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TAKING STOCK OF PROGRESS UNDER THE CLEAN DEVELOPMENT MECHANISM (CDM)

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FOREWORD

This document was prepared in May 2004 by the OECD and IEA Secretariats at the request of the Annex I Expert Group on the United Nations Framework Convention on Climate Change. The Annex I Expert Group oversees development of analytical papers for the purpose of providing useful and timely input to the climate change negotiations. These papers may also be useful to national policy makers and other decision-makers. In a collaborative effort, authors work with the Annex I Expert Group to develop these papers. However, the papers do not necessarily represent the views of the OECD or the IEA, nor are they intended to prejudge the views of countries participating in the Annex I Expert Group. Rather, they are Secretariat information papers intended to inform Member countries, as well as the UNFCCC audience.

The Annex I Parties or countries referred to in this document refer to those listed in Annex I to the UNFCCC (as amended at the 3rd Conference of the Parties in December 1997): Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, the European Community, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom of Great Britain and Northern Ireland, and United States of America. Korea and Mexico, as new OECD member countries, also participate in the Annex I Expert Group. Where this document refers to "countries" or "governments" it is also intended to include "regional economic organisations", if appropriate.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Kyoto Protocol's Clean Development Mechanism (CDM) was established in 1997 with the dual purposes of assisting non-Annex I Parties in achieving sustainable development and assisting Annex I Parties in achieving compliance with their quantified greenhouse gas (GHG) emission commitments. This paper looks at the achievements of the CDM to date in the context of wider private and public flows of investment into developing countries.

Market demand for GHG credits from CDM projects comes from Annex I countries' emission commitments. Annex I countries can meet those commitments by domestic as well as international emission mitigation activities, including the CDM. The CDM can be an attractive compliance option as it can help meet Annex I GHG commitments more cost-effectively through project-based activities that are consistent with host-countries' sustainable development priorities. The extent of the demand for CDM credits depends on the stringency of emission commitments, the "gap" between countries' emission commitments and actual emissions, and the relative use of CDM and other means of meeting emission commitments.

Although there are no officially-registered CDM project activities as yet, there are already several achievements of the CDM. These include the development of proposed CDM projects, increasing awareness of climate change mitigation options among possible investors and others that may facilitate transactions (i.e. governments), and the strengthening of climate-relevant institutions within countries. This paper examines information from more than 160 emission-reduction project activities being developed as potential CDM projects that are currently underway or planned in 48 countries and several different sectors. These project activities anticipate reducing greenhouse gas emissions by almost 32 Mt CO_2-eq/year (or slightly more than Ireland's CO_2 emissions in 1990) during the Kyoto Protocol's first commitment period and by more than 50 Mt CO_2-eq. before 2008. The current size of the CDM market is expected to grow to between 50- to 500 mt CO_2-eq per year during the first commitment period (Grubb 2003)**.** For comparison, the estimated size of the emissions "gap"[1] of Annex I Parties (excluding the US and Australia) has been estimated between 275-880 Mt CO_2-eq in 2010 (Grubb 2003).

Proposed CDM projects include a relatively wide spread of activities and host countries. However, anticipated emission reductions from CDM project activities are concentrated in three sectors, i.e. renewable electricity generation, reduction of methane emissions and F-gas decomposition. Anticipated emission reductions are also concentrated in a few countries, e.g. India, Brazil, China, and Indonesia. With a few exceptions, the countries expecting to generate large amounts of credits from proposed CDM projects to date are also often countries that are recipients of a significant proportion of total flows of foreign direct investment (FDI). Many of the poorest nations that are unable to attract outside investment for other reasons also do not appear to be attracting significant interest in investment in CDM projects,

[1] The "gap" is the difference between actual emissions and emission commitments. Even if the emission "gap" was close to zero in Annex I countries, it is still likely that there would be a demand for CERs in the 1st Kyoto commitment period, given the preferences of some market players.

even if they have established a "designated national authority" for the CDM to facilitate and approve transactions.[2] .

Renewable electricity projects account for 56% of the project portfolio in terms of numbers of projects, and approximately 37% of the portfolio in terms of expected annual credits. Transport and energy-efficiency projects account for only a small share of the total project portfolio (2% and 3% respectively of expected annual credits), as do projects in Africa (5% of expected annual credits). The proportion of "brownfield", relatively low-cost and large-volume emission reduction options such as F-gas decomposition and reduction of methane emissions (which together account for 40% of the portfolio in terms of expected emission reductions) has grown very rapidly since early 2003, although few such projects are currently underway. These project types, as well as others not yet included in the CDM project portfolio, such as reduction of N_2O from adipic acid production, have the potential to dominate the expected market for CDM credits during the first commitment period and to reduce CDM credit prices from current levels of between \$3-6 per tonne of CO_2-equivalent. The current price of emission credits varies according to the project's characteristics and distribution of risks between CER-buyers and sellers, with some CER-buyers being prepared to pay a premium for development-friendly projects.

The success of the CDM will depend in part upon the amount of investment it is able to stimulate in GHG mitigation activities and on the other types of long-term benefits that such activities are able to deliver. To date, more than \$800m has been allocated to carbon funds or CDM (or CDM/JI) programmes. These funds, which are mainly public, focus on providing a revenue stream for emission credits from a project rather than providing up-front project finance. This \$800m is a conservative figure as other private sources of funding for CDM project activities are also expected to be available. Taking these other sources of CDM investment into account, CDM financing to 2012 is likely to be more than \$1 billion.

This flow of funds (\$1b) into the CDM is small relative to other flows of foreign investment from developed countries to developing countries, such as foreign direct investment (FDI) from the private sector or official development assistance (ODA) from the public sector. However, such funds may have the potential to leverage six to eight times this amount – or about 6-8 billion USD of investment capital towards GHG mitigation activities. This compares to GEF investment in climate change of \$1.4b between 1991-2002, thus it is significant with respect to climate change. However, flows of investment in CDM are likely to be only a small fraction of FDI and ODA flows in any particular country in a year. To the extent that CDM investments stimulate or add to the ongoing private investment flows in a country, the CDM may be uniquely well placed to stimulate transfer of low- or no-GHG emitting technologies. Achieving transfer of climate-friendly technology is essential if mitigation is to be extended successfully across the world in the coming decades. Thus, the CDM has the potential to contribute not only to reducing the overall cost of meeting GHG objectives, but also to lasting technology change over time.

International governance of CDM projects focuses on assessing the GHG-reduction aspect of CDM project activities. This assessment is led by the CDM Executive Board under the UNFCCC, involves many different actors and can take several months, particularly if the proposed project activity is not using a pre-approved baseline and monitoring methodology. In contrast, the host country alone assesses the compatibility of a proposed project to its sustainable development objectives. Some potential host countries have set out criteria by which to do this. These criteria can differ from country to country. Many proposed CDM projects have clear benefits through lowering local environmental pollution or boosting economic development and/or employment – as well as reducing emissions of GHG. Other project activities may have few outputs other than CERs and few direct environmental, economic or social effects other than to

[2] The establishment of a "designated national authority" is a prerequisite to approval of CDM projects as set out in decision 17/CP.7 in the Marrakech Accords.

reduce GHG emissions, although they may have some positive indirect effects in non-GHG areas, particularly if some of the CDM revenues are earmarked for other purposes.

Experience with developing CDM project activities has also highlighted some important barriers to increased CDM activity during the first commitment period. These barriers include financial and institutional issues, risks and uncertainties associated with generating CERs and delays in approving CDM project activities and methodologies. Some uncertainties, delays and other transaction costs will be reduced – at least for selected project types – once there are a greater number of approved baseline methodologies for particular project types from the CDM Executive Board (EB) and/or if the CDM EB approves "consolidated" methodologies for grid-connected electricity projects and landfill gas projects. If this occurs in 2004, it could still encourage further interest and possibly development of project types requiring a long lead-time to generate emission reductions (such as renewable electricity generation activities) – although their attractiveness as a CDM investment will still depend on their cost-effectiveness compared to other possible mitigation options. Successfully addressing such barriers may be key to increasing the importance of the CDM.

Project search costs could be reduced by encouraging potential project participants in host countries to bring forward project ideas (e.g. to their DNA) and by facilitating initial technical appraisal in the host country or by using a "unilateral" CDM-type model. However, this could require significant institutional capacity in potential host countries and is also less likely to lead to technology transfer. Thus, it may not be widely applicable to non-Annex I countries, at least not those in early stages of development. Project validation costs could be reduced by encouraging the development of validators in CDM host countries.

While there has been a positive start to the CDM, the contribution that CDM is expected to make to emission reductions in the first Kyoto commitment period is likely to be small. However, the lessons learned to date from the CDM, and its contribution to setting-up a carbon market are already quite valuable. A significant increase in size of the CDM market is feasible. The practical mitigation potential in 2010 of energy efficiency, renewable energy activities and methane gas capture from landfills and fossil fuel systems in non-Annex I countries has been estimated at 470 mt CO_2-eq at $5/t CO_2-eq (TAA 2004) and that from F-gas reduction in China alone has been estimated at 90 mt CO_2-eq/year (Lu 2004).

Looking further into the future to a post-2012 regime, the role that the CDM, or any project-based mechanism generating emission credits, could play depends on the architecture of and participation in mitigation commitments. In order to deliver emission benefits at a large enough scale to slow growth in global emissions, such a regime would clearly need to deliver deeper emission reductions than those foreseen by the Kyoto Protocol. Stabilisation of atmospheric concentrations of greenhouse gases will only be possible if all major emitting countries take on some form of commitment over the next few decades to begin to curb and eventually reverse growth in global emissions. As part of a future climate regime, any project-based mechanism would sensibly build on the institutions developed and project-level experience gained by companies and countries currently implementing the CDM. Current investors in CDM projects do not have a clear signal on the need for (or value of) GHG credits post-2012, thus increasingly the focus of investments is on near-term, "brownfield" and low cost emission reductions. In addition, resolving the tension between global emission reductions and local benefits is a key challenge for the future which could help to build local support for global GHG mitigation through the CDM or a similar project-based mechanism. All of these suggestions point to the valuable learning that is occurring through emerging experience with the CDM, pointing to lessons that will hopefully establish a knowledge base and a starting point for discussions about how to shape next steps under the Convention to curb global emissions of GHG.

1. INTRODUCTION

The Kyoto Protocol's Clean Development Mechanism (CDM) was established in 1997 with the dual purposes of assisting non Annex I parties in achieving sustainable development and assisting Annex I Parties in achieving compliance with their quantified emission reductions of greenhouse gases (GHG). This paper looks at the achievements of the CDM to date in the context of wider private and public flows of investment into developing countries.

The CDM does not exist in isolation. Market demand for credits from CDM projects ("certified emission reductions" or CERs) occurs as one set of countries (those listed in Annex I to the Convention) has a regulatory constraint on its GHG emissions and can offset domestic emissions with emission benefits from CDM project activities located in non-Annex I countries. . Demand for CERs therefore depends both on the stringency of emission commitments for Annex I countries, the "gap" between emission commitments and likely emissions (which depends in turn upon the countries willing to take on such agreements[3]), and the relative use of CERs or other means of meeting emission commitments.[4] Thus, the CDM is, in the short term, a GHG-neutral instrument which extends to countries without emission commitments the flexibility in where emission reductions can occur. This flexibility can help reduce the total cost of achieving emissions commitments. In the longer term, experience with implementing GHG-friendly project activities under the CDM can help encourage development of such activities under business-as-usual, and thus help to move countries to a more sustainable development pathway.

The Clean Development Mechanism and Joint Implementation

CDM and JI projects generate credits from certain eligible activities that reduce GHG emissions or enhance carbon "sinks". These credits are generated in one country and are used by outside investors to offset GHG emissions in another country. CDM projects are for transactions between developing and industrialised countries – or those listed in Annex I of the Convention. JI projects are for project-based credit transactions conducted among Annex I countries. Eligibility criteria are different for the different mechanisms.

CDM project activities enable developing countries to voluntarily participate GHG emission mitigation, that is, in the absence of legally binding emission commitments. By allowing flexibility as to where emission-reducing or sink enhancement projects are undertaken, as well as in which sectors and gases mitigation occurs, the Kyoto Protocol's flexibility mechanisms reduce the cost for developed country (Annex I) Parties of attaining their emission commitments.

Following the establishment of the CDM in the Kyoto Protocol (COP3, 1997) several years were needed in order to agree the framework in which CDM project activities would operate. These "modalities and procedures" were agreed in the Marrakech Accords (COP7, 2001). The Marrakech Accords lay out several issues - including the functioning of the CDM's Executive Board (EB), which supervises the CDM, participation requirements, as well as validation, registration and monitoring issues. These give general guidance on how to estimate the emission benefits of projects. Further rulemaking on the CDM emerged in 2002 and 2003 with agreement on simplified modalities and procedures for small-scale emission reduction

[3] In particular, the withdrawal of the US from the Kyoto Protocol has reduced the likely demand (and price) for CERs.

[4] Annex I countries can also use domestic policies and measures, credits from "joint implementation" projects, or traded "assigned amount units" to meet their emission commitments.

CDM project activities and a framework for afforestation and reforestation (A/R) CDM project activities[5]. Agreement should also be reached by COP10 on processes for small-scale A/R CDM projects. These rulemaking decisions have allowed the CDM project preparation to move forward, well in advance of the formal implementation of the Kyoto Protocol and the Kyoto mitigation commitment period (2008-2012) – although not as fast as had originally been hoped.

In parallel with drawing up rules governing the CDM, project development has been getting underway. Indeed, there is now almost a decade's experience with setting up "joint" GHG mitigation projects: first under the FCCC's pilot phase for "Activities Implemented Jointly" and subsequently as potential projects under the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI).

