Methodologies & Climate-Friendly Technologies

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ABSTRACT

With the Kyoto Protocol becoming legally binding on 16 February 2005, the Clean Development Mechanism (CDM) is becoming a key instrument for limiting greenhouse gas emissions (GHG) and promoting sustainable development. For both developing and developed countries to benefit from the CDM, it is important to establish increased awareness and understanding of its various aspects. Building capacities in the baseline methodology and assessment of GHG emission reductions/sequestration benefits of CDM projects are keys to the successful development and implementation of the CDM. This research paper aims to address these important issues and thus assist project developers in establishing baselines for CDM projects following guidelines based on relevant decisions of Conference of Parties (COP) and CDM Executive Board (CDM-EB) as well as other sources.

The authors in this research study highlight the key CDM project criteria and eligible CDM projects. It further explains the basic concept of a baseline and its context in CDM. It then discusses the key concepts of a baseline and the key elements of a baseline methodology. The authors present the tools for assessment of additionality recommended by the CDM-EB for large scale CDM projects. The research study also discusses the application of the tool and highlights the key elements for assessing additionality in proposed CDM projects. The study focuses on small scale CDM (SSC) projects. The paper attempts to presents the guidelines for SSC and SSC categories recommended by CDM-EB. The study further discusses the recommended simplified baseline methodologies for SSC categories along with examples to explain the use of these methodologies. Finally, the process of submission of new project categories and methodologies to the CDM-EB is discussed. The author presents the steps for establishing baselines for large scale CDM projects. Baselines for large scale CDM projects can be established either using existing approved baseline methodologies or by developing a new baseline methodology. The

projects, solid waste management projects and industrial process improvement projects.

Key Words: Additionality, Baseline CDM, GHGs, Sustainability

Introduction

Technology lies at the heart of development process of any country. Given that the lion's share of technologies, including climate-related technologies, still originates from developed countries, North-South technology transfer (TT) assumes enormous significance for developing countries. Endeavors on the part of developing countries to follow a low-carbon development trajectory are also contingent, in large measure, upon technology transfer from developed countries.

The United Nations Framework Convention on Climate Change (UNFCCC) recognizes the need for technology transfer in various provisions (e.g. Article 4.5) and has over the years undertaken several initiatives towards implementing them, *albeit* with very limited headway. It was, however, only with the Bali Action Plan that the issue moved to the centre stage. Against the backdrop of the enhanced importance of technology transfer in the context of the ongoing negotiations, the potential of the Clean Development Mechanism (CDM) as a vehicle for technology transfer has been underscored. The UNFCCC itself has come out with three studies on this subject since 2007 (Seres *et al.*, 2007; Seres and Haites, 2008; UNFCCC, 2010b).

The study makes a value addition to the existing literature in some important respects. Whereas most of the multi-country studies (Haites *et al.,* 2006; Seres *et al.,* 2007; Dechezleprêtre *et al.,* 2008; Seres and Haites, 2008; Dechezleprêtre *et al.,* 2009; UNFCCC, 2010b) base their analysis on explicit claims on technology transfer made in the CDM Project Design Documents, the present paper enumerates technology transfer on the basis of an operational definition. This study undertakes a richer and more in-depth scrutiny of the various kinds of foreign involvement, explores the extent of interlocking of the various roles played by these foreign entities, and also considers their potential influence on technology transfer. While most of the multi-country studies (Haites *et al.,*006; Seres *et al.,* 2007; Dechezleprêtre *et al.,* 2008; Seres and Haites, 2008; Dechezleprêtre *et al.,* 2009; UNFCCC, 2010b) gather detailed information on the CDM projects from the UNEP Risoe Center CDM Pipeline Database, this study builds upon an exclusive database that has been

Documents.

Operational definition of technology transfer under the CDM

The Intergovernmental Panel on Climate Change (IPCC 2000) 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".

Neither the Marrakesh Accords nor any other UNFCCC official document contains a clear cut definition of technology transfer. Even most of the developing countries that have included technology transfer under the sustainable development criteria for CDM projects do not define the concept of technology transfer clearly[11]. Given such lack of clarity as to what is meant by technology transfer in the CDM context, different CDM project developers seem to have taken the liberty to interpret the concept in their own ways (often with the aim of facilitating the approval of the project) as evidenced by an in -depth scrutiny of the Project Design Documents undertaken in this study[12]. However, in order to undertake an analysis of technology transfer under the CDM, it is essential to be clear as to what is meant by technology transfer. This section is an attempt in that direction.

Literature Review

Table-1: Core categories of literature on the CDM related to technology transfer

Type of literature	Main authors / organisations
Quantitative analysis of technology transfer	Dechezlepretre, A.; Glachant, M; Meniere Y.; Haites, E.; Seres, S.
Policy review and reform of CDM design, and processes for enhancing technology transfer	De Sepibus, J.; Schatz, A.B., Wara, M., Teng, F & Chen, W & He, J (Tsinghua university, China), ENTTRANS.
Country based case studies of technology transfer	Hansen, U.E (Malaysia), Wang, B (China), Lewis, J.I (China), Hultman et al (forthcoming – Brazil and India)

listed below.

