Tyndall°Centre
for Climate Change Research

The Clean Development Mechanism: An assessment of current practice and future approaches for policy

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In cooperation with EcoSecurities

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The Clean Development Mechanism: An assessment of current practice and future approaches for policy

Environmental Change Institute Oxford
Tyndall Centre for Climate Change Research UK

In cooperation with

EcoSecurities

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Executive summary

The 1997 Kyoto Protocol obliged industrialized countries to reduce their emissions to specific targets by the period 2008-2012. A core principle in the Kyoto Protocol was to protect the climate system "for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (Article 3.1). The UNFCCC, by incorporating the principle of global cost-effectiveness of emissions reductions (Article 3.3), encouraged geographical and temporal flexibility to achieve these reductions.

The Kyoto Protocol established the first global mechanisms for the trading of carbon permits, so that reductions in emissions could occur where they are more economically efficient. Poor nations were exempt from the Protocol's binding limits but, in what was to become a key provision, were able to participate in the global project of emissions reductions by hosting projects under the Protocol's Clean Development Mechanism, or CDM.

The Clean Development Mechanism thus enabled developing nations to participate in the treaty by selling emissions credits, termed "certified emissions reductions" (CERs), to parties with commitments to reduce their greenhouse gases. These CERs were to be subject to a process of certification and verification by the U.N. accrediting body under the treaty before sale. Unlike allowance trading, in which Parties are granted a quota of emissions and may then trade under this cap, the CDM is a *project-based* approach to reducing emissions, with new credits continuously being created as new projects are approved. It was intended from the beginning that the CDM would create sustainable development benefits for developing nations.

Expectations were high to the billions of euros expected to flow from the global North to South through the CDM, generating substantial new development and a new impulse for environmental protection there.

Key findings in this report show that:

- **The CDM has shown to be effective as a new market mechanism in its aim to achieve cost effective emissions reductions in developing countries.**

- **The CDM has fallen short of contributing to sustainable development contributing to an uneven geographical distribution of projects and dominance in certain sectors. For example China is capturing the majority of projects, while Africa has gained little from technology transfer to kick start development activities, gaining only 4 percent of projects to date.**

- **The CDM dividends have been largely climate or employment related. The difficulty of defining sustainable development and the issue of sovereignty allocated to host governments the responsibility for setting sustainable development criteria, which has meant in some countries sustainable development has been overlooked.**

- **Perspectives on the CDM are diverse, some more positive, yet all highlight the potential risk factors associated with the CDM. One of the key challenges for the future of the CDM is how to illustrate to civil society that participation of local stakeholders in the CDM is possible and that sustainable development criteria at the government level will lead to social development benefits that will outweigh social costs.**

- **In discussing the future of the CDM, policy makers will have to consider the wider contributions of the CDM to development, and ways to offer additional incentives to develop a minimum percentage of CDM projects in Africa. In this way civil society, donor and business interests may all be addressed.**

- **Possible CDM futures are presented focusing on the main post 2012 proposals summarised. Five alternative options for systematically addressing sustainable development benefits in the CDM are presented. The most likely scenario is one that falls in between "not doing anything" to "politically favouring" CERs which ensure high sustainable development projects.**

Chapter 1 of this report presents the basic operationlisation of the CDM. The status of the CDM is examined in Chapter 2, and the types, location and distribution of development benefits assessed. Perspectives on the CDM are reviewed in Chapter 3, ranging from business to nongovernmental and equity based perspectives on the CDM. Chapter 4 presents a set of alternative frameworks for the operationalisation of the mechanism under plausible post-Kyoto regimes, and we discuss their environmental and development implications.

Preface

The Report was instigated by Professor Diana Liverman, of the Environmental Change Institute, University of Oxford, in collaboration with the Tyndall Centre and Ecosecurities. The overarching aim of the report was to provide a comprehensive overview of the status of the Clean Development Mechanism (CDM), to offer insights into the different actor perspectives on the CDM and to aid policy development with alternative avenues for the design of the CDM.

The creation of the report also provided an important opportunity for three different climate science and policy actors to engage in a topic of mutual interest. In undertaking this process the ECI, Tyndall and Ecosecurities have aimed to provide a report that is relevant, timely and useful to policy makers, practitioners and scholars in the run up to post 2012 negotiations.

Acknowledgements

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1 Overview of the CDM

The Clean Development Mechanism is widely viewed as an imperfect, but potentially useful, approach to encourage the development of emissions-reducing projects in developing countries. Thus far, the CDM has encouraged low-cost emissions reductions, spurring the creation of over 2000 projects which are expected to account for reductions of over 2000 MT CO_{2e} by 2012. As of June 2007, 685 CDM projects are registered and a further 125 are in the registration process. 155 new CDM projects were added to the project pipeline in May 2007 - the largest number of projects ever added to the Pipeline (UNEP-Risoe, 2007). But many questions have been raised about efficiency, equity, and effectiveness within the CDM's current architecture. As a pioneering mechanism with dual goals of emissions reductions and sustainable development, many proposals have been put forward to improve the CDM for the post-2012 period, or to adapt it to new arrangements in the post-Kyoto round agreement. The report provides an overview of the CDM's current activities, assess the literature on the CDM's successes and failures from multiple perspectives, and summarize the proposals for post-2012 improvements. We conclude by evaluating some of the potential benefits and pitfalls of likely future scenarios for the CDM.

1.1 Background

The 1997 Kyoto Protocol obliged industrialized countries to reduce their emissions to specific targets by the period 2008-2012. A core principle in the Kyoto Protocol was to protect the climate system "for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (Article 3.1). The UNFCCC, by incorporating the principle of global cost-effectiveness of emissions reductions (Article 3.3), encouraged geographic and temporal flexibility to achieve these reductions (Dutschke and Michaelowa, 1998). In the negotiations leading up to the Protocol's completion in 1997, the United States insisted on mechanisms for the trading of carbon permits, so that reductions in emissions could occur where they are more economically efficient. Poor nations were exempt from the Kyoto Protocol's binding limits but, in what was to become a key provision, were able to participate in the global project of emissions reductions by hosting projects under the Protocol's Clean Development Mechanism, or CDM.

The Clean Development Mechanism thus enabled developing nations to participate in the treaty by selling emissions credits, termed "certified emissions reductions" (CERs), to parties with commitments to reduce their greenhouse gases. These CERs were to be subject to a process of certification and verification by the U.N. accrediting body under the treaty before sale. Unlike allowance trading, in which Parties are granted a quota of emissions and may then trade under this cap, the CDM is a *project-based* approach to reducing emissions, with new credits continuously being created as new projects are approved. CERs are fungible with other carbon currencies under the Kyoto framework and mostly[1] fungible with the currency of European Emissions Trading Scheme (ETS). It was intended from the beginning that the CDM would create sustainable development benefits for developing nations. Many developing nations saw the opportunity to bring substantial investments and new technology into their nations through

[1] CERs generated from nuclear power and land use, land use change and forestry (LULUCF) projects are excluded from the EU ETS.

CDM projects, for example through new energy efficient projects in China, or agro-forestry in the rural areas of Latin America or Africa; indeed, the language of the Kyoto Protocol mandates a dual goal of the CDM for both emissions reductions and sustainable development.

In practice, the CDM has provided uneven benefits for different developing nations. For example, China is the world's second largest emitter after the US and forecasts are that China will capture the majority of projects, supplying up to 61 percent of emissions credits purchased since 2002 projects in the CDM market due to the relatively low cost of emissions abatement in China (World Bank, 2007). On the other hand, Africa has gained little from technology transfer to kick start development activities. The difficulty of defining sustainable development and the issue of sovereignty has also resulted in the decision to allocate to host governments the responsibility for setting sustainable development criteria, which has meant in some countries sustainable development has been neglected/overlooked.

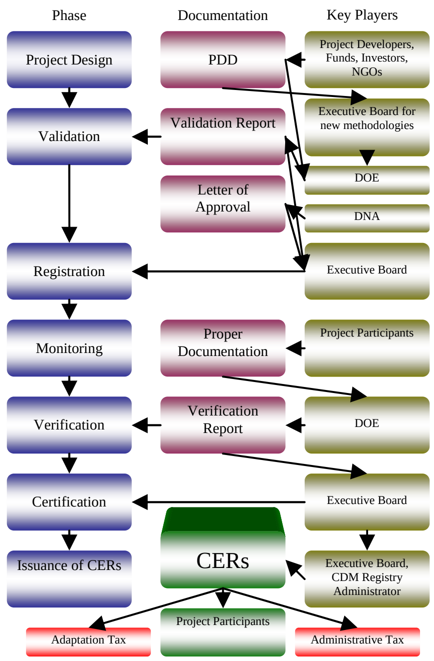

Figure 1: The CDM Project Cycle. Source: Bozmoski et al (in prep) PDD (Project Design Document); DOE (Designated Operational Entity); DNA (Designated National Authority)

The ideal cases that many designers and observers of the Kyoto Protocol had in mind were projects where local benefits such as cleaner urban air would come from CDM projects which also generated the "global good" of reducing greenhouse gases. Billions of euros were expected to flow from the global North to South through the CDM, generating substantial new development and a new impulse for environmental protection there. Although it was initiated by Brazil and other developing countries, the CDM was initially met with skepticism by many environmentalists and some negotiators. Yet the trading mechanism has now become a major feature of the treaty and the driver for extensive project implementation.

Evaluating the successes, shortcomings, and future possibilities for the CDM requires a detailed understanding of the CDM's current operations and how these affect performance. We turn to present key challenges presented to the CDM: baselines, additionality, permanence and leakage.

Further details are provided in the Appendix on procedures for establishing the quantity of credits for CDM projects; legal and institutional frameworks, how the resulting credits are traded in practice; and the relationship of CDM credits to other types of marketable greenhouse gas emissions reductions.

1.2 Project establishment

As a project based mechanism the CDM is designed to deliver certified emissions reductions credits from developing countries to developed countries. The process of CDM project establishment is generally complex and time consuming. The project cycle consists of 7 stages, from project design to issuance of CERs (Figure 1). Key actors include project developers, investors, NGOs, the Executive Board (EB) (made up of 10 members) the Designated Operational Entity (DOE), the Designated National Authority (DNA), project participants, CDM registry administrator, and administrative accountants. The creation of a well functioning DNA is a precondition for the CDM. Creation of a DNA requires designating a unit within a government body, establishing procedures and sustainability criteria and clarifying sources of DNA funding (Lambert and Grashof, 2007). Extensive documentation is required, including project design documents, validation reports, letters of approval from the host country and verification reports. The project applicant provides documentation to the EB illustrating additionality and baseline scenario for future emissions in absence of the project. The DOE registers the project and the EB approves or rejects the project, or may request revisions. The EB issues CERs to the project applicant (1 CER signifies the reduction of a Kyoto gas by 1 metric tonne of carbon-dioxide equivalent) if the project is approved and implemented successfully. CERs are then usually subject to taxes.

1.3 Baselines

As mentioned earlier, the CDM is a so-called “project-based” system. Individual projects are conceived for a specific location and host country, and the team of project developers submits the project for approval. If approved, the project is granted credits according to how much it reduces emissions relative to a “baseline” case—the emissions that would happen if the CDM project were not implemented.