Project documentation detailed in Annex 1 indicates that the importance of currently proposed CDM activities in different sectors is expected to be at least 32 million CO_2-eq/year during the first commitment period (2008-2012)[6]. This is greater than Ireland's CO_2 emissions in 1990. Many more project activities, for which data are unavailable, are underway or being developed. Still more potential projects, yet to be initiated, could be implemented and generate emission reductions by 2012. Thus the estimated importance of CDM project activities during the first commitment period should be much higher than this figure.

This 32 million tons CO_2-eq. reduction is not insignificant, but it is balanced by an allowance to emit an equivalent amount in Annex I countries that would otherwise have been reduced domestically. However, it is a small fraction of the currently-anticipated "gap" between projected emissions and Kyoto targets or the potential "demand" for CERs by Annex I countries excluding the US and Australia, which Grubb (2003) estimates to be between 275 - 880 mt CO_2-eq. 32 million tonnes of CO_2-eq. is also dwarfed by the size and expected increase in world emissions of GHG. For example, the increase in total energy-related CO_2 emissions[7] between 1990 and 2010 is expected to be 7.4 billion tons (IEA 2002 and IEA 2003b)[8]. Non-Annex I countries are estimated to account for the majority (5.2 billion tons or 70%) of this increase under a business-as-usual scenario (IEA 2003).

Huge investments are needed in order to satisfy the world's growing demand for energy goods and services. The energy sector is projected to require $16 trillion investment by 2030 (IEA 2003). Investments will also be needed in other GHG-producing sectors, such as industry and agriculture. These investments will be needed both for equipment and infrastructure. Because capital stock is often long-lived, turnover is sometimes slow. Today's choices on types of equipment or production processes will affect the levels of GHG emissions for several decades hence. The challenge is to encourage a significant proportion of investment for new or replacement systems to "leapfrog" to such lower-GHG choices.

Linking future GHG emissions requires significant investment today in environmentally-friendly goods and services from the private sector. Typically, though not always, improved environmental performance will have an added cost. A chief motivation in the design of the CDM was to stimulate private sector involvement to improve GHG performance of on-going investments. Although the role of the public sector is not excluded and has to date been important, some private sector monies are also already financing CDM project activity development directly and indirectly (e.g. via contributions to carbon funds and development of "unilateral" CDM projects). Making investment in environmentally-friendly goods a routine decision for both the public and private sector is key to moving towards a more sustainable development pathway.

[5] The modalities and procedures for A/R projects are for the first commitment period only.

[6] This number includes projected emission reductions from the projects listed in Annex 1.

[7] Excluding emissions from international marine and air bunkers.

[8] Total energy-related emissions in 2010 are projected to be 27.5 billion tons CO_2 (IEA 2002).

It is therefore timely to review CDM experience to date and to consider its expected role during the first commitment period. This paper aims to do just that. Section 2 outlines the nature of the "CDM challenge" and the different flows of investment. Section 3 provides a stock-taking of developments under the CDM to date. Section 4 highlights key conclusions from this analysis.

2. CONTEXT

On the horizon of international climate change negotiations is the question about next steps on global mitigation. Beyond contentious debate how much and how fast to limit greenhouse gas emissions, the existence of the UN Framework Convention on Climate Change, which 167 countries have ratified, reflects broad international agreement that climate change is underway and that something needs to be done about it. The Convention's objective (Article 2) notes the need to stabilise atmospheric concentrations of greenhouse gases so as to limit the pace and magnitude of climate change, while assuring food security, ability of ecosystems to adapt naturally to climate change, and sustainable economic development for the world's nations. Stabilisation of concentrations at any level will require deep emission reductions globally over the next half of century compared to existing trends (Watson et al. 2001; Philibert et al. 2003; Corfee Morlot and Hoehne 2003). The main question on the table for international negotiators is how to facilitate a transition to low-emission global development pathways in a cost-effective manner so as to assure a stable climate for future generations to come.

Achieving significant global emission reductions in the next half a century will only be possible if the world's largest emitting nations participate in mitigation efforts, limiting emissions below what they would otherwise be. This group of countries includes not only the developed countries but also the largest and most rapidly industrialising developing countries as well as large "transition" economy countries. For example, the IEA's World Energy Outlook (2002) projects that the share of energy-related CO_2 emitted by non-OECD countries will rise from 45% of the world's total in 2000 to 57% in 2030, with emissions from China will more than doubling (from 3.1 to 6.7 billion tons) in the same period. Successfully avoiding dangerous climate change will thus depend upon an ability to widen participation in mitigation efforts.

While the Convention commits all countries to prepare and adopt programmes and policies to address climate change, it does not require developing countries to do so in specific time frames nor does it quantify levels of mitigation for developing countries. As a result, the CDM, in which participation is purely voluntary, may currently be the main focus of mitigation efforts in many developing countries. The interest for developing countries to participate in the CDM as project "hosts" lies in the possibility to attract new investment to projects that will contribute to sustainable development in the near-term, while also facilitating learning about greenhouse gas mitigation possibilities. This knowledge may be particularly valuable over the longer-term as international pressure builds for deeper emission reductions at the global level. The demand for CDM, on the other hand, is based in the mandatory emission constraints undertaken in Annex I countries.

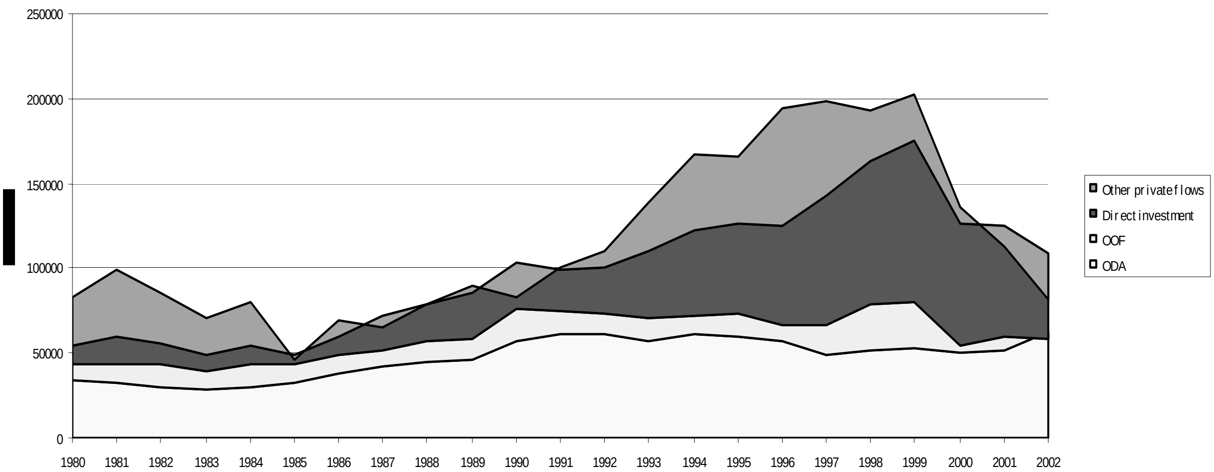
Responding to the opportunities presented by the CDM, many developing countries have begun to establish national institutions or mechanisms to facilitate or promote CDM investments (see Section 3). As a potential win-win approach to voluntary GHG mitigation, the CDM has attracted the attention of many developing country governments and business actors. In those developing countries that are actively pursuing the CDM, it is seen as a means to attract new, foreign capital and possibly also to stimulate technology transfer. As noted above, it is also a means to engage a wide range of different types of actors in learning about the technical and economical aspects of mitigation opportunities. Only time will tell whether the investment opportunities pursued will yield the expected environmental and economic benefits to the partners involved.

A key question is: How significant is the CDM likely to be given the range of other factors that influence socio-economic development, technology change and emission trends in developing countries? One way is to compare the flows of investment likely to go to CDM with other sources of foreign financing available to developing countries. Another way to think about this is to place the CDM in the context of technology transfer phenomena.

2.1 Investment flows for development and technology change[9]

The total flows of investment available in any particular country for development and technology change is comprised of both foreign and domestic sources. In developing countries, the size of foreign direct investment (FDI) from industrialised countries relative to domestic financing is still relatively low, with FDI estimated to be approximately 50 billion USD in 2002 (Figure 1). By comparison, foreign investment from other developing countries is roughly twice this amount and domestic investment in the same year is estimated at approximately 1 trillion USD (OECD 2003a). Domestic capital could be used to support CDM investment through the unilateral CDM approach and some analysts have begun to look at the potential to generate CDM projects of this type (Janssen 2002).

Figure 1: Total foreign investment flows to developing countries (1980-2002)



Source: OECD DAC - Creditor Reporting System 2003

Notes: Data for developing countries only, excluding flows to developed countries and other aid recipients e.g. central and eastern European countries, Russia, Singapore, Taiwan and Israel. 1) **Official Development Assistance (ODA):** grants and loans to countries and territories on Part I of the DAC List of Aid Recipients (developing countries); 2) **Other Official Flows (OOF):** Transactions by the official sector with countries on the DAC List of Aid Recipients which do not meet the conditions for eligibility as official development assistance or official aid, either because they are not primarily aimed at development, or because they have a grant element of less than 25%; 3) **Direct Investment** (also referred to as FDI here): Investment made to acquire or add to a lasting interest in an enterprise in a country on the DAC List of Aid Recipients. "Lasting interest" implies a long-term relationship where the direct investor has a significant influence on the management of the enterprise, reflected by ownership of at least 10% of the shares, or equivalent voting power or other means of control. In practice it is recorded as the change in the net worth of a subsidiary in a recipient country to the parent company, as shown in the books of the latter. 4) **Other private flows**: Mainly reported holdings of equities issued by firms in aid recipient countries.

Although foreign investments from one developing country to another are potentially large and could also shape CDM (along with domestic financing), flows of investment from OECD countries are of interest because they have the potential to deliver much higher technology transfer and innovation benefits. Evidence indicates that many of the world's new technologies originate in OECD countries and that FDI thus has the potential to transfer such technology out of the country of origin (OECD 2002a). FDI may also be a means to improve environmental performance of investments, provided the proper environmental regulatory frameworks are in place in host countries (OECD 2002b). Focusing on technology transfer and change issues, the discussion below concentrates on FDI flows from OECD to developing countries to provide a context for understanding the potential influence of CDM in larger trends related to technology

9 See also a parallel paper by Philibert (2004) has a broader discussion on technology collaboration including a review of technology transfer and investment issues.

change over time. It also considers flows of private investment compared to another source of foreign investment, that of "Official Development Assistance."

Within the foreign capital going to developing countries, private flows only became a dominant element in the 1990s, while public flows remained relatively stable in absolute terms over this period.[10] FDI tends to rise and fall with the financial cycles of the market and is risk averse compared to ODA. The downward decline in bank lending and FDI across developing countries in the late 1990s and in the early part of the current decade shows the effects of the east Asian financial market and the currency crisis in some Latin American countries. By comparison, between 1980 and 2002, ODA remained a more stable source of foreign capital for development across all developing countries (Figure 1), however its importance relative to other sources of capital varies widely by country.

Table 1: Foreign investment flows from OECD countries to developing countries public and private sources

(1980 and 2002; million USD current year figures)

	ODA		OOF		Direct investment		Other private flows		Total by region	
	1980	2002	1980	2002	1980	2002	1980	2002	1980	2002
Africa	10510	22285	2124	1877	1433	1839	6054	-1919	20121	24082
Asia	13630	19143	3105	-7503	-660	15553	1365	-12068	17440	15125
America	2259	5112	3191	-23	7269	15433	10657	-12394	23376	8128
Europe	1200	5508	1063	1151	815	2934	4597	-2163	7675	7430
Oceania	1024	709	63	-4	59	-36	3	966	1150	1635
Unspecified	4971	9201	611	1012	1982	14121	5711	758	13275	25092
Total by source	33594	61958	10157	-3490	10898	49845	28388	-26820	83037	81493

Source: OECD DAC - Creditor Reporting System 2004

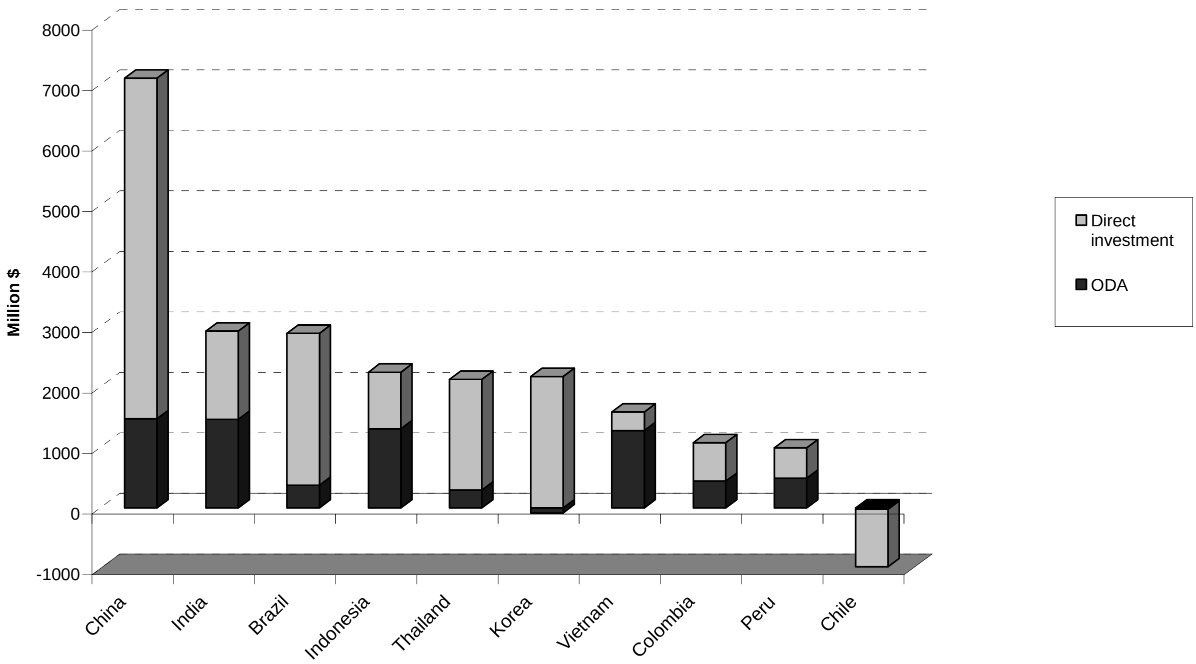
Notes: To allow for comparability between public and private flows, these data are for investment flows from OECD Development Assistance Committee "donor" countries only, thus excluding a handful of OECD countries that are not DAC donors. They also exclude flows of investment between developing countries i.e. roughly half of foreign direct investment flows inn 2002 were between developing countries.

