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CDM: Taking stock and looking forward

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Abstract

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 development of the CDM portfolio as well as achievements of the CDM to date in the context of wider private and public flows of investment into developing countries. These achievements include the development of 325 (by May 2005) proposed CDM projects which are together expected to generate more than 79 Mt CO_2-eq credits/year during 2008–2012, 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. The paper also draws lessons from this experience to date, and outlines what changes may be needed to transform the CDM concept to a broader scale after the end of the first commitment period in 2012.
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Keywords: Clean development mechanism (CDM); Emission credits; Project investment

1. Introduction

The objective of the UN Framework Convention on Climate Change suggests a focus on stabilising atmospheric concentrations of greenhouse gases so as to limit the pace and magnitude of climate change, while assuring food security, adaptation of ecosystems to climate change and sustainable economic development. However, this will require deep global emission reductions over the next half of century compared to existing trends (Watson et al., 2001; Corfee-Morlot and Höhne, 2003). The main question on the table for negotiators is how to initiate a transition to low-emission global development pathways and, thus, towards a stable climate (IPCC, 2001; Hoffert et al., 2003; Philibert et al., 2003).

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. Indeed, non-OECD countries are expected to account for 58.6% of energy-related CO_2 emissions in 2030 (IEA, 2004), with emissions from China more than doubling (from 3.1 to 7.1 billion tons) between 2000 and 2030. Indeed, energy consumption in developing countries will more than double in the same time frame. Successfully avoiding dangerous climate change will thus depend upon an ability to widen participation in mitigation efforts. Countries with high emissions per capita have particular responsibility to act, while countries with high emissions intensity (GHG/$ GDP) have potential to make their economies more climate-friendly.

While the Convention commits all countries to prepare and adopt programmes and policies to address climate change, it does not quantify or even suggest specific time frames or levels of mitigation to be undertaken by

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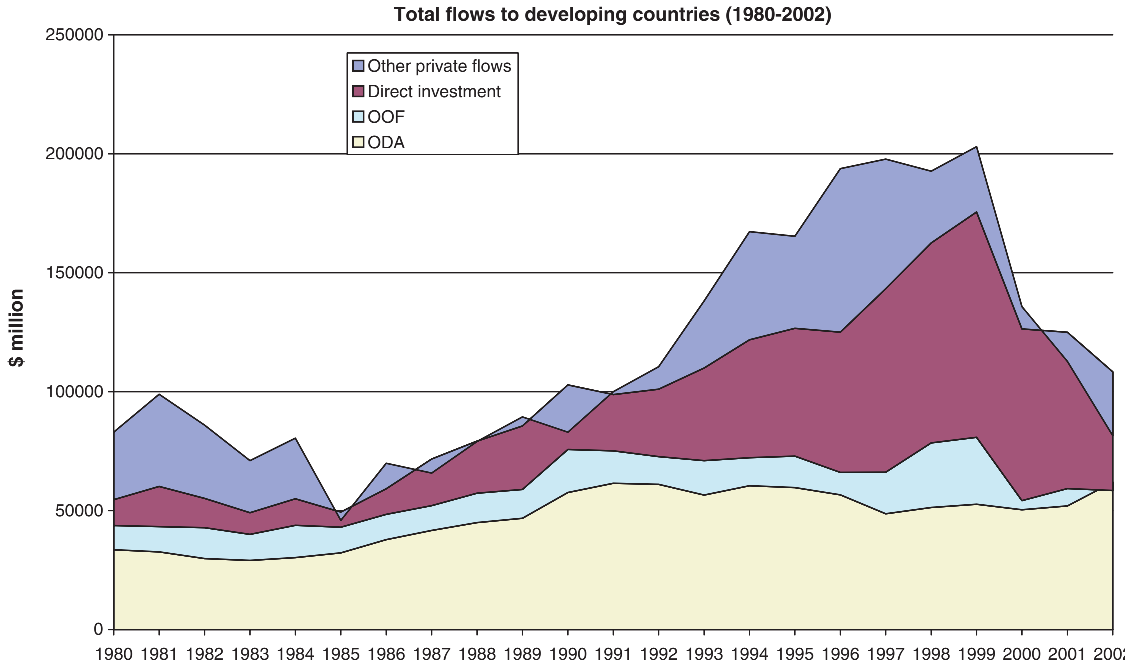

Fig. 1. Total foreign investment flows to developing countries (1980–2002). *Source*: OECD DAC—Creditor Reporting System, 2003. *Notes*: Data for developing countries only, excluding flows to developed countries and other aid recipients e.g. central and eastern European countries, Russia, Singapore, 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: 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.

developing country Parties. Indeed, for some developing countries that are actively pursuing mitigation, the CDM may currently be the main focus of such efforts. The demand for CDM is based in the mandatory emission constraints in Annex I countries, while the interest that host countries have to participate lies in the possibility to attract new investment to projects that will contribute to sustainable economic development at home. In those developing countries that are actively pursuing the CDM, it is seen as a means to attract new, foreign capital and possibly to stimulate technology transfer. It is also a means to build climate-related institutions and for a wide range of different types of actors—in the public and private sectors—to learn about the technical and economical aspects of mitigation opportunities.

