technology transfers, so those projects were classified as not involving technology transfer.

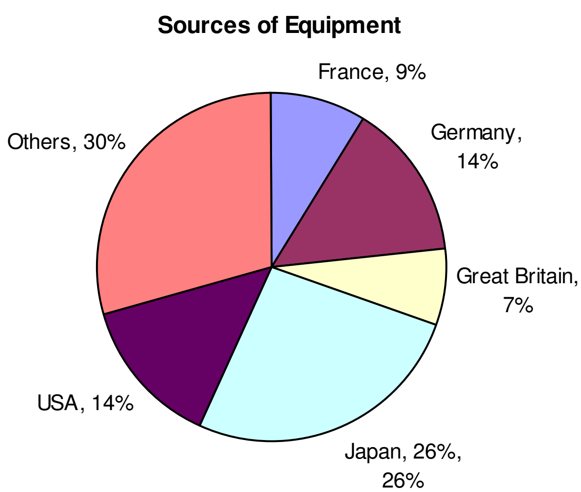
Table 8 shows the frequency of each claim as a percentage of the projects that involve technology transfer and as a percentage of the annual emission reductions of those projects. More than half (56%) of the projects that involve technology transfer claim both equipment and knowledge transfers, and account for 47% of the emission reductions. About one-third of the projects that claim technology transfer involve only equipment imports, but those projects account for 39% of the emission reductions. Transfers of knowledge alone involve 11% of the projects accounting for 13% of the emission reductions.

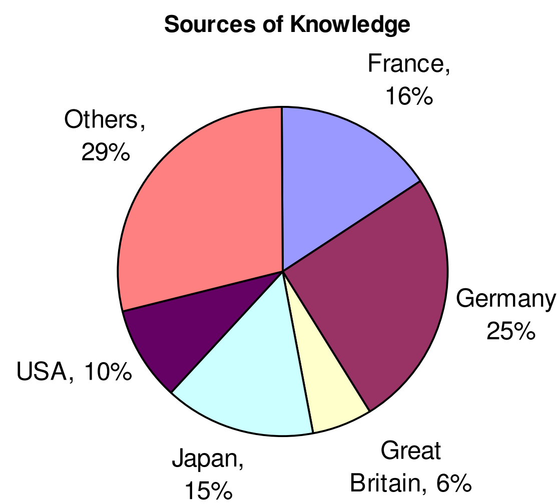
Where does the technology come from? To answer this question the country providing the technology for a project was credited with the estimated annual emission reductions of the project. If more than one country supplied technology to a project, the estimated annual emission reductions were divided equally among the countries involved. For projects that involved a transfer of both equipment and knowledge, half of the estimated annual emission reduction was attributed to the knowledge suppliers and half and to the equipment suppliers. So a project with expected annual emission reductions of 100 ktCO_2e per year with three countries supplying equipment and two supplying knowledge would be counted as 16.7 ktCO_2e per year for each of the equipment suppliers and 25 ktCO_2e per year for each of the knowledge suppliers. In practice most projects obtain the technology from one country.

Many PDDs identify a technology transfer, but do not specify the source of the technology. If the source was not identified, the project's developers were contacted to determine the origins of the technology. The source of the technology remains "Unknown" for about 20% of the projects that claim technology transfer. This is, at least partly, due to projects for which the technology has not yet been sourced because the project has not yet been implemented yet.

When projects for which the source of the technology is "unknown" are excluded, 93% of the equipment and 99% of the knowledge transfer comes from Annex I countries (including USA and Australia). While a relatively large number of countries are identified as sources of technology, five countries are the sources for over 70% of the transfer of equipment or knowledge; Japan, Germany, the USA, France, and Great Britain (Figure 2).

Figure 2





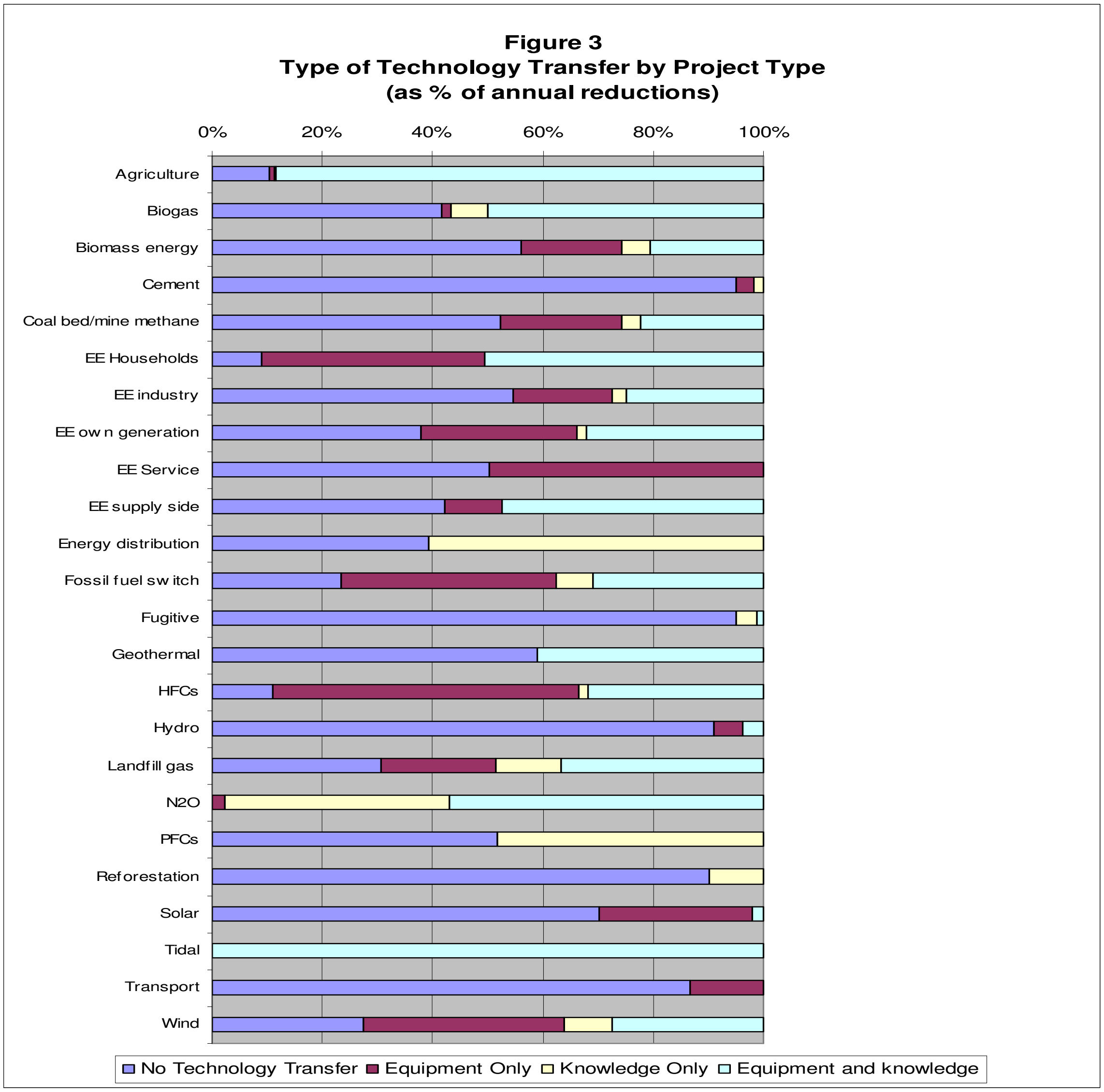
Although technology transfer from Non-Annex I countries is less than 10% of all technology transfer, five countries figure prominently; Brazil, China, India, South Korea and Chinese Taipei are the source of 94% of equipment transfers and 74% of knowledge transfers from Non-Annex I sources.

10. Technology Transfer by Project Type

As noted earlier (Table 1) the frequency of technology transfer claims varies widely across project types. Thus the nature of the technology transfer and the sources of the technology are also likely to vary by project type. The nature of the technology transfer – equipment only, knowledge only, or both – by project type is summarized in Table 9. There is no obvious pattern to the nature of the technology transfer by project type.