Though the total flow of ODA is less than total private flows, it remains the dominant source of foreign investment in many of the poorest developing countries. For example, in 2002, ODA to Africa was more than ten times the amount of FDI. However, FDI flows are larger relative to development assistance in the relatively industrialised or medium income regions such as Asia and Central and Latin America (Table 1). Table 1 also shows the large shifts that have occurred since 1980, when all investment flows were positive, compared to 2002 when repayment of debt and other concessional financing in some regions considerably offsets the more stable ODA source.

A small, but significant portion of the total ODA to developing countries goes to economic infrastructure. Over the period 1980 to 2002, it was roughly 20% of ODA, with this share dropping to only 6% in 2002. Transport and energy infrastructure are the largest shares, representing about 50% and 40% respectively of share of ODA going to economic infrastructure in 2002.

[10] Relative to gross domestic product in OECD countries (the donors), ODA was declining in this period, with a slight upturn in 2002 (OECD 2003b).

Figure 2: ODA and direct investment to selected countries (2002)

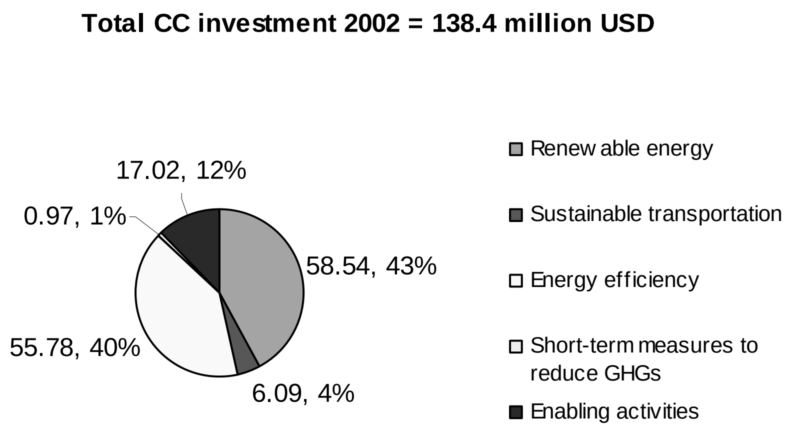


Source: CRS database, 2004
Note: The selected countries correspond to those that have been the most active in CDM (see Section 3)

Figure 2 shows flows of investment from FDI and ODA sources for ten developing countries that have been the most active in CDM project development (see Section 3). In 2002, FDI played the strongest role in almost all of these countries, indicating a possible relationship between the types of enabling conditions that attract FDI and the ability to succeed in the establishment and use of a "CDM" type mechanism. However, ODA is still significant in absolute and relative terms in China, India, Indonesia, Vietnam and Peru.

Another source of finance for climate-friendly technology change is the Global Environmental Facility. The Global Environmental Facility portfolio for climate change investments totalled $138.4 million in 2002 (Figure 3); between 1991 and 2002, GEF portfolio for climate investments equalled $1.4 billion. This is but a small fraction of the flows from ODA and FDI, outlined above. However, like CDM investment, it has significant leveraging power and is estimated to stimulate at least four times more investment capital through co-financing (GEF 2003). GEF financing is also significant because it is targeted to climate change activities, with the vast majority of the funding going to mitigation technologies, including renewable energy, energy efficiency, sustainable transportation and other emission-reducing activities.

Figure 3: GEF portfolio investments in climate change (2002)



2.2 Different means and mechanisms for technology transfer

Several different means exist for a firm to transfer technology outside its host country (OECD 2002a; Metz et al. 2000) and many of these means operate through private investment channels. For example, trade, technology licensing and foreign direct investment are all parallel pathways for a firm to transfer technology. OECD (2002a) suggests that foreign direct investment is the most important means of technology transfer to developing countries. Working through multinational enterprises (MNE) in developing countries, FDI may have a number of unique advantages compared to other means of technology transfer:

- ability to promote the transfer of the management and technical "know-how" needed to accompany successful technology transfer as well as focus on an explicit transfer of hard technology;
- forcing innovation in domestic firms that would not otherwise occur;
- bringing in new, higher technology options that may not be otherwise available locally but rather exist only in the multinational enterprise;
- scale economics, marketing skills and other features of MNEs may give them the competitive edge to more profitably exploit a particular technology compared to local firms, making that technology less costly and more valuable in that particular market.[11]

A number of different channels for technology transfer through FDI exist. This includes *vertical linkages*, where MNEs transfer technology and know-how to other firms with which they are working in the developing country, i.e. buyers or suppliers of intermediate products. *Horizontal linkages* provide a second channel, where local firms in the same industry adopt technology through imitation or from innovation stimulated by competition. *Labour migration* is another channel, where workers trained by the MNE with higher technical capacity move on to other local firms and transfer their knowledge. The fourth and final channel is *international R&D*, where multinational enterprises (MNEs) may conduct research locally to build knowledge about new technologies or processes. Empirical evidence indicates, however, that this last channel is relatively limited, as a large majority of R&D carried out by MNEs is conducted in home countries rather than oversees (OECD 2002a).

[11] Of course, where local skills and capabilities are high, technology transfer through FDI may be more rather than less costly compared to another alternative -- the licensing agreement.

How do the various features of FDI with respect to technology transfer relate to the discussion about CDM? Where FDI is a main source of investment in CDM, there may already be an open opportunity to contribute to technology transfer. In addition, the features noted above may also be useful ways to review whether proposed CDM projects are achieving conditions conducive to technology transfer.

The potentially large technology spillover effects from FDI in developing countries suggest that FDI trends may be particularly important for GHG mitigation – that is, to influence new technology investment toward low- or no-emission options. Empirical evidence is less clear, however, on whether these technology spillovers are environmentally positive (Metz et al. 2000; OECD 2002a; OECD 2001).

In theory, FDI, and MNE operations more generally, can provide access to newer, cleaner technologies as well as to cutting-edge knowledge about environmental performance in a particular industry. More intangible factors, such as improved corporate image abroad and at home, may also play a role. In practice, a number of other factors will also influence the environmental performance of MNE operations abroad, including environmental regulations in host countries and which industrial activity is undertaken. If FDI in some developing countries is flowing largely to resource-intensive activities, these may have high environmental impacts. The main question with respect to the environmental performance of FDI is whether such investments perform better, worse or equivalent to that of similar investments/industrial activities in the home country of the investing corporation. A recent trend in FDI is that it has been flowing to service sector investments rather than to primary or secondary production activities, which will change the environmental profile of such investments (Heller and Shukla 2003).

As noted above, FDI from one developing country to another is significant and it has increased dramatically in the last few years, raising the potential for "South-South" knowledge and technology transfers to occur. However there is little empirical analysis on how well South-South investments, which are often from a relatively wealthy developing country to a poorer country, are performing with respect to the environment and technology transfer (Christiansen 2004).

The IPCC's review of the literature concluded that environment-FDI linkages were weak and that it was best to avoid sweeping generalisations (IPCC 2000). The empirical evidence is mixed and debate continues about whether FDI encourage pollution "havens" by encouraging a lowering of environmental standards at the national level so as to attract more FDI, or create pollution "halos" through MNE good-practices (OECD 2001; OECD 2002b). However, a strong conclusion cutting across most assessments is that host country environmental policies are a necessary safeguard to provide incentives for improvements in environmental performance of FDI.

There is broad agreement that two main avenues exist to improve the environmental performance of FDI. The first is through national environmental institutions, including the legal framework, as well as mechanisms, to ensure effective enforcement (OECD 2002b). Ultimately, only the host government is in a position to ensure that direct incentives are in place to promote environmental performance through the use of clear national regulatory and institutional frameworks. The second avenue is through the propagation of firm-level good-practices, where multinational enterprises (MNE) may have corporate-wide policies that (voluntarily) support higher levels of performance based on home country practices. In this way, voluntary actions by MNEs can supplement formal regulations to promote good environmental performance. The OECD Guidelines for MNEs are an example of efforts to move in this direction (OECD 2000).

In addition to the question of environmental performance of FDI is the question of where it will flow and why. As highlighted above, recent trends show that FDI is a more stable source of investment for developing countries than other private flows that tend to be extremely sensitive to market fluctuations. However, the data also shows that FDI flows are selective – it will only flow to countries and locations where relatively strong "enabling conditions" for investment exist (OECD 2002a; OECD 2003). These include stable political regimes, strong legal environments for contracts and proven enforcement capabilities, macro-economic stability, availability of pools of skilled workers and other sources of human capital. Since many of the poorest of developing countries do not have the basic “governance” conditions to attract FDI, ODA will remain a relatively more important source of financing for technology transfer in these countries for the foreseeable future (Metz et al. 2000; OECD 2002a). Increasingly important to long-term development prospects is how to use ODA as a means to leverage FDI for development in developing countries, for example, through public-private partnerships to invest in human capital and infrastructure improvements (OECD 2003).

2.3 How does CDM compare to other investment flows?

The funds available to date for the CDM amount to more than $800m USD (section 3) and this amount is expected to be augmented especially by private sector flows in the coming years. In addition, CDM financing can be used to leverage other investment. The World Bank indicates that carbon finance is between 1:6 to 1:8 of total project cost (Sinha 2004). If we take 1 billion USD as an estimate of the amount of financing available for CDM in the coming years, this would mean that the amounts of investment stimulated by a CDM mechanism could become significant, i.e. 6-8 billion USD. Using the estimates developed recently by the IEA (2003) with respect to projected investment in energy infrastructure in developing countries in the 2001-2030 timeframe, this would represent about 1% of the required energy investment in developing countries’ electricity sector to 2010. However, this CDM-leveraged finance for the entire Kyoto period is equivalent to just over 10% of FDI and ODA flowing annually to developing countries, which stood at about $50 and 60 billion USD respectively in 2002. By comparison to GEF flows for climate change investments, which totalled about $1.4 billion over 1991 to 2002, the CDM is of at least a similar magnitude.

3. REVIEWING PROGRESS WITH THE CDM

A “gap” is projected between Annex I (developed) countries’ GHG emissions and emissions commitments. This has resulted in much interest from many Annex I and non-Annex I (developing) countries in participating voluntarily in the CDM. Indeed, the CDM offers the opportunity for Annex I countries to meet their emission commitments at a lower cost, and for developing countries to attract new sources of finance and technology for activities which help sustainable development.

While no CDM projects have yet been approved by the CDM EB, there has been progress towards implementing the CDM in the six years since it has been established. The achievements include development of on-the-ground projects and several more project proposals; development of CDM-related legislation and institutions; increased awareness of climate change, its mitigation measures and the cost of mitigation; and impetus for developing “carbon” funds, e.g. by the World Bank.

Nevertheless, there are also significant barriers to developing CDM project activities. These include financial and institutional issues, risks and uncertainties associated with generating CERs, delays in approving CDM project activities and methodologies, and other barriers such as difficulties in matching potential projects with potential investors or barriers for investment by non-domestic entities.This section outlines the achievements of the CDM to date as well as barriers to developing CDM project activities.

3.1 Development of concrete project activities

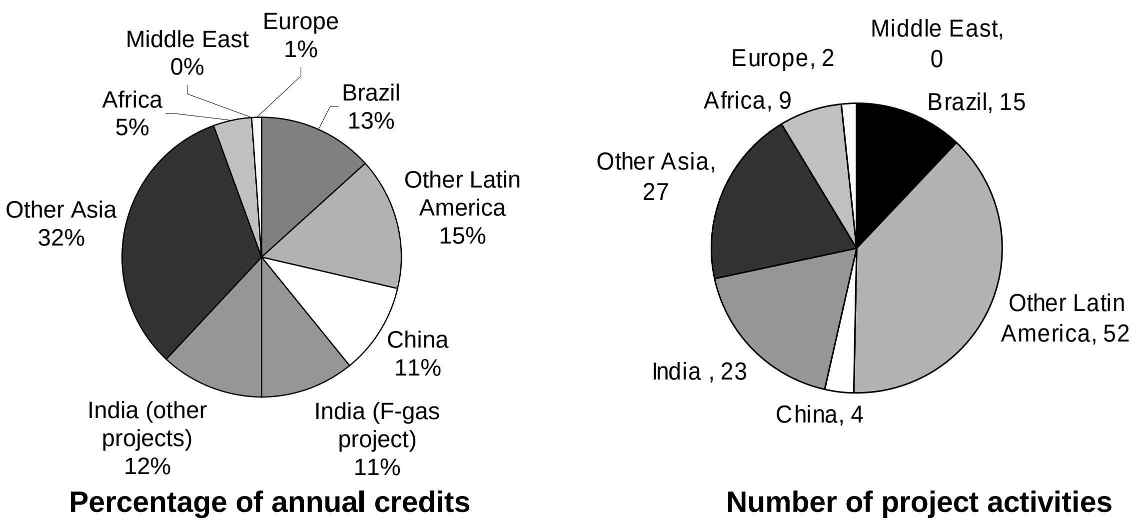
More than 160 projects in 48 countries have been or are being developed as CDM project activities, with an estimated mitigation effect of almost 32 million tons CO_2-eq/year during the first commitment period and at least a further 50 million credits prior to 2008. These activities are mainly emission-reduction projects, are implemented in different sectors and reduce emissions of a variety of GHG (CO_2, CH_4, N_2O and HFCs). Information on only a few potential CDM “sinks” projects is available. No project activities have been proposed to date that reduce emissions of SF_6 or of PFCs. Proposed project activities range from very small-scale projects with low projected emission reductions (< 100 t CO_2-eq/y) to large-scale activities that are estimated to mitigate over 3 mt CO_2-eq/y.