While baselines are relatively simple to understand in theory, establishing a convincing and defensible baseline is difficult in practice, mainly due to its counterfactual nature. A baseline is defined by UNFCCC 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” (UNFCCC, 2002). It is not a static number; indeed, the baseline emissions would often be expected to grow over time. Thus, when the emissions of a CDM project activity are below the emissions of the baseline a reduction of emissions occurs (see Figure 2). This concept can be rewritten as:

Number of Credits from Project = Baseline Emissions – Project Emissions

This equation underscores the central importance of baseline emissions for calculating emission reductions from a project. As an example, the baseline for a wind power project in a Non-Annex I country could be the continuation of the business-as-usual scenario: electricity would be generated from fossil fueled power plants which cause GHG emissions. In order to satisfy future energy demand of the country, even more fossil fueled power plants may be constructed in the future, leading to a growth of GHG emissions. If a wind farm project was constructed and registered under the CDM instead to supply electricity, the level of GHG emissions would be decreased. As a consequence, such a CDM project would generate emission reductions.

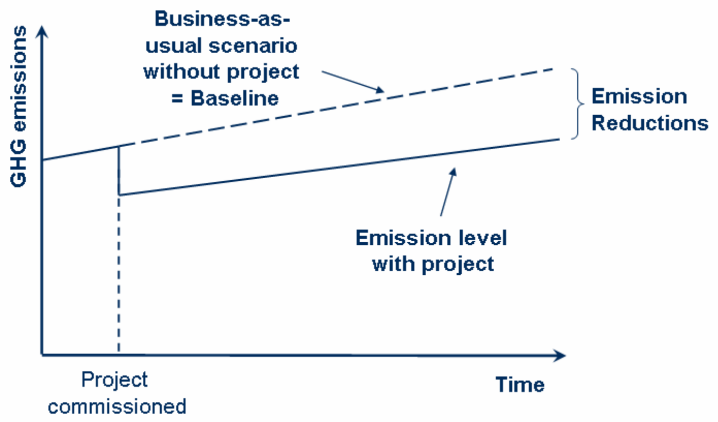

Figure 2: Baseline scenario of a CDM project activity

The key weakness of a baseline is, of course, that it will always be hypothetical: It is impossible to tell and monitor what would have really happened, if the CDM project had not been implemented. A baseline is a counterfactual scenario of the emissions without the CDM project activity (Krey, 2005) and it is hypothetical because several possible Baseline scenarios could occur without the CDM project activity (Begg and Horst, 2004). Therefore, if a wind farm project was implemented, it would be impossible to tell how else the electricity it provides would have been produced instead.

Because of this weakness it is crucial that the baseline is calculated conservatively and transparently to ensure the integrity of the emission reduction calculation. The Marrakech Accords make a number of provisions for this: baselines need to account for relevant national and or sectoral policies and circumstances, consider uncertainties, avoid the earning of CERs by events outside the project activity (project boundary) and be based on a comprehensive methodology (UNFCCC, 2002). For the CDM wind farm project example, this means that governmental action plans and projections for future energy supply need to be considered, as well as a detailed calculation of the present energy mix. For detailed steps on how this needs to be done a UNFCCC registered methodology is applied.

In the early stages of the negotiations on the project methodologies a variety of different approaches to construct baselines were debated. The two key components of this debate were the identification of baselines that would cover entire sectors, such as the renewable energy sector, on the one hand, and a project-specific baseline that would have to be re-determined for every project (Ellis and Bosi, 1999 and ProBase, 2002) on the other hand. During the negotiations it became clear that the development of sector-wide baselines was not a feasible option: this top-down approach (through the UNFCCC Executive Board) could not have adequately covered the wide variety of projects and simultaneously ensured the integrity of the baseline calculations on a per project basis. Instead the development of the baseline on a project-specific basis is applied. Through such a bottom-up approach the baseline emissions has to be determined every time a project is submitted. The project developer of a wind farm would therefore has to calculate the baseline for the particular CDM project.

A baseline approach must be applied using an approved CDM methodology. The approach to selecting the most plausible baseline scenario is clearly laid out in such a methodology. In addition, it also:

- defines the applicability conditions of the methodology
- defines the project boundary applied for the calculation of emission reductions

- provides guidance on how to determine project “additionality”
- addresses possible “leakage” effects due to the project
- includes calculations for baseline and project emissions as well as emission reductions
- includes a monitoring methodology which outlines procedures and parameters for the monitoring of the project.

Aside from these requirements, projects must meet other criteria. In particular, CDM rules require proposals to demonstrate that projects would not happen without CDM assistance.

1.4 Additionality

A complement to the concept of baselines, “additionality” refers to the requirement that a CDM project lead to reductions that would not have happened without CDM financing. The CDM activity is defined as additional only if it allows implementation of an activity that would have otherwise been prevented by investment, technological or institutional barriers. An investment barrier could be more that it is more financially viable to develop one activity over another, leading to higher greenhouse gas emissions. Another barrier might be that the prevailing norms lead to higher emissions, such as absence of regulatory policy for landfill sites. Activities claiming to reduce emissions when they do not may generate valueless and undeserved CERs. (Michaelowa, 2005a). Legitimising worthless CERs would result in displacing real emissions reductions in developed countries (Kartha et al. in Michaelowa, 2005a).

According to the Marrakech rules, additionality needs to be accounted for in the project design document. To facilitate this process the CDM EB has developed a tool to demonstrate and assess additionality. This tool is **not** obligatory, but is often used by project developers to gain approval from the EB.

Outstanding challenges posed by additionality (Cosbey et al., 2006) include:

- Methodological complexity;
- High transaction costs;
- Weak environmental integrity;
- Narrow focus on investment additionality;
- Misperceptions of mandatory nature of additionality tool.

1.5 Leakage

Climate mitigation projects can lead to an increase in emissions outside of their boundaries. Such off-site effects of emission reduction activities or carbon sinks are generally referred to as “leakage”. In principle, leakage does not only exist in a negative form, partly cancelling out the climate benefits of a project, but could also have positive spill-over effects, e.g. through the diffusion of clean technology. However, leakage is mainly discussed in its negative form because it can undermine the effectiveness of CDM projects and the integrity of associated carbon credits. It has therefore been the subject of some controversy during climate negotiations and is now an integral component of many CDM methodologies. Leakage can be subdivided into two basic categories, namely emissions associated directly with a specific project activity (“primary leakage”), and more indirect “market or secondary leakage” caused by the project’s marginal impact on supply and demand of a product such as energy or agricultural products (Aukland et al., 2003; Chomitz, 2002).

Examples of primary leakage from energy projects are the loss of natural gas throughout the pipeline distribution network in a fuel-switch projects and the production of raw materials for renewable biomass energy projects. Such leakage must be deducted from a project's carbon benefits. Secondary, market leakage could occur, e.g., when the addition of a renewable energy plant to an electricity grid or the implementation of energy efficiency measures in industries or households increases the supply of energy, thereby depressing prices of electricity and of fossil fuels used for its production. Given variable consumption rates (elastic demand), electricity and fuel use will increase in response to lower prices, thereby negating a certain proportion of the project's climate benefits. Contrary to common perception, it does not matter if a project is very small in comparison to the overall market: The amount of leakage is simply proportional to the scale of the project (Chomitz, 2002). Since market leakage is very difficult to calculate it is not taken into account in CDM projects.

In the case of forestry (i.e. sink) projects similar mechanisms apply. A reforestation project could simply displace agricultural or logging activities from one place to another, a process referred to as "activity shifting" (Aukland et al., 2003). For example, farmers could be forced to leave an area because of the establishment of a timber plantation. Therefore, most CDM forestry activities to date have been carried out on marginal, degraded land with few other productive land uses. In cases with a definite risk of leakage that cannot be quantified, CDM project developers have to assume a worst-case scenario and deduct the effect of a hypothetical clearing of primary forest from the project benefit. Market leakage could occur if the land demand of carbon forestry projects competes with commercial timber plantations or agriculture. As a result, markets for these products will tighten and timber and crop prices may rise and this can provide an additional incentive to clear forests for timber or agriculture elsewhere (Chomitz, 2002). The same logic exists for avoided deforestation projects where a simple displacement of deforestation pressures is conceivable. This concern was one of the main reasons for the exclusion of forest conservation from the CDM and is addressed in recent proposals through national-level, rather than project-based carbon accounting (see Section 4 and Box 3).

As mentioned above, positive leakage is also conceivable. For example, CDM projects employing innovative technologies can overcome information barriers that may exist for otherwise profitable but poorly understood technologies. Likewise, the establishment of forest plantations combined with a continuous, sustainable harvesting of timber can lessen the pressure on natural forests elsewhere.

1.6 The remaining challenges of sinks

Some of the most difficult methodological issues concern carbon sinks. A sink is any carbon pool that is being retained as terrestrial carbon rather than emitted as CO_2. For the CDM, a sink would normally mean organic carbon in the form of a forest, in a peat bog or in agricultural land. For now, the only sink activities eligible are reforestation and afforestation, but improving sinks in other forms of land-use may become eligible after 2012 (see Section 4).Technological approaches to sequestering carbon – such as carbon capture and storage – are not conventionally defined as sinks projects and are currently excluded from the CDM.

Demonstrating permanence is a significant challenge for sinks projects. In the case of a power station or factory, a tonne of avoided carbon emissions is very certain. In contrast, creating a sink removes CO_2 from the atmosphere, but it may be emitted again through fire or deforestation. However, C in a sink does mitigate climate change while it stays there. So, as

Fearnside (2002) states: "Credit given for options that result in temporary C storage should not be equal to that from permanent displacement…, but neither should it be zero" (p 37).

As discussed in Section 1.3, setting baselines for CDM projects involves modelling future trends both with and without the project. With land-use projects, one may lack past data for the baseline year; reforestation and afforestation must take place on land where there were no trees at the end of 1989, but although Landsat images may exist for this date they may not give sufficient resolution, especially for small-scale projects (Desanker, 2005). Should agricultural land be brought into the CDM, baseline-setting will involve historic soil carbon data that is unlikely to exist – although it can sometimes be modelled fairly accurately, as Poussart et al. (2004) have demonstrated in Sudan.

Should agricultural sinks become eligible for the CDM after 2012, there will be further challenges. For example, it will become necessary to accurately estimate GHG fluxes from agricultural land. This is sometimes very difficult. CO_2 emissions from organic matter exposed by soil erosion have been only roughly quantified at global level, but may be significant (Lal, 2003). But measuring erosion has always been more difficult than it appears. Material in sediment traps may be of uncertain origin, and consistent construction, calibration and handling of equipment are problematic (Stroosnijder, 2005); and there are special challenges of this type in developing areas (Carpenter, 1989). Similarly, estimations of N_20 fluxes from fertilizer are possible but need data on several variables, including slope, runoff, soil type and rate of application. Even with zero tillage, there is some uncertainty. Zero or reduced tillage retain and often sequester useful amounts of CO_2, as soil carbon as organic matter is not exposed to air. Although this is widely accepted, it has also been suggested that no-till does not sequester carbon and that its distribution between soil horizons – which often occurs through tillage – is the real need (Baker et al., 2007). None of these uncertainties are insoluble, but, if not addressed, could undermine the scientific legitimacy of mitigation initiatives.