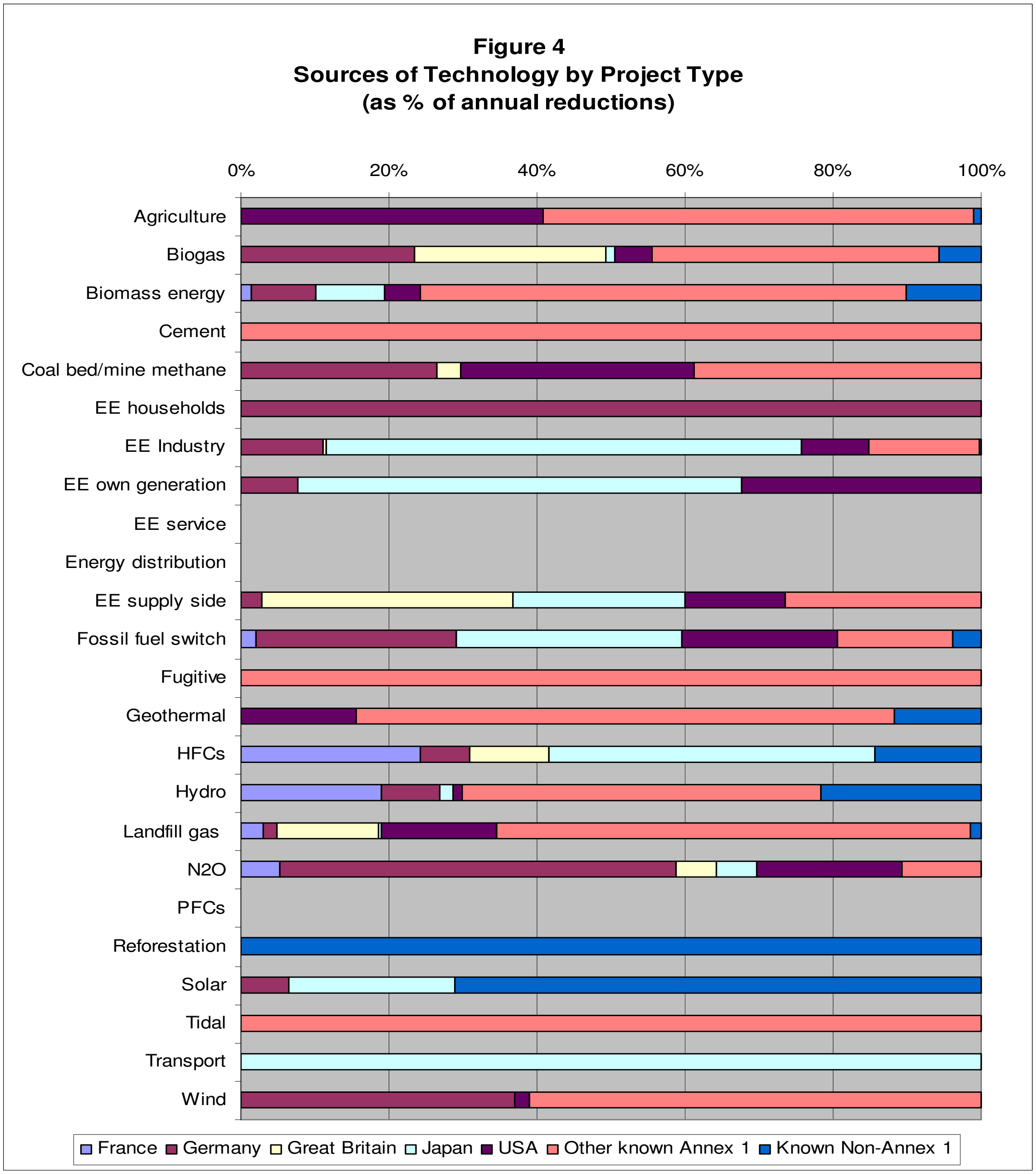
Tables 10, 11 and 12 show the expected annual emission reductions for each project type by technology supplying country for equipment transfers only, knowledge transfers only and transfers of both equipment and knowledge respectively. Due to the amount of data in these tables, it is difficult to discern any underlying patterns if there are any.

Figure 3 shows the share of technology transfer claims and the nature of the technology transfer claims by project type.



Relatively few Cement, Fugitive, Hydro, Reforestation, Solar and Transport projects claim technology transfer. Large shares of the EE Households, EE Service, Fossil fuel switch, HFC and Wind projects involve imported equipment. Equipment imports also account for a large share of the limited amount of technology transfer for Cement, Hydro, Solar and Transport projects. Transfer of knowledge is particularly important for Energy distribution, PFC and Reforestation projects. Equipment and knowledge is most common for Agriculture, Biogas, EE Households, EE supply side, Geothermal, N_2O and Tidal projects. In some cases these patterns reflect a small number of projects.

Figure 4 shows the sources of the technology by project type.



Most project types draw on technology from several countries. Japan is the dominant supplier of technology for EE industry, EE own generation, HFC and Transport projects. Germany is the dominant supplier for EE households and N_2O projects.

For two project types most of the technology transferred comes from other Non-Annex I countries: Solar (20.8% of all projects representing 71.2% of total technology transfer) and Reforestation (10.0% of all projects representing 100% of total technology transfer). For another four project types over 10% of the technology transferred comes from other Non-Annex I countries: HFCs (14.3% of total technology transfer), Hydro (21.6%), Geothermal (11.8%) and Biomass energy (10.1%).

11. Diversity of Technology Supply by Project Type

A large market share for a few technology suppliers might indicate that the technology is controlled by a few sources, an oligopoly, that could restrict the distribution of the technology and / or keep the price relatively high. The data in Table 13 focus on this issue. The table presents the shares of the largest supplier country and four largest supplier countries as percentages of the annual emission reductions for projects that claim technology transfer and for which the technology supplier is known.

Three project types – EE service, Energy distribution and PFC destruction – have only a single project that claims technology transfer. The supplier is unknown. For each of these project types the supplier would have a 100% share unless equipment and knowledge were obtained from different countries. The total number of projects is 5 or less for each of these project types. Obviously the number of projects is too small to assess whether the industries that supply these technologies have an oligopolistic structure.

Five project types – Cement, EE households, Reforestation, Tidal and Transport – have only one technology supplier country with a 100% share. For each of these project types, except Cement, the number of projects that claim technology transfer is 3 or less and the total number of projects is 7 or less. Again the number of projects is too small to assess whether the industry that supplies the technology imposes barriers to technology transfer for any of these project types. The high concentration of foreign technology supply does not appear to be a barrier for Cement projects, since less than 10% of such projects claim technology transfer.

Other project types with a large market share (over 50%) for the largest supplier include EE industry, EE own generation, Fugitive emissions, N_2O and Solar. In the case of Solar the number of projects is small. Only 4 (29%) of the Fugitive emission projects claim technology transfer so a large market share for the largest supplier is not surprising, but also might not be a concern given that most projects do not involve technology transfer.

EE industry, EE own generation and N2O each include over 40 projects that claim technology transfer. The number of known technology supplier countries is 16, 3 and 8 respectively. But the largest suppler country has a market share of over 50%. Whether that is due to concentration in the relevant technology supply industries, replication of similar projects, or other reasons warrants further investigation.

All of the other project types – Agriculture, Biogas, Biomass energy, Coal bed/mine methane, EE supply side, Fossil fuel switch, Geothermal, HFC destruction, Hydro Landfill gas, and Wind – have at least 5 known supplier countries and a market share of less than 45% for the largest supplier. With a few exceptions (EE industry and EE own generation) these are also the project types with the largest number of projects, suggesting the suppliers do not impose barriers to transfer of the technologies for these project types.

A recent report found that unlike the pharmaceutical sector, the suppliers of biofuel, solar photovoltaic and wind technologies are not able to charge prices that exceed the production cost.[22] Competition among a number of patented products and between these products and other sources of fuel or electricity generation reduces the prices. As a result developing countries have good access to all three technologies. This is consistent with the data in Table 13 for Biomass energy and Wind. The number of Solar projects is too small to support or reject the conclusion.