Yet 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. CDM in the context of investment

2.1. Investment flows for development and technology change

Investment flows available in any particular country for development and technology change include both foreign and domestic sources. In developing countries, the size of private investment and, most importantly, foreign direct investment (FDI) from developed countries relative to domestic financing is still relatively low, estimated to be approximately 50 billion USD in 2002. This compared to private flows from both developed and other developing countries at roughly twice this amount and domestic investment at approximately 1 trillion USD (OECD, 2003a; Fig. 1). Domestic capital could be used to support CDM investment through the unilateral CDM approach. However, domestic flows for CDM investment, or private flows from other developing countries, are less likely to have technology transfer benefits equivalent to those from FDI driven investments.

Within the foreign capital going to developing countries, private flows became a dominant element in the 1990s,

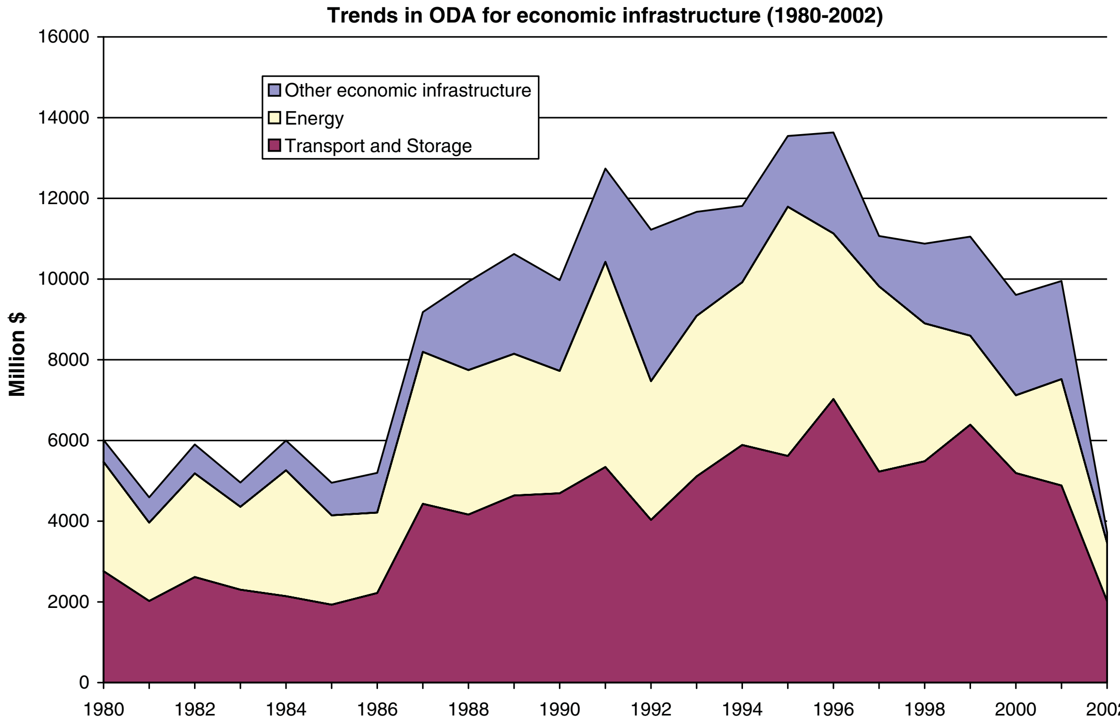

Fig. 2. Trends in ODA for economic infrastructure (1980–2002). *Source*: OECD DAC—Creditor Reporting System, 2004.

while public flows remained relatively stable in absolute terms over this period (Fig. 2).[1] Private flows are relatively large and have high potential to assist with critical technology transfers from OECD to developing countries. Evidence indicates that many of the world's new technologies originate in OECD countries and that private investment flows, and FDI in particular, has the potential to transfer such technology out of the country of origin (OECD, 2002a). It 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). Although FDI tends to rise and fall with the financial cycles of the market and is risk averse compared to ODA, 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.

FDI flows are also selective—it will only flow to countries and locations where relatively strong ''enabling conditions'' for investment exist (OECD, 2002a, 2003a, b). These include stable political regimes, strong legal environments for contracts and proven enforcement capabilities, macro-economic stability, availability of pools of skilled workers, institutional capacities 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, 2003a, b).

A small, but significant portion of the total ODA to developing countries goes to economic infrastructure. Over the period 1980–2002, it was roughly 20% of ODA, with this share dropping to only 6% in 2002. Transport and energy infrastructure are the largest shares (Fig. 2), representing about 50% and 40%, respectively of share of ODA going to economic infrastructure in 2002.

Fig. 3 shows flows of investment from FDI and ODA sources for 10 developing countries where large numbers of CDM credits are expected to be generated. In 2002, FDI played the strongest, if not dominant, role in 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 China, India, Indonesia, South Africa and Peru.