Monitoring and verification of sinks are also problematic. Remote sensing can confirm the extent of forest cover, but as Cheng and Kimble (2001) point out: "Anyone who has ever walked through a forest can readily see the difference in the size of trees and in some areas, the absence of trees." In a recent submission to the UNFCCC, FAO (2006) argues that remote sensing, ground truthing and field inventories should be used, in appropriate combinations.

2 Status of the CDM

This section reviews the current status of the CDM. We provide an overview of the distribution and typology of projects developed until March 2007, and we analyse the level of financial transfers to developing countries. We also examine the contribution of CDM projects to sustainable development by reviewing literature sources and a selected subset of projects in the CDM portfolio.

2.1 Project distribution and typology

Up to March 2007, there have been 547 projects registered under the CDM Executive Board (UNEP-Risoe, 2007). These are unevenly distributed across regions and countries, as shown in Figures 3-8[2]. Projects are concentrated in Asia and Latin America, with a 50% and 45% share of the project portfolio, respectively. Africa and the Middle East have been poorly represented so far. Africa hosts only 41 projects as of July 2007. Brazil, Mexico, India, China, South Africa and Israel have benefited most in their respective regions. If one incorporates into the analysis projects under validation and those which have already requested registration (CDM pipeline), it appears that this inequitable distribution is unlikely to change, at least during the first commitment period. Asia will further dominate the CDM market, increasing its share from 50% to 66%. The share of Latin America, in contrast, will diminish from the current 45% to 30%. Countries in Africa and the Middle East will continue to host a very small number of projects and they will see their share of the market reduced by 0.2%. Brazil and Mexico will host the majority of projects in Latin America, and India and China will be consolidated as key players in the CDM market, with China increasing its share of the CDM Asian market from 15% to 32%. Taken together, India and China will host over 54% of the total number of CDM projects in the world (Table 2, Figures 3, 4 and 5).

Table 1: CDM projects by region including leading countries. Data as of March 2007, from UNEP-Risoe (2007).

Region & country	Registered March 2007	Requested registration + under validation	Total	% share of region	% share of the CDM portfolio
Latin America	**244**	**274**	**518**		**29.99**
Brazil	94	125	219	42.28	12.68
Mexico	78	74	152	29.34	8.80
Asia	**278**	**869**	**1147**		**66.42**
India	178	408	586	51.09	33.93
China	42	328	370	32.26	21.42
Africa & Middle-East	**20**	**28**	**48**		**2.78**
South Africa	6	10	16	33.33	0.93
Israel	5	5	10	20.83	0.58
Total (all countries)	**547**	**1180**	**1727**		**100**

[2] "Other countries" includes countries in Latin America and Asia which host 3 CDM projects or less.

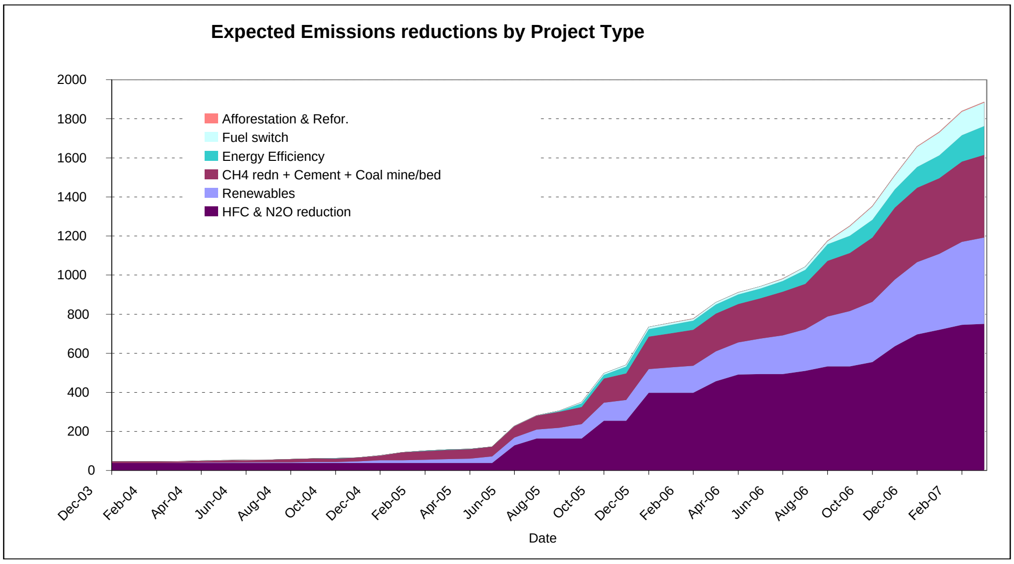

Figure 3: Time series of expected cumulative emissions reductions to 2012 (kCERs) for projects submitted to the Executive Board. Reductions are grouped according to project type. Data from (UNEP-Risoe (2007).

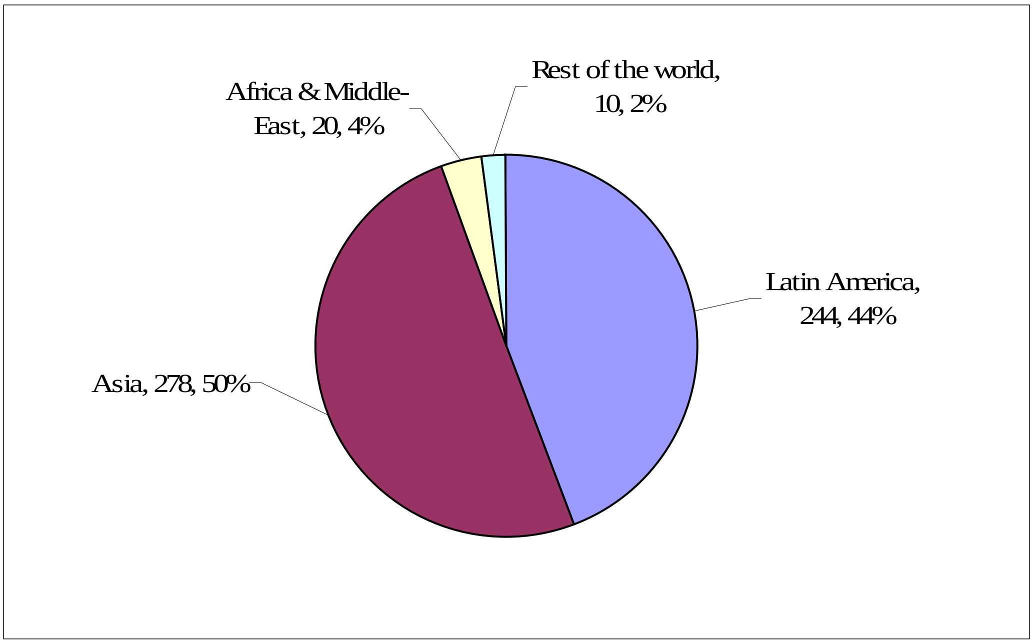

Figure 4: Global distribution of CDM projects. Number and proportion (%) of CDM projects per region. Data as of March 2007, from UNEP-Risoe (2007).

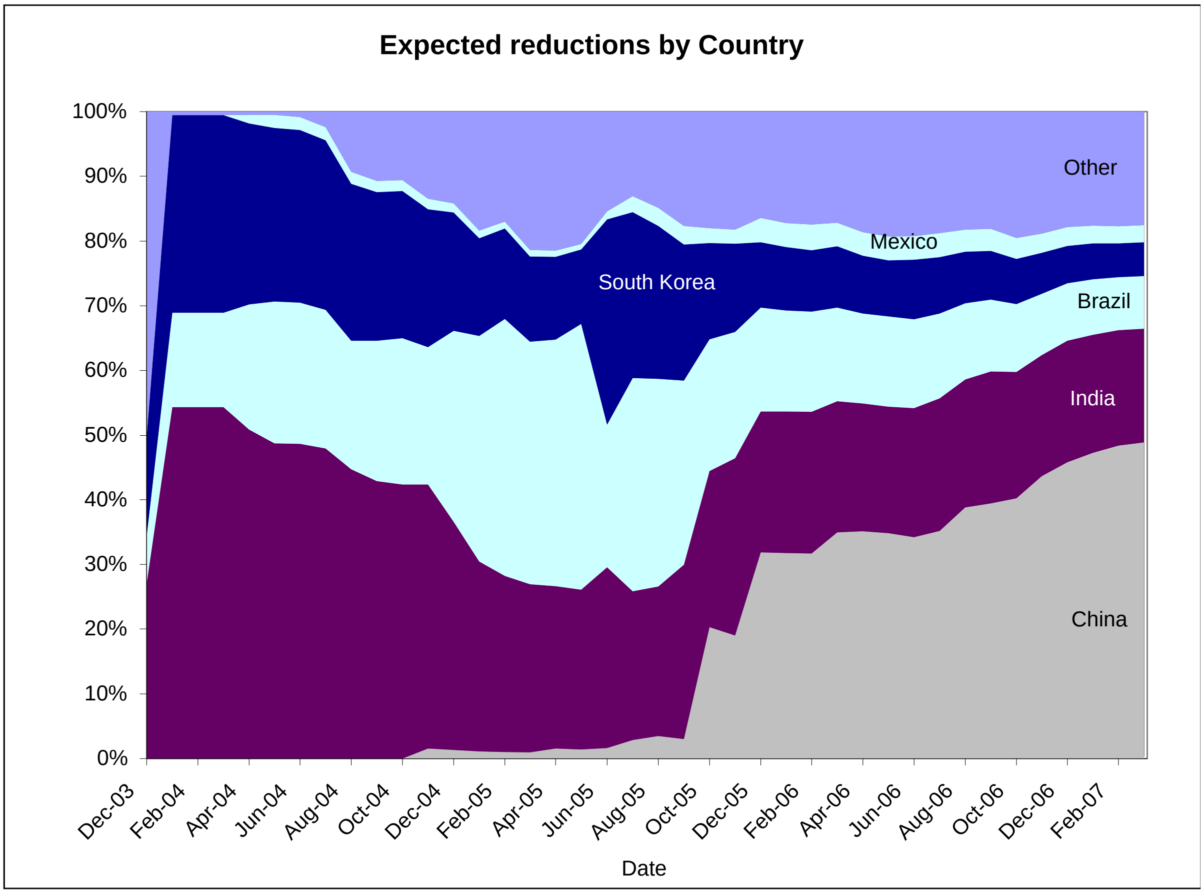

Figure 5: Time series of expected share of emissions reductions to 2012 (kCERs) grouped by host country. Starting in mid-2005, China has hosted a large and increasing share of the expected total volume, stemming largely from the availability of HFC decomposition opportunities. Data from (UNEP-Risoe (2007).