In summary, the technology supply industry does not appear to restrict the distribution of the technology and/or keep the price high for most of the project types and project developers appear to have a choice among a number of domestic and/or foreign suppliers. Further investigation of the reason(s) for the large market share of the dominant foreign technology supplier for EE industry, EE own generation and N2O is warranted. For a number of other project types the number of projects is too small to infer whether barriers to technology transfer might exist.

12. Technology Needs Assessments

The UNFCCC secretariat summarized the technology needs identified by Non-Annex I Parties in their Technology Needs Assessments (TNAs) and national communications.[23] That report highlights priority technology needs identified in various sectors to reduce greenhouse gas emissions and facilitate adaptation to the adverse impacts of climate change. Among other issues, it draws attention to specific barriers to technology transfer and suggests measures to address them, including through capacity building.

A summary of the mitigation technology needs identified by the TNAs and national communications from 25 Non-Annex I countries submitted to the UNFCCC secretariat by 13 March 2006 was provided for comparison with the technology transfers taking place under the CDM. Unfortunately, only 13 of those countries are also host countries for CDM projects. Since the summary was prepared 14 more countries have submitted TNAs including 8 countries that host CDM projects. Thus an updated summary would provide a more robust sample for the analyses.

The data from the TNA summaries was used to explore the following questions:

- Do countries identify technology needs for project types that rely predominantly on local technology?
- Do the barriers identified in the TNAs inhibit technology transfer for CDM projects?
- Do countries that promote technology transfer under the CDM identify fewer and/or different technology needs?

Project types that rely mainly on local technology as identified by equation 2 in Table 5 are: Biogas, Biomass energy, Cement, Coal bed/mine methane, Energy efficiency own generation, Energy distribution, Fossil fuel switch, Fugitive, Hydro, Landfill gas, and Reforestation[24]. The ratio of technology needs identified for one of these project types to the total number of technology needs identified was calculated and compared with the ratio of CDM projects in these project types to the total number of CDM projects analysed. It appears that the technology needs identified are for project types that rely on imported technology[25].

To analyse the possibility that the barriers identified in the TNAs might inhibit technology transfer for CDM projects, the percentage of CDM projects involving technology transfer was regressed on the number of barriers and an indicator of "openness" to technology transfer. The "openness" variable has a value of 1 if the country's coefficient in Equation 3 in Table 5 is positive; it is found to encourage technology transfer, and a value of zero other wise.

The data for the analysis are provided in Table 14. Note that while thirteen countries are listed, the number of barriers is missing for three of the countries (Dominican Republic, Moldova, and Nicaragua) so they get dropped from the analysis by the computer. Furthermore, four countries host fewer than 5 CDM projects (Georgia, Kenya, Mauritius, and Tajikistan) so their inclusion in the analysis seems questionable. That leaves six countries with more than 5 CDM projects for the analysis.

Regressing the number of barriers on the "openness" variable yields the correct (negative) sign for the "openness" coefficient but it is far from significant. Although the sign of the coefficient is correct, we cannot determine definitively that openness to technology transfer is inversely related to the number of barriers identified due to the small sample size.

Of the six countries, Ecuador and Viet Nam promote technology transfer (section 7 above) while China, Indonesia, Moldova, and Nicaragua are neutral in terms of technology transfer promotion. The number of technology needs identified averages 35.0 for Ecuador and Viet Nam and 17.8 for the other four countries. A regression analysis that includes the country's population and per capita GDP indicates that countries that promote technology transfer identified significantly *more* technology needs.

The distribution of technology needs identified by the 25 Non-Annex I Parties, the distribution of projects in the CDM pipeline, and the distribution of CDM projects that claim technology transfer are compared in Table 15 for each project type. The share of CDM projects that claim technology transfer is lower than the share of technology needs identified for EE households, EE industry, EE supply side and Transport. The share of CDM projects that claim technology transfer is higher than the share of technology needs identified for Biogas, Biomass energy, Coal bed/mine methane, EE own generation, Fossil fuel switch, HFCs, Hydro, N_2O and Wind. This may indicate that the CDM is helping to meet the technology needs for these project types.

When the average number of needs identified is calculated by project type for countries that promote technology transfer (Ecuador and Viet Nam) and for the technology transfer neutral countries (China, Indonesia, Moldova, and Nicaragua) large differences are found for Agriculture, EE households, EE industry, EE supply side, Landfill gas and Transport.

Regression analyses that include the country's population and per capita GDP indicate that countries that promote technology transfer identified *more* technology needs for all of these project types except EE supply side, but the results are not statistically significant due the small number of countries in each group.

In summary, the technology needs identified are predominantly for project types that rely on imported technology. Based on data for six countries, the number of barriers identified does not appear to affect the percent of CDM projects involving technology transfer. Countries that encourage technology transfer tend to identify fewer barriers, but not significantly fewer. Countries that promote technology transfer identify more technology needs for Agriculture, EE households, EE industry, Landfill gas and Transport and overall. Data for more countries is needed to confirm these patterns.

13. Capital Investment

Using reported values of the investment per ktCO2e reduced by project type, shown in Table 7, the capital that is, or will be, invested in the 2293 CDM projects analysed is estimated at over US$55.8 billion (Table 16). Of that amount over 40% ($24.1 billion) represents capital invested in unilateral projects by host country project proponents. China accounts for half of the total investment in CDM projects ($28.3 billion) and India accounts for almost another quarter ($13.0 billion). India is home to the most unilateral projects so its investment in unilateral projects ($11.3 billion) is over 45% of the total unilateral investment. In India unilateral projects represent over 85% of the total investment.

14. Conclusions

Technology transfer is not an explicit objective of the Clean Development Mechanism, but the CDM can contribute to technology transfer by financing emission reduction projects using technologies currently not available in the host countries. This paper analyzes the technology transfer claims made by project participants in the Project Design Documents of 2293 projects in the CDM pipeline as of September 2007.

A definition of "technology transfer" is not provided to project participants, so each project is free to use its own interpretation of "technology transfer". However, from the claims it is clear that project participants overwhelmingly interpret technology transfer as meaning the use of equipment or knowledge not previously available in the host country for the CDM project. Nevertheless, technology transfer is claimed for some projects with very simple technology (e.g. solar cookers) while no technology transfer is claimed in other projects where it might be expected (e.g. cement).

Approximately 39% of the 2293 registered and proposed CDM projects claim some technology transfer. But these projects account for about 64% of the annual emission reductions, so technology transfer is more common for larger projects. Technology transfer varies widely by project type ranging from almost none to all of the projects of a given type. Technology transfer is claimed for a higher share of Agriculture, N_2O and HFC projects while less than 20% of the Cement, Hydro, and Reforestation projects claim technology transfer. Technology transfer is more common for projects that involve foreign participants than for unilateral projects.

Most (56%) projects that claim technology transfer involve transfers of both equipment and knowledge. About 32% of the projects that claim technology transfer involve only imports of equipment, but those projects account for 39% of the emission reductions. Transfers of knowledge alone involve 11% of the projects accounting for 13% of the emission reductions.

A host country can influence the extent of technology transfer involved in its CDM projects through the criteria it establishes for approval of CDM projects. Other factors, such as tariffs on imported equipment, also affect the extent of technology transfer involved in CDM projects. As a result, the rate of technology transfer is significantly higher than average for several host countries, including Ecuador, Honduras, Mexico, Sri Lanka, Thailand and Viet Nam and significantly lower than average for India.

Although Finland and France are participants in projects with a significantly higher rate of technology transfer, this is not associated with technology supplied by those countries. Switzerland is a technology supplier and credit buyer for over half of the projects it participates in.

The technology transferred mostly (over 70%) originates from Japan, Germany, the USA, France, and Great Britain. Although technology transfer from Non-Annex I countries is less than 10% of all technology transfer, Brazil, China, India, South Korea and Chinese Taipei are the source of 94% of equipment transfers and 74% of knowledge transfers from Non-Annex I sources.

Technology transfer is very heterogeneous across project types. A few project types rely heavily on imported technology and a small number of other project types rely mainly on locally available technology. The imported technology is mainly equipment – alone or together with knowledge – but the mix and sources vary widely by project type.