The Global Environmental Facility portfolio for climate change investments totalled \$138.4 million in 2002 (Fig. 4). Between 1991 and 2002, GEF portfolio for climate investments equalled \$1.4 billion. If one compares GEF investments to the private and public sector flows outlined above, it is but a small fraction of the share. However, like

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

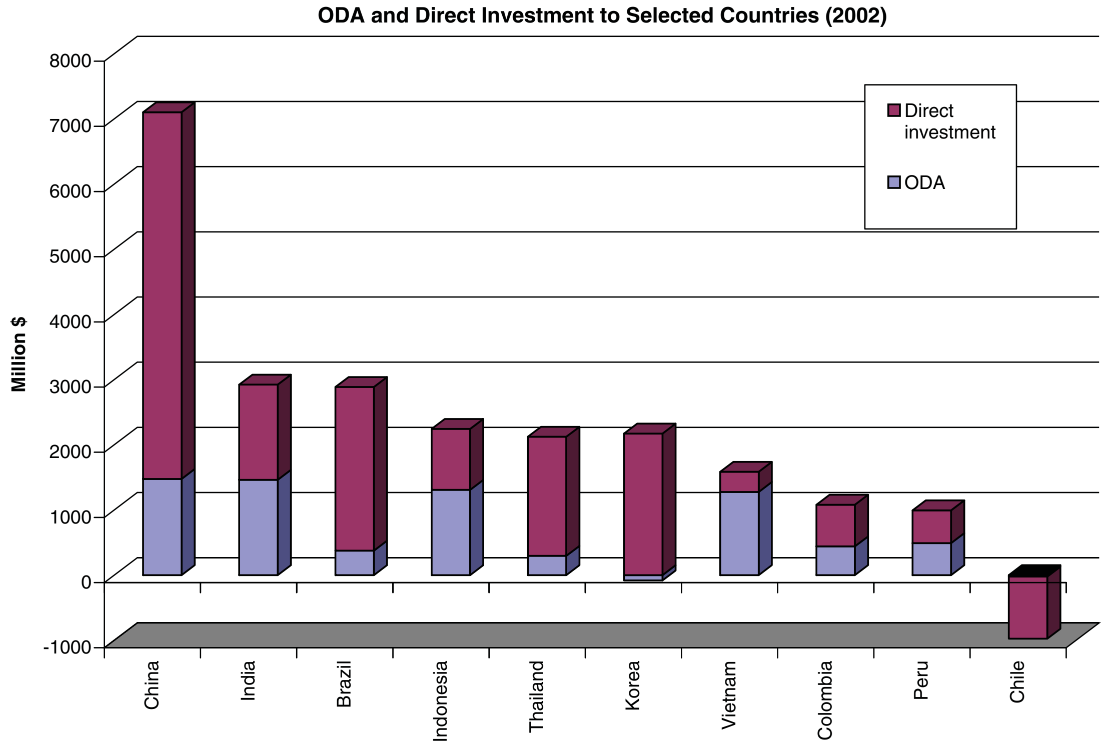

Fig. 3. ODA and Direct Investment to Selected Countries (2002). *Source*: CRS database, 2004.

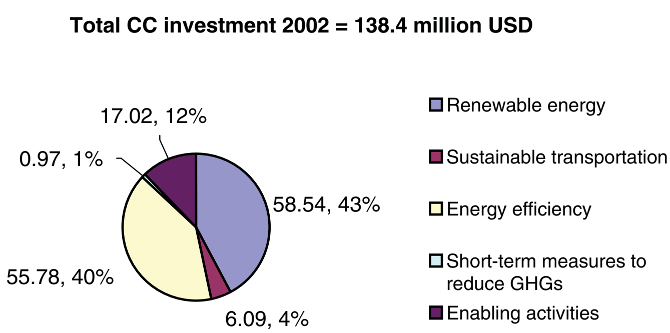

Fig. 4. GEF portfolio investments in climate change (2002). Total CC investment 2002 = 138.4 million USD.

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.

2.2. How does CDM funding compare to other investment flows?

The funding allocated to CDM/JI programmes to date amounts to more than $1.9 billion USD (Ellis, 2005) 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 and 1:8 of total project cost (Sinha, 2004). If we take 2 billion USD as an estimate of the amount of funds allocated to CDM in the coming years, this would mean that the amounts of investment stimulated by a CDM mechanism could become significant, i.e. 12–14 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 2% 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 foreign private investment 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 1991–2002, funding allocated for CDM credits is of at least a similar magnitude.

3. Portfolio of CDM projects: an overview

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. At the time of writing, 12 CDM projects have been registered, and a further three projects that have been submitted to the CDM EB for

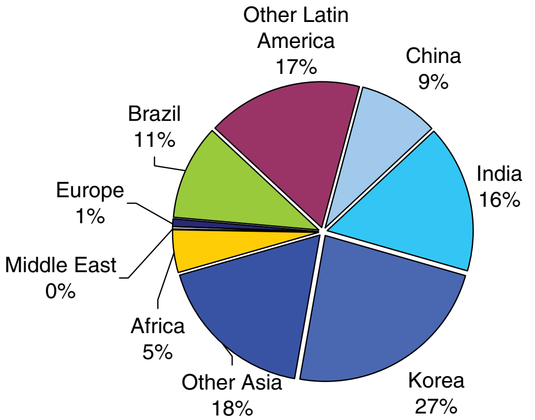

Fig. 5. Geographical spread of credits from proposed CDM projects (% of total expected credits generated during 2008–2012). *Source*: Authors' calculations based on project information for 325 proposed CDM projects.