Rapid changes have occurred in the project portfolio during 2003/04 with shifts in the relative importance of different countries and sectors. The project portfolio examined in the figures below (and detailed in Annex 1) includes information, where available, on projects planned, underway or for which a project idea note has been agreed between a project developer and potential CER-buyer. These figures give a general overview of the current project portfolio. However, one or two very large projects can change the picture significantly.

Figure 4 outlines the varying importance of different host countries/regions in the CDM portfolio. Asia dominates in terms of the flow of expected credits (67% of the total) although more than half of the projects identified occur in Latin America. As was the case for projects registered under the pilot phase of Activities Implemented Jointly (AIJ) under the UNFCCC, projects located in Africa represent a small share of the total however it is measured. No project activities to date are located in the Middle East, but two are located in Europe (Moldova).

Examining which countries (rather than regions) CDM project activities occur in further highlights the unequal geographical spread of such activities. Four countries: India, Brazil China and Indonesia, are expected to generate 17.8 million certified emission reductions (CERs) per year during the first commitment period (56% of the total). The remaining 44 countries in which CDM activities have been initiated are together expected to generate 14 million CERs in the same timeframe. While CDM project activities are being planned or implemented in most Latin American countries (16 out of 19), similar activities are present in only 19 (out of 46) Asian countries[12] and 9 (out of 54) African countries. Ten countries (India, Brazil, Indonesia, China, Korea, Vietnam, Costa Rica, Chile, Peru, Thailand) account for more than 80% of expected annual credits.

Figure 4: CDM portfolio to date – importance of different countries and regions



Sources: Project documentation detailed in Annex 1 detailed in Annex 1

The relative mitigation potential of different countries is not reflected in their share of the current project portfolio. Indeed, although China has a mitigation potential estimated at 144 m CERs/y just for energy-sector and gas flaring projects (Jotzo and Michaelowa 2002), Brazil currently accounts for more of the annual CER market even though its non-sink CDM potential has been estimated at <2% of that of China (Jotzo and Michaelowa 2002),. India, however, accounts for 23% of expected annual credits – with almost half of this coming from just one proposed project activity (F-gas decomposition in Gujarat). Although Costa Rica is a small country with a predominantly renewable energy electricity system, it is currently expecting to generate more CERs/y than Malaysia and the Philippines combined.

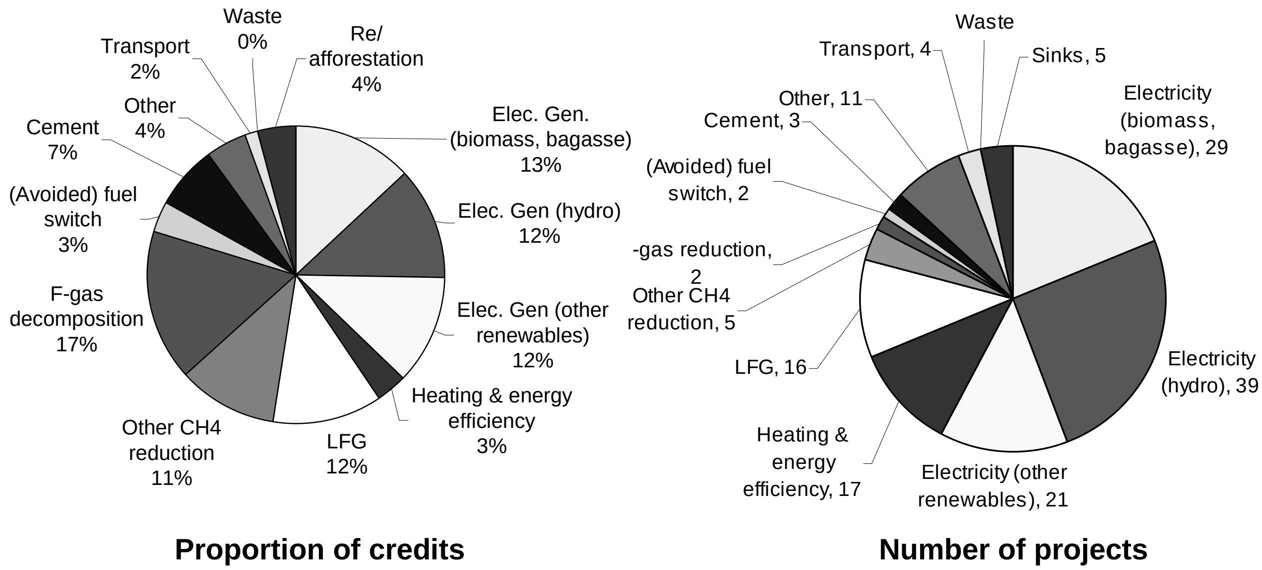
Figure 5 shows the relative importance of different sectors for proposed emission-reduction CDM projects. Examining the number of projects initiated or the number of expected annual credits gives a very different picture. Almost three-quarters of the total number of project activities initiated focus on energy-sector initiatives – particularly electricity generation from renewable energy sources. However, these renewable electricity projects account for 37% of the expected emission credits. Conversely, the two F-gas decomposition projects account for 17% of the estimated annual generation of CERs. This disparity between the number of projects and number of credits generated is caused both by the gases reduced (HFC-23 has a global warming potential (GWP) of 11,700) as well as the size of the project (some energy-sector projects are small-scale).

It is also noteworthy that the relative importance of different sectors has changed rapidly over time. In particular, two very large projects that estimate reduction of HFCs to be more than one and three million

[12] Including Kazakhstan and Uzbekistan.

CERs per year respectively were submitted to the UNFCCC in 2003 and account for 17% of credits expected to be generated during the first commitment period. Several landfill-gas or other methane-capture projects have also been developed relatively recently. These are often also relatively large in terms of estimated emission reductions because of methane's GWP of 21[13], and together account for 23% of the project portfolio. Given the low cost and large potential volume reductions in N_2O emissions from adipic acid production in many developed countries over the 1990s and the high GWP of N_2O, it would not be surprising if N_2O-reduction projects were also to begin to be developed. In contrast, earlier projects, such as those developed by CERUPT as well as many of the early PCF projects, focus on energy sector projects that reduce emissions of CO_2 and CH_4.

Figure 5: CDM portfolio – relative importance of different sectors



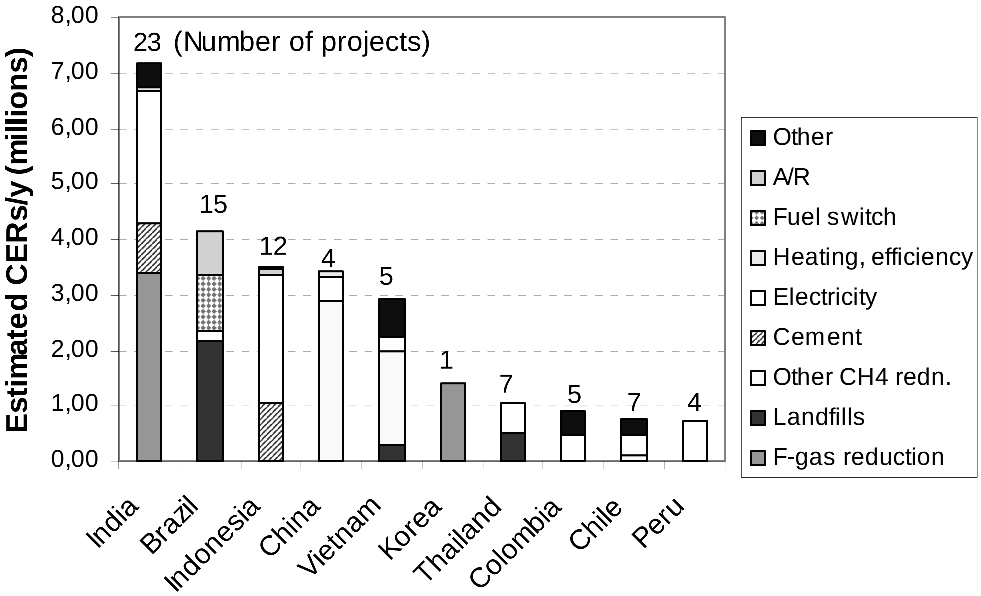
Sources: Project documentation detailed in Annex 1

Clearly, the most popular project type is hydro-electricity, with other electricity generation (biomass and other renewables) making up the next two largest shares. Together, electricity generation makes up about two thirds of the number of projects, but only 38% of total credits / tons. Again, these results are shaped in part by the very large credits from two F-gas decomposition projects and several landfill gas projects.

Figure 6 highlights the variation in project portfolio of different host countries. This figure also highlights the importance that a small number of large projects have on the national (and global) potential CDM project portfolio. The identified project portfolio of South Korea consists of just one project of F-gas decomposition, and the project portfolio of China is also dominated by an individual project: gas recovery from coal mines. Single projects in India (F-gas decomposition) and Indonesia (reduction of GHG from cement manufacture) are also very important in their country's project portfolio.

[13] Although not the most recent estimate of GWP, 21 is the GWP currently assigned to proposed CH_4-reducing CDM project activities.

Figure 6. CDM Portfolios – Top 10 countries



Sources: Project documentation detailed in Annex 1

Several potential CDM project activities to date have been developed as part of a national or international scheme or fund. Eligibility criteria for these different schemes can vary, and can affect the geographical spread, sector and size of projects developed. For example, the Finnish CDM/JI programme has to date focused on small-scale emission-reduction projects. The World Bank's Community Development Carbon Fund (CDCF) also focuses on smaller-scale projects. Many CERUPT projects are energy-sector projects of both small and large-scale – several of which are located in Asia. Many of the earlier PCF projects are located in Latin America, although Asia is now becoming more important. Several feasibility studies for projects initiated by the Japanese government, as well as the PCF's Plantar project, involve A/R project activities. The two F-gas decomposition projects also both have Japanese involvement.

As well as the project activities identified above, several more are in development. These include project activities proposed to e.g. INCaF (the Dutch carbon fund at the IFC), the Netherlands Clean Development Facility at the World Bank, or the Japanese, Swedish or Italian governments. However, information on many of these (and other project activities under development) it is difficult to obtain before they are submitted to the CDM EB. Thus, it is difficult to estimate what proportion of the CDM portfolio under development is "visible".

However, recent documentation suggests that the shift in project sectors, particularly away from renewable energy projects, is set to continue. For example, the project portfolio in Guatemala is shifting from one focused on renewable energy projects to including projects in the forestry and industry sectors (Alvarez 2003). The Asian Development Bank's (ADB) Clean Development Mechanism Facility has a project pipeline that includes methane reduction from coal-beds and sanitary landfills as well as energy-sector (including renewable energy) projects (ADB 2003). Moreover, there is increasing interest in the CDM from project types currently or until recently absent from the project portfolio, e.g. natural-gas fired power plants and F-gas decomposition. These project types – particularly F-gas reduction - have the potential to generate very large amounts of credits, at very low prices.

3.2 Developing CDM-related institutions and legislation

In order to be able to participate in the CDM, and therefore benefit from i.a. enhanced inward investment and/or generation of cost-efficient credits, both national and international institutions are needed. The CDM Executive Board (EB) is the CDM's international supervisory body and was established by the Marrakech Accords in November 2001. It is composed of 10 members and 10 "alternates" from non-Annex I and Annex I Parties. There are also three international advisory panels established by the EB on different issues:

1. Simplified modalities and procedures for small-scale project activities (now disbanded);

2. Guidance on baseline and monitoring methodologies (the "Methodology Panel"); and

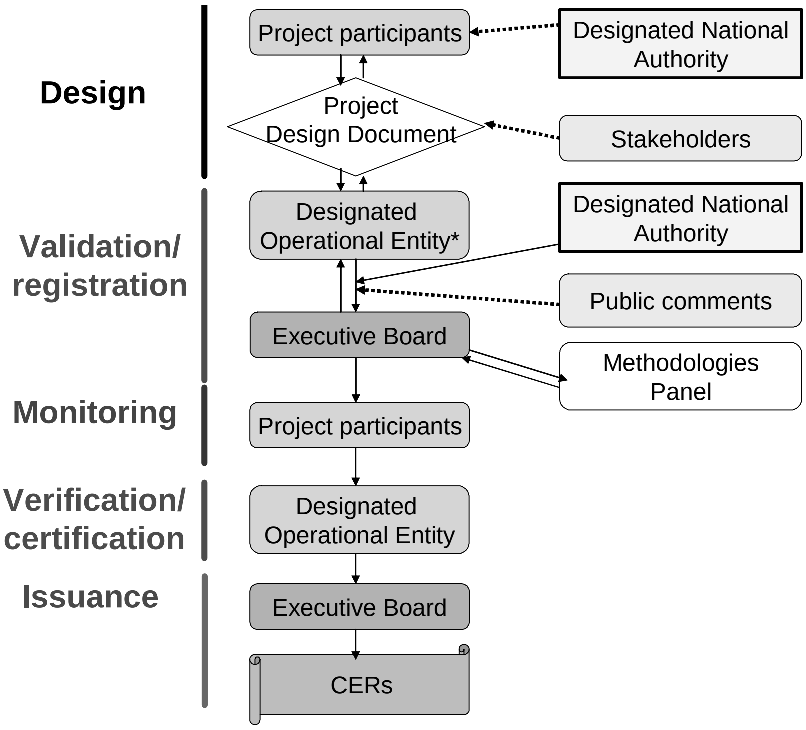
3. Accreditation of operational entities (the "Accreditation Panel").