Quantities of expected reductions do not correlate strongly with the number of projects in a given country or region. So far, Asia accounts for 50% of the total number of registered projects but these provide 70% of CERs currently in the market up to 2012. China hosts 15% of CDM projects yet provides 52% of CERs from the region. India, in contrast, provides only 25% of emission reductions despite hosting the largest number of projects (178). A similar phenomenon occurs in Africa and the Middle East. While South Africa and Israel host 55% of CDM projects in the region, it is one project in Nigeria and two projects in Egypt which account for 38% and 31% of the region's CERs up to 2012. In Latin America, Brazil provides 53% of total emission reductions from Latin America.

The present and near-future structure of the CDM market is largely dominated by biomass energy, agriculture residues, hydro, wind and landfill gas projects (see Figure 6). If all projects in the current pipeline are registered, these sectors will continue to dominate the market. However, the graph below also shows that biomass energy, energy efficiency in the industry sector and hydro projects will experience a substantial increase in number over the next two or three years.

The difference between the number of projects hosted per country and the CERs provided to the market occur primarily as a result of different types of projects. Figure 6 shows that two relatively insignificant sectors in terms of the number of existing projects, HFCs and N_2O reduction projects, dominate the provision of CERs. Half of all HFCs projects (6 out of 12) are located in China, explaining its substantial contribution to the global market in CER terms. Seemingly, landfill and coal/bed mine methane projects are also very significant in the provision of CERs. Figure 7 shows that, on a sectoral basis, the number of small-scale projects is higher in the biogas, biomass and hydro sectors, while the contrary is true for agriculture, landfill gas and wind-related investments. Sectors, such as coal/bed mine methane, HFCs and cement, encompass only large-scale projects. Currently, there is an even distribution in the number of CDM projects in terms of scale (50.5% small-scale; 49.5% large-scale)[3].

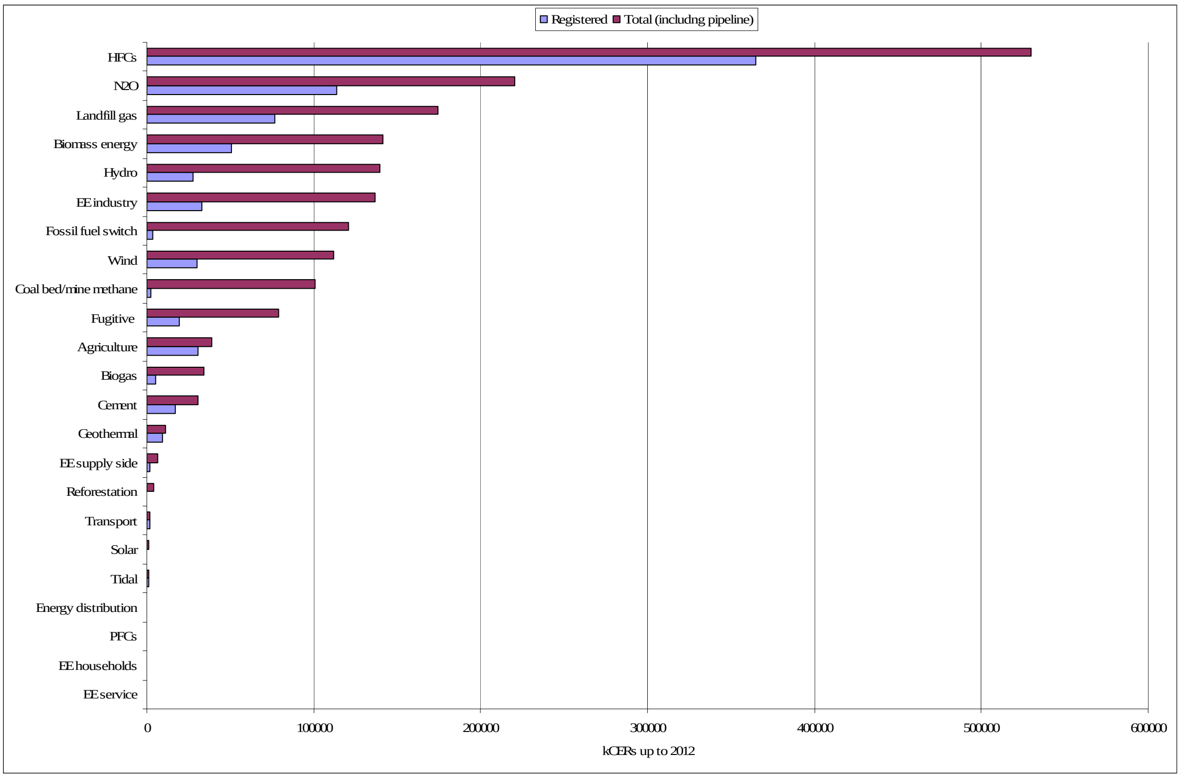

Figure 6: Contribution of CDM project types to emission reductions (kCERs up to 2012)

[3] Small-scale projects include renewable energy project activities with a maximum output capacity equivalent to up to 15 megawatts; energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 gigawatt hours per year; and other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually.

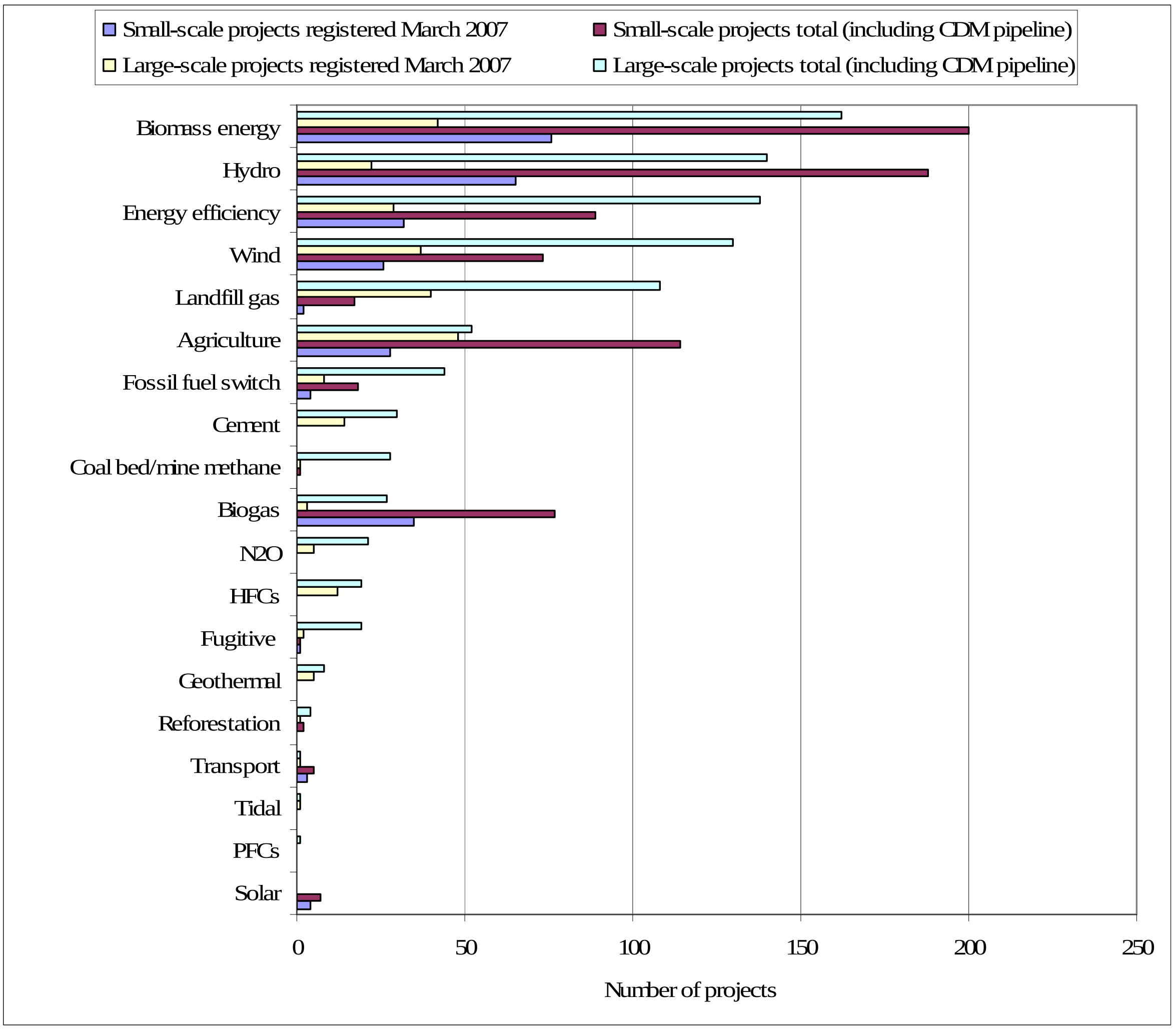

Figure 7: Number and scale of CDM projects across project types as of March 2007, data from UNEP-Risoe (2007)

2.2 Financial transfers to developing countries

As demonstrated in the previous section, all CDM investment to date has concentrated on energy-related projects, including biomass energy, hydro, energy efficiency and wind, among others. To date, there is no significant investment (in term of number of projects) in forestry. We believe it is important to compare the level of financial transfers generated through the CDM with those transfers via Overseas Development Assistance (ODA), Foreign Direct Investment (FDI), and other multilateral investment sources, such as the Global Environment Facility (GEF). By these means, we can capture the relative importance of the CDM in promoting cleaner technologies and transforming the energy mix in developing countries.

Energy investment needs over the next 25 years in developing countries are anticipated to be high, totalling some $10 trillion dollars (International Energy Agency, 2006). This figure dwarfs the amounts available for investment particularly in poorer parts of the developing world, notably Africa. For electricity investments particularly, the World Bank has calculated that $165 billion of investment per year is required by 2010, increasing by 3%

per year up to 2030. Only half of the required investment funds are readily identifiable, representing a funding gap in electricity alone of $80 billion per year (World Bank, 2006). It is assumed that the private sector will have a very significant role to play in meeting these investment needs. The nature of these energy investments will have a significant impact on climate change mitigation efforts. A major question is therefore whether the CDM can act as a catalyst to increase energy investment in the developing world while shifting the focus to clean energy technologies.

CDM contracts are *over the counter* (OTC) contracts, which mean that the financial terms of individual contracts are not public. Also, the price of CERs negotiated in individual contracts vary significantly based on the specific terms and particularly risk sharing of those contracts. Thus, to estimate the size of financial flows related to CDM, a price estimate is required. This analysis uses an estimate of US$11.45 per CER – an average price for 2006 (World Bank, 2007)**.** Reviewing projects registered as at March 2007 (UNEP-Risoe, 2007), the value of CERs up to 2012 totals $9.04 billion, averaging almost $1.34 billion per year. When comparing this figure with other energy and climate change related financial flows, including FDI, ODA and GEF finance, it appears that FDI far outweighs other north - south energy investment flows (see Figure 8). These investments include fossil energy extraction and distribution as well as, for example, fossil fuel-based electricity generation. FDI does not discriminate between clean and other energy investments. But FDI statistics need to be evaluated with care. For example, 17% of FDI relates to share for share transfers where a developing country firm is bought out by a developed country firm (UNCTAD, 2005). This does not result, in the short term, in any net additional funds in the developing country. ODA also outweighs CDM financial flows.