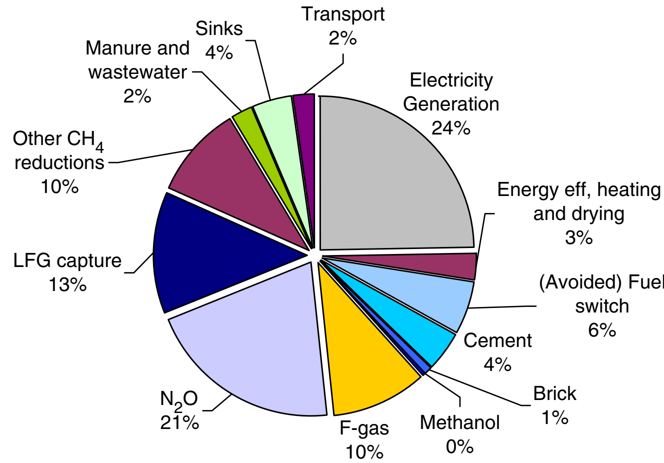

Fig. 6. Proposed CDM portfolio: relative importance of different project types (% of total expected credits generated per year during 2008–2012). *Source*: Authors' calculations (May 2005) based on project information for 325 proposed CDM projects.

registration are either under review or have a review requested. CDM project activities are currently underway or planned in 51 countries and several different sectors. These 325 project activities anticipate reducing greenhouse gas emissions by almost 79 mt CO_2-eq/year (more than Hungary's CO_2 emissions in 1990) during the Kyoto Protocol's first commitment period.

The spread of proposed project activities and host countries is thus relatively wide. However, proposed CDM project[2] activities are concentrated in a few countries, e.g. Korea, India, Brazil (Fig. 5). 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.

If assessed in terms of the number of credits generated, CDM project activities currently under development are concentrated in three sectors (Fig. 6): renewable electricity generation, reduction of methane emissions and decomposition of gases from industrial processes (particularly HFC23 and N_2O). However, the scale of emission reductions from these project activities is often very different. Renewable electricity projects expect to generate between 0.2–780 kt CO_2-eq credits per year, whereas HFC23 and N_2O reduction projects often generate millions of credits per year. Indeed, the combined credits from 161 proposed CDM project activities generating renewable electricity from hydro, biomass, wind and solar are expected to be lower than from four HFC23-reducing projects. Thus, the CDM portfolio is very different if examined in terms of numbers of projects, as more than half involve renewable electricity generation but less than 10 out of 325 involve reducing F-gases or N_2O. (However, the methane-reducing projects account for approximately an equal share of the "pie" whether measured in terms of numbers of credits or projects).

The ancillary benefits of these different project types vary significantly. Table 1 summarises some of the different characteristics of different project types as well as their reduction potential. Electricity-generating projects (of which the overwhelming majority is from renewables) currently account for the largest single "slice" of the CDM project portfolio credit "pie". This is partly due to the initial preference for such project activities 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 and delays 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

[2]There are several different possible ways of representing the CDM development "pie". It should be noted that these numbers are different to those on the CDMWatch website, www.cdmwatch.org. This is because the analysis in this paper is (a) based on a greater number of projects (325 compared to 166) and (b) based on project information publicly available on the UNFCCC website and other sources, as well as project information available to the author about projects at the PDD stage, and those approved by different DNAs. This analysis does not include projects at the feasibility stage (which are however included in the CDMWatch statistics).

Table 1
Summary characteristics of potentially widespread CDM project types

	Renewable electricity	Reduced CH_4 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	CH_4	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	45%, decreasing	23%, increasing rapidly	17%, increasing rapidly	6%, increasing	3%, decreasing	n/a	Low, decreasing
Potential reductions (mt in 2010 at \$5/t CO_2)*	20.4	229.1	18.6	1.4	219.1	3.9	7.8
Potential reductions (mt in 2010 at \$10/t CO_2)*	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, author assessment, Cogen et al., 2003, 3E project.
*From Trexler Climate and Energy Services, 2004.

projects, as the potential project participants have already demonstrated their financial solidity.

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 90 m 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 (see Ellis and Gagnon-Lebrum, 2004 for a comparison of relative costs). 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 growth in proposed CDM project activities has been significant in 2004, and extremely rapid in 2005, with CDM project plans currently exceeding the lower end of estimated sizes of the CDM market during the first commitment period, i.e. between 50 and 500 mt CO_2-eq per year (Grubb, 2003; Haites, 2004). Further large expansions in CDM-related emission reductions are also planned: some of the carbon funds (e.g. Spanish Carbon Fund) or CDM/JI programmes (e.g. Austria) have only recently been initiated and have not yet resulted in much project development.

Table 1 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.