The Marrakech Accords indicate that "Parties participating in the CDM shall designate a national authority for the CDM". This "Designated National Authority" (DNA) needs to provide written approval of a Party's participation in a particular CDM project activity, and – for host countries – confirm that the project activity assists it in achieving sustainable development. Thus, potential project participants and investors need DNA approval of their proposed project activity before it can generate emissions credits.

This requirement for project approval by the host country government means that some institutional capacity is needed at the national level, even if the CDM project participants are in the private sector. Project investors also need to be sure that host country legislation allows transfer of CERs to them. Thus, as well as the institutional structure needed for CDM project approval, new or amended legislation may also be needed to lay the groundwork for CDM project activity development. For example, work is underway in Bolivia and Ecuador to evaluate legal aspects relating to CERs (Jáuregui 2003, Castro 2003). Changes to current legislation in order to establish a suitable framework for the CDM is also in progress in Vietnam (Phung and Hieu, 2002).

The Marrakech Accords also outline the process of developing and approving a CDM project. This involves several different actors, including the project participants, designated operational entity, the CDM EB and stakeholders. Figure 7 outlines this process for a project activity proposing a new baseline and monitoring methodology.

Figure 6: Outline of the CDM project cycle



Source: adapted from UNFCCC (2003)

3.2.1 Growth in national CDM-related institutions

National-level CDM institutions have grown very rapidly since the establishment of the CDM EB in November 2001.

By May 2004, 57 countries had designated a DNA, as had the European Community (EC)[14]. 48 non-Annex I countries have DNAs, and so do 9 Annex I Parties (including the EC). Almost all of these DNAs are co-located in the national Environment Ministry or Agency. Many DNAs also include representation by (or co-ordination with) other government ministries, and some also include representation or input from other groups, such as NGOs.

Work on establishing the roles and responsibilities of the DNA has started in many more countries, e.g. China and South Africa. However, several countries active as either potential CDM hosts (e.g. Indonesia, the Philippines) or as direct or indirect investors (e.g. Sweden, Finland, Spain) have yet to notify the UNFCCC of their DNA.

DNAs can have several functions as well as that of evaluating and approving proposed CDM projects. Some of these functions are outlined in Table 2. These include CDM information dissemination and capacity building amongst local potential hosts and financiers; technical assessment of proposed projects; outreach to promote CDM investment in the country. DNAs, or the Ministries in which they are located, can also work to set an enabling environment (such as an appropriate legal framework) for CDM within the country.

[14] An up-to-date list of DNAs is available at http://cdm.unfccc.int/DNA .

Table 2: Key functions of selected DNAs

	Provide CDM info. within country	Ensure appropriate legal framework	Capacity Building	Produce technical info (e.g. baseline)	Technical Assessmt. of Projects	Promote country as CDM host	Promote financing of project	Develop/ ensure compliance with national SD/other criteria
Bangladesh				X (LFG)				X (criteria under devt.)
China	X		X	X	(indirectly)		(indirectly)	X
Guatemala	X					X	X	X
Indonesia * (proposed)	X				X	X		X
Mozambique			X		X	X		(Not yet developed)
Nicaragua				X	X		X?	X
Peru	X	X	X				X	

Sources: Guatemala, Alvarez 2003; Indonesia, Bratasida 2003; Mozambique, Saidé 2003, Nicaragua, Stadthagen 2003; Peru, Cigarán 2003, China, Lu 2003; Bangladesh, Reazzudin and Sinha 2003.

Some countries simply designate an existing government official to carry host country approval and rely on consultants (often Annex I) to carry out any technical work. However, other DNAs are more proactive. For example, depending on the institutional set-up within the country, DNAs can also help in formulating the national CDM policy and any criteria used to judge proposed projects, such as particular sustainable development indicators and/or preferred (or non-eligible) project types. Indeed, some DNAs – both potential investors and hosts – have outlined preferred project types or characteristics. For example, China has indicated that priority will be given to energy-sector and CH_4-capture project activities that "shall bring about GHG emission reductions, shall bring additional financial resources [and] shall bring technology transfer" (Lu 2003). India has developed a series of interim criteria on project eligibility, financial indicators and technological feasibility as well as sustainable development indicators that "should be considered" when developing a CDM project activity (MOEF 2002). Costa Rica's DNA was originally set up under the AIJ pilot phase, and had then set up general criteria, including sustainable development criteria, for project approval.

3.2.2 Barriers to developing efficient DNAs

Some countries have experienced difficulties in setting up their DNAs, including constraints in the supply of financial and personnel resources. Since governance structures and responsibilities are different in different countries, effective DNA structures are also likely to vary (see e.g. CAEMA/DFAIT 2003, Jaurégui 2003, Bratasida 2003). This limits the possibilities for countries who have not yet developed a DNA to replicate the structure of one already in place. It takes time to set up an appropriate structure and membership of a DNA. It can also take time to reach agreement within a country on the roles and responsibilities of each body (e.g. ministry) involved.

Although "DNAs" are new, some of their potential functions are similar to that of "National Cleaner Production Centres" (NCPCs). For example, NCPCs functions include raising awareness, capacity building/training and "encouraging new and additional finance … and promoting environmentally-sound technology cooperation" (UNEP 2003). NCPCs have been set up in several Annex I and non-Annex I countries, and suggestions on their structure, membership and functioning are available (UNEP 2003).

Financial issues can hinder both the creation and continued operation of a DNA. This has been noted by several countries, e.g. Nicaragua (Stadthagen 2003), Cambodia[15], as well as in several offices in Latin America (Morena et al. 2004). Financial barriers to establishing a DNA have been overcome in some countries with the input of international resources, e.g. from the Dutch government via UNEP's "Capacity Development for the CDM" programme,[16] from Japan (Fukushima 2003) and from the German International Cooperation Agency. Funding from external sources may also be needed to maintaining already-established DNAs, e.g. the World Bank and Latin American Carbon Program help fund activities of the Columbian DNA (CAEMA/DFAIT 2003).

Expanding a DNA's activities to include identifying potential CDM projects and making this information available to potential investors could help increase the financial viability of a DNA. However, it could also cause a conflict of interest if the same organisation is both identifying projects and providing host-country approval of these projects. This is because the interest of an investment promotion agency may be to maximize total investment, while the interest of a DNA should include checking the contribution to sustainable development. The conflict is that one would seek to maximise the number of CDM-generated credits, while the other would only approve those CDM projects that really meet domestic criteria.

Established project approval criteria and processes are also needed so that DNAs are set up in such a way as to avoid further delays in evaluating and approving a proposed project activity. The international process for approving proposed CDM project activities is already a lengthy process, particularly if a proposed project activity uses a new baseline or monitoring method. Existing national approval procedures can also be lengthy. For example, this step takes an average of 55 days in Bolivia (CAEMA/DFAIT 2003), up to 30 working days to evaluate an expression of interest in Austria (AFEW 2003b) and up to four weeks in Denmark (DEA 2002).

3.2.3 Growth in other CDM-relevant institutions

Institutions other than those needed to approve potential CDM projects at a national and international level have also grown over the last few years. These include "carbon funds" set up to procure emission credits. Such funds are often located and run within international banks, such as the World Bank, International Finance Corporation, Asian Development Bank, but also by national banks (e.g. Japan Bank for International Cooperation) and private-sector companies.

Capacity to validate and verify CDM projects has also grown, with 20 companies applying to become a "designated operational entity" (DOE). However, 18 of these, including the first two to become DOEs, are located in Annex I countries with the remaining two located in Korea and Malaysia. Further development of DOEs, particularly in Latin America, would help to reduce verification costs, which increase with increasing distance between verifier and projects.

Some potential CDM investors and/or the funds in which they invest carry out similar functions to some host-country DNAs. For example, they provide technical assessment of projects, can provide technical information related to a particular project, and may also indicate sustainable development indicators or outline a list of favoured project types or locations. For example, the developing KfW fund indicates that it will not purchase credits from large hydro or sink projects (Zander 2003). The Austrian JI/CDM

[15] See http://www.camclimate.org.kh/camkyoprotocol/cdm.htm.

[16] See http://www.cd4cdm.org/ for up-to-date information.

programme outlines a list of preferred project types (AFEW 2003). The CDCF focuses on projects with a clear community benefit. The Italian Carbon Fund focuses on China, the Mediterranean region, Middle East and the Balkans (Pinna 2003).

3.3 Defining guidelines for CDM project development

The decisions governing CDM project activities agreed at COP7 (for emission reduction projects) and COP9 (for afforestation/reforestation projects) outline the general framework of the CDM, including its governance, and eligibility/participation requirements. These eligibility requirements allow for a large range of different CDM project activities. Indeed, as illustrated by the types of project activity submitted to the CDM EB, the CDM project portfolio already covers a wide variety of different project types and sizes.

The agreements on the CDM at COP7 and COP9 also include very general guidance on how to determine "additionality" and establish a baseline for a project activity. Additionality is important as only "additional" CDM projects can get credits. The determination of whether or not a project activity is additional is the role of the EB, based on information from a project activity's designated operational entity. Neither the Parties involved in a CDM project activity nor the project participants take this decision. General guidance on determining a project's additionality has been established in the Marrakech Accords. The CDM EB has given further guidance on assessing additionality (UNFCCC 2003d and e). However, assessing additionality in practice has proved both difficult and contentious, with different stakeholders coming to opposite conclusions about the additionality of particular projects (e.g. CDMWatch 2003). This approval process could also be difficult for the Parties involved, as it could result in a "loss of face" if they approve a project only to have it subsequently, and publicly, rejected by the CDM EB.

The decisions at COP7 and COP9 also outline that the emission benefits of a CDM project are assessed by comparing emissions (or sequestration) from a project with those of its baseline. A baseline is defined as "*the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity*." The Marrakech Accords outlines three general "approaches" that can be used to develop "baseline methodologies"[17].

Different project types need to take different aspects into account when establishing a baseline. For example, the current and expected GHG-intensity of electricity generation is a key factor for electricity-generating projects, the number of hours/year equipment is used is key to determining the emission benefits of an energy-efficiency projects. For landfill projects, the current practice of landfill gas capture at a particular site is important in determining baseline emissions. Different project contexts, including national circumstances of host countries, will also influence the baseline.

At one stage the development of detailed top-down guidance on baselines was envisaged, referred to before COP6 as the CDM "reference manual" (UNFCCC 2000). However, developing such technical guidance during negotiations would have been challenging. Thus, in the end, it was decided that guidance on baselines, additionality and monitoring for most CDM projects should be approved by the CDM EB following a bottom-up "case law" approach. The exceptions are the pre-approved methods for small-scale projects, adopted at COP8 for emission-reduction projects and to be developed for small-scale re/afforestation projects.

[17] These approaches are "a) existing actual or historical emissions… b) emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment, or c) the average emissions of similar project activities undertaken in the previous five years, in similar… circumstances and whose performance is among the top 20 per cent of their category".

To date, detailed, approved, guidance for selected CDM project activities is available for the following project activities:

- 13[18] types of small-scale emission reduction CDM (SSC) project activities, including for grid and off-grid renewable electricity projects, energy efficiency projects, thermal energy use, supply-side energy efficiency improvements, methane recovery (UNFCCC 2003c)

- 11 types of larger-scale emission reduction CDM project activities that generate emission reductions from renewable electricity generation, fuel-switch projects, landfill gas capture, fuel switching and F-gas decomposition. A further three methodologies (on fuel switching, steam system efficiency improvements and methane capture from swine manure treatment) have been recommended for EB approval by the Methodology Panel.

Together, the SSC methods approved at COP8 and the EB-approved methods during 2003/2004 cover almost a third of the estimated emission reductions from currently-planned CDM projects.

However, developing a methodology that is approved by the EB can take a significant amount of time and money. Indeed, the minimum length of time to approve a new methodology has been 3 months (UNFCCC 2003f). This delay is partly because bodies involved in its approval (i.e. the EB and the Methodology Panel) only meet sporadically. However, many proposed methodologies have been incomplete (e.g. lacking procedures to assess whether or not a proposed project is the baseline scenario) or need other revisions. Requiring revisions of the methodology by the project participant and re-submission to the MP/EB further delays the process, for example, the first "new methodology" proposed (for the Vale de Rosário bagasse co-generation project in Brazil) was approved two revisions and almost 8 months after its initial submission. The number and timing of deadlines for new methodology reviews, EB and Methodology Panel meetings has also meant that not all new baseline and monitoring methods submitted (e.g. that for the Zafarana wind project) have been reviewed by the EB within the four month timeline stipulated by the Marrakech Accords.

3.4 Financing GHG-mitigation projects

There are costs and risks associated with developing any type of project. However, certain costs and risks are peculiar to CDM project development, such as establishing emission baselines and approval by a DNA and the CDM EB. The transaction costs associated with developing CDM projects often occur up-front and can be significant.

CDM projects also offer a unique set of benefits. One of the main benefits of developing a project as a CDM project is that it could generate a stream of emission credits, and therefore revenue, for up to 21 years for emission-reduction projects and up to 60 years (for re/afforestation projects). This revenue stream provides an added economic incentive to undertake projects that contribute both to mitigating GHG emissions and to sustainable development. However, this incentive is not as high as originally anticipated, as the expected price for GHG credits in the first commitment period is likely to be low (e.g. almost 10 EUR/t CO_2-eq (Buen et al 2003) or \$11.4/t CO_2-eq (Haites 2004 forthcoming). For many CDM projects under development with an agreed emission reduction purchase agreement the price is even lower, ranging from EUR 2.47 to EUR 5.5 /ton CO_2eq., e.g. from the PCF, CERUPT and the Finnish Government small-scale project tender. CER prices vary according to project characteristics and risk distribution between CER-buyers and sellers. For CDM projects that do not yet have an agreed emission reduction purchase

[18] In addition to the 12 project types detailed in UNFCCC 2003c, the 10th meeting of the Methodology Panel recommended EB approval of a methodology for methane avoidance projects.

agreement, the value of expected benefits is uncertain. Of course, a low expected price, or uncertainty in the value of the credit stream asset, provides a smaller incentive than a higher expected price.