To interpret the potential leverage of CDM finance it is important to differentiate between revenue generating projects (such as wind farms and hydro) and pollution abatement projects with no additional economic benefit (such as those capturing but not exploiting fugitive gases – HFCs projects and N_2O projects being notable). Pollution abatement projects do not stimulate additional finance. CERs revenues are used to reimburse the project owners for the industrial process improvement – usually also with a profit (Wara, 2007). To date, a majority of CDM revenue has been sourced from pollution abatement projects ($5.5 billion out of total revenue to 2012 of $9 billion). The amount of leverage is uncertain because it only could be drawn from existing private contracts among project developers. The World Bank, from its own project experiences, made some early estimates of 6 to 8 times leverage (i.e. the project financing was 6–8 times the total value of the CERs delivered from the project) (Lecocq and Capoor, 2003). In comparison GEF finance is reported as delivering, on average, 3 to 4 times leverage across all focal areas (GEF 2006). Incorporating the project finance leverage into an evaluation of the impact of CDM on financial flows to developing countries also requires there to be confidence in project additionality tests. There has to be confidence that the projects would not have occurred without the additional inducement of carbon finance.

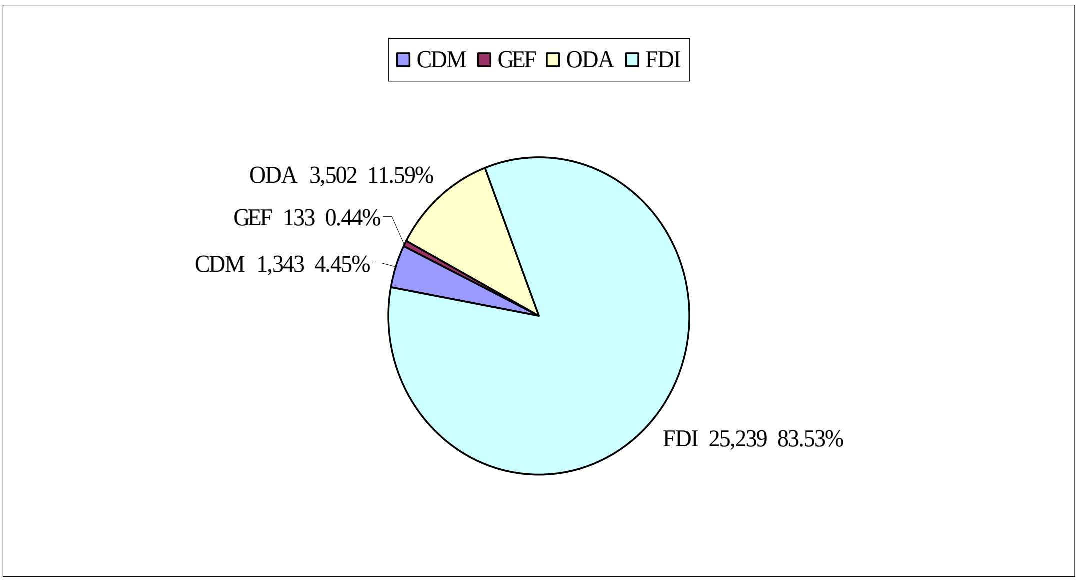

Figure 8: Energy and Climate Mitigation Financial Flows to Developing Countries (latest available data – US$ millions), averaged over 2002-2004. Source: (UNCTAD, 2006, Global Environment Facility, 2006, UNEP-Risoe, 2007, OECD, 2007). GEF data includes only climate change focal area projects; ODA data derived from 2006 OECD aid report using a 5% allocation for energy aid (OECD, 2006)[4]

Given these caveats, the full impact of the CDM programme on financial flows to developing countries (using the World Bank's leverage estimates and including HFCs and N_2O project CERs without leverage) lies between $3.8 billion and $4.8 billion annually ($26.85 billion and $33.97 billion up to 2012). This compares with 2005 GEF climate change leveraged funding of approximately $532 million. These are material flows but are, at best, 6% of the $80 billion annual shortfall in developing country electricity investment needs that the World Bank has identified. It should also be noted that ODA falls well short of filling the energy investment gap, leading the World Bank to surmise that private investment is going to have to provide the bulk of additional finance (World Bank, 2006). The degree to which the CDM, GEF or ODA are sufficient to influence the direction of these investments is very much in doubt.

The CDM programme also provides financing for an adaptation fund (to be administered by GEF). The fund is financed by a 2% levy on all CER issuance (excluding projects hosted by the least developed countries). It is not anticipated that the fund will begin disbursements until 2010 (Global Environment Facility, 2007). However, assuming an $11.45 CER price and a 2% levy on all CERs issued by 2012, the fund could ultimately be in the region of $180 million. This compares with funding of $200 million currently provided for three other GEF adaptation initiatives; the Strategic Priority on Adaptation (SPA), the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF) (GEF, 2007).

[4] FDI energy investment data derived using the best available sector disaggregation averaged over 2002 - 2004, but this incorporates some investments other than energy (mining, quarrying and petroleum; coke, petroleum products and nuclear fuel; electricity, gas and water) and is therefore likely to be over-stated.

Box 1: China and the CDM

China's regulatory framework for CDM projects is outlined in the *Measures for Operation and Management of Clean Development Mechanism Projects in China* (the "CDM Measures") promulgated by China's Designated National Authority (DNA), the National Development and Reform Commission (NDRC) on 12 October 2005. The NDRC began as the State Planning Commission, responsible for supplying sufficient energy to fuel China's growing economy, and is the architect and primary advocate of China's energy policy.

The CDM Measures establish priority areas for CDM projects. These comprise projects that achieve energy efficiency, the development and utilization of new and renewable energy and methane recovery and utilization. Although methane is a priority area, the NDRC will not approve methane projects that flare more than 20% of the methane captured, furthering China's energy policy of promoting additional electricity generation capacity.

The CDM Measures also reflect China's energy development policy. The goals of this policy are self-sufficiency and addition of electricity generating capacity. These goals have resulted in two controversial provisions of the CDM Measures that concern foreign CDM project developers. The first provision (Art. 11) requires that a CDM project owner be 51% Chinese-owned, preventing foreign project developers from undertaking wholly or majority owned CDM projects in China. This is called a local-content requirement and is characteristic of doing business in China.

The second provision (Art. 24) provides that the Chinese government and the project owner jointly own the CERs. China's basis for this position is that the underlying emissions reduction resource is owned by the government and it should thus be entitled to a share in the emissions reductions thereby generated. The government's designated share of the CER revenues and other benefits under the CDM Measures is:

a) 2% from afforestation and reforestation projects and the priority areas (essentially, projects that generate electricity);

b) 30% from N_2O projects; and

c) 65% from HFC and PFC projects.

The NDRC and the China Renewable Energy Industry Association, an NGO with significant NDRC links, justify this structure as a mechanism for encouraging the priority areas. In their view, N_2O, HFC and PFC projects do not generate job opportunities or sustainable development, reflecting their bias that the existence of the project itself must meet Chinese sustainable development goals of economic growth, addition of electricity generating capacity or job creation. These provisions do not seem to have dampened enthusiasm for HFC, PFC and N_2O projects as the six UNFCCC-registered Chinese HFC, PFC and N_2O projects are projected to constitute 14.2% of CERs generated globally through 2012 for all 547 CDM projects registered before 14 March 2007. A review of the 12 HFC, PFC and N_2O projects in the validation and registration phases, together with the foregoing UNFCCC-registered projects, indicates that these 18 projects are forecast to constitute 24.4% of all CERs generated before 2012 by those 1727 CDM projects registered, in validation and pending registration.

China's promotion of energy self-sufficiency and the addition of electricity generating capacity must be read as twin goals and not alternatives. Elsewhere China promotes foreign investment in the renewable energy sector. Renewable energy is an "encouraged" sector in the Chinese Catalogue for Guiding Foreign Investment in Industries (promulgated by the NDRC and the Ministry of Commerce on 30 November 2004 and effective as of 1 January 2005). This means foreign project developers are not only permitted to invest in the sector through wholly or majority owned enterprises, they are actively encouraged to do so with incentives such as tax free import of equipment. On the other hand, the effect of the CDM Measures' 51% Chinese ownership requirement is to render majority foreign-owned entities uncompetitive in public tenders for renewable energy projects. This is because Chinese electricity tariffs are comparatively low and the ability of 51% Chinese-owned companies to supplement tariff revenue with CERs is a significant competitive advantage. The result is an increase of electricity generating capacity by Chinese controlled companies leading to an increase in self-sufficiency. These factors have not dissuaded project developers from investing in China. As of 14 March 2007, 7.7% of UNFCCC registered projects were in China, representing 40.2% of the annual CERs expected from all such projects. Due to the NDRC's long approval times, Chinese projects are behind in the UNFCCC approval process. If projects pending UNFCCC registration or in validation are also included, 21.4% of global CDM projects will be in China, and those projects are expected to generate 48.9% of the global CERs through 2012 from those 1727 projects registered, in validation or pending registration.

2.3 Sustainable development in the CDM

The principles of the CDM outlined in Article 12 of the Protocol stress that CDM activities should contribute to sustainable development in the host-country. The elaboration of the CDM framework in the 2001 Marrakech Accords (UNFCCC, 2001) emphasises that it is the host country prerogative to define whether a project contributes to sustainable development. In most countries this has become a process through which DNAs assess project documentation against a set of pre-defined criteria. These criteria tend to encompass the following aspects: environmental, social and economic, which are evaluated by qualitative and quantitative indicators (Schneider and Grashof, 2007). Recent studies suggest that CDM contribution to sustainable development has been and is likely to be limited (Olsen, 2007, Lohmann, 2006). In some large-scale CDM projects with very little benefits to local people, developers have committed to use a percentage of CER revenues to fund local development projects (Capoor and Ambrosi, 2006, Ellis et al., 2007). For CDM small-scale projects, Brunt and Knechtel (2005) show that CDM investment is often insufficient to cover the high transaction costs involved in the design and implementation of community-based CDM projects, which puts project developers in the position of searching for additional funding to kick-start and consolidate projects. For this reason, it has been argued that a future CDM framework should allow for project bundling, sectoral crediting approaches and the use of ODA to foster local capacities, which would contribute to reduce small-scale projects transaction costs (Begg et al., 2003, Egenhofer et al., 2005).

Box 2: Africa and the CDM

The Nairobi COP/MOP in 2006 found many African nations bemoaning the lack of benefit for Africa of the CDM. Some figures illustrate these concerns. As of March 2007 [5]Africa had 37 projects in the CDM pipeline (including those registered, in validation, rejected/withdrawn etc), making up 2.1% of projects in the pipeline globally. There were 15 registered African CDM projects, accounting for almost 2.7% of projects registered globally. Removing North African countries from the analysis, sub-Saharan Africa had 25

[5] All figures quoted are from Pipeline Overview of the CDM & JI projects, by the UNEP Risoe Centre Denmark, which was accessed at www.cd4cdm.org/Publications/CDMpipeline.xls on 28th March 2007.

projects in the CDM pipeline (1.4% of global total) and accounted for only 1.8% of registered projects.