The technology supply industry does not appear to restrict the distribution of the technology and/or keep the price high for most of the project types and project developers appear to have a choice among a number of domestic and/or foreign suppliers. Further investigation of the reason(s) for the large market share of the dominant foreign technology supplier for EE industry, EE own generation and N_2O is warranted.

The technology needs identified by Non-Annex I Parties in their Technology Needs Assessments are predominantly for project types that rely on imported technology. Countries that encourage technology transfer tend to identify fewer barriers, but not significantly fewer. Countries that promote technology transfer identify more technology needs for Agriculture, EE households, EE industry, Landfill gas and Transport and overall. Data for more countries is needed to confirm these patterns.

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[1] United Nations, 1992, Article 4.1.

[2] United Nations, 1997, Article 10(c).

[3] See FCCC, 2006a.

[4] IPCC, 2000, p. 3.

[5] IPCC, 2000, p. 3.

[6] FCCC, 2006b, p. 16.

[7] FCCC, 2006b, pp. 5-12.

[8] The definition of a small-scale project has changed over time. For the analyses a project is classified as a small-scale project based on the methodology used to calculate the emission reductions. The means the definition of small-scale applicable when the PDD was prepared is used for the project.

[9] An arbitrary date must be chosen because the number of projects in the pipeline increases by about 3 per day.

[10] There are no "afforestation" or "other" projects so only 24 project types are used in the analysis. This is the most extensive list of project types. Ellis and Karousakis, 2006 reports 14 project types – renewable electricity, electricity generation, energy efficiency, (avoided) fuel switch, F-gas reduction, N_2O reduction, landfill gas capture, other CH_4 reduction, manure and wastewater, transport, cement, sinks, carbon capture and storage, and other. The UNFCCC reports registered projects by 8 project types – agriculture, chemical industries, energy demand, energy industries (renewable / non-renewable sources), fugitive emissions from fuels (solid, oil and gas), fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride, manufacturing industries, and waste handling and disposal. See http://cdm.unfccc.int/Statistics/Registration/RegisteredProjByScopePieChart.html

[11] A few projects use both a small-scale methodology and a methodology for a regular project. Those projects are classified as regular projects.

[12] Keywords included: technology, transfer, import, foreign, abroad, overseas, domestic, indigenous, etc.

[13] The population and GDP data are from the "Data-Population2000" and "Data-GDP-PPP" sheets respectively.

[14] When total emission reductions to 31 December 2012 are used as the measure of project size the results are similar. It also yields similar results for unilateral and small-scale projects. Since total reductions to 31 December 2012 combines the effect of annual emission reductions and the project start date, annual emission reductions is judged to be a better measure of project size and only those results are reported.

[15] Brazil, 2005, p. 2.

[16] China, 2005, Article 10, p. 2.

[17] India, undated, p. 1.

[18] Lee, 2006, slide 7.

[19] Diagnostic tests on the influence of individual observations while comparing both the Pearson $\chi 2$ and the deviance to the predicted probabilities indicated that there was one outlier observation exerting undue influence on the model. This observation was discarded

[20] Dropping the additional project type variables has virtually no impact on the explanatory power of the equation because the pseudo R^2 and percentage of observations classified are virtually unaffected.

[21] Both analyses find that Malaysia encourages technology transfer (significant at 0.1 but not 0.05 level) and that South Korea does not have a significant impact on technology transfer.

[22] Barton, 2007.

[23] UNFCCC, 2006.

[24] The coefficient for Solar is not statistically significant, so Solar is not included in this group.
[25] Of the 370 technology needs identified (some by more than one country), 115 (31.1%) are for project types that rely mainly on local technology. For the projects in the CDM pipeline, the corresponding figure is 66.2%. The difference is statistically significant.

Table 1
Technology Transfer by Project Type

Project Type	Number of Projects	Average Project Size ($ktCO_2e/yr$)	Technology Transfer Claims as Percent of	
			Number of Projects	Annual Emission Reductions
Agriculture	170	44	94%	89%
Biogas	127	64	57%	58%
Biomass energy	438	61	25%	44%
Cement	28	136	7%	5%
Coal bed/mine methane	44	603	36%	48%
EE households	5	18	60%	91%
EE industry	239	103	25%	45%
EE own generation	112	176	42%	62%
EE service	3	8	33%	50%
EE supply side	16	160	50%	58%
Energy distribution	5	64	20%	61%
Fossil fuel switch	72	328	36%	77%
Fugitive	14	623	29%	5%
Geothermal	10	190	50%	41%
HFCs	18	4,563	89%	89%
Hydro	500	81	9%	9%
Landfill gas	170	202	67%	69%
N2O	41	1,038	100%	100%
PFCs	2	83	50%	48%
Reforestation	7	71	14%	10%
Solar	7	26	57%	30%
Tidal	1	311	100%	100%
Transport	4	74	25%	13%
Wind	260	81	57%	73%
Grand Total	2293	164	39%	64%

Table 2
Technology Transfer Claims by Project Type for Unilateral and Small-Scale Projects

Project Type	Unilateral Projects		Small-Scale Projects	
	Number of Projects	Annual Emission Reductions	Number of Projects	Annual Emission Reductions
Agriculture	95%	94%	97%	99%
Biogas	29%	15%	56%	45%
Biomass energy	14%	23%	22%	40%
Cement	0%	0%		
Coal bed/mine methane	33%	38%	0%	0%
EE households	33%	85%	60%	91%
EE Industry	14%	21%	24%	28%
EE own generation	19%	20%	0%	0%
EE Service	0%	0%	33%	50%
EE supply side	33%	36%	17%	28%
Energy distribution	25%	64%	33%	76%
Fossil fuel switch	24%	65%	12%	14%
Fugitive	57%	8%	50%	29%
Geothermal	67%	80%		
HFCs	67%	90%		
Hydro	13%	19%	9%	8%
Landfill gas	60%	61%	43%	43%
N2O	100%	100%		
PFCs	50%	48%		
Reforestation	20%	17%		
Solar	50%	28%	57%	30%
Tidal	100%	100%		
Transport	0%	0%	33%	81%
Wind	46%	64%	35%	39%
Average for all projects	33%	46%	33%	34%
	Number	Reductions (ktCO2e/yr)	Number	Reductions (ktCO2e/yr)
Total	1242	109,474	1004	29,533
Percentage of all projects	54%	29%	44%	8%

Note: The percentages in the upper panel are the unilateral or small-scale projects that claim technology transfer as a percentage of the unilateral or small-scale projects in the category.

Table 3
Technology Transfer by Host Country Characteristics

	Number of Projects	Average Project Size ($ktCO_2e/yr$)	Technology Transfer Claims as Percent of: Number of Projects	Technology Transfer Claims as Percent of: Annual Emission Reductions
Country Size (Population)				
Population less than 1 million*	8	336	38%	4%
Population 1 million to 5 million	38	74	58%	73%
Population 5 million to 10 million	62	76	61%	65%
Population 10 million to 25 million	155	124	59%	68%
Population 25 million to 50 million	116	275	51%	72%
Population 50 million to 100 million	261	78	87%	85%
Population 100 million to 250 million	266	135	36%	60%
Population 250 million to 1 billion				
Population over 1 billion	1387	186	25%	62%
Total	2293	164	39%	64%
Country Groups				
(Based on per capita GDP)				
Least Developed Countries	14	57	71%	92%
Other Low-Income Countries	751	88	17%	40%
Lower Middle-Income Countries	1151	219	41%	67%
Upper Middle-Income Countries	356	151	74%	81%
Other	21	169	62%	24%
Grand Total	2293	164	39%	64%

* Project in Qatar is a significant outlier causing this category to be inflated

Table 4
Technology Transfer for Projects in Selected Host Countries

Host Country	Number of Projects	Estimated Emission Reductions ($ktCO_2e/yr$)	Average Project Size ($ktCO_2e/yr$)	Technology Transfer Claims as Percent of	
				Number of Projects	Annual Emission Reductions
Brazil	226	24,491	108	32%	68%
China	671	203,184	303	37%	68%
India	716	55,248	77	14%	40%
Malaysia	56	8,782	157	71%	87%
Mexico	171	11,878	69	91%	87%
South Korea	34	16,692	491	50%	81%
Other host countries	419	55,740	133	60%	58%
Total	2293	376,015	164	39%	64%