The financial profile of different types of CDM projects varies widely. This is in part linked to the project size and sector, and whether the project is "greenfield" (new) or "brownfield" (retrofit). Some common CDM project types, such as renewable electricity generation, typically have high capital costs – indeed, higher capital costs (but lower operating costs) than alternative fossil-fuelled technologies. They may also be perceived as risky investments if they rely on an intermittent energy source. So although in many countries such technologies are implemented in small numbers under business-as-usual, they are far from mainstream investments. These technologies may thus not necessarily be well known or understood by potential financiers. Such projects may therefore have difficulty in attracting sufficient investment capital whether or not they are developed as CDM projects. Wariness of financiers may be even more pronounced if the financial attractiveness of such projects is dependent on a potential revenue stream of GHG-credits.

Nevertheless potential CDM projects such as renewable electricity systems do generate a product (in this case, renewable electricity) as well as a potential revenue stream. In contrast, some of the larger and more recent CDM projects being developed have completely different characteristics in that the CDM-related investment of a project produces no new output except (potentially) CERs. Examples of this type of project would be retrofitting HFC decomposition equipment to an already-functioning HFC plant, or capturing and flaring (not using) methane from landfills.

The Kyoto Protocol allows for participation in the CDM by private entities, as well as by Parties. Several Annex I governments and companies, and some banks, have set up or contributed towards funds that aim to buy GHG-credits from CDM projects. Some Annex I governments have initiated tenders for CDM (and/or JI) projects. These funds often pay for emission credits from a project rather than the project itself, although some also allow for some up-front payment. One new scheme expects to provide equity for CDM projects.This section outlines the funding opportunities and barriers peculiar to CDM project development.

3.4.1 Funding available for CDM (or CDM/JI) activities

Expected demand for significant quantities of CERs to meet Parties' emission commitments under the Kyoto Protocol has spurred funding in CDM-type projects directly and indirectly, e.g. via carbon funds or tenders. Indeed, several public and private funds aiming to buy emission credits from CDM (and/or JI) projects have been set up in potential investor countries over the last few years (see Table 3).

Together, these funds add up to more than $800m, to be invested in projects that both reduce GHG emissions and contribute to sustainable development. Although the majority of the funding sources above comes from publicly-funded sources, private-sector sources of finance are also involved, e.g. as for private-sector "carbon funds", such as the Spanish Carbon Fund. Sources of venture capital also exist – for example, Econergy are active in the CDM market, and have identified a large portfolio of potential CDM project activities in Latin America (Moscarella 2003), however, information on the importance of this source of financing is sketchy. The vast majority of the carbon funds focus on only the emission-reduction (or sink enhancement) component of the proposed project, and thus account for only a small component of total project costs. Thus, total investment in GHG-friendly projects will be much higher (see e.g. Sinha 2004). Moreover, if proposed CDM projects submitted to the CDM EB are representative, a significant amount of this investment will be from the private sector.

Table 3: Selected CER/ERU procurement initiatives

Scheme	Coverage	Involvement	Amount
Austria	JI/CDM	Austrian government	EUR 72 m (2003-2006)
BioCarbon Fund	CDM/JI	Interest from governments (e.g. Canada) and companies.	\$30-\$50m
CDCF	CDM	4 governments (Austria, Canada, Italy, Netherlands) and 7 companies (Japanese, German, Spanish, Swiss)	\$40-70m
CERUPT	CDM	Dutch government	EUR 32.5 m
Denmark	JI/CDM	Danish government	EUR 120 m to 2007
Finland	CDM/JI	Finnish government	EUR 10m
Germany	JI/CDM	KfW (Federal government and states)	EUR 25m (to EUR 50m)
INCaF	CDM	Dutch government	EUR 44 m
Italian Carbon Fund	JI/CDM	Italian government (also open to contributions from Italian companies)	\$20m (target \$80m)
Japan carbon fund	CDM/JI	JBIC (Japan Bank for International Cooperation) and DBJ (Development Bank of Japan)	EUR 31.3m + EUR 23.5m
NCDF	CDM	Dutch government	\$120-160m (32 mt CO_2-eq.)
PCF	JI/CDM	6 governments (Canada, Finland, Netherlands, Norway, Sweden, Japan Bank for International Cooperation) and 17 companies	\$180m
Sweden (SICLIP)	JI/CDM	Swedish government	EUR 15m

Sources: Pointcarbon November 2003, World Bank (undated) and Pinna 2003, Halich 2003, Sinha 2004, Mulders 2004, Bostrom 2004

CDM projects generate a stream of credits once the project is approved and implemented. Several funding schemes (e.g. INCaF, CERUPT, KfW) plan to purchase these credits only once they have been verified (or issued). This protects the buyer from some (but not all) of the risks associated specifically with developing a CDM project, including Parties' non-approval of the project or non-ratification of the Kyoto Protocol as well as risks associated with the CDM-component of project design such as baselines and additionality[19]. Thus, for "carbon fund" type financing, there may be a considerable delay (several years) between project investors incurring CDM-related capital expenditures and receiving the CDM-related benefits.

[19] Of course, CDM projects are also subject to "normal" project risks, including political/country risks, natural disasters, risk of non-construction/completion of project, financial or legal risks, operational risks.

Obtaining an emissions reduction purchase agreement for a proposed CDM project does not in itself reduce the need for capital investment in the project. However, agreeing a forward emissions purchase contract, e.g. an ERPA from a carbon fund, can facilitate a project developer in obtaining the financing required. This is because a project incorporating CER revenue will have a higher internal rate of return (IRR) than a similar project not developed as a CDM activity. For example, the WB indicate that at \$3/t CO_2, credit revenues could increase the IRR of hydro projects by 0.8-2.6%, wind projects by 1-1.3%, bagasse projects by 0.4-3.6% and biomass power projects that also reduce methane emissions by 2-7% (Heister 2002). Even in countries with coal-intensive electricity baselines such as India and South Africa, the IRR of wind projects are only expected to be boosted 1.5% (at \$5/t CO_2) and 2-3% (at \$20/t CO_2) respectively (Bhandari 2002, Spalding-Fecher et al. 2001). This CER revenue will also be in the form of "hard currency". Moreover, financiers may be more willing to lend money to e.g. a proposed CDM project if one of the project participants is the World Bank or other carbon fund manager.[20]

Obtaining up-front funding from a potential buyer of CERs reduces the requirement for capital investment from other sources, and can therefore facilitate financial closure of a proposed project. However, obtaining up-front investment from CER-buyers is rare, as these focus more on guaranteeing a revenue stream for project-generated credits rather than (co-)financing the project itself. Nevertheless, limited up-front funding may be available in some programmes for selected projects. For example, the Austrian JI/CDM programme allows for payment of up to 30% of the CER contract value (AFEW 2003b) and subsidies of a third of the additional costs of emission-reducing equipment are available from the Japanese government in return for a third of the CDM credits (MoE 2003). The recently-established Climate Investment Partnership also plans to provide both equity and debt for CER-generating projects (Joshua 2003).

3.4.2 CDM-related transaction costs

Transaction costs related to CDM projects occur at the national level, e.g. to establish and maintain a DNA, and at the project level. For proposed CDM projects, CDM-related transaction costs occur both before and during a project's implementation. Estimates for the different transaction costs incurred prior to project implementation are shown for "regular" projects (i.e. projects that do not qualify for the simplified modalities and procedures for small-scale CDM projects) in Table 4, below.

These transaction costs of up to almost 270,000 USD constitute a big barrier to developing CDM projects – particularly for potential projects that are already capital-intensive and/or that have difficulty in raising project finance, and that are not developed as part of a carbon fund. The important transaction cost barrier has been widely noted by project developers/DNAs (e.g. Hatano 2002, Stadthagen 2003, Maulidia 2003) even though some support for project design, development of PDD etc. is available from potential investor Parties, e.g. Canada, Denmark[21] and Japan.

Even the lowest estimate of transaction costs means that a project will need to generate approximately 10,000 CERs over its crediting lifetime just in order to break even. Despite the establishment of pre-approved baseline methodologies and other simplifications for small-scale CDM emission reduction projects, the transaction costs for these projects are also projected to be significant. These have been estimated at 23-78,000 USD (de Gouvello and Coto, 2003) or 110,000 USD (World Bank 2003).

[20] There are also cases where different parts of one lending organisation fund different aspects of the same project. For example, a proposed bagasse co-generation CDM project has obtained debt financing from the International Finance Corporation (IFC) as well as an ERPA from the IFC's Netherlands Carbon Facility (Halich 2003).

[21] Examples of Danish support available to project development in Thailand are available at http://www.denmark-embassy.or.th/danida/levelofsupport.htm

Table 4: Estimates of pre-implementation transaction costs for CDM projects

	WB "regular" projects" [1] (000$)	HWWA[2] (000$)	Danish Energy Authority[3] (000 EUR)
Project search, preparation, feasibility study	40	19-29	20-50
Negotiating ERPA	50	10.5	--
Developing baseline, monitoring plan, PDD	40	6.5-120	(not estimated)
Consultation and Project appraisal	105	--	5-40
Validation	30	6-80	5-25
Registration	--	5-30	(not estimated)
Total	265	47-269.5	30-115

Sources: [1] World Bank 2003, [2] Krey 2003, [3] DEA 2002

3.5 Sustainable development aspects of CDM projects

The host country government has the prerogative to decide whether or not a proposed CDM project activity helps it in achieving sustainable development. Some potential CDM host countries have established sustainable development criteria to be used to assess CDM projects. Unsurprisingly, these vary – as do host countries' national circumstances and development priorities.

This variation in host country criteria for approving proposed CDM projects has therefore led to differences in the sustainable development aspects of CDM projects underway or in development. Some project types, such as renewable electricity generation, can have clear positive effects on local environmental pollution, economic development and employment – while also reducing emissions of GHG. Several different project types in other sectors can also have significant sustainable development benefits. For example, CH_4 capture can reduce the smell and risks of explosions near landfill sites. Increased use of waste fuels as a fuel in cement factories can lead to reduced landfills/incineration of waste (as well as reduced use of fossil fuels). Advanced manure management systems can lead to increased employment and reduced risk of groundwater contamination. Energy-efficiency systems can also reduce water pressures (e.g. by reducing leaks of steam).

Nevertheless, a large and rapidly growing portion of the CDM project portfolio has few direct environmental, economic or social effects other than GHG mitigation, and produces few outputs other than emissions credits. These project types generally involve an incremental investment to an already-existing system in order to reduce emissions of a waste stream of GHG (e.g. F-gases or CH_4) without increasing other outputs of the system.

3.6 Lessons learned from the CDM

Although there are as yet no officially-approved CDM projects, there is enough experience with developing CDM projects, institutions and markets to be able to draw some lessons that could be useful for the future – either of the CDM or of a different project-based mechanism under a different climate regime.

There is wide coverage of proposed CDM project activities, highlighting that the potential for cost-effective GHG mitigation activities is widespread – both in terms of gases and sectors targeted, and countries in which proposed activities occur. However, the majority of CDM investment is focused on just a few countries, and on three project types: renewable electricity generation (particularly from bagasse and biomass), decomposition of HFCs and reduction of CH_4 emissions from landfills or coalmines.

Significant flows of money have been directed towards CDM-related projects, programmes and funds. This review identifies at least $800m which will be dedicated to CDM projects in the coming years. However, this generally accounts for a small proportion of expenditure on a project and is estimated to leverage 6-8 times more investment in GHG-friendly equipment and systems, i.e. up to $6-8 billion over the Kyoto commitment period. Moreover, this level of investment is not enough to tap the full potential of CDM activities. For example, in order to meet electricity demand growth, more than $500 billion needs to be invested in electricity generating capacity alone in developing countries over 2001-2010 (IEA 2003).

The majority of CDM investments and projects known today are planned in countries that already attract large amounts of foreign direct investment (FDI). As a motor for technology transfer and change and an indicator of the location's desirability for foreign investors, the conditions for a strong presence of FDI may be similar to conditions that will support CDM investments as well as effective national CDM institutions. Also as CDM may add to or influence FDI flows towards climate-friendly technology transfer, which could lead to lasting benefits.

Much of the CDM-related funding to date has been from public funds (i.e. Annex I governments), although companies are also contributing to centralised carbon funds. Moreover, both companies from Annex I and non-Annex I countries are investing in potential CDM projects. Companies' involvement can be expected to increase once Annex I companies in EU countries have received their credit allocation under the EU emissions trading scheme, and therefore have a clearer idea of their own emissions commitments and gap. Increased private participation may also occur once more top-down guidance (e.g. on baselines and additionality) has been agreed, as this reduces the transaction costs, risks and delays associated with CDM project development.

The effect of the CDM during the first commitment period is likely to be small compared either to the "gap" between expected Annex I Parties' GHG emissions (with current climate policies) and their commitments under the Kyoto Protocol or to the technical and economic potential of the CDM to mitigate GHG emissions. However, CDM project activities can potentially stimulate lasting technology transfer and thus long-term climate change benefits.