1. The rate of technology transfer through the CDM has fallen.
2. Technology transfer through the CDM prevails in a few countries and sectors, and bypasses others.
3. The CDM, while contributing to individual project level technology transfer, has been incapable of encouraging more widespread policy support for technology transfer, resulting in the transformation of energy systems.
4. Technology transfer through the CDM often means import of foreign equipment which does not improve technological understanding and capacity to innovate in developing countries (Schneider et al, 2008)
5. Technology transfer in the CDM is not consistently monitored because there is no common definition of what is considered technology transfer. Data is collected on the basis of Project Design Document (PDD) claims and cannot always be compared across projects.

Data sources and methodology

The main data sources used for this study are the Project Design Documents and other relevant information pertaining to the CDM projects covered, as available on the web portal of the UNFCCC. The first registered CDM project is the Brazil Nova Gerar Landfill Gas to Energy Project, which got registered with the UNFCCC CDM Executive Board with effect from 18 November 2004. Starting from this project, the Project Design Documents and other relevant information on the first 1000 registered projects have been downloaded in a chronological manner from the UNFCCC web portal - the registration date of the 1000th project being 26 March 2008. A template has been designed for systematic compilation of the raw data.

Given that technology-related information may well be scattered in different parts of a Project Design Document, the entire Project Design Document has been carefully scrutinized for each of the 1000 projects, so as not to miss out on any information useful for the study. For classification of each project under the various categories, the categorization developed by the UNEP Risoe Center CDM Pipeline has been adopted (see Table 1). Most of the information included in the database template by following the aforementioned steps is which relevant qualitative information have been numerically codified (e.g. 1 for 'Yes'; 2 for 'No'; 3 for 'Not applicable', etc.). After constructing the database, a detailed cross-tabulation exercise has been carried out in order to generate a series of pivot tables and graphs for the purpose of analysis.

Technologies, technology transfer and barriers

A broad spectrum of technologies already exists for mitigation and adaptation. In addition, there are state-of-the-art technologies nearly ready for large-scale deployment, and technologies still under research and development.

Table 1 enumerates the major mitigation technologies according to how soon they are expected to be ready for large-scale deployment.

Adaptation technologies may require new hardware or different implementation approaches ('software'). Five main areas of adaptation technology application are: regional and local climate modeling and early warning, coastal zone management, water resources, agriculture and public health. Table 3 provides an indicative list of adaptation technologies in these five areas.

Technological progress can take place through: scientific innovation and invention, the adoption and adaptation of pre-existing but new-to-the-market technologies, and the diffusion of technologies. Enormous gaps remain, especially in the case of the least developed countries.

Mechanisms for enhancing technology development and transfer

Mechanisms for technology transfer are designed to facilitate the support of financial, institutional and methodological activities. The Parties of the Convention have assigned operation of the financial mechanism to the Global Environment Facility (GEF). The Kyoto Protocol also recognizes the need for the financial mechanism to fund activities by developing country Parties. One relevant mechanism under the Protocol is the Clean Development Mechanism (CDM). Also, the Parties have established three special funds: the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), under the Convention; and the Adaptation Fund (AF), under the Kyoto Protocol.

Studies of technology transfer under CDM, based on an analysis of project design documents, suggest that CDM has made some contribution to financing emission off, project-specific nature of CDM raises questions about how much cumulative technological learning it can promote.

A number of innovative financing proposals have been advanced by various countries (or groups of countries) in the climate change negotiations to address financing gaps for mitigation and adaptation. This includes proposals from the "Group of 77 (G77) and China," Ghana, Mexico, Norway, the Republic of Korea and Switzerland. A number of proposals call for the establishment of global technology funds. The main differences are in the methods of financing and replenishing such funds (e.g., assessed contributions, auction of carbon allowances, carbon taxes or other means) and in the methods of governance. Few proposals are specific on mechanisms, beyond those for financing, for Promoting technology transfer. Criteria which can help in evaluating the various proposals include: newness and additionality to ODA, predictability, fairness in terms of both revenue raising and resource allocation, and governance structure. The main proposals are summarized in **Table 4.**

Intellectual property rights (IPRs)

Intellectual property (IP) comes in a variety of forms, only some of which are legally protected. Countries have different legal approaches to intellectual property protection, based in part on their level of technological capabilities and on the degree to which strict IPR protection is perceived as an aid or an obstacle to economic development and the building of a technological base. Patents and trade secrets are the two most important models of IPR protection with regard to environmentally sound technologies.

Public-private roles for innovation and technology transfer

The development of new, low-carbon technologies responds to both supply-push and demand-pull factors. Government financing for science and technology development is one key push factor. The policy-induced price of carbon is a key demand factor.

The roles of government and business differ depending on the stage of a technology's development. Normally, government plays a vital role in basic research on the science underpinning low-carbon technologies. Firms are more active in research, development and demonstration (RD&D) and in the actual commercialization of new technologies.