Of projects either at validation, requesting registration or registered - the volume of CERs expected to be delivered by 2012 from sub-Saharan African projects makes up 4% of the global total. The table below highlights how, in addition to the low volume of projects and anticipated CERs in absolute terms; the volume of 2012 CERs per capita is also low in Africa compared to other regions.

Various analyses have attempted to identify the reasons for the poor performance of Africa with respect to the CDM. These issues include lack of awareness, capacity and skills to develop CDM projects, and poor development of relevant institutions (especially DNAs). However it is important to note that most investors do not differentiate in practice between an investment in an energy project *per se* and a CDM energy project. In this sense the relative lack of CDM investment in Africa reflects the more general problem of a difficult investment environment in Africa, including issues of governance, policy development and regulation (Ellis, 2007).

Despite the barriers, numerous opportunities are available for the CDM in Africa, ranging from hydro-power through to small-scale energy projects delivering direct development benefits to those in poverty, to land-use projects. Discussions continued at the Nairobi COP/MOP in 2006 on CDM methodologies for certain small-scale projects. This included discussions on energy used for cooking stoves, which accounts for large proportions of energy use in sub-Saharan Africa through the burning of biomass. Using traditional stoves presents a significant health hazard for women and children [6] through exposure to very high levels of indoor air pollution. Despite the opportunity that improved biomass cook-stoves present for improving health, reducing wood use, and achieving GHG emissions reductions, the opportunity to increase their use through CDM funding was largely missed in Nairobi, and progress within the CDM Executive Board is slow.[7]At the Nairobi COP/MOP, the UN Secretary General Kofi Annan announced the launch of a new initiative, the Nairobi Framework, initiated by the United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), World Bank Group, African Development Bank, and the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), which aims to support the participation of poor countries – in particular African - in the CDM. Activities planned within the Framework include[8]:

* Building and enhancing capacity of DNAs to become fully operational

* Building capacity in developing CDM project activities

*Promoting investment opportunities for projects

*Improving information sharing/outreach/exchange of views on activities/education and training

*Inter-agency coordination

Once operational, this initiative should help to support the improvement of the investment environment for CDM projects in Africa, although it is unlikely to deliver significant benefits in the first commitment period given the short window still available.

[6] The World Health Organisation (The World Health Report 2002) estimates that indoor air pollution from inefficient, unvented stoves causes around 1.6 million premature deaths annually in the developing world.
[7] This section draws on draft Tyndall Centre Working Paper draft "Assessment of key negotiating issues at COP12/MOP2 in Nairobi and thoughts on what it means for the future of the climate regime", Lead authors: Okereke, C and Mann, P
[8] Source UNFCCC CDM Secretariat http://cdm.unfccc.int/Nairobi_Framework/index.html

We review below the environmental and development benefits of 10 illustrative CDM projects (Table 2). They are located in India, as leading CDM host country in Asia, Brazil, as leading CDM host country in Latin America, the Republic of South Africa, as leading CDM host country in Africa, China, which together with India and Brazil is one of the three largest destinations for CDM investment, and Peru for the distinctive approach of its DNA to the project approval process. We consider "direct benefits" those that arise directly from the project, for instance through the provision of employment to develop and operate the project, as occurred in the Poechos I project where 200 local people were hired during the construction phase and 30 permanent jobs were created. "Indirect benefits" reflect the case where there are not direct benefits for local people but there is a hypothetical improvement in environmental and social conditions, either globally or locally. To use again the Poechos I project as an example, indirect benefits result from the use of renewable energy and the correspondent reduction of global GHG emissions. When the benefits of a project are almost negligible, these are classified as "little" direct or indirect benefits. The Ganpati project design document, for instance, claims that there will be some (unspecified) employment opportunities in material collections, which will be minimal at the plant's operational level.

Project	Project summary	Environment and development benefits						
		Environment	Economic	Tech transfer	Health	Employment	Other social	Education
Ganpati (India)	Expansion / modernisation of the biomass co-generation facility at Ganpati Sugar Industries Limited (GSIL) sugar mill, India. The biomass to be used as fuel would consist of bagasse generated by the sugar mill	(√)	√-	√		√-, (√)-		
TSIL (India)	Waste heat recovery of the waste gas generated to produce steam at the Tata Sponge Iron Limited (TSIL), which is further utilised to generate 7.5MW power meeting the electricity demand of the factory. The surplus power generated is exported to the state electricity grid	(√)	(√)-			√-		
Santa Lúcia II (Brazil)	7.6 MW run-of-river hydroelectricity project that does not include a reservoir. It replaces a diesel powered thermal plant that originally supplied electricity to a remote area in the State of Mato Grosso	(√)						
Klabin Piracicaba (Brazil)	Switching fuel oil to natural gas in four steam boilers, at Klabin S.A. in the plant of Piracicaba, São Paulo	(√)						
Durban (RSA)	Collection of landfill gas at two landfill sites of eThekwini municipality and the use of the recovered gas to produce electricity, which will be fed into the state grid	√				√-		
Rosslyn Brewery (RSA)	Replaces the equipment at the boiler room of Rosslyn Brewery plant to use natural gas and biogas, which is generated in an anaerobic digester of the industrial facility and is currently flared	√			(√)-	(√)-		
Huitengxile (China)	Construction and operation of a wind park of 95 wind turbines generating 266.1 million kWh per year, which will supply electricity to the State grid in north China	(√)		(√)	(√)-	√-		
Nanjing Tianjingwa (China)	Landfill gas collection and utilization project in Pokou District, Nanjin City, to produce electricity for export to the state grid	√		(√)	(√)-	√-		
Turucani I (Peru)	49MW hydroelectric power station, operating from an existing water regulating reservoir, in Querque. It displaces electricity generated from oil, diesel, coal and gas-fired plants	(√)	(√)		√	√	√	
Poechos I (Peru)	15,2MW hydroelectric power station, operating from the existing reservoir. The energy generated will be sold to Electronoroeste S.A., a state-owned company	(√)	(√)			√	√	(√)
√: Direct benefits; √-: Little direct benefits; (√): Indirect benefits; (√)-: Little indirect benefits								

Table 2: Environment and development benefits of 10 CDM projects

Table 3 shows that all projects address emission reductions but fall short in delivering other substantial direct benefits. Landfill projects use the recovered gas which has negative effects on local health to produce electricity and improve landfill management, thus reducing surface and groundwater pollution. However, little direct employment and other benefits are provided. In fact, the South African project has been criticised by environmental groups and local activists, who claim that carbon finance is contributing to postpone the closing down of the waste disposal site, which for the past two decades has not addressed its negative impacts on local people's health and environment (Lohmann, 2006: 287-292). Fuel switching projects do not generate significant social benefits either, as they do not involve construction or the creation of specific jobs.

Sponge iron projects, such as the Indian case, are similar at this respect. They only provide indirect environmental benefits by reducing emissions on-site and CDM finance does not bring additional employment or social benefits. In fact, one of the biggest Indian sponge iron companies involved in a CDM project has been suit in the state High Court by concerned individuals and NGOs who claim that the company is putting pressure onto local villagers to sell their land and to appropriate local water resources for the expansion of the company facilities and its business. Other sponge iron companies across the country have also been subject to severe criticisms, and in some cases local revolts have taken place to protest against employees' bad working conditions (ibid.: 259-261). Environmental benefits across the renewable energy projects are achieved by displacing fossil-fuel generation and only in the Peruvian projects we appreciate direct benefits in terms of health and employment.

Ellis (2007) suggests that the provision of additional benefits is a consequence of the process by which countries approve their projects. For example, in a recent paper comparing CDM projects in Brazil and Peru, Cole (2006) concludes that these countries have established different social development goals, with Brazil emphasising employment and income distribution objectives and Peru pursuing more general local community needs. They have also chosen contrasting regulatory approaches. Peru has chosen an *ad-hoc* regulatory approach whereby the DNA visits project sites and asks local communities about their needs and their potential contribution to the project. Brazil, similar to India and South Africa, developed a set of generic criteria, and applied a desk-based "checklist" approach. In many cases, this has resulted in PDDs where project developers' existing (business-as-usual) activities were sufficient to meet the prescribed criteria. China has also chosen sustainable development criteria which aims to advance its energy policy. While the Chinese regulations are procedurally similar to Brazil, India and South Africa, their goals appear to be quite different. The Chinese projects have a stronger focus on promoting national economic growth over the local dimension of sustainable development.

In conclusion, our illustrative review shows divergences and no causal relationship between project types and sustainable development outcomes. In most cases, these outcomes seem constrained to some direct employment benefits. Our analysis also reveals that it can be misleading to assess projects performance only through project documentation, as local struggles and other development and climate mitigation alternatives may result invisible. This is the case because project developers may be biased in selecting participants for stakeholder workshops, thus under representing critical views in project reports (Sutter, 2003, Cole, 2006; Corbera and Brown, 2007). Moreover, the fact that PDDs are open to public scrutiny only through the internet before their final approval by the CDM Executive Board limits the number of people who can practically participate in such process, as most people in developing countries have difficult access to the internet (Corbera, 2005; Lohmann, 2006). This only underscores the importance of conducting further research in planned and ongoing projects in order to provide valuable lessons for the re-design and improvement of the CDM in the future.

3 Perspectives on the CDM

In this section, perspectives on the CDM are considered. These include: business, NGO and civil society, and donor and recipient perspectives. Table 3 provides a summary of perspectives derived from the literature in terms of risks and motivations and the CDM.

Table 3: Perspectives on the CDM

Perspective	Risks	Motivations	Source
Business perspectives	Financial risks Free-riding resulting from asymmetric information International regulatory uncertainty Long-term investment and loss of CER value Accountability (e.g. breach of contract by host government) Loss of reputation	Publicity, Corporate Social Responsibility Climate leadership	Bernow et al., 2001; Zhang and Maruyama, 2001; Jotzo and Michaelowa, 2002 OECD, 2002 Matsuhashi et al., 2004 Kearney, 2004 Strech, 2004 Murdiyarso, 2004, Parikh and Parikh, 2004, Zeng and Yan, 2005 Jung, 2006, Fischer, 2005, Krey, 2005, Michaelowa and Jotzo, 2005, Ellis et al., 2006 Diakoulaki et al., 2007, Río, 2007
NGO, Civil Society & Equity perspectives	Local social and ethical costs Loss of land tenure, access, increased vulnerability Reinforced hierarchies/power dynamics Supports bad science Fear of green-wash Additional emissions Costly Risky	Livelihoods benefits/poverty alleviation Locally driven projects/Renewable energy Enhancing local capabilities	Lohmann 1999, 2001, 2006 Fearnside 2002, 2005 Meinhausen and Hare 2003 Boyd, 2003, Boyd et al., 2007ab Kim, 2004 Brown, 2004 May et al, 2004 Gundimeda, 2004 Bachram, 2004 Corbera, 2005 Ayres et al., 2006 Liverman, 2006
Donor and recipient perspectives	Sovereignty Accountability Scientific uncertainty	Source of development finance Technology transfer	Michaelowa, 2004;2007 Cosbey et al., 2005, 2006 Boyd et al., 2007c Roberts and Parks, 2007

3.1 Business perspectives

The CDM in its current form presents disincentives that affect the total quantity of projects submitted for certification as well as the type, host country, and size of the projects. These pressures affect the areas of opportunity that businesses evaluate as they consider allocating capital and resources to new projects. First, critics of the CDM have repeatedly pointed out the unwieldy bureaucratic structure of the mechanism and the associated large transactions costs for initiating a project and steering it through the approval process (Krey, 2005; Michaelowa and Jotzo, 2005; Zhang and Maruyama, 2001; Jotzo and Michaelowa, 2002). However, transactions costs are but one of several obstacles. CDM-eligible carbon reductions carry a high degree of financial risk that practitioners must integrate into their investment decisions (Streck, 2004). To enhance their return, CDM projects require the transfer of an intangible commodity—carbon credits—generated over many years, creating significant investment uncertainty.