Thus, although a CDM-like activity may be uniquely well placed to stimulate private sector driven transfer of low- or no-GHG emitting technologies, it is unlikely to do so in significant levels in its current form. This is because as a strict market mechanism with international oversight focusing solely on the GHG-reduction component of projects, the CDM encourages the development of low cost emission reductions. Where small changes in existing facilities offer large amounts of cheap reductions, brownfield projects will inevitably dominate the market in its early years. In this market context, projects with large sustainability benefits, such as energy efficiency or renewables projects, or even sustainable farming projects, are not likely to account for a large proportion of the CDM market, as such projects are likely to carry relatively higher costs.

4. Sustainable development and the CDM: a dual objective?

4.1. Growth in national CDM-related institutions

National-level CDM institutions have grown very rapidly since the establishment of the CDM Executive Board in November 2001. By December 2004, 68 countries had designated a Designated National Authorities (DNAs), as had the European Community (EC).[3] 55 non-Annex I countries have DNAs, and so do 14 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 non-governmental environmental advocacy and business organisations.

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

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 and actively participate in project assessment based on pre-agreed criteria or policy guidance.

Thus, 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 have outlined preferred project types or characteristics for both potential investors and hosts. 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, 2004). China will require CDM host companies to be locally owned and for a share of the credits remain within the host country. 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. Various institutional models to carry out these functions are also possible. For example, the case of Africa shows how some countries simply add the task of host country approval onto the existing process of Environmental Impact Assessment. The EIA model has the added benefit of binding CDM projects into a process that assesses impacts on *local* sustainable development. Further, for a country such as Mozambique expecting few projects, it may make sense to use existing institutions for project screening and approval rather than the more costly option of setting up a dedicated institution. Should a large number of project proposals and investments materialise, the option of setting up a dedicated office remains open.

Host countries could also choose to outsource some DNA functions to a private agency. This agency would evaluate projects and recommend on whether they should be receive host country approval or not. The final letter of approval, however, would need to be issued by government. This option would have low set-up costs, but potentially a high cost for each CDM project if we assume that it would be used in situations where there is low project flow. Uganda has outsourced some initial investigations in setting up its CDM office, although the final DNA may be part of government.

International governance of CDM projects focuses on assessing the GHG-reduction aspect of CDM project activities. This assessment 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, it is the host country alone that 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 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 such purposes.

4.2. Sustainable benefit aspects of proposed CDM projects

The sustainable development aspects of different project types vary widely. Projects that produce large amounts of emission reductions, such as those targeting HFCs, often have little tangible benefit for local sustainable

[3] An up-to-date list of DNAs is available at http://cdm.unfccc.int/DNA, the countries mentioned were not listed as having notified the secretariat of their DNA as at 31 December 2004.

Table 2
Direct and indirect sustainable development benefits of selected proposed CDM projects as presented in their PDD

Project	Project summary	Direct and indirect non-GHG SD or technology benefits						
		Environment	Economic	Technology transfer	Health	Social (non-employment)	Employment	Education/ awareness
OnSan (N_2O)	Involvement of either thermal or catalytic destruction of N_2O, a by-product of adipic acid production. Several plants currently operate using both (proven) technology types.	✓						
Gujarat (F-gas)	Development of a system to decompose HFC23, as used in Ulsan Project. Commitment to a fund of EUR 1.375m (approx 1% of CER revenues at 3 EUR/t CO_2) to spend on selected community development activities once CER revenue begins.	*	(✓)	✓	*	*	✓, *	
Ulsan (F-gas)	Installation of technology used by Japanese investor company to decompose HFC23.			✓				
Rang Dong (gas recovery)	Construction of gas pipeline and compressor to capture and use on-shore gas currently flared 140km offshore. The CERs will be transferred to the project participants, including host country firms.	✓	(✓)					
Metrogas pipeline rehabilitation (Gas leakage prevention)	Refurbishment of a pipeline that distributes gas to reduce leakage	✓	(✓)				(✓)	
Birla (cement)	Reduction in the proportion of GHG-intensive clinker in cement by increased blending with flyash (waste) from coal-fired power plants.	✓, (✓)			(✓)		✓[1]	
Indocement (cement)	Installation of facilities to enable increased cement blending and use of alternative fuels in clinker production (3 sites).	✓					✓	
Cartago (energy efficiency)	Retrofit of existing cement plant to increase energy efficiency, allow for increased use of "alternative fuels" and increase blending.	(✓)	(✓)				✓[1]	
Optimization of steel production (Energy efficiency)	Installation of gas recovery system and optimise the operational control of the electric equipment of the steelmaking shop.	✓			✓[1]	✓[1]		✓
OSIL (Energy efficiency)	Recovery and utilization of heat contained in the waste gases generated in sponge iron making in a coal based rotary kiln for generation of electrical energy.	✓					✓	
Hou Ma (Heating)	Energy efficiency improvements of heat supply in the city of Hou Ma by establishing a new district heating system (technology proven in W. Europe but not traditionally used in host country).	✓			✓			✓
NovaGerar (LFG)	Installation of landfill gas collection system and use gas to generate electricity (12 MW) or flare. 10% of electricity generated will be given to the local community.	✓	(✓)		✓	✓	✓	(✓)
Salvador de Bahia (LFG)	Installation of CH_4-destruction equipment (comparable to that used in the investor company's European operations) to flare LFG. Project sponsor will allocate 5% of net CER proceeds "to activities that would benefit the local community"	✓	(✓)	✓		*		(✓)