	Near-term	Mid-term	Long-term
ENERGY SUPPLY			
Fossil fuels	IGCC[1]commercialization Solid oxide fuel cells Cleaner coal plants	Hydrogen (H_2) co-production from coal/biomass	
Hydrogen	Integrated stationary fuel cell Systems Demonstration H_2 production from renewable sources	Low cost H_2 storage and delivery. H_2 from renewable sources. Renewable H_2- powered fuel cell vehicles	H_2 and electric economy
Renewable energy	Lower cost wind power Demonstration cellulosic ethanol Photovoltaic (PV) clad Buildings. Cost-competitive solar PV First-generation bio-refinery	Low-wind speed turbines Advanced bio-refineries Cellulosic biofuels Community-scale solar systems, Water photolysis Energy storage options	Widespread renewable energy utilization Genetically engineered biomass Biologically inspired energy and fuels
Nuclear fission & fusion	Advanced reactor and fuel cycle technology	Generation IV nuclear plants. Fusion plant demonstration	Advanced concepts for waste Reduction. Fusion power plants
END USE AND INFRASTRUCTURE			
Transportation	Hybrid and plug-in hybrid electric vehicles Alternative and flex-fuel vehicles Improved energy storage Power electronics	Fuel cell vehicles and H_2 fuels Efficient and clean heavy trucks Cellulosic ethanol vehicles Intelligent transport systems Low-emissions aircrafts	Zero-emission vehicle systems Optimized multi-modal inter-city and freight transport Engineered urban designs and regional planning
Buildings	High-performance integrated Homes, High-efficiency appliances Insulation control windows	"Smart" buildings. Solid-state Lighting. Ultra efficient, HVACR[2] Neural-net building controls	Energy managed communities Low-powered sensors with wireless communications
Industry	High-efficiency boilers Greater waste heat utilization Bio-based feedstock's	Superconducting electric Motors. Efficient thermoelectric systems	High-efficiency all-electric Manufacturing. Widespread use of bio-feedstock's
Electric grid and infrastructure	Distributed generation. Smart metering and controls for peak shaving. Long-distance direct current (DC) transmission	Neural-net grid systems Energy storage for load leveling	Superconducting transmission and equipment Wireless transmission
CO_2 CAPTURE, STORAGE AND SEQUESTRATION			
CO_2 capture	Post- combustion capture Oxy-fuel combustion Oxygen separation techniques	Novel capture technologies Biomass coupled with CO_2 capture and storage (CCS)	Novel in-situ CO_2 conversion technologies
Geological sequestration	Reservoir characterization Enhanced hydrocarbon recovery. CO_2 injection for coal-bed methane production	Mineralization of solid carbonates Well sealing techniques demonstrated	Sufficient effective CO_2 storage capacity
Terrestrial sequestration	Reforestation Soil conservation	Sequestration decision support tools. Bio-based and recycled products	Biological sequestration Carbon & CO_2 based products & materials
Marine sequestration	Effective dilution of directly injected CO_2	Carbonate dissolution/alkaline addition	Safe long-term marine storage
EMISSION REDUCTION OF OTHER GHGs			
Methane from energy production and waste	Bioreactor land-fill technology New drilling techniques for recovery of coal-bed methane	Advanced land-fill gas Utilization. Ventilation-air methane technologies	Integrated waste management systems
Methane and N_2O from agriculture	Anaerobic digesters for heat and electricity production	Utilization of soil microbial processes	Zero-emission agriculture
High global warming potential gases	Advanced refrigeration Technologies. Advanced aluminum smelting processes	Alternative refrigeration fluids	Solid-state refrigeration and air conditioning systems
N_2O from combustion	Catalytic reduction of N_2O in nitric oxide plants	Catalysts that reduce N_2O to elemental nitrogen in diesel engines	Advanced vehicles and non-carbon based fuels

MAJOR AREAS	TECHNOLOGIES AND PROCESSES
Extreme weather, climate and sea-level events	Climate models and systems for monitoring and early warning Climate-proofing infrastructure
Coastal zone management	To protect: tidal barriers, dune and wetland, Restoration, and A forestation To retreat: establishing set-back zones and creating upland buffers To accommodate: improved drainage technologies and early warning and evacuation systems
Water resource management	Desalination techniques, Reservoirs and levees for flood management Advanced recycling and efficient technologies in industrial cooling.
Agriculture	New varieties of crops, Advanced irrigation systems, Efficient wind breaks Advanced erosion control techniques
Public health	Advanced urban planning to reduce heat island effects Improved public transport, Disease vector control, and vaccination