The CDM's regulatory architecture introduces additional uncertainties. For example, asymmetric information between the investor, the host country government, and the DOE creates the possibility of systematic bias in the development of acceptable project parameters. In particular, CDM participants may conceal information from the DOE that might lower baseline estimates (Fischer, 2005). Asymmetric information also may lead to free-riding with non-additional projects and threaten the carbon neutrality of the CDM (Bernow et al., 2001), but this risk is not borne by investors. International regulatory uncertainty creates further disincentives.

Because the Kyoto Protocol's first commitment period ends in 2012, a major market risk for investors is the possibility that CERs will lose value beyond the relatively short horizon of 2012. Risk-averse investors will thus favour projects that generate many CERs quickly. This preference supports such high-volume projects as HFC, N_2O, and CH_4 reductions at the expense of longer term renewable electricity generation and energy efficiency investments (Ellis et al., 2006). Other risks seen by project developers include the possibility that the DNA may not verify the project, meaning that investors already having financed the project would not earn any CERs; that the DOE may modify the project parameters when projects are renewed, which would change the number of credits earned; that the host country may not approve the project; or that CER buyers may breach the original contract (Matsuhashi et al., 2004).

CDM-project sponsorship varies at the country, sector, and firm level. Variations across countries can be explained in part by the host country's mitigation potential, institutional capacity and investment climate (Diakoulaki et al., 2007; Jung, 2006; Murdiyarso, 2004; Parikh and Parikh, 2004; Zeng and Yan, 2005). It appears that the constituents of a successful "enabling environment" for foreign direct investment (FDI), such as macroeconomic and political stability, institutional predictability, legal competence in contract law and enforcement, and regulatory and business transparency (OECD, 2002), mirror the variables that explain variation in CDM investment across different countries (Ellis et al., 2006). Indeed, with only one exception (Malaysia), the developing countries with the highest FDI Confidence Index also have the greatest CDM attractiveness: India and Brazil, the two most active CDM host countries, ranked 3rd and 17th highest in the world, respectively, in 2004 for FDI confidence (Jung, 2006; Kearney, 2004).

Some sector variation is explained by mitigation potential. Certain sectors, like flare gas reduction, CH_4 reduction from landfills, N_2O reductions from adipic acid production, and HFC decomposition, can generate high volumes of certified emissions reductions (CERs) at low cost and are therefore very attractive to investors (Ellis et al., 2006). Other sector-dependent variables include the required initial capital investment, the difficulty of calculating baselines to assess additionality and determine CERs, and the length of time between investment and CER generation (Fischer, 2005, del Río, 2007). While relatively small CDM projects benefit from simplified baseline calculation methodologies, they also suffer at current CER prices due to fixed costs in the project cycle (Michaelowa and Jotzo, 2005). Indeed while certification remains a goal of many project developers because of the price premium, the constraints of the certification process—in particular the imminent time constraint—are enough to push some developers to retail or voluntary markets.

3.2 Divergent NGO, Civil Society and Equity perspectives

The CDM by design links markets to wider poverty agendas. The tension between these two approaches—market efficiency and often non-market improvements in human welfare—can make CDM projects controversial. Moreover, the CDM is time consuming, risky and expensive thus limiting local development benefits and small-scale projects (Ayres et al., 2006). The most vocal groups have been anti sinks and CDM groups such as SinksWatch while development NGOs such as, Oxfam and Mercy Corps have only recently begun to engage in the mitigation debate. The CDM also represents an ideological split between those who see climate change primarily as a problem of consumption and a responsibility for the industrial sector to meet domestic emissions efforts (Lohmann, 2006). Groups like Greenpeace argue that CDM is a loophole for rich countries to avoid emissions reductions and could provide an entry point for nuclear power into the CDM. Critical NGO positions focus on ethics, structural inequalities and scientific inadequacies of the CDM. These groups suggest that CDM projects are an unethical way for rich societies and industries to sidestep their domestic responsibilities to tackle climate change. While industry benefits from projects poverty and underlying structural inequalities are not addressed. Moreover, significant remaining uncertainties in the effectiveness of CDM to realize its emissions reduction goals, underscoring lack of consensus on the treatment of additionality, permanence and leakage.

Despite a very small scope in the current pipeline of projects, much of the debate on the CDM revolves around forest mitigation projects and their negative impacts on local and indigenous communities (see Box 3). In particular, Greenpeace raises concerns that credits for sinks projects will allow higher fossil fuel related emissions to distract financial resource flows from renewable energy and energy efficiency, and that the CDM rules (specifically for afforestation and reforestation for CDM) may result in environmentally and socially destructive projects (Meinhausen and Hare, 2003). The most critical voices contest carbon markets as ‘carbon colonialism’ (Lohmann, 2006) and as a ‘modern incarnation of a dark colonial past’ (Bachram, 2004:16). These carbon sceptics raise ethical implications of the CDM and the ramifications of privatizing the Earth’s atmosphere. One major concern is that the CDM will allow multinationals to usurp indigenous lands through monoculture carbon sinks plantations (Lohmann, 1999, 2001).

Because central governments are responsible for certifying sustainable development under the DNA some critics suggests a conflict of interest between national governments overall desire for foreign investment and the needs of local communities who may be affected by the project. The extent to which local communities may comment on or benefit from CDM projects is highly dependent on structures of local governance and opportunity for participation (Boyd, 2003; Boyd et al., 2007b; Kim, 2004).

A number of NGOs and civil society organizations also see opportunity in the CDM (Fernside, 2002). Civil society movements, such as the Green Belt Movement, responsible for planting some 30 million trees across East Africa, are exploring opportunities for forest mitigation projects. Community groups in Mexico have engaged in payments for ecosystem services, voluntary projects akin to the CDM (Corbera et al., in press). In its present form, the CDM provides limited opportunity for individuals to offset their emissions through community initiatives such as solar power or renewable energy projects. These types of schemes mainly fall outside of the CDM, under voluntary offset projects supported by the World Bank, International Aid Organizations, and companies such as Climate Care UK.

Box 3: Conflicting positions on forests and CDM

Key watchdog groups that scrutinize CDM projects include the CDMWatch (www.cdmwatch.org) and SinksWatch (www.sinkwatch.org). Fern, a Brussels based NGO, has been monitoring CDM sinks projects for several years together with the World Rainforest Movement, Friends of the Earth, and the International River Networks. These organizations have all been prominent lobbyists at the international climate negotiations. Specifically, these groups lobby against sinks, large dams, coal projects (CCS) and nuclear from entering the CDM. Sink projects are the most controversial currently, and the majority of these organizations have focused on the negative effects on biodiversity and communities from monoculture tree plantations in the CDM. Despite such concerns, there is little evidence to suggest that CDM projects have led to significant human rights abuses. From a critical development perspective, some suggest that CDM projects have however fallen short of their development expectations (Boyd, 2003; Brown and Corbera, 2003; Brown et al., 2004; Gundimeda, 2004; Corbera, 2005; Pearson, 2007). Similarly, in the energy sector, Sutter (2003) highlights that CDM has proved little benefit to communities living adjacent to biomass projects. Most projects have failed actively to engage local populations in participating in project activities, although capacity building has often been a positive spin off. In contrast, NGOs such as the Nature Conservancy, the Union of Concerned Scientists, and various other International conservation NGOs have taken a more ‘positive’ stance toward the CDM, largely pushing for the inclusion of conservation as offset projects (see section on Avoided Deforestation below; Fearnside 2002, 2005).

Although CDM is considered less nebulous than voluntary offsets, some have identified that voluntary carbon offsets may actually transfer resources that will allow communities to leverage benefits locally (Ayres, 2006). In particular, this points to small-scale projects in India and Latin America where alternative cooking stoves are provided to communities. Thus, ‘lumping’ all carbon offsets together as one and opposing these ideologically has serious implications of excluding people from benefiting from the global carbon market (Liverman, 2006; Bumpus and Liverman, 2007). As described in section 1.3 additionality remains a problematic aspect of CDM. If projects are not monitored effectively they may contribute rather than reduce CO_2 emissions. Failure to monitor projects could jeopardise the integrity of the Kyoto Protocol as it may result in double counting of CO_2 emissions.

3.3 Donor and recipient perspectives

Multilateral donors and bilateral donors have made key investments to start up the CDM. Many donors have been actively supportive of building CDM capacity, contributing to almost 10 percent of the allocated funds invested in CDM (Michaelowa, 2004).
Donors can be split into two categories, those that invest primarily in CDM capacity building and those that engage in project development and engage with investors and credit purchasers (Cosbey et al., 2005). Development agencies and UN multilateral organizations have mainly focused on capacity building activities to assist participation of developing countries in the CDM and have limited enthusiasm for the CDM (Cosbey et al., 2005). The countries that have been active in promoting the CDM and capacity development are the Netherlands, Denmark, Japan, Norway and Canada, Austria, Belgium, France and Germany (ibid, 2005). Donor perspectives are summarized in Box **4**.

Among the multilateral agencies, the World Bank has taken a leading role in the CDM. The World Bank has established three funds with an estimated total value of $352 million. The Prototype Carbon Fund was the first carbon fund with 17 private and 6 public investors. The Community Development Carbon Fund focuses on small-scale and community projects and the Bio Carbon fund targets forestry and agricultural sinks with social co-benefits. The Bank also acts as a trustee for funds established with national governments in reaching emissions reductions targets, for the Netherlands, Italy, Spain and Denmark (Cosbey, 2005).

According to Cosbey et al (2005) multilateral banks perceive CDM as an opportunity to engage in international environmental cooperation and for companies to comply with international regulation. On the downside, the high transaction costs, of up to $200 000 per project, are a deterrent. The bureaucratic nature of project approval was also highlighted as negative as are the lack of host country capacity to integrate CDM into national planning.

Often property rights and institutions are absent in host countries or remote regions where some projects are being developed, and as with other development interventions, mainly the elite are able to take advantage of any new income streams. Implementing agencies in these countries must allocate significant resources and staff to CDM project planning and execution, which may represent significant lost opportunities in other areas such as social development. Overall, the key issues that need addressing are accountability and transparency in project design and implementation. These design and implementation problems are also exacerbated by the challenges associated with the loss of state control over regulating externalities, and the general breakdown of community structures and social cohesion. In other words, the CDM is almost expected to address a multitude of highly complex issues, which it is not equipped to do. These are issues, which could be addressed given the right circumstances and incentives (Boyd et al, 2007a, b; Brown et al., 2004; May et al., 2004).