Table 5
Regression Results -- Logit Model

	Equation 1	Equation 2	Equation 3		
Constant	0.1862	1.4001	1.0665	Argentina	-0.5371
	1.7130	**7.792**	**3.95**		(-0.979)
Project Size (kt C02e/year)	0.0014	0.0014	0.0013	Armenia	0.0742
	6.1700	**5.257**	**5.001**		(0.054)
Unilateral project	-0.3378	-0.9849	-0.4495	Brazil	-1.0262
	-3.3590	**-8.025**	**-3.14**		**-3.527**
Population (millions)	-0.0023	-0.0020		China	-0.3186
	-15.5360	**-10.479**			(-1.213)
GDP (millions US $)	0.00000141	0.00000121		Costa Rica	1.0971
	7.8520	**5.491**			(1.213)
Agriculture		1.7410	1.6884	Cyprus	0.5006
		4.886	**4.35**		(0.384)
Biogas		-0.6285	-1.2442	Ecuador	2.6451
		-2.575	**-4.188**		**3.968**
Biomass energy		-1.4129	-1.2122	Egypt	0.6854
		-8.425	**-6.573**		(0.664)
Cement		-3.0313	-3.4139	Guatemala	1.1792
		-3.862	**-3.874**		**1.81**
Coal bed/mine methane		-1.7712	-2.1387	Honduras	2.4461
		-4.671	**-5.601**		**4.063**
EE own generation		-0.6493	-1.0226	India	-1.9783
		-2.774	**-4.21**		**-7.427**
EE supply side		-0.1441	0.2404	Indonesia	0.2796
		(-0.243)	(-0.413)		(0.595)
Energy distribution		-2.1375	-1.5938	Israel	0.0790
		-1.842	(-1.334)		(0.132)
Fossil fuel switch		-1.1316	(-0.936)	Malaysia	0.6818
		-3.727	**-2.923**		**1.755**
Fugitive		-2.8458	-3.0702	Mexico	1.6884
		-3.855	**-3.696**		**4.291**
Hydro		-2.9330	-3.5338	Moldova	0.3591
		-14.749	**-15.002**		(0.38)
Landfill gas		-0.4248	-0.3199	Nepal	1.7327
		-1.957	(-1.397)		(1.201)
Reforestation		-2.1553	-2.3627	Nicaragua	0.7433
		-1.884	**-2.034**		(0.559)
Solar		0.4415	0.5302	Philippines	0.6314
		(0.529)	(0.607)		(1.237)
Transport		-1.2827	-0.8153	South Africa	0.7310
		(-0.957)	(-0.599)		(1.225)
				South Korea	-0.5007
					(-1.092)
				Sri Lanka	2.4988

					4.071
				Thailand	1.3868
					2.731
				Uruguay	0.3861
					(0.295)
				Vietnam	3.5107
					3.945
Number of observations	2291	2291	2291		
Pearson's chi2	431.95	941.55	1145.29		
Probability > chi2	0	0	0		
Pseudo R2	0.1414	0.3081	0.3746		
Correctly classified	68.44%	79.22%	81.06%		

Notes: Each cell shows the estimated coefficient for the variable above and the "asymptotic z" value below, which indicates its statistical significance. Variables NOT significant at the 0.05 level or greater are indicated by "parentheses".

The coefficients describe the effects of the independent variables on the predicted logarithmic odds of technology transfers. For example, in equation 3, each occurrence of a unilateral project decreases the log odds of a technology transfer by -0.4494581. In other words, each occurrence of a unilateral project multiplies the odds of a technology transfer by $e^{-0.4494581} = 0.6379$, where e = 2.71828 is the base for natural logarithms. More simply, each occurrence of a unilateral project reduces the odds of a technology transfer by 36% (1 - 0.6379).

The value of the Pearson χ^2 is used to test the null hypothesis that the coefficients of all of the variables are equal to zero. The probability of a χ^2 value greater than the value calculated for each of the equations is less than 0.0000. Thus the null hypothesis can be rejected with a very high degree of confidence, indicating that at least some of the variables are statistically significant. That is confirmed by the tests for the individual variables using the "z" values.

The pseudo R^2 and percent of observations correctly classified are indicators of the explanatory power of the equation. If the equation predicts a probability of technology transfer greater than 0.5 for a project given its characteristics, it is correctly classified if technology transfer was claimed and incorrectly classified if no technology transfer was claimed. Similarly, if the predicted probability is less than 0.5, it is correctly classified if no technology transfer was claimed and incorrectly classified if technology transfer was claimed.

Table 6
Regression Results – Linear Probability Model

Variable	Coefficient	Standard Error	t-statistic	Share of Projects with Technology Transfer	Number of Projects
Project Size (kt C02e/year)	.000086	.0000153	5.612		
Unilateral project	-.069511	-.0695111	-3.071		
Agriculture	.239268	.0461657	5.183		
Biogas	-.151373	.0442951	-3.417		
Biomass energy	-.204371	.0258112	-7.918		
Cement	-.345647	-.3456467	-7.080		
Coal bed/mine methane	-.320396	.0751337	-4.264		
EE own generation	-.159932	.0502095	-3.185		
EE supply side	.034261	.0938946	0.365		
Energy distribution	-.425216	.0501046	-8.487		
Fossil fuel switch	-.126720	.0567412	-2.233		
Fugitive	-.268800	.2060066	-1.305		
Hydro	-.512743	.025252	-20.305		
Landfill gas	.032754	.0427927	0.765		
Reforestation	-.354026	.1974408	-1.793		
Solar	.077379	.1450323	0.534		
Transport	-.127174	.2432879	-0.523		
Ivory Coast	-0.71718	0.114418	-6.268	0	1
Tunisia	-0.66568	0.114000	-5.839	0	2
Kyrgyzstan	-0.64246	0.114037	-5.634	0	1
Uzbekistan	-0.64116	0.114044	-5.622	0	1
Guyana	-0.40288	0.111650	-3.608	0	1
India	-0.26376	0.111375	-2.368	0.139665	716
Qatar	-0.47971	0.235799	-2.034	0	1
Nigeria	-0.47344	0.234062	-2.023	0	2
Brazil	-0.10144	0.112711	-0.900	0.318584	226
El Salvador	-0.18008	0.208088	-0.865	0.333333	6
Fiji	-0.09281	0.111497	-0.832	0	1
Bhutan	-0.09072	0.111501	-0.814	0	1
Morocco	-0.17590	0.236339	-0.744	0.400000	5
Uganda	-0.10202	0.146418	-0.697	0	2
Chile	-0.06983	0.134954	-0.517	0.432432	37
Tajikistan	-0.02553	0.111782	-0.228	0	1
Argentina	-0.00745	0.150245	-0.050	0.526316	19
South Korea	-0.00021	0.138431	-0.001	0.500000	34
Armenia	0.00579	0.200309	0.029	0.333333	6
China	0.01907	0.111420	0.171	0.370149	670
Uruguay	0.15889	0.317669	0.500	0.666667	3
Israel	0.08928	0.171161	0.522	0.625000	16
Peru	0.09195	0.147836	0.622	0.352941	17