Table- 4: Summary of main financing and institutional proposals

Sponsor	Proposal	How would it be financed?	How would revenues be allocated, used?	Governance mechanisms	Issues to consider
G77 and China – financial and technology mechanisms	New linked financial mechanism and technology mechanism under the UNFCCC Technology mechanism modeled – institutional mechanism designed to address all aspects of cooperation on technology research, development, diffusion and transfer; – comprises an Executive Body, technical panels focusing on key Technologies/sectors.	Multilateral Climate Technology Fund (MCTF): "new and additional" financial resources over and above ODA. Raised from: environmental and energy taxes, revenue from permit auctions – public budgets international organizations.	The funds would support R&D, deployment & transfer of technologies as well as the enhancement of developing countries' domestic capacity. Promote public-private partnerships (PPPs), active private sector participation Could support a range of activities: – joint EST design, R&D & technology demonstration – market development; covering incremental costs of investment through, e.g., subsidies, export credit guarantees; – Capacity-building.	MCTF operates as a single window facility within the UNFCCC financing mechanism; Fully accountable to the COP of the UNFCCC; Equitable and balanced representation of all Parties; Direct access to funding by the recipients. Policies relating to the MCTF guided by the technology mechanism.	Financing mechanism Complementary to technology mechanism. Funds provided outside the UNFCCC would not count as fulfilling developed countries' commitments. This is a potential political hurdle.
Ghana – international framework agreement for technology development and transfer	International framework agreement would address both mitigation and Adaptation. Two mechanisms: Technology Development and Transfer Board (TDTB) and Multilateral Technology Fund (MTF)	Funding would come from Annex II countries, in accordance with their commitments under the UNFCCC as per Article 4.3. Additional sources of funding, including market-based mechanisms and private sector financing.	Not specified.	TDTB: would be a standing body under the UNFCCC responsible for the development, deployment, diffusion and transfer of ESTs and know-how. MTF: would guidance of and be fully accountable to the COP. (Essentially same model as in G77 and China)	Provides an institutional framework in addition to a financing scheme, which allows for a more integrated approach. Details of revenue raising mechanism not fully specified.

Sponsor	Proposal	How would it be financed?	How would revenues be allocated, used?	Governance mechanisms	Issues to consider
Mexico – World Climate Change Fund (Green Fund)	The proposed Fund could establish linkages between mitigation, adaptation and technology transfer and Development.	All countries would contribute to the Fund. Contributions would be based on levels of GHG emissions, population, and gross domestic product. All contributions to the Fund would be subject to a double levy: –first levy for the Adaptation Fund the second levy for a Clean Technology Fund.	Fund would be designed to: (a) significantly increase funds available for mitigation (b) support adaptation efforts, (c) promote transfer and diffusion of ESTs, (d) Contribute to financing global climate change arrangement under UNFCCC. Portion could go to LDCs. Developing countries that Choose not to join Fund would be excluded from its benefits without penalty.	All contributing nations, whether developed or developing, would participate in the governance structure that would be established for the Fund. The structure would also be open to representatives of all beneficiaries.	Assessed contribution based on criteria of fairness, efficiency and 'polluter pays' Areas of possible contention: formula for determining contributions opt out for d'ing countries; if dev'ed countries want same option, could undermine Fund.
Norway – auctioning a share of national emission allocations	Auctioning a portion of the assigned amounts (national emission allowances) to raise revenues for global climate change action	The percentage or the Number of allowances auctioned could be set to reach revenue target. Could generate significant financial resources – estimated $15-25 billion per year.	The revenues could be used to Finance adaptation activities in the first instance, but could also be used to finance mitigation.	A designated international institution would conduct the auction; governance of revenues unspecified.	Unresolved questions include: the number/ share of allowances to be auctioned; criteria for use of the resources raised by the mechanism; Governance principles of the fund.
Republic of Korea – carbon credits for NAMAs	Issuance of carbon credits for verifiable mitigation associated with Nationally Appropriate Mitigation Actions (NAMAs) taken by developing countries as per Bali Action Plan Decision 1(b)(ii)	Sale of carbon credits generated by NAMAs in international carbon markets	The proposal recommends that details on operating the scheme, including criteria and extent of credit issuance, could be worked out at the fifteenth session of the COP.	Under UNFCCC; other details not specified	Provides a vehicle for Private sector participation in mitigation financing, technology transfer to developing countries. Does not address the adaptation challenge.
Switzerland – global carbon levy and adaptation fund	Global levy on fossil fuel emissions linked to funding scheme for adaptation Based on the principle of common but differentiated responsibilities and on the polluter-pays principle	Uniform global tax of $2/tCO2 on all fossil fuel emissions. Basic emission allowance per inhabitant exempted from tax; would result in countries with higher emissions per capita paying higher taxes. Developed countries would deliver a significantly larger fraction of their carbon tax revenues to the MAF than would developing countries.	Major portion of revenues allocated to a Multilateral Adaptation Fund (MAF) Would finance adaptation policies and measures under: – a "prevention pillar" involving climate-change impact risk reduction; –an "insurance pillar" that involves, inter alia, insuring against climate- related risks not covered by private insurance companies. A portion of revenue channeled into a National Climate Change Fund.	The function of MAF would initially be taken on by the Kyoto Protocol Adaptation Fund (AF) until a significant number of countries have joined the scheme, at which point the function is meant to be taken over by a new international institution, Complementary to the AF.	Designed to ensure fairness in its implementation as countries with higher per capita emissions would contribute more to the fund. Proposed uniform tax rate may not be politically acceptable if seen as failing to acknowledge different economic circumstances and historical responsibilities. Implementation challenge of global levy