Prices for CERs are relatively low, but vary according to project characteristics and risks. Available ERPAs indicate a price range of EUR 2.5 – 6 per CER for different project types, with a premium being paid for renewable energy projects and/or projects with obvious community or sustainable development aspects. However, even prices at the higher end of the range provide only limited economic incentives to capital-intensive project types. Thus, at present there is no single "CER" price, but a range. Moreover, prices for credits where the project registration risk is borne by the buyer tend to be lower (averaging $3.51/t CO_2-eq. in 2003) than where this risk is borne by the seller, where prices averaged $4.88/t CO_2-eq. in 2003 (Lecocq and Capoor 2003). Prices for the (temporary) credits from sink enhancement projects are likely to be lower than those for the (permanent) emission-reduction projects.

Lack of detailed up-front rules governing the CDM's functioning has led to significant delays, and a "case law" approach to establishing guidance, e.g. for baseline methods (see also Ellis 2003). These delays have reduced the likelihood of significant GHG mitigation between 2008-2012 from potential projects with long lead-times, such as new electricity generating plants and afforestation activities. This is exacerbated by uncertainties over the post-2012 climate regime, as the value of credits generated post 2012 are highly uncertain.

CDM-related transaction costs can be high, and are also a significant barrier. These costs are incurred both at a Party level (e.g. for establishing a DNA) and at the project level, as outlined above. Moreover, the majority of project-related transaction costs occur before the proposed project generates emissions credits. Thus, the transaction cost barrier is highest for the development of new, capital-intensive project activities.

Uncertainties as to whether a proposed project will ultimately generate credits can also be high. These uncertainties are at both a national and international level. At the national level, it is the host country DNA that decides whether or not it will approve a proposed project. Such national approval is dependent on the host country's CDM policy/criteria in general (which may not be available to potential project proponents) as well as its stance on a particular proposed CDM project activity. At the international level, it is the DOE and the CDM EB that have the mandate to make the final decision on a project's "additionality" - rather than the project proponents or the Parties involved in a proposed CDM project. While there are advantages with this process, it also highlights the non-negligible risk that the proposed revenue flow generated by a project's credits will not materialise. This puts the project developers in a difficult situation. Depending on how project developers choose to demonstrate a project's additionality, they may need to show to the validator and the EB that the flow of credits are enough to influence a decision whether or not to go ahead with the project, but to financiers that the CER-associated revenue flow is not important enough to make or break the project's economic viability.

Even for projects that are approved as "additional", ***the number of credits that a proposed project will generate is uncertain***. For example, the project's validator, verifier or the CDM EB, may alter the baseline initially used by the project participants, financiers and involved Parties, to calculate a project's expected emission reductions. Indeed, requests by the EB to modify suggested first-of-a-kind methodologies are relatively common, and can result in substantial changes to a project's baseline (and therefore it's expected credit generation).

The value of credits generated by a proposed project is also uncertain. There is a wide range of estimates for likely credit prices during the first commitment period (IETA/ADB 2003). Moreover, credit prices may fluctuate considerably during this time. This makes investing in CERs as a speculative commodity a risky business – although one that is being considered by some (Lauverjat, 2003). Moreover, fluctuations in the market value(s) of CERs will only affect the revenue stream from a project if they are traded on the CER market. If, alternatively, the potential buyer and seller of CERs have entered into an ERPA, the project developer has been shielded from the negative effects of lower-than-expected prices. For CERs that are to be retired, fluctuations in their theoretical value is less important.

The sustainable development aspects of different project types vary widely. Some degree of variation is expected, and reflects different host country development and CDM priorities when approving projects. In particular, small-scale renewable energy and energy efficiency projects account for a shrinking proportion of the CDM project portfolio, whereas large-scale end-of-pipe projects e.g. in industry (that offer much cheaper emission reductions but less obvious non-GHG benefits) are growing rapidly. The current incentive structure for CDM only values the emission-reduction component of a proposed CDM project and international governance of the CDM, i.e. the CDM Executive Board and its panels also focus on assessing the GHG-component of proposed CDM projects. In contrast, the current structure of the CDM governance leaves assessment of the sustainable development benefits of a project as an issue of national sovereignty.

Capacity and institutional issues are significant barriers to a more widespread use of the CDM. Some of these barriers, such as lack of capacity to identify and assess potential projects in host countries and lack of awareness of the CDM and its benefits amongst potential financiers, could be lowered in the current climate regime – with appropriate resource input. However, the institutional set-up and oversight of the CDM can be cumbersome and lengthy at a national and international level. The priority allocated to developing CDM projects and institutions within a potential host country can greatly facilitate CDM investments within a country – as illustrated by the relative importance in the project portfolio of smaller but proactive countries such as Costa Rica.

Current institutional capacity between potential CDM host countries is uneven, and is likely to remain so. While developing countries that expect many projects may have already built up a dedicated institution, many African countries, for example, cannot risk large investments in institutional infrastructure. On the other hand, fairly significant capacity has been built particularly amongst those developing countries that most need to take some form of action beyond 2012 due to high absolute emissions or high emissions intensity, e.g. China, India, Brazil, South Africa, South Korea, Indonesia and Mexico, suggesting that it may be useful to build on this experience in shaping future mitigation commitments.

4. CONCLUSIONS

Cuts in emissions of greenhouse gases are needed in order to stabilise their atmospheric concentrations and to limit the pace and magnitude of climate change. Achieving emission reductions agreed by Annex I Parties under the Kyoto Protocol is only a small first step in this direction, and in the longer-term mitigation efforts will be needed from all major emitting countries. The CDM was established under the Kyoto Protocol with the dual purposes of helping non-Annex I Parties to achieve sustainable development and Annex I Parties to reach their emission commitments. While individual CDM project activities displace (rather than reduce) GHG emissions, experience with implementing GHG-friendly project activities can help technology transfer and moves to a more GHG-friendly development pathway in the longer term. Achieving transfer of climate-friendly technology is essential if mitigation is to be extended successfully across the world in the coming decades.

The success of the CDM will depend in part upon the amount of investment it is able to stimulate in GHG mitigation activities and on the other types of long-term benefits that such activities are able to deliver. To date, more than $800m has been allocated to carbon funds or CDM (or CDM/JI) programmes. These funds, mainly public, focus on providing a revenue stream for emission credits from a project, rather than providing up-front project finance. This $800m is a conservative figure as, in addition to participation in C-funds or CDM projects from Annex I industries, private sources of funding for CDM project activities are also likely to be available. Taking these other sources of CDM investment into account, CDM financing over the Kyoto period is likely to at least $1 billion.

This flow of known CDM investment to date is small relative to other flows of foreign investment from developed countries to developing countries. For example, foreign direct investment from the private sector or official development assistance from the public sector equalled about $50 b and $60 b respectively in 2002. However, CDM funds may have the potential to leverage six to eight times their amount – or about 6-8 billion USD - of investment capital towards GHG mitigation activities. This compares favourably with the $1.4b GEF investment in climate change activities from 1991 to 2002, and thus the CDM is significant with respect to investment available for climate-friendly technology. Although flows of investment in CDM are only a small fraction of FDI and ODA flows in any particular year, it may stimulate or add to the ongoing FDI flows in a country. The CDM may thus be uniquely well placed to stimulate transfer of low- or no-GHG emitting technologies driven by the private sector.

Although as yet there are no officially-registered CDM project activities, there have been several achievements of the CDM to date. These include increased implementation of climate-friendly projects, awareness and experience of climate change mitigation measures in developing countries, and increased institutional capacity to assess and develop climate mitigation projects.

More than 160 CDM project activities are currently underway or planned in 48 countries and several different sectors. These project activities anticipate reducing greenhouse gas emissions by almost 32 mt CO_2-eq/year (or more than Ireland's CO_2 emissions in 1990) during the Kyoto Protocol's first commitment period.

The spread of project activities and host countries is relatively wide. However, proposed CDM project activities are concentrated in a few countries, e.g. India, Brazil, China, and Indonesia. The countries expecting to generate the most credits from proposed CDM projects to date are also often countries that are recipients of a significant proportion of total flows of FDI. Many of the poorest nations that are unable to attract flows of FDI do also not appear to be attracting significant interest in investment in CDM projects.

CDM project activities proposed to date include project activities that reduce emissions of CO_2, CH_4, N_2O and HFCs. These activities are concentrated in three sectors: renewable electricity generation, reduction of methane emissions and F-gas decomposition. Sinks projects and proposed projects in the transport sector account for only a small proportion of proposed CDM project activities. The ancillary benefits of these different project types vary significantly. Table 5 summarises some of the different characteristics of different project types as well as their reduction potential. It is notable that project types currently accounting for the largest proportion of the CDM project portfolio are not necessarily those that have the largest emission reduction potential or that generate the cheapest emission reductions. This is partly due to the initial preference for CO_2-reducing project activities such as renewable electricity systems by some of the larger "early movers" in the CDM market.

This preference is now changing, and more recent buyers in the carbon market appear to prefer investments in lower-cost GHG reductions rather than more capital-intensive energy technology options with long lead-times. This development may be a sign that the market for GHG reductions is beginning to function as a true market. It may also be partly due to lower uncertainties in assessing baselines and additionality for end-of-pipe project types rather than for new energy technology types of projects. End-of-pipe options, such as methane gas capture or F-gas decomposition, are usually "brownfield" sites, and project developers can reasonably show that in the absence of requirements to the contrary, there is no incentive to make an investment to reduce emissions from current levels. The fact that these projects occur on "brownfield" sites, and therefore presumably have been operating for several years, may also help in financing such projects, as the potential project participants have already demonstrated their financial validity.

The potential of low-cost options to generate large amounts of CERs is significant. For example, the potential for F-gas reduction has been estimated at almost 90m CERs/y in China alone (Lu 2004). The potential for CH_4 reduction from landfills is also significant, and reduction of N_2O from adipic acid production could also be very cost-effective. If these project types were widely used, they could dominate the market for CERs and significantly lower the market price. This would increase the barriers for potential CDM project such as renewable energy and energy-efficiency systems, which often deliver higher-cost emission reductions but also have a higher long-term value in terms of project replicability, reduction of local pollution, technology transfer benefits and other sustainable development benefits.

The likely importance of CDM during the first commitment period depends on many factors, including the level of effort embodied in the emission commitments, the effects of domestic emission-reduction and sink-enhancement policies and measures in Annex I countries, as well as the potential to use emissions trading and joint implementation. Thus, the CDM is one of a basket of GHG-mitigation measures, and was not initiated with the aim that it should be the main focus of global mitigation efforts. However, the availability of climate-friendly technologies and the large projected growth in demand for goods and energy, including in non-Annex I countries, means that the potential to limit growth in GHG emissions is huge (Table 5).

Table 5: Summary characteristics of potentially widespread CDM project types

	Renewable electricity	Reduced CH4 from landfills, coal-beds, oil & gas	F-gas reduction	Cement	Energy efficiency	Reduced N_2O from adipic acid production	Sinks
Gases reduced	Mainly CO_2	CH4	HFC-23	Mainly CO_2	Mainly CO_2	N_2O	CO_2
Scale of per-project reductions	L-M (sig. Variations)	M-H (also varies)	Very High	H	L	n/a (likely H)	L-H
Importance in current CDM portfolio	37%, decreasing	23%, increasing rapidly	17%, increasing rapidly	7%, increasing	3%, decreasing	n/a	4%, de-creasing
Potential reductions (mt in 2010 at $5/t CO2)*	20.4	229.1	18.6	1.4	219.1	3.9	7.8
Potential reductions (mt in 2010 at $10/t CO2)*	24.4	272.1	20.5	1.6	286.5	3.9	28.9
Technology transfer potential	H	M-L	L	M	M-H	L	n/a
Cost of CERs	L-H	L-M	Very Low	L-H (depending on where in production chain)	L-M (depending on sector)	Very Low	L-M
Difficulties in assessing additionality and baseline	H	L	L	L-H	M	L	H
Greenfield or brownfield (G/B)?	G/B	B	B	B	B	B	(G)
Potential for geographical balance	H	M-H	L	H	H	M	H

Sources: Project documentation detailed in Annex 1, author assessment, Cogen et al 2003, 3E project, * from Trexler 2004

While a positive start, CDM activity will have to increase within the next few years in order for CDM credits to grow to the estimated size of the CDM market during the first commitment period, i.e. between 50- to 500 mt CO_2-eq per year (Grubb 2003). The institutional groundwork has already been laid in several countries, as evidenced by the rapid growth in numbers of designated national authorities (of which there were 57 by May 2004). Moreover, large expansions in CDM-related emission reductions are planned: some of the carbon funds or CDM/JI programmes have only recently been initiated and have not yet resulted in project development. Table 5 also highlights that significant further levels of emission reductions are both possible and feasible, particularly in energy efficiency and methane reduction projects. The question is how can this potential best be tapped during the first commitment period and afterwards, particularly when current prices of GHG credits from CDM projects are relatively low. These are often between $3-6/CER, with some developers paying premiums for particularly SD-friendly or low-risk projects. This price level may not provide enough of a pull to invest in project types that have long lead-times and are capital-intensive, and/or provide uncertain levels of credits.

Increased CDM activity could be facilitated by certain changes in the national and international processes for developing, approving and validating CDM projects and their underlying methodologies. These changes could include actions to reduce the time and cost associated with developing CDM projects, as these can both be significant. For example, project development costs could be reduced by providing detailed "top-down" guidance on baselines. Work on this has recently started in the CDM EB's Methodology Panel, which recommended to the CDM EB (in May 2004) a baseline and monitoring methodology to be used for landfill gas projects and another for grid-connected electricity projects. If the CDM EB approves these methodologies, which have a relatively broad applicability, it could reduce the time, cost and uncertainty currently involved with methodology development for two important sectors for CDM projects. Such work may also usefully be extended to projects in other sectors.

Project search costs could be reduced by encouraging potential project participants in host countries to bring forward project ideas (e.g. to their DNA) and by facilitating initial technical appraisal in the host country or by using a "unilateral" CDM-type model. However, this could require significant institutional capacity in potential host countries and is also less likely to lead to technology transfer. Thus, it may not be widely applicable to non-Annex I countries, at least not those in early stages of development. Project validation costs could be reduced by encouraging the development of validators in CDM host countries.