Cyprus	0.18044	0.259418	0.696	0.666667	3
Indonesia	0.11544	0.146623	0.787	0.593750	32
Moldova	0.15058	0.186732	0.806	0.714286	7
Nicaragua	0.21682	0.260380	0.833	0.666667	3
Bolivia	0.17129	0.200455	0.854	0.428571	7
Panama	0.21905	0.212717	1.030	0.285714	7
Costa Rica	0.24472	0.214341	1.142	0.625000	8
Philippines	0.17409	0.132675	1.318	0.789474	38
Egypt	0.21686	0.162854	1.332	0.714286	7
South Africa	0.21868	0.156132	1.401	0.700000	20
Guatemala	0.21427	0.145856	1.469	0.437500	16
Nepal	0.33161	0.209839	1.580	0.666667	3
Malaysia	0.20959	0.126951	1.651	0.714286	56
Mexico	0.25958	0.115571	2.246	0.906433	171
Sri Lanka	0.42702	0.167311	2.552	0.588235	17
Thailand	0.33859	0.129885	2.607	0.800000	35
Pakistan	0.56022	0.202227	2.770	1.000000	3
Vietnam	0.56544	0.204066	2.771	0.800000	10
Bangladesh	0.48757	0.172782	2.822	1.000000	3
Ecuador	0.41501	0.146363	2.836	0.736842	19
Senegal	0.35256	0.114014	3.092	1.000000	1
Georgia	0.35759	0.114037	3.136	1.000000	1
Malta	0.36211	0.114064	3.175	1.000000	1
Honduras	0.46375	0.137599	3.370	0.700000	20
Jamaica	0.39208	0.111916	3.503	1.000000	1
Lao PDR	0.39598	0.111962	3.537	1.000000	1
Tanzania	0.42447	0.114278	3.714	1.000000	1
Dominican Republic	0.42983	0.113020	3.803	1.000000	3
Papua New Guinea	0.44215	0.111927	3.950	1.000000	1
Kenya	0.74198	0.154206	4.812	1.000000	2
Mauritius	0.57542	0.111606	5.156	1.000000	1
Cambodia	0.60465	0.111422	5.427	1.000000	2
Macedonia	0.89196	0.111506	7.999	1.000000	1
Mongolia	0.89605	0.111859	8.011	1.000000	3
Colombia*				0.388889	18
Regression Statistics					
Number of obs	2291				
F(57, 2216)	967.98				
Prob > F	0.0000				
R-squared	0.4303				
Root MSE	.3736				

Note: * Colombia was used as the reference country since its share of projects claiming technology transfer is almost identical to the overall average – 39%.

Table 7
Regression Analyses – Foreign Participants

	Linear Probability Model			Logit Model		
	Coefficient	Robust Standard Error	t-statistic	Coefficient	Standard Error	asymptotic z value
Constant	0.54257	0.0780942	**6.948**	0.134921	0.499688	0.270
Project size (ktCO2/yr)	8.57E-05	0.0000157	**5.456**	0.001369	0.000267	**5.119**
Unilateral project	-0.17773	0.0765883	**-2.321**	-0.885530	0.499420	-1.773
Agriculture	0.54593	0.0291342	**18.739**	3.281948	0.327882	**10.010**
Biogas	0.01943	0.0496945	0.391	0.058414	0.227652	0.257
Biomass energy	-0.19544	0.0279735	**-6.987**	-0.918810	0.149092	**-6.163**
Cement	-0.40879	0.0524094	**-7.800**	-3.250030	0.902271	**-3.602**
Coal bed/mine methane	-0.28139	0.0725095	**-3.881**	-1.989370	0.399775	**-4.976**
EE own generation	-0.11096	0.0488173	**-2.273**	-0.638720	0.235383	**-2.714**
EE supply side	0.04362	0.1204020	0.362	0.177402	0.548119	0.324
Energy distribution	-0.21503	0.1930935	-1.114	-1.035180	1.149621	-0.900
Fossil fuel switch	-0.09867	0.0551047	-1.791	-0.671190	0.293965	**-2.283**
Fugitive	-0.16804	0.1676821	-1.002	-1.591590	0.779946	**-2.041**
Hydro	-0.40289	0.0258788	**-15.568**	-2.516860	0.196694	**-12.796**
Landfill gas	0.16170	0.0423907	**3.815**	0.573841	0.201211	**2.852**
Reforestation	-0.25705	0.1424345	-1.805	-1.360840	1.099571	-1.238
Solar	0.16947	0.1817257	0.933	0.830324	0.786909	1.055
Transport	-0.21818	0.1873739	-1.164	-1.090160	1.202717	-0.906
Austria	0.18545	0.1011989	1.833	0.980539	0.665687	1.473
CCAC16	-0.38513	0.1843016	**-2.090**	1 project	Predicts failure perfectly	
Canada	-0.03688	0.1246724	-0.296	-0.213650	0.631658	-0.338
Czech Republic	0.28478	0.0870997	**3.270**	1 project	Predicts success perfectly	
Denmark	-0.02939	0.1333668	-0.220	-0.000670	0.653765	-0.001
Finland	0.38592	0.1580400	**2.442**	2.321799	0.899084	**2.582**
France	0.27773	0.0949049	**2.926**	2.709775	1.042468	**2.599**
Germany	0.06625	0.0896511	0.739	0.536676	0.585165	0.917
Ireland	-0.13622	0.0759961	-1.792	4 projects	Predicts success perfectly	
Italy	0.01986	0.0874133	0.227	0.266629	0.610543	0.437
Japan	0.04578	0.0817597	0.560	0.350448	0.501991	0.698
Luxembourg	-0.21872	0.0929123	**-2.354**	5 projects	Predicts failure perfectly	
Netherlands	-0.01319	0.0817576	-0.161	0.037481	0.530955	0.071
New Zealand	0.31308	0.1003656	**3.119**	1 project	Predicts success perfectly	
Norway	-0.37946	0.1843076	**-2.059**	1 project	Predicts failure perfectly	
Spain	0.07271	0.0982713	0.740	0.528138	0.633105	0.834
Sweden	-0.15411	0.0811470	-1.899	-1.176410	0.679187	-1.732
Switzerland	0.18465	0.0605060	**3.052**	0.956666	0.386648	**2.474**
UK	0.05234	0.0742713	0.705	0.319915	0.481394	0.665
World Bank	-0.07629	0.0932328	-0.818	-0.249370	0.581250	-0.429
Regression statistics						
	R^2=.3167			Pseudo R^2 = .2765		
	n=2291			n=2278		

Table 8
Technology Transfer Actions

	Percent of Projects	Percent of Annual Reductions
Transfer of Equipment Only	32%	39%
Transfer of Knowledge Only	11%	13%
Transfer of Equipment and Knowledge	56%	47%
Other	1%	1%
Total	100%	100%

Table 9
Technology Transfer by Project Type

Project Type	Projects	No Technology Transfer	Equipment Only	Knowledge Only	Equipment and knowledge	Average Investment ($/000 tCO_2e/yr)
Agriculture	170	6%	9%	2%	83%	$137.39[a]
	7,512	11%	1%	0%	88%	
Biogas	127	43%	6%	6%	45%	$33.12
	8,127	42%	2%	7%	50%	
Biomass energy	438	75%	11%	3%	12%	$261.68
	26,575	56%	18%	5%	20%	
Cement	28	93%	4%	4%	0%	$137.39[a]
	3,817	95%	3%	2%	0%	
Coal bed/mine methane	44	64%	11%	5%	20%	$38.65
	26,523	52%	22%	3%	22%	
EE Households	5	40%	40%	0%	20%	$160.80[b]
	89	9%	40%	0%	51%	
EE industry	239	75%	13%	3%	10%	$160.80[b]
	24,557	55%	18%	3%	25%	
EE own generation	112	58%	21%	1%	20%	$160.80[b]
	19,756	38%	28%	2%	32%	
EE Service	3	67%	33%	0%	0%	$160.80[b]
	23	50%	50%	0%	0%	
EE supply side	16	50%	19%	0%	31%	$160.80[b]
	2,554	42%	10%	0%	47%	
Energy distribution	5	80%	0%	20%	0%	$137.39[a]
	320	39%	0%	61%	0%	

Fossil fuel switch	72	64%	22%	3%	11%	$377.65
	23,629	23%	39%	7%	31%	
Fugitive	14	71%	0%	14%	14%	$137.39[a]
	8,725	95%	0%	4%	1%	
Geothermal	10	50%	0%	0%	50%	$577.83
	1,898	59%	0%	0%	41%	
HFCs	18	11%	39%	6%	44%	$0.29
	82,128	11%	56%	2%	32%	
Hydro	500	91%	5%	0%	4%	$306.48
	40,397	91%	5%	0%	4%	
Landfill gas	170	33%	23%	11%	34%	$31.90
	34,411	31%	21%	12%	37%	
N2O	41	0%	2%	15%	83%	$1.47
	42,549	0%	2%	41%	57%	
PFCs	2	50%	0%	50%	0%	
	166	52%	0%	48%	0%	
Reforestation	7	86%	0%	14%	0%	$113.62
	497	90%	0%	10%	0%	
Solar	7	43%	43%	0%	14%	$137.39[a]
	185	70%	28%	0%	2%	
Tidal	1	0%	0%	0%	100%	$137.39[a]
	311	0%	0%	0%	100%	
Transport	4	75%	25%	0%	0%	$137.39[a]
	295	87%	13%	0%	0%	
Wind	260	43%	24%	12%	22%	$640.63
	20,972	27%	36%	9%	27%	

Grand Total	2,293	61%	13%	4%	22%
	376,015	36%	25%	8%	30%

Note: the top row for each project type shows the distribution based on number of projects while the bottom row shows the distribution based on estimated annual emission reductions.
a The average for all CDM project types is used when capital cost data for the specific project type is not available.
b Average capital cost calculated for all types of energy efficiency projects.