Table-5: Innovative mechanisms to promote technology development and transfer

Mechanism	Rationale	Issues to consider
Publicly-supported centre's for technology development and transfer	Green revolution model of technology diffusion; makes technologies available to developing countries without IPR protection	Similar to proposal for innovation centre's in section on 'public-private roles'; suitable for Mitigation or only for adaptation technologies?
Technology funding mechanism to enable participation of developing countries in international R&D projects	Resultant IPRs could be shared; patent buyouts could make privately owned technologies available to developing countries	Is there sufficient incentive for participation by developed country private sector technology leaders?
Patent pools to streamline licensing of inventions needed to exploit a given technology	Developing country licensees won't have to deal with multiple patent holders	What are the incentives to patent holders? Would government regulation be needed?
Global R&D alliance for research on key adaptation technologies	Model of research on neglected tropical diseases	Is such an approach suited to mitigation technologies?
Global clean technology venture capital fund	Fund located with a multilateral financing institution which will also have the rights to intellectual property	Will new technology ventures be viable commercially if they don't own intellectual property?
Eco-Patent Commons for environmentally sustainable technologies	Approach initiated by the private sector to make certain ESTs available royalty-free on a "give-one, take-one" model	Voluntary; private incentives appear weak. What about those companies without a patent to contribute?
Blue Skies proposal of European Patent Office: differentiated patent system with climate change technologies based on a licensing of rights	Complex new technologies based on cumulative innovation processes need to be treated differently from, e.g., pharmaceuticals	Appears to address similar concerns to patent pool proposal: more specifics needed on implications for technology access
More favorable tax treatment in developed countries for private sector R&D performed in developing countries	More pro-active, technology-push approach by developed country governments	May face domestic political constraints
Technology prizes	Reward innovation without awarding IPRs to innovators	Require a well-specified research objective

In the past decade, there have been broad changes in the types and magnitudes of the international financial flows that drive technology transfer between countries. The trend of official development assistance (ODA) was downward during the 1990s, both in absolute terms and as a percentage of funding for projects with a significant impact on technology flows to developing countries. In the last several years, however, the ODA has been fluctuating and experienced a net increase during the 2000-2007 period. Sources and amounts of development finance, some portion of which goes for technology transfer, vary widely from region to region.

Levels of FDI, commercial lending, and equity investment all increased over this period. As a result, private sources have supplied more than three-fourths of the total net resource flows from member countries of the Organization for Economic Co-operation and Development (OECD) to developing countries compared to only one-third in 1990 (IPCC 2000). FDI, loans, and equity are the dominant means by which the private sector makes technology-based investments in developing countries and in countries with economies in transition, often in industry, energy supply and transportation. Private sector investment in the form of FDI in developing countries has favored East and South East Asia, and Latin America.

Table II.6 shows the total cumulative lending by multilateral development banks during the period 1995–2005 for all reported climate-relevant sectors. The miscellaneous sectors shown in the last row are excluded from the analysis.

Table-6: Lending by multilateral development banks in developing countries for all sectors in selected years (billions of 2005 US dollars)

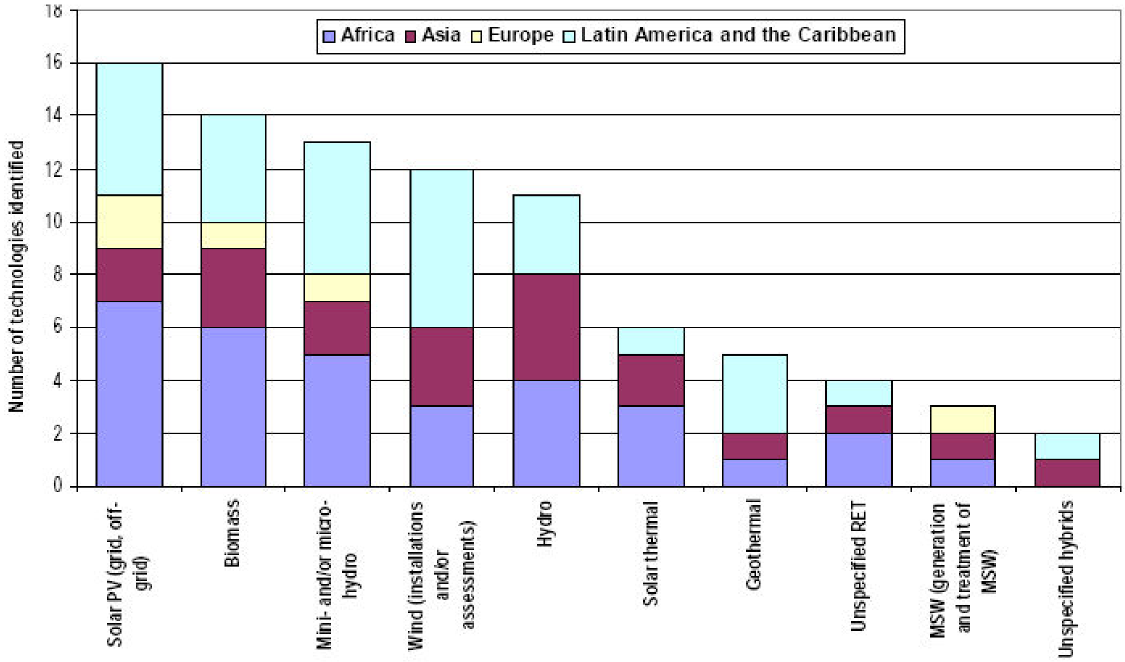
Sector	1995	2000	2005	Annual average (1995-2005)	Share (percentage)
Education	3.405	1.750	2.550	2.463	6.1
Health	1.262	1.446	1.328	1.395	3.5
Water supply and sanitation	2.967	1.496	2.645	2.125	5.3
Transport and storage	4.585	4.209	6.969	5.550	13.8
Communication	0.441	0.080	0.248	0.220	0.5
Energy generation and supply	4.422	2.707	2.707	3.095	7.7
Agriculture	2.672	3.360	2.464	2.559	6.3
Forestry	0.101	0.053	0.125	0.134	0.3
Fisheries	0.085	0.006	2.120	0.067	0.2
Industry	0.845	0.747	2.414	1.089	2.7
Mineral resources and mining	0.025	0.342	0.405	0.222	0.6
General environmental protection	5.614	1.014	0.319	0.696	1.7
Urban and rural development	1.380	0.883	1.439	1.235	3.1
Reconstruction, relief and rehabilitation	0	0.269	2.497	0.569	1.4
Disaster prevention and preparedness	0	0	0.660	0.060	0.1
Emergency response	0.122	0.189	0	0.226	0.6
Miscellaneous	37.389	32.733	37.273	18.620	46.2
TOTAL	**65.316**	**51.285**	**66.162**	**40.326**	**100**