Looking further into the future to a post-2012 regime, the role that the CDM, or any project-based mechanism generating emission credits, could play depends on the architecture of and participation in mitigation commitments. In order to deliver emission benefits at a large enough scale to slow growth in global emissions, such a regime would clearly need to deliver deeper emission reductions than those foreseen by the Kyoto Protocol. Stabilisation of atmospheric concentrations of greenhouse gases will only be possible if all major emitting countries take on some form of commitment over the next few decades to begin to curb and eventually reverse growth in global emissions. As part of a future climate regime, any project-based mechanism would sensibly build on the institutions developed and project-level experience gained by companies and countries currently implementing the CDM. Current investors in CDM projects do not have a clear signal on the need for (or value of) GHG credits post-2012, thus increasingly the focus of investments is on near-term, "brownfield" and low cost emission reductions. In addition, resolving the tension between global emission reductions and local benefits is a key challenge for the future which could help to build local support for global GHG mitigation through the CDM or a similar project-based mechanism. All of these suggestions point to the valuable learning that is occurring through emerging experience with the CDM, pointing to lessons that will hopefully establish a knowledge base and a starting point for discussions about how to shape next steps under the Convention to curb global emissions of GHG.

5. ANNEX 1: LIST OF PROJECTS

Project	Country	Expected credits (kt CO_2/y)	Expected credits pre-2008 (ktons CO_2 eq)	Project type	Source
Olavarria Landfill	Argentina	12,8	18,49	LFG capture	3
Battery-powered vehicles	Bangladesh	3,85		Transport	9
Micro-hydro project	Bhutan	0,5		Elec gen	14
AyP gas plant	Bolivia	35,3		Elec gen	17
Vale de Rosário (NM1)	Brazil	95,7	669,6	CHP	1
Nova Gerar (landfill gas to energy) (NM5)	Brazil	345	754,6	LFG capture	3
Barreiro	Brazil	35,31	154,5	Elec gen	3
Plantar	Brazil	811	2 852,6	A/R, avoided fuel switch	11
Aquarius hydroelectric project	Brazil	14,9	36,0	Elec gen	3
Salvador da Bahia (NM0004)	Brazil	822	2 558,5	Elec gen	3
Granja Becker (NM34)	Brazil	5,24		Swine manure	1
V&M (NM0029)	Brazil	976	5 859	Avoided fuel switch	3
Biogas and biodiesel for power	Brazil	3		Elec gen	9
Biodiesel for transport	Brazil	4	19,25	Transport	9
Onyx Landfill gas recovery (NM21)	Brazil	88,3	259,3	LFG capture	1
MARCA Landfill Gas	Brazil	231		LFG capture	3
Lara landfill	Brazil	664,00	1 941	Elec gen	3
Energy efficiency	Brazil	0,2		Elec gen	16
PCH Passo do Meio (NM 51)	Brazil	94,4	393,3	Elec gen	1
The Metrogas Package Cogeneration Project (NM18)	Chile	11,6	34,80	CHP	1
Chacabuquito	Chile	79,00	425	Elec gen	4
N2O Removal	Chile	285,6	1 428	N2O	10
Guardia Vieja	Chile	250	1 000	Elec gen	10
Peralillio (NM22)	Chile	117		Swine manure	1
Planta Graneros (NM16)	Chile	16,1	53,6	Fuel switch	1
Metrogas pipeline rehabilitation (SSC)	Chile	8,06	110,50	CH4 reduction	3
Huitengxile	China	60,02		Elec gen	11

Steam efficiency improvements (NM17)	China	79,8	528,2	Energy efficiency	1
Coal-bed methane	China	2900		CH4 reduction	4
Run-of-river	China	371,00		Elec gen	4
La Vuelta and La Herradura Hydroelectric Project (NM20)	Colombia	71,10	243,36	Elec gen	1
Jepirachi (NM24)	Colombia	37,85		Elec gen	1
Rio Amoya	Colombia	361	1 803	Elec gen	10
Urban mass transportation system (TransMilienio)	Colombia	437	602	Transport	1
Furatena	Columbia	11,9		Energy efficiency	4
SARET Rio Azul	Costa Rica	78,6		Elec gen	11
Biogas recovery	Costa Rica	47		Biogas	5
Umbrella Project -Vara Blanca	Costa Rica	20,3	101,0	Elec gen	4
Umbrella Project - Chorotega	Costa Rica	18,73	93,2	Elec gen	4
Umbrella Project - Hidroelectrica de Cote	Costa Rica	11,98	62,4	Elec gen	4
Rio General hydroelectric project	Costa Rica	128	638,5	Elec gen	10
Cartago (NM33)	Costa Rica	63,2	133,8	Cement	1
Sabanilla	Ecuador	130,4	391,2	Elec gen	10
Sibimbe	Ecuador	68,4	271,0	Elec gen	1
Guachala	Ecuador	7,84		Elec gen	10
Perlabí	Ecuador	13,2		Elec gen	10
Sigchos 1	Ecuador	130		Elec gen	10
Salinas	Ecuador	12		Elec gen	17
Hidroelectrica Pilalo 3	Ecuador	74,1	222	Elec gen	10
Zafarana (NM36)	Egypt	227	455	Elec gen	1
Electrica del Norte	El Salvador	8	69,97	Elec gen	5
Ingenio da Cabana	El Salvador	24,74		Elec gen	10
Valco Aluminium smelter efficiency	Ghana	13		Elec gen	11
El Canadá (NM6)	Guatemala	144	577		1
Hidroelectrica Candelaria hydroelectric project	Guatemala	21		Elec gen	3

AHPPER	Honduras	45		Elec gen	15
Wind farm - Francisco Morazan	Honduras	137,5	687	Elec gen	10
Koppa (NM11)	India	62,92	382	Elec gen	1
Sankaneri Wind	India	37,84		CHP	11
Lucknow (ABIL) (NM32)	India	101,9	155	Elec gen	1
BCML Bagasse Cogeneration A43(NM30)	India	95,2	365	Elec gen	1
TA Sugars (NM35)	India	584,00	1 374	CHP	1
Raghu Rama (in Tamilnadu) (NM25)	India	82,55	282	CHP	3
Wind in Tamil Nadu	India	36,8	177	Elec gen	19
Solid Waste Management - Chennai	India	234	184	Elec gen	10
Ind-Barath	India	42		Elec gen	11
Kalpa Taru	India	115		Elec gen	11
FaL-G brick units	India	387		Elec gen	4
Balrampur biomass project	India	46,8		Other	11
Biomass gasifiers	India	9,26	18,51	Elec gen	5
Gujarat	India	3380		Elec gen	11
OSIL waste heat (NM31)	India	29,53	288	F-gas decomposition	1
Agrinergy	India	50		Waste heat recovery	13
Birla (NM45)	India	917,3	1 225	Elec gen	1
Karnataka wastewater (NM42,44)	India	35,6	107	Cement	1
Indo gulf (NM37)	India	22,8	103	energy efficiency	1
SRS bagasse	India	22		energy efficiency	11
Jindal Vijayanagar Steel Plant (NM 49)	India	87,9	308	Elec gen	1
Ethanol Fuel Production	India	38,9		Elec gen	7
Off-season Bagasse Cogeneration	India	734,00		Elec gen	4
Indocement (NM 47, NM48)	Indonesia	1045	1 373	CHP	1
Lumut Balai	Indonesia	730		Cement	6
Rice Husk Power	Indonesia	14		Elec gen	6
Renewable agro-industry	Indonesia	9		Elec gen	6

Micro-hydro project	Indonesia	5,56		Elec gen	11
Urban Buses in Yogyakarta	Indonesia	2,1		Elec gen	6
Unocal's Sarulla project	Indonesia	692		Transport	6
Palm oil waste power plant	Indonesia	56,5		Elec gen	12
Darajat Unit III	Indonesia	780	84,75	Elec gen	1
Reforestation project on Lombok	Indonesia	27,7		Elec gen	7
Forest Plantation - East Kalimantan	Indonesia	68,4		Sequestration	7
Carbonization and Power Generation -South Sumatra	Indonesia	102,5		Elec gen	7
Wigton (NM12)	Jamaica	49,2	148	Elec gen	1
NEDO	Kazakhstan	62		Energy efficiency	
Smallholder Tea	Kenya	54		Other	4
Webuye Falls	Kenya	0,24		Elec gen	11
Improved efficiency of transformers and motors	Kenya	0,30		Energy efficiency	11
Efficient boilers and kiln	Kenya	119		Energy efficiency	11
New solar power	Kiribati	1,656		Elec gen	7
Ulsan (NM0007)	Korea	1400	3 850	F-gas decomposition	1
Bumibiopower (NM39)	Malaysia	24,53	73,59	Elec gen	3
Kunak Palm oil mill	Malaysia	51,2	153,6	Elec gen	3
Air Hitam landfill gas capture	Malaysia	9,86		Elec gen	11
Feldar Lepar Hilir (NM13)	Malaysia	24,9	125,35	Palm Oil	7
INELEC -El Gallo (NM23)	Mexico	70,8	82,23	Elec gen	3
INELEC - Benito Juarez	Mexico	40,8	40,80	Elec gen	2
INELEC - Chilatán	Mexico	51,8	104	Elec gen	2
INELEC - Trojes	Mexico	22,6	113	Elec gen	2
Fuerza éolica del Istmo - in Oaxaca	Mexico	214		Elec gen	4
Moldova wastewater (NM38)	Moldova	72,7	218	Elec gen	1
Soil Conservation Project	Moldova	276,00		Sequestration	4
Ulaanbaatar	Mongolia	28		Heating	4
City Council of Rabat	Morocco	75,71		Elec gen	13
Office Chérifien des Phosphates	Morocco	88,8		Energy efficiency	13

Office National d'Electricité	Morocco	162		Elec gen	13
Biogas	Nepal	142,9		Elec gen	4
Vinasse aerobic treatment	Nicaragua	98	187	Elec gen	1
New wind plant	Niue	0,355		Elec gen	7
Fortuna	Panama	22,4		Elec gen	17
Esti	Panama	357		Elec gen	11
Bayano	Panama	39,09	156	Elec gen	1
Lihir Geothermal power plant	Papua New Guinea	287	741	Elec gen	1
Huanza	Peru	277		Elec gen	8
Tarucani	Peru	220		Elec gen	8
Poechos	Peru	31,3		Elec gen	8
SIIF Andina S.A.	Peru	200		Elec gen	8
Cogen	Philippines	200		Elec gen	4
Panay	Philippines	41,94		Elec gen	18
Steam generator efficiency	Senegal	1,89		Energy efficiency	11
SONACOS efficiency	Senegal	86,13		Energy efficiency	11
Durban (NM10)	S. Africa	367,4	1 620	Elec gen	1
Mondi Kraft Biomass	S. Africa	64,9		Heating	9
Small-scale CDM project	Samoa	1,164		Elec gen	7
Reforestation	Solomon Islands	30,9		Sequestration	7
Small hydro	Sri Lanka	94,8	190	Elec gen	10
Hydro	Swaziland	23,3	117	Elec gen	10
A.T. Biopower (NM19)	Thailand	81,6	177	Elec gen	1
Nontaburi	Thailand	55	55	Elec gen	7
Yala Rubber Wood	Thailand	60,4	190	Elec gen	3
Korat waste-to-energy (NM41)	Thailand	362,00	1 731	Elec gen	1
Ratchasima SPP	Thailand	40		Elec gen	1
Power Generation by Landfill Gas	Thailand	70	0	Elec gen	7
Thai Biomass Electricity	Thailand	378,00		Elec gen	7
Improve efficiency of fossil fuel plants	Tonga	32,8		Energy efficiency	7
Improve efficiency of power transmission	Tonga	11,916		energy efficiency	7

M5000 (NM03)	Trinidad & Tobago	229		New Methanol Plant	1
West Nile hydropower	Uganda	88,34	239	Elec gen	4
Andijan	Uzbekistan	40,8	68,16	Heating	1
Tashkent	Uzbekistan	285		Heating	4
Thuong Ly	Vietnam	7,35	37,95	LFG capture	5
Rang Dong (NM26)	Vietnam	1676	5 580	Gas recovery	1
Production of ethanol-containing gasoline	Vietnam	690		Ethanol for gasoline	7
Biogas for Animal Husbandry	Vietnam	270		Elec gen	4
Grontmij Landfill	Vietnam	293		LFG capture	4
Lwakela	Zambia	8,14		Elec gen	5
Tazama pipeline	Zambia	13,88		Energy efficiency	11
Osborne Dam	Zimbabwe	20		Elec gen	11
Electric motor	Zimbabwe	15,5		Energy efficiency	11
Brick firing	Zimbabwe	14,30		Brick drying and firing	11

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2 = http://cdm.unfccc.int/Validation/PublicPDD;
3 = http://www.dnv.com/certification/climatechange/;
4 = http://www.carbonfinance.org/ (assuming a 10y crediting lifetime);
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7. GLOSSARY

A/R	Afforestation and reforestation
BAU	Business as usual
CDCF	Community Development Carbon Fund
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CH_4	Methane
CO_2	Carbon dioxide
COP	Conference of the Parties
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	The Executive Board of the CDM
ERPA	Emission Reduction Purchase Agreement
EU	European Union
FDI	Foreign Direct Investment
GHG	Greenhouse Gas
GWP	Global Warming Potential (relative to CO_2)
HFCs	Hydrofluorocarbons
IRR	Internal rate of return
JI	Joint Implementation
NCDF	Netherlands' Clean Development Facility
NGO	Non-governmental organisation
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OOF	Other Official Flows
PAM	Policies and measures
PCF	The Prototype Carbon Fund
PFCs	Perfluorocarbons
SD	Sustainable development
TT	Technology transfer