Table 10

Originating Countries of Equipment Only Technology Transfers by Project Type
ktCO2/year

	Agriculture	Biogas	Biomass energy	Cement	Coal bed/mine methane	EE households	EE Industry	EE own generation	EE service	EE supply side	Fossil fuel switch	HFCs	Hydro	Landfill gas	N2O	Solar	Transport	Wind	Grand Total
Australia			298				26												323
Austria		15	85		1,746		26			59	36		31	615					2,613
Belgium			504								755								1,259
Brazil			179										247						426
China			211				13						51	41					317
Czech Republic													12					37	50
Denmark			1,476							30								1,331	2,838
Europe							608				96			1,202					1,907
France													236						236
Finland											6								6
Germany			610		1,746		340	611			1,789		182		960			1,790	8,027
Great Britain							39				10	3,393		1,755					5,198
India													33						33
Japan			690				2,792	540			3,059	19,893				12	39		27,025
Malaysia			163																163
Mexico		11																	11
Netherlands			31				12											9	52
Norway							13												13
Romania													26						26
Russia													478						478
South Africa																39			39
South Korea												4,248							4,248
Spain													20					1,955	1,975
Sweden			25										174						199
Switzerland							13												13

Taiwan	41											3,993							4,033
Thailand	24	34																	58
USA		11	286		2,283		426	2,802		177	1,680			1,407				192	9,263
Unknown		82	274	118		36	59	1,654	12		1,738	14,185	577	2,182		1		2,337	23,254
Grand Total	65	154	4,832	118	5,774	36	4,366	5,607	12	266	9,169	45,711	2,068	7,203	960	51	39	7,650	94,082

Table 11

Originating Countries of Knowledge Only Technology Transfers by Project Type
ktCO2/year

	Agriculture	Biogas	Biomass energy	Cement	Coal bed/mine methane	EE industry	EE own generation	Energy distribution	Fossil fuel switch	Fugitive	HFCs	Hydro	Landfill gas	N2O	PFCs	Reforestation	Wind	Grand Total
Belgium		61																61
Brazil																49		49
Canada	19																	19
Denmark			123														7	130
Europe			65															65
Finland									347									347
France													574					574
Germany			96			546								13,319			1,819	15,780
Great Britain													231	20.716				252
India			96															96
Italy		52											548					600
Japan						16			1,246									1,262
Netherlands		140								89			1,175					1,404
Russia						136												136
Spain													132					132
Switzerland			864	66						220								1,150
Unknown		280	176		921			194			1,434	24	1,418		80			4,527
USA							337							4,081				4,417
Grand Total	19	533	1,419	66	921	698	337	194	1,593	310	1,434	24	4,078	17,420	80	49	1,826	31,002

Table 12

Originating Countries of Equipment and Knowledge Technology Transfers by Project Type

ktCO2/year

	Agriculture	Biogas	Biomass energy	Coal bed/mine methane	EE households	EE Industry	EE own generation	EE supply side	Fossil fuel switch	Fugitive	Geothermal	HFCs	Hydro	Landfill gas	N2O	Solar	Tidal	Wind	Grand Total
Argentina													67						67
													51						51
Australia		22	129								93			104					348
		22	193								93		10	104					422
Austria		61		376		353								110			311		1,211
		39		376		353								110			311		1,189
Belgium			572								281								853
			572																572
Brazil		81	236																317
		62	297																359
Canada	2,190	51	49											2,542					4,833
	2,739	62	74					342					10	4,796					8,023
China													230						230
													88						88
Costa Rica																			
													0.267						0.3
Denmark	67		2,535			87								108				1,392	4,190
	613	43	2,535			87								108	1,158			1,324	5,869
El Salvador																			
											140								140
Europe			92						1,513					94					1,699
			92	912					455				56						1,515
Finland			122			9													130
			122			17							0						139
France			129						283			13,980	276						14,668
			193			12			283			13,980	276		4,302				19,046
Germany		756	298	167	45	169	185	36	903			3,834	27	394	9,113	4		417	16,350

		772	120	167	45	24	185	36	3,173			3,834	36	234	6,765	4		477	15,873
Great Britain		805	37	167				532				2,802		406	2,466				7,216
		874		293				361				2,802		781	1,887				7,000
Iceland											37								37
											37								37
India			161										34						195
			98										34						132
Italy						33								1,470					1,503
						33								38	2,288				2,359
Japan		38	272			2,937	5,715	304	8			5,410	50	73	2,317				17,125
		38	334			2,937	5,715	304	8			5,410	55	73	2,317				17,193
Luxembourg															3,050				3,050
															2,288				2,288
Malaysia		27	44											70					141
			44											70					114
Mexico		19																	19
		38																	38
Netherlands	364	197	30											2,819				53	3,462
		170	30											2,819				53	3,071
New Zealand											93			76					169
		1,251									233			76					1,559
Norway													351						351
													351						351
Poland													67						67
													51						51
Singapore		22																	22
		22																	22
Slovenia													67						67
													51						51
South Korea									1,058					163					1,221
														163					163
Spain		48						171					41					1,950	2,210
													41	126				1,939	2,106
Sweden	1,826	21		231										77					2,155
				231									51						282
Switzerland						27								231					258
						27								767					794
Taiwan																			

													0.267						0.3
USA	2,190	130	238			325	216		2,244		93		1	2,393	6,071			39	13,940
	3,284	181	238			450	216		283		93		57	605	2,014			39	7,460
Unknown		1,784	473	4,981		2,128	209	167	1,309	111	182		266	1,489	1,150			1,901	16,150
		488	473	3,943		2,128	209	167	3,115	111	182		262	1,751	1,150			1,920	15,898
Grand Total	6,636	4,063	5,417	5,922	45	6,068	6,325	1,211	7,319	111	779	26,026	1,478	12,620	24,168	4	311	5,752	114,254
	6,636	4,063	5,417	5,922	45	6,068	6,325	1,211	7,319	111	779	26,026	1,478	12,620	24,168	4	311	5,752	114,254

Note: the top row for each country shows the expected annual emission reductions based on the technology transfer of equipment, while the bottom shows the expected annual emission reductions based on the technology transfer of knowledge

Table 13

Diversity of Technology Supply by Project Type

Project Type	Number of Projects	Projects with No Technology Transfer	Projects that Claim Technology Transfer	Number of Known Technology Suppliers	Share of Largest Supplier (% of annual emission reductions)	Share of Four Largest Suppliers (% of annual emission reductions)
Agriculture	170	11	159	7	41	96
Biogas	127	55	72	19	26	78
Biomass energy	438	329	109	19	38	66
Cement	28	26	2	1	100	
Coal bed/mine methane	44	28	16	6	32	94
EE households	5	2	3	1	100	
EE industry	239	179	60	16	64	91
EE own generation	112	65	46	3	60	100
EE service	3	2	1			
EE supply side	16	8	8	8	34	84
Energy distribution	5	4	1			
Fossil fuel switch	72	46	26	10	31	86
Fugitive	14	10	4	2	71	100
Geothermal	10	5	5	6	27	82
HFCs	18	2	16	6	44	86
Hydro	500	455	45	23	19	59
Landfill gas	170	56	114	19	21	70
N2O	41	0	41	8	54	85
PFCs	2	1	1			
Reforestation	7	6	1	1	100	
Solar	7	3	4	3	71	100
Tidal	1	0	1	1	100	
Transport	4	3	1	1	100	
Wind	260	112	148	6	37	99
Grand Total	2293	1408	885			

Table 14
Technology Needs Assessments Matrix

	Number of Barriers Identified in the TNA	Number of CDM Projects	Openess Coefficient from Equation 3 is Statistically Significant	Share of Projects that Claim technology Transfer (%)
Albania	9			
Azerbaijan	6			
Bolivia	8	7		42.9
Burundi	5			
Chile	2	37		43.2
China	8	669		37.0
Congo DR	8			
Dominican Rep		3		100.0
Ecuador	5	17	1	73.7
Georgia	9	1		100.0
Ghana	9			
Haiti	4			
Indonesia	9	32		59.4
Kenya	6	2		100.0
Lesotho	4			
Malawi	8			
Mauritius	9	1		100.0
Moldova		6		71.4
Nicaragua		3		66.7
Niue	2			
Paraguay	1			
Tajikistan	7	1		100.0
Viet Nam	8	10	1	80.0
Zimbabwe	7			

Note: Countries in bold were used for the statistical analyses.