Source: OECD 2007

Because of the limited ability to compare trends in technology transfer on the basis of financial flows, other indicators and data to quantify the level and flows of environmentally sound technologies are needed to better inform Governments about their policy choices. In addition, technology performance benchmarks for different sectors could be compiled to give an indication of the real degree of implementation of these technologies and the potential of technological improvements. It would be useful to have simple and agreed criteria for measuring the transfer of such technologies.

UNFCCC technology transfer framework and national technology needs

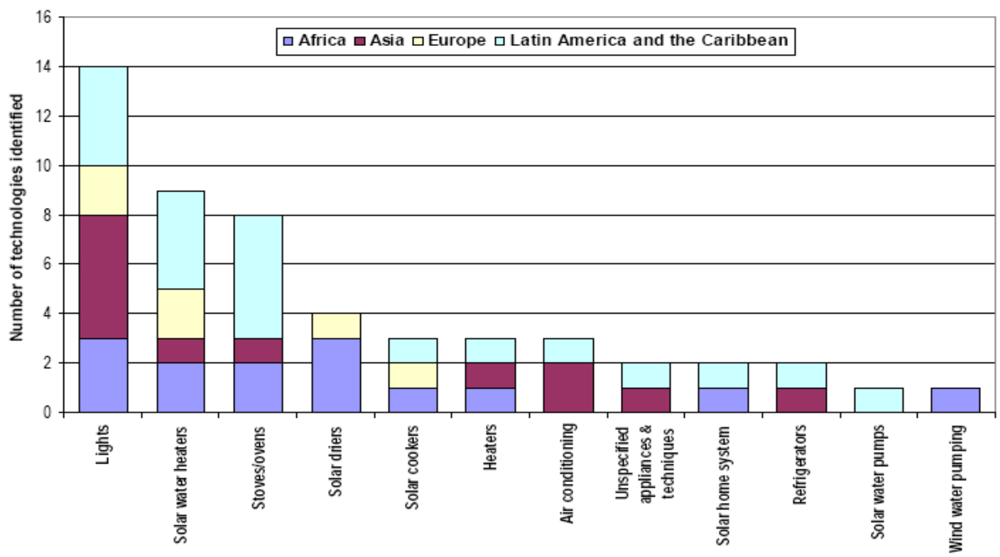
The COP to the UNFCCC defined a framework for meaningful and effective actions to increase and improve the transfer of and access to environmentally sound technologies and know-how.[8] This technology transfer framework defines five key elements for meaningful and effective actions: (1) technology needs and needs assessment, defined as a set of country-driven activities to determine technology priorities through widespread stakeholder consultations; (2) technology information; (3) enabling environments, defined as government actions, including the removal of technical, legal and administrative barriers to technology transfer, sound economic policy and regulatory frameworks to create a conducive environment for private and public sector investment in technology transfer; (4) capacity building, which is a process for building, developing, strengthening, enhancing and improving existing scientific and technical skills, capabilities and institutions in developing countries to enable them to assess, adapt, manage and develop environmentally sound technologies; and (5) mechanisms to facilitate the support of financial, institutional and methodological activities to enhance coordination among stakeholders, to engage stakeholders in cooperative efforts to accelerate the development and diffusion of these technologies and to facilitate the development of projects and programmes to support these ends with Graph-1.



Note: Solar PV - solar photovoltaic; MSW - municipal solid waste; RET - renewable energy technology

Graph-1: Commonly identified renewable energy technology needs

Source: SBSTA 2006.



Graph -2: Commonly identified energy efficiency technology needs in the building and residential subsectors

Source: SBSTA 2006.