Lara (LFG)	Installation of landfill gas capturing and flaring system with a pilot electricity generator (1 MW, up to 10 MW in 2nd phase). Project sponsor "intends to share parts" of the CER revenues with local stakeholders through various programmes.	✓	(✓)	✓		*	✓	*
Organic Green Waste (LFG)	Installation of the first large-scale plant in host country to produce compost and capture methane from organic green wastes.	(✓)		✓			✓	
Chisinau (LFG)	Capture and combustion of CH_4 from landfill	✓						(✓)
Olavarría's landfill (LFG)	Capture and destroy CH_4 from municipal landfill. Project sponsors intend to use part of the income from CER to install a safe and reliable water distribution system in a village close to Olavarría.				*	*	✓[1]	(✓)
V&M (avoided fuel switch)	Avoid a switch from coal (from sustainably managed tree plantations) to coke in a steel plant. Improve the carbonisation installations to reduce CH_4 emissions. The PDD states that "no new technology [is] needed at this stage"	✓			✓[1]		✓	
Lafarge cement (fuel switch)	Installation of a new feed system at a cement plant to allow kernel shells to be used as well as coal.	No SD benefits mentioned. The new technology developed for the project is exclusive to Lafarge (Lafarge UK developed technology, Lafarge Malaysia is implementing the project).						
TransMilienio Project (Transport)	Addition of over 1000 articulated buses for public transport in Bogotá.	✓, (✓)				✓		
Korat waste-to-energy (Wastewater treatment)	Removal of organic material in the wastewater of a starch production facility. Biogas used to dry starch instead of fossil fuel and to generate electricity. A foundation will be created and funded by CER proceeds to finance local projects.	✓	(✓)			(✓)	(✓)	✓
M5000 (Methanol production)	Improvement of methanol production to reduce CO_2 emissions						✓	
Mountain Pine Ridge Reforestation	Reforestation, tending and protection of part of a reserve in Belize.	✓		✓		✓	✓	

Legend	
✓	Direct benefits, and generic and/or limited information provided, available or expected
(✓)	Indirect benefits, and generic and/or limited information provided, available or expected
✓ (shaded)	Direct benefits, and detailed and/or extensive information provided, available or expected
(✓) (shaded)	Indirect benefits, and detailed and/or extensive information provided, available or expected
*	CER revenues, or project output, earmarked for local development projects
1	During project construction/ at project site

Source: Ellis and Gagnon-Lebrun 2004.

development. For example, the Ulsan HFC23 project does not outline any expected benefits from the project on non-GHG air emissions, the local economy, water, health, employment, or education.[4] Similarly, landfill gas projects (a popular project type) produce cheap emission reductions, but in some cases face opposition from local communities opposed to the extension of the life of these sites (e.g NM 10, Durban LFG). By contrast, some projects that have direct benefits for local communities—for example, increases in household energy efficiency—may be much smaller projects that deliver fewer CERs and are accompanied by high transaction costs. While this generalisation does not always hold true, resolving the tension between global emission reductions and local benefits is a key challenge for the future of climate change system. Table 2 outlines the sustainable development benefits expected for some proposed 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 does the stringency of assessment. It is not always clear what weight these criteria have in a country's decision to approve or not a potential CDM project.

The CDM was created as a market institution, but sustainable development is not incorporated into the market aspect of the mechanism. A properly functioning market would lead to project developers pursuing mainly low cost options such as HFC, N_2O or CH_4-reducing projects (although there may also be a small market for higher-priced credits from buyers who want credits from projects with particular characteristics, e.g. on sustainable development). Thus, although sustainable development is one of the two purposes of the CDM, and of a key concern to developing countries, the CDM only provides monetary incentives for the other, GHG-reduction, purpose.

5. Lessons learned from the CDM

Although the CDM market is still young, there is enough experience with developing CDM projects, institutions and markets to be able to identify 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. Focussing on questions of market size and project characteristics, types of investors, and the potential for achieving sustainability and technology transfer benefits through the CDM, a number of points can be made.

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, although coverage is wide the majority of CDM revenue is expected to be generated by relatively low-cost projects in a handful of large countries, and by three project types: renewable electricity generation (particularly from bagasse and biomass), decomposition of HFCs and reduction of CH_4 emissions from landfills or coalmines.

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. These include stable political regimes, strong legal environments for contracts and proven enforcement capabilities, macro-economic stability, availability of pools of skilled workers, institutional capacities and other sources of human capital. Indeed, the majority of CDM credits from the current portfolio are expected to be generated in countries that already attract large amounts of foreign direct investment (FDI).