Table 15

Distribution of Technology Needs Identified and Projects in the CDM pipeline by Project Type

CDM project Type	Total	Total	Distribution of: all CDM projects by number	all CDM projects by ER	projects with TT by number	projects with TT by ER
Agriculture	18	5%	7.4%	2%	18%	3%
Biogas	4	1%	5.5%	2%	8%	2%
Biomass Energy	23	6%	19.1%	7%	12%	5%
Cement	9	2%	1.2%	1%	0%	0%
Coal Bed Methane	1	0%	1.9%	7%	2%	5%
EE Households	69	17%	0.2%	0%	0%	0%
EE Industry	48	12%	10.4%	7%	7%	5%
EE Own Generation	4	1%	4.9%	5%	5%	5%
EE Service	10	3%	0.1%	0%	0%	0%
EE Supply side	28	7%	0.7%	1%	1%	1%
Energy Distribution	11	3%	0.2%	0%	0%	0%
Fossil Fuel Switch	4	1%	3.1%	6%	3%	8%
Fugitive	6	2%	0.6%	2%	0%	0%
Geothermal	5	1%	0.4%	1%	1%	0%
HFCs	1	0%	0.8%	22%	2%	31%
Hydro	24	6%	21.8%	11%	5%	1%
Landfill Gas	24	6%	7.4%	9%	13%	10%
N2O	2	1%	1.8%	11%	5%	18%
PFCs	1	0%	0.1%	0%	0%	0%
Reforestation	5	1%	0.3%	0%	0%	0%
Solar	22	6%	0.3%	0%	0%	0%
Transport	39	10%	0.2%	0%	0%	0%
Wind	12	3%	11.3%	6%	17%	6%
Not eligible for CDM	17	4%				
Unclassified*	2	1%				
Unspecified**	7	2%				
Grand Total	396	100%	100%	100%	100%	100%

* unclear where the technology identified by country would fit into CDM project category

** technology not specified by country

Table 16

CDM Project Revenue and Investment by Country for Projects that Entered the Pipeline until September 2007

Host country	Number of projects that entered the CDM pipeline until Sept 2007	Projected annual emission reductions of those projects (kCERs)	Estimated Annual Revenue ($ million)		Estimated capital invested in projects that entered the pipeline until Sept 2007	Estimated capital invested in unilateral projects that entered the pipeline until Sept 2007
			$10.70/CER (primary market)	$17.75/CER (secondary market)		
			Million USD			
Argentina	19	4,901	$ 52.4	$ 87.0	$ 294	$ 230
Armenia	6	304	$ 3.3	$ 5.4	$ 35	$ 1
Bangladesh	3	288	$ 3.1	$ 5.1	$ 20	$ 14
Bhutan	1	1	$ 0.0	$ 0.0	$ 0	
Bolivia	7	698	$ 7.5	$ 12.4	$ 129	$ 126
Brazil	226	24,491	$ 262.1	$ 434.7	$ 2,720	$ 1,680
Cambodia	2	106	$ 1.1	$ 1.9	$ 13	$ 2
Chile	37	5,928	$ 63.4	$ 105.2	$ 690	$ 341
China	671	203,184	$ 2,174.1	$ 3,606.5	$ 28,319	$ 5,733
Colombia	18	3,231	$ 34.6	$ 57.3	$ 263	$ 166
Costa Rica	8	342	$ 3.7	$ 6.1	$ 64	$ 31
Cuba	1	342	$ 3.7	$ 6.1	$ 55	
Cyprus	3	97	$ 1.0	$ 1.7	$ 49	$ 49
Dominican Republic	3	458	$ 4.9	$ 8.1	$ 293	$ 219
Ecuador	19	930	$ 10.0	$ 16.5	$ 220	$ 117
Egypt	7	2,574	$ 27.5	$ 45.7	$ 430	$ 16
El Salvador	6	518	$ 5.5	$ 9.2	$ 156	$ 34
Fiji	1	25	$ 0.3	$ 0.4	$ 8	
Georgia	1	73	$ 0.8	$ 1.3	$ 2	
Guatemala	16	1,470	$ 15.7	$ 26.1	$ 476	$ 243
Guyana	1	45	$ 0.5	$ 0.8	$ 12	
Honduras	20	456	$ 4.9	$ 8.1	$ 122	$ 55
India	716	55,248	$ 591.2	$ 980.6	$ 12,965	$ 11,276
Indonesia	32	4,178	$ 44.7	$ 74.2	$ 892	$ 98
Israel	16	931	$ 10.0	$ 16.5	$ 52	$ 46
Ivory Coast	1	944	$ 10.1	$ 16.7	$ 30	
Jamaica	1	53	$ 0.6	$ 0.9	$ 34	
Kenya	2	307	$ 3.3	$ 5.4	$ 90	

Kyrgyzstan	1	73	$	0.8	$	1.3	$	2		
Lao PDR	1	7	$	0.1	$	0.1	$	1		
Macedonia	1	202	$	2.2	$	3.6	$	62		
Malaysia	56	8,782	$	94.0	$	155.9	$	1,096	$	168
Malta	1	20	$	0.2	$	0.4	$	1		
Mauritius	1	298	$	3.2	$	5.3	$	78		
Mexico	171	11,878	$	127.1	$	210.8	$	1,721	$	725
Moldova	7	551	$	5.9	$	9.8	$	39	$	4
Mongolia	3	254	$	2.7	$	4.5	$	45	$	27
Morocco	5	354	$	3.8	$	6.3	$	140	$	122
Nepal	3	121	$	1.3	$	2.2	$	12		
Nicaragua	3	397	$	4.2	$	7.0	$	178	$	16
Nigeria	2	4,044	$	43.3	$	71.8	$	556	$	348
Pakistan	3	2,827	$	30.3	$	50.2	$	117	$	67
Panama	7	471	$	5.0	$	8.4	$	144	$	118
Papua New Guinea	1	279	$	3.0	$	5.0	$	161	$	161
Peru	17	2,188	$	23.4	$	38.8	$	583	$	485
Philippines	38	1,518	$	16.2	$	26.9	$	423	$	104
Qatar	1	2,500	$	26.7	$	44.4	$	343	$	343
Senegal	1	131	$	1.4	$	2.3	$	4		
South Africa	20	4,136	$	44.3	$	73.4	$	310	$	272
South Korea	34	16,692	$	178.6	$	296.3	$	630	$	506
Sri Lanka	17	541	$	5.8	$	9.6	$	146	$	45
Tajikistan	1	51	$	0.5	$	0.9	$	16	$	16
Tanzania	1	103	$	1.1	$	1.8	$	3	$	3
Thailand	35	3,415	$	36.5	$	60.6	$	324	$	6
Tunisia	2	688	$	7.4	$	12.2	$	22		
Uganda	2	35	$	0.4	$	0.6	$	10	$	10
Uruguay	3	276	$	3.0	$	4.9	$	19	$	11
Uzbekistan	1	58	$	0.6	$	1.0	$	2		
Vietnam	10	1,003	$	10.7	$	17.8	$	188	$	73
Grand Total	2,293	376,015	$	4,023.4	$	6,674.3	$	55,810	$	24,108

Notes