Table -7: Description of the project categories

Project category	How the project category is defined in the study
Agriculture	Projects producing biogas that is flared, methane avoidance
Biogas	Projects producing biogas that is used for energy purposes
Biomass energy	New plant using biomass or existing ones changing from fossil to biomass, also biofuels
Cement	Projects where lime in the cement is replaced by other materials, or neutralization with lime is avoided.
Coal bed/mine methane	CH4 is collected from coal mines or coal beds
EE households	Energy Efficiency improvements in domestic houses and appliances
EE industry	End-use Energy Efficiency improvements in industry
EE own generation	Waste heat or waste gas used for electricity production in industry
EE service	Energy Efficiency improvements in buildings and appliances in public & private sevice
EE supply side	More efficient power plants producing electricity and district heat, Coal Field Fire Extinguishing
Energy distribution	Reduction in losses in transmission/distribution of electricity/distric heat, Country interconnection
Fossil fuel switch	Switch from one fossil fuel to another fossil fuel (including new natural pas power plants)
Fugitive	Recovery instead of flaring of CH4 from oil wells, gas pipeline leaks, charcoal production, fires in coal piles
Geothermal	Geothermal energy
HFCs	HFC-23 destruction
Hydro	New hydro power plants
Landfill gas	Collection of landfill gas, composting, or incinerating of the waste in stead of land filling
N2O	Reduction of N2O from production of nitric acid, adipic acid, caprolactam
Reforestation	According to LULUCF rules
Solar	Solar PV, solar water heating, solar cooking
Tidal	Tidal power
Transport	More efficient transport
Wind	Wind power

Source: UNEP Risoe CDM Pipeline, 1 January 2009.

Findings and analysis

Key features of the dataset

The database that has been constructed for this study comprises 1000 projects spread across 49 host countries and 23 project categories, accounting for an estimated annual emission reduction of 208240 kt CO_2e/year. The distribution of projects is highly uneven across host countries. Only four countries, namely India, China, Brazil and Mexico (in that order) are host to as many as 745 projects. Only 16 countries host *at least* 10 projects each; while 14 countries host only one project each. The distribution of projects is highly uneven across project categories also. Only five categories - Biomass Energy, Hydro, Wind, Agriculture and Landfill Gas - account for as many as 713 projects. Only 13 categories have *at least* 10 projects each, whereas three categories have only one project each. In terms of the share in total estimated annual emission reduction from all 1000 projects also, the top four host countries account for the lion's share (77%). In contrast, the shares of the top five categories in the total estimated annual emission reduction is only 28%.

Technology transfer by host country

Table 2 depicts the distribution of projects with technology transfer by host country and estimated annual emission reduction. From the last row of the table it could be observed that among the projects studied, 27% have been found to comply with the operational definition of technology transfer. Overall, these projects account for 46% of total estimated annual emission reduction. In other words, the projects involving technology transfer are, on average, substantially larger than those not involving any technology transfer.

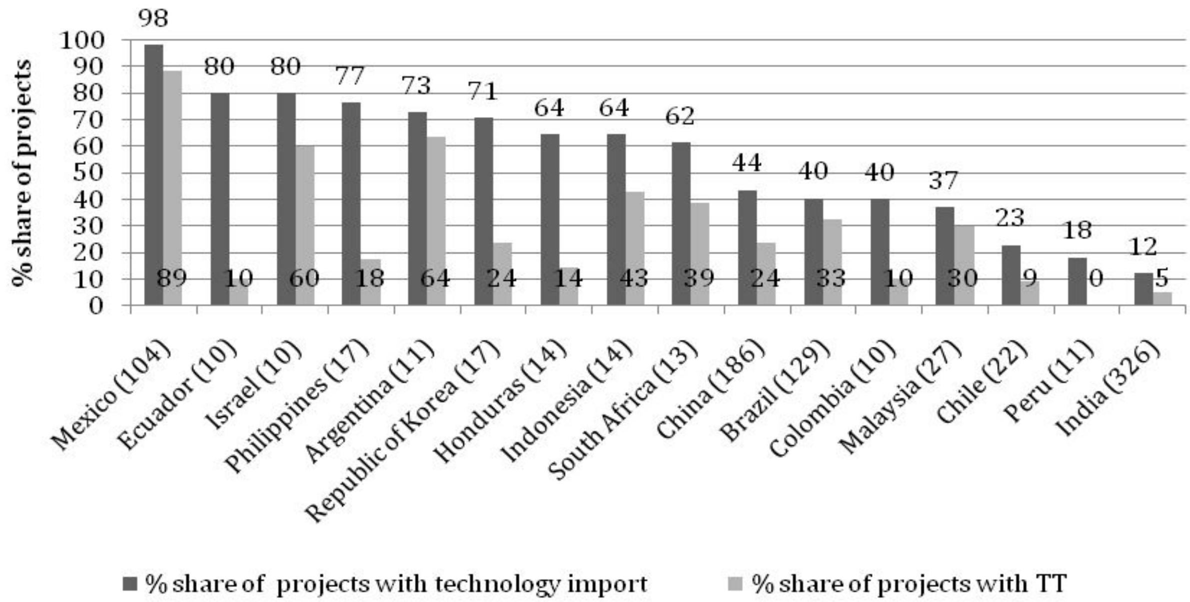
Table-8: Technology transfer by host country and estimated annual emission reduction