Much of the CDM-related funding to date has been from public funds (i.e. Annex I governments), although companies are also contributing to carbon funds. Moreover, both companies from Annex I and non-Annex I countries are investing in potential CDM projects. The involvement of companies should increase now that 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.

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 et al., 2003). Prices for the (temporary) credits from sink enhancement projects are likely to be lower than those for the (permanent) emission-reduction projects.

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

[4]Project design document is available at http://cdm.unfccc.int/UserManagement/FileStorage/FS_147587320.

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. However, 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.

The sustainable development aspects of different project types vary widely. Some variation is expected, and reflects different host country development and CDM priorities when approving projects. However, 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 GHG market is designed to seek out and develop least-cost mitigation projects through the CDM and this seems to be working. Projects with dual sustainability and mitigation benefits (e.g. energy efficiency, renewables, sustainable farm or waste practices) do not necessarily offer the cheapest emission reductions and are therefore are unlikely to develop an important share of the activities generated under the current CDM. Technology transfer benefits were also expected to emerge under the CDM. However the emphasis on development of markets for least-cost mitigation has meant that the CDM project portfolio now has a large and growing share of brownfield projects, where investment in new technology is limited, e.g. to end-of-pipe abatement systems in existing facilities.

6. Looking forward

Post-2012, different potential climate regimes could build on developments under the CDM in different ways. For example, the project-based credit component of the CDM could apply to a future climate regime where the types of commitments are differentiated by countries and only some countries have total or sectoral emission commitments. Other types of emission commitment could also build on experience and/or institutions built up during experience with developing and implementing CDM projects. For example, the development of a baseline for a particular CDM project activity in a country could be a first step in developing policy baselines used to implement SD-PAMs or a sectoral crediting mechanism.

6.1. What role might CDM play in future commitments?

Mitigation approaches starting from a development perspective seek to make national development objectives the starting point for climate mitigation. Whether countries will be prepared to register such commitments under a multilateral system (Winkler et al., 2002) remains to be seen. The potential exists, however, to extend the circle of those involved in climate mitigation beyond environment ministries to other ministries, e.g. energy, agriculture, trade, industry, etc. This type of approach would also aim to deliver sustainable development benefits and emission benefits on an equal basis.

Such an approach may not go fast enough or far enough to deliver significant emission reductions for developed countries. However, it may be an appropriate and constructive starting point for developing countries as a first step towards future mitigation commitments. Re-structuring the CDM to be able to use sector-wide baselines or to help develop SD PAMs for example, could build on the learning that has occurred to date on the construction of baselines and on understanding opportunities for low-cost emission reductions in different sectors. This could advance mitigation efforts in developing countries in the future.

6.2. What changes could transform the CDM concept to a broader scale?

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 developing countries, means that the potential to limit growth in GHG emissions is huge. If the CDM is to have a more significant role in the second and subsequent commitment periods, or if a CDM-type mechanism were to have a role in a future climate regime, its role could be made more significant by making changes to the structure, scope and working of the CDM. Changes, such as those outlined below, may also be needed if a "CDM+" is to satisfy both GHG-reduction and other goals, such as sustainable development, technology transfer and adaptation.

6.2.1. Define and give incentives to the desired outcome

The CDM aims to achieve dual cost-effective emission-reduction and sustainable development benefits, and one of the strengths of the CDM is its potential to promote local sustainable development in host countries. However, the current incentive structure for CDM only values the emission-reduction component of a proposed CDM project. The international governance bodies of the CDM, i.e. the CDM Executive Board and its panels, have the mandate to ensure that the emission reductions in developing countries are real, long-term and measurable. 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.

If a project-based mechanism is to be included in a future climate change regime, negotiators will need to decide upon its role in climate mitigation (e.g. as part of a package of measures aiming to mitigate greenhouse gas emissions). They will also need to agree upon its goals. There may be several, e.g. reducing emissions of GHGs, technology transfer or increased use of renewable energies, or more generally local sustainability benefits defined in a wide variety of ways. Negotiators will need to consider the efficiency of designing specific instruments for each goal, against the costs of creating multiple instruments. The experience with the CDM thus far indicates that projects with a high SD component also have higher costs per unit of emission reduction. A means to exploit the potential link between local sustainable development benefits and mitigation is likely to be a key to motivating developing countries to take on future mitigation commitments.

Any future project-based mechanism, or "CDM+", would also need to provide financial incentives similar to that of the CDM to encourage private-sector participation. This would be possible if developing country Parties, were able to use the CDM+ to generate emission credits that could be traded in international markets. If the incentives are for GHG reductions, it should be expected that this will be the primary focus of project developers, with other possible "ancillary benefits" of CDM+ projects as a secondary focus. Alternatively, an approach could take development, and not GHG reductions, as the starting point for any future commitments. This could be consistent with commitments based on SD-PAMs, sectoral CDM and the "development first" approach (Pan, 2002; Heller and Shukla, 2003). Moreover, to developing countries, the value of these other sustainable development benefits may be greater than the added cost of emission reductions. Internationally, such a system might be more costly than an approach focused on cost-effective GHG mitigation alone. But one would need to ask whether an approach focused on market mechanisms for GHG-mitigation would have a significant chance to successfully engage investment in projects that are widely replicable, with multiple GHG and other benefits—but perhaps of higher capital cost. Such investment, particularly in the key growth sectors of large developing country partners (e.g. electricity generation in China and India) is crucial. A shift of incentives to include local sustainable development, and not pursue only least-cost GHG mitigation, will likely be needed in future if a different focus of CDM or CDM+ project portfolio is desired.