Host country	No. of projects in a country	No. of projects with TT [Col.4+Col.5]	No. of projects with Type I/Type II TT	No. of projects with Type III TT	Estimated annual emission reduction (ktCO2e/yr) from all projects in a country	Estimated annual emission reduction (ktCO2e/yr) from projects with TT	% share of projects with TT [(Col.3/Col.2)*100]	% share of estimated annual emission reduction from projects with TT [(Col.7/Col.6)*100]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
India	326	16	5	11	29974	7811	4.9	26.1
China	186	44	0	44	106047	64920	23.7	61.2
Brazil	129	42	0	42	18096	5106	32.6	28.2
Mexico	104	92	0	92	7106	2996	88.5	42.2
Malaysia	27	8	0	8	2319	403	29.6	17.4
Chile	22	2	0	2	3950	1405	9.1	35.6
Philippines	17	3	0	3	488	211	17.6	43.2
Republic of Korea	17	4	0	4	14356	1728	23.5	12
Honduras	14	2	0	2	280	58	14.3	20.8
Indonesia	14	6	1	5	2493	992	42.9	39.8
South Africa	13	5	0	5	2525	941	38.5	37.3
Argentina	11	7	0	7	3888	3218	63.6	82.8
Peru	11	0	0	0	1129	0	0	0
Colombia	10	1	0	1	958	340	10	35.5
Ecuador	10	1	0	1	465	30	10	6.5
Israel	10	6	0	6	1113	854	60	76.7
Others[2]	79	26	0	26	6907	4243	52	61.4
All countries	**1000**	**265**	**6**	**259**	**208240**	**95256**	**26.5**	**45.7**

Source: UNEP Risoe CDM Pipeline, 1 January 2012.

1. The host countries have been sorted by the number of projects hosted, in descending order.

2. 'Others' stands for 33 host countries with <10 projects each.



Graph -3: Technology import vis-à-vis technology transfer in top 16 countries

Source: UNEP Risoe CDM Pipeline, 1 January 2009.

1. The countries have been sorted here by the share of projects with technology import in descending order

2. Figures in the parentheses against the country names on the horizontal axis indica te the number of projects hosted by that country.

Technology transfer by project category

Table 7 provides distribution of projects with technology transfer by project category and estimated annual emission reduction. The *percentage share of projects with technology transfer* varies widely across project categories. Among the top 13 categories, the share of projects with technology transfer is the highest for Agriculture and lowest for Hydro (see Col.8). Apart from Agriculture, the share is fairly high (>60%) for Nitrous Oxide (N20), Biogas and Hydro fluorocarbons (HFCs)[20]. Besides Hydro, the share is very low (<20%) for Cement, Fossil Fuel Switch, Biomass Energy, Energy Efficiency Own Generation, and Energy Efficiency Supply Side projects.

Table -9: Technology transfer by project category and estimated annual emission reduction

Project category	No. of projects in a category	No. of projects with TT [Col.4+Col.5]	No of projects with Type I/ Type II TT	No. of projects with Type III TT	Estimated annual emission reduction ($ktCO_2e/yr$) from all projects in a category	Estimated annual emission reduction ($ktCO_2e/yr$) from projects with TT	% share of projects with TT [(Col.3/Col.2)*100]	% share of estimated annual emission reduction from projects with TT [(Col.7/Col.6)*100]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Biomass energy	202	16	0	16	11195	1029	7.9	9.2
Hydro	180	5	0	5	11961	54	2.8	0.5
Wind	136	32	0	32	11289	3020	23.5	26.7
Agriculture	108	89	0	89	4587	3658	82.4	79.7
Landfill gas	87	31	0	31	19636	7803	35.6	39.7
EE own generation	58	7	0	7	10295	5281	12.1	51.3
Biogas	57	35	1	34	2093	755	61.4	36.1
EE industry	42	11	3	8	1016	509	26.2	50.1
N2O	26	19	0	19	39101	22601	73.1	57.8
Fossil fuel switch	26	2	0	2	8890	694	7.7	7.8
HFCs	17	10	0	10	72950	45880	58.8	62.9
Cement	14	1	0	1	2014	470	7.1	23.3
EE supply side	12	2	0	2	478	354	16.7	74
Coal bed/mine methane	8	2	0	2	5046	3101	25	61.5
Fugitive	7	0	0	0	5399	0	0	0
Geothermal	6	1	0	1	1507	44	16.7	2.9
Solar	4	2	2	0	43	4	50	8.1
EE households	3	0	0	0	42	0	0	0
EE service	2	0	0	0	15	0	0	0
Transport	2	0	0	0	288	0	0	0
Energy distribution	1	0	0	0	55	0	0	0
Reforestation	1	0	0	0	26	0	0	0
Tidal	1	0	0	0	315	0	0	0
All categories	**1000**	**265**	**6**	**259**	**208240**	**95256**	**26.5**	**45.7**

Source: UNEP Risoe CDM Pipeline, 1 January 2009.

1. The categories have been sorted by the number of projects in a category, in descending order.
2. Abbreviations used: EE: Energy efficiency; HFCs: Hydrofluorocarbons; N2O: Nitrous Oxide.

Conclusions and policy implications

The core finding that emerges from this study is that the contribution of the CDM to technology transfer can at best be regarded as minimal. Out of 1000 projects studied, only 265 involve technology transfer. Among these, 259 projects qualify for Type III TT, in which technological learning and capability building are restricted only to the level of operation and maintenance of an imported technology. Only six projects involve technology transfer of Types I or II, in which the host country entity is either found to develop a technology in collaboration with some foreign entity; or the host country entity is involved in in-house technological efforts towards adapting or improving upon an imported technology.

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