6.2.2. Promote a stable market structure

There are some uncertainties that cannot be resolved by a new climate regime. For example, non-participation by large potential "credit-buying" countries will reduce the demand for and the price of credits irrespective of how any future climate commitments are set, e.g. in terms of absolute, sectoral or per capita emissions. Conversely, non-participation by large "credit-selling" countries could raise the price of credits by limiting the supply of available credits. Nevertheless, decisions by the international community can reduce some uncertainties. For example, current uncertainties as to what the climate regime will be beyond 2012 (in particular, whether some countries will continue to have a legally binding emissions "cap") means that investors in CDM projects do not have a clear signal on the need for credits or their value post-2012. This will lead investors to focus on short-term emission reduction projects—even though many potential CDM projects have technical lifetimes of several decades. A clear signal that emission commitments are part of a longer-term regime to control greenhouse gases would help project participants in valuing emission reductions over periods greater than 5 years.

Projects which have direct benefits for local communities—for example, increases in household energy efficiency—typically deliver relatively few CERs and have high transaction costs. While this generalisation does not always hold true, resolving the tension between global emission reductions and local benefits is a key challenge for the future of the climate change system.

7. 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. Emission commitments for Annex I Parties under the Kyoto Protocol are only a small first step in this direction, and in the longer-term mitigation efforts will be needed from all major emitting countries including developing countries. The CDM was established under the Kyoto Protocol with the dual purposes of helping developing countries to achieve sustainable development and industrialised (or Annex I) Parties to reach their legally binding emission limitation commitments. But what can we learn from the lessons noted above and how might we adapt and build on the positive lessons to strengthen the role it plays in a future agreement?

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 $800 m 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 flow of known CDM investment to date is small relative to other flows of foreign investment from developed countries to developing countries, such as foreign direct investment and other private flows or official development assistance from the public sector, which equal about $50 and $60 billion, respectively in 2002 alone. However, CDM funds may have the potential to leverage 6–8 times their amount—or about 6–8 billion USD—of investment capital towards GHG mitigation activities. This amount is about 6 times the amount of GEF investment in climate change activities from 1991 to 2002, thus it 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 and country, it may stimulate or add to the ongoing FDI flows in a country. The CDM may be uniquely well placed to stimulate private sector driven transfer of low- or no-GHG emitting technologies.

Despite the dual goals of emission reductions and achieving sustainable development, the emerging CDM project portfolio is shaped almost exclusively by financial incentives for the emission-reduction component of projects (apart from the small share of investors that wish to pay a premium for particularly SD-friendly CDM projects). As a result, many of the projects identified in the current project portfolio represent relatively low-cost emission mitigation opportunities that result from ''tweaking'' existing technologies and processes and identifying and eliminating out unnecessary waste, as opposed to the investment in new infrastructure and technology. Some proposed projects also have low sustainable development benefits. Currently, the price of GHG credits from CDM projects is relatively low: often between $3–6/CER. This price level may not provide enough of a market pull for project types that have long lead-times and are capital-intensive, and/or provide uncertain levels of credits.

If a project-based mechanism is to be included in a future climate change regime, negotiators will need to decide upon its goal(s). Our view is that providing a means to exploit the potential link between local sustainable development benefits and mitigation could be a key to motivating developing countries to take on future mitigation commitments. Such a vision includes a re-design of the CDM to provide financial incentives to exploit the technical options with synergies between local sustainable development and mitigation. This would lead to lasting changes in energy infrastructure and demand. New investment in local sustainable development should also flow into other sectors, e.g. improved farm management practices. In return, some of the more rapidly industrialising developing countries may be willing to take on a quantified mitigation commitment, particularly if the incremental cost difference between local sustainable development projects and those adding climate mitigation is financed through an agreed financial mechanisms (e.g. see Ott et al., 2004).

What are the implications of this for a post-Kyoto regime and any project-based mechanism that might arise there? Given that both industrialised and rapidly industrialising developing countries will need to come into the climate regime to achieve atmospheric GHG stabilisation over the long-term, experience to date suggests a two-fold strategy. First, countries entering into a GHG limitation or reduction regime in its early stages would be able to generate domestic economic benefits from their own ''low-hanging fruit'' (rather than leaving these to be ''picked'' by CDM investors). Secondly, a different type of project-based or crediting mechanism may be needed for use in some important yet still quite poor developing countries: one which aims to exploit those options that deliver both specific sustainability and mitigation benefits. To do so would require an additional set of institutional and financial requirements, mobilising finance for local sustainable development as a parallel priority with greenhouse gas limitation. Resolving this tension between mitigation and local sustainable development will be critical to encourage developing countries to engage in the discussion on future commitments.

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Appendix 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