Box 4: Summary of Donor perspectives

Cosbey et al (2005) positive and negative donor perspectives on the contributions of the CDM:

(+)

Effective increase in climate awareness at national level
Concrete action
Potential increase in FDI
Value on emissions reductions

(–)

CDM secondary to adaptation
CDM outside of mandated scope and Millennium Development Goals
Lack of capacity in Ministries on sustainable development and DNAs
CDM not integrated into national planning processes or country driven
High transaction costs, lack of transparent institutional and legal frameworks
Knowledge gaps
Unrealistically high expectations of host countries
Tradeoffs between low cost CERs and sustainable development
Costly

In the early negotiations leading up to Kyoto, many developing countries were initially opposed to allowing credit trading. China, India and Indonesia, for example, repeatedly objected to the inclusion of joint activities in the Protocol, while Brazil supported inclusion on the bases that it should not deter from developed countries meeting emissions targets (Thompson, 2005). By COP-10 in Buenos Aires (1998) developing countries were competing to attract CDM investments, with rumors of aid flows from North to South of a magnitude ten times the size of all current foreign aid (Roberts and Parks, 2007).

A priority for developing countries has consistently been to strengthen commitments to technology transfer, leverage investment in – for example – energy infrastructure and assist efforts to support sustainable development (Boyd et al., in prep). Ways to achieve these objectives included joint implementation and the clean development fund (originally proposed by Brazil). However, some parties suspected such measures would create loopholes and exacerbate inequalities between countries (*ENB* 1997:6). For example, the Alliance of Small Island States focused on efforts to mitigate future climate impacts by reducing the use of fossil fuels.

Costa Rica and several other Latin American countries have been under the assumption that the CDM brings the transfer of large sums of money for forest protection. Brazil in contrast, has opposed sinks in the CDM on the grounds that such projects would jeopardize the integrity of the Protocol and continue to do so in the recent debates on avoided deforestation (see Section 4).

3.4 Summing up perspectives

In spite of expectations that the CDM would bring sustainable development benefits to a host of communities and nations, the first period has seen very few projects which create significant employment or other development benefits. Rather, being a market-based instrument, we have seen in earlier sections how the inexpensive, high-volume projects have been favored—projects generating large numbers of CERs with minimum complications

(Wara, 2007). We have also seen that there are huge national differences in the levels of expectations by DNAs as to the level and nature of the sustainable development benefits they expect to achieve in connection with a project. A recent comparison by Cole (2006), showed how some nations require virtually none, and these are precisely the nations which are attracting the most attention from CDM investors. Some DNAs expect much more, and have successfully negotiated with project developers to deliver many local benefits, both those related to the project and some entirely unrelated. A further comparison might be made between the efforts of CDM project developers to deliver local development benefits and those of transnational mining or hydroelectric companies, who have been under severe international pressure to provide health clinics, schools, transport and other benefits to their host communities. Further research is needed on the actual sustainable development benefits of CDM projects, especially on what factors contribute to successful local social benefits (Boyd, 2003, 2007ab; Corbera, 2005; Bumpus and Liverman, 2007).

Therefore as the CDM moves into its next phase, the question must be asked: should the program continue to attempt to bring sustainable development benefits, or should it be streamlined to be simply a market mechanism? It can be argued, for example, that the CDM was in fact designed to be a market-based mechanism rewarding the cost-effective mitigation of carbon. Sustainable development, being a politically desired and poorly defined “addition” to its requirements, is not incorporated into its core incentive structure. It is evident from the current pipeline of CDM projects, that the market has been very successful in finding efficient mitigation options. From a climate mitigation viewpoint, any additional, non-carbon specific requirements increase mitigation costs and lead to fewer emission reduction activities overall. Similarly, it is logical that private investors focus their efforts on countries with low political and economic risks for their projects, and the CDM is no different in this regard from other forms of foreign investments. It may simply be too much to ask of one mechanism to achieve such diverse goals simultaneously, and sustainable development goals might more appropriately be funded through different channels.

However if the CDM was to be divorced from sustainable development demands, these would have to be addressed elsewhere in the Protocol, or at least in the larger system of global governance. An example of a socially and environmentally-desirable project which might be ignored if the CDM is divorced from sustainable development might be energy-efficient fixtures, appliances and insulation in popular housing across the millions of informal housing units in urban peripheries of the developing world. While creating both local and global public goods, installing and maintaining these would require huge amounts of staffing and institutional capacity, and reliable and high levels of financing and institutional attention from agencies and watchdog groups.

From a business perspective we have seen that the CDM poses some opportunity and many risks. Yet, the CDM market continues to grow – as illustrated in previous chapters. From a civil society and equity perspective the contribution of CDM to local sustainable development is limited. Negative impacts are highlighted, particularly in the case of forest projects, but also in renewable energy projects. One of the key challenges for the future of the CDM is how to illustrate to civil society groups that participation of local stakeholders in the CDM is possible and that sustainable development criteria at the government level will lead to social development benefits that will outweigh social costs.

From a developing country perspective expectations for financial and technology transfers have been high. Yet, Section 2 illustrated that the majority of CDM projects have been usurped by two or three developing countries, China, India and Brazil. Given the reluctance of the business sector to engage in CDM it can be concluded that investment climate in Africa is unfavourable. In discussing the future of the CDM, policy makers will have to consider the wider contributions of the CDM to development, and ways to offer additional incentives to develop a minimum percentage of CDM projects in Africa. In this way civil society, donor and business interests may all be addressed.

4 Possible CDM Futures

Looking ahead to how the CDM may evolve in the next few years, negotiators have important decisions to make, considering a number of alternative possibilities. In this section, we outline several of these possibilities and discuss the strengths and weaknesses of each. We first consider the broader range of possibilities for the Kyoto Protocol post-2012, since these will have direct implications for any version of the CDM that exists. Any changes to the CDM will in turn have significant implications for the larger Kyoto framework. The CDM issues then break into the broader questions of sustainable development benefits and public participation; and important technical decisions and potential institutional possibilities of how the CDM will be organized and run in the future. Within these categories we lay out what we believe are the key questions facing negotiators.

4.1 Alternative Post-Kyoto Frameworks

An increase in climate change mitigation efforts involves two questions:

- What kind of overarching framework or regime will govern these efforts?
- What kinds of instruments or mechanisms might be used?

This section focuses on whether and how to build on existing climate change mitigation approaches, what needs to be changed or amended based on experiences thus far, and the ongoing role for the CDM.

Many proposals for a post-2012 regime, addressing GHG mitigation and adaptation to climate change have been made in the academic and policy literature. Michaelowa (2006) classified the approaches and proposals into seven categories. The strategies and approaches underlying these categories can be summarized by dividing them into two basic groups, i.e. quantified emission reduction targets with emission trading (some based on the basic Kyoto Protocol architecture) and non-target based approaches (see also Table 4). Binding emission targets can be based on a) the continuation of ‘Kyoto-style’ absolute emission targets or b) intensity targets (e.g. emissions per unit of GDP) or c) flexible types of emission targets. Non-target based approaches could involve technology development and transfers, sectoral agreements (including sectoral intensity agreements), policy based approaches (e.g. Policies and Measures – PAMs), equity and development, and a variety of financial measures. We here discuss briefly what these potential post-2012 architectures might mean for the future of the CDM.

A direct continuation of the Kyoto-project mechanisms would involve quantified emission limitations with binding targets, emissions trading, and the continuation of a CDM-style mechanism (which might include tighter sustainable development and technology transfer provisions). This could be augmented by including similar quantified emission limitations on certain rapidly developing countries, or other new signatories. If quantified emission limitations are not agreed upon by major developing countries, a number of alternatives could be considered for this group of countries. These include non-binding or voluntary, flexible commitments or targets, intensity targets, and benchmarks. This could then result in national programmes with unilateral CDM projects that would contribute to such voluntary or flexible commitments, with measurable impacts. The approach could otherwise be similar to the CDM, but rely on voluntary trading (see Bodansky 2004; Sterk and Wittneben, 2006 and van Schaik and Egenhofer, 2005; Figueres 2005a, b; Michaelowa, 2005b, c, and Ellis, 2006).

Many other alternatives for the post-2012 regime exist, as listed in Table 4, but many apparently will not include a prominent role for a trading mechanism because they do not force nations with commitments to meet definite targets, so a detailed discussion of these is beyond the scope of this paper. Each has potential impacts on the stability of the CDM and other carbon trading markets; many, in fact, reduce the demand for carbon permits or eliminate the need for a CDM entirely. In evaluating these alternative post-2012 frameworks, negotiators need to consider whether they create sustainable development benefits within host developing countries while lowering the overall cost of reducing greenhouse gas (GHG) emissions released to the atmosphere. To fulfil the joint objectives of the CDM, new frameworks must meet the key over-arching principle of "common but differentiated responsibilities." Put plainly, in the grand bargain in the run-up to the Kyoto agreement, the CDM was designed to create the flows of wealth and technology so that developing nations could reduce their growing environmental impact without sacrificing their economic development. In particular, weakening quantified targets or creating non-target approaches post 2012 risks the collapse of the CDM and the substantial financial flows which are just beginning to gain momentum. As demonstrated in Section 2.2, there is a significant short-fall in the investment predicted to be available for energy infrastructure in developing countries in the coming decades—on the order of $US10 trillion dollars needed over the next 25 years (International Energy Agency, 2006). If the CDM is to make a significant contribution to such investment needs post 2012 it could be argued that quantified targets should be significantly tightened.

Table 4: Overview of the main post-2012 climate change mitigation proposals and approaches. Policies are grouped by mitigation approach—for example, whether explicit targets are included in the eventual regime.

Main mitigation group		***Approach***	***Type of mechanisms / targets***	***Impact on the CDM***
Quantified emission reduction targets		1. Absolute emission reduction targets with emissions trading (continuation of Kyoto-style emission targets)	1a. Deeper fixed, binding emission targets for developed countries; 1b. Expansion of fixed, binding emission targets to (at least some) developing countries	CDM remains in a similar form, may increase in importance and scale
			1c. Voluntary absolute targets (i.e. *REDD*)	Questionable, depending on nature of voluntary targets
		2. Alternative indexed flexible emission targets with emissions trading	2a. Positively binding targets	CDM remains in its current form. Demand uncertain
			2b. Dual targets	CDM remains in current form? Demand uncertain
			2c. Price cap (safety valve)	CDM remains subject to caps? Demand uncertain
			2d. Dynamic targets (variables GDP, physical production)	CDM remains in its current form
			2e. Targets based on per-capita allocation	CDM remains in its current form
			2f. Voluntary flexible targets	CDM remains subject to nature of voluntary targets
No absolute emission reduction targets	Technology	3. Enhanced technology development and diffusion of technology	3. Technology agreements and standards (i.e. alternative technology based protocol)	No CDM
	Policy	4. Coordinated policies and measures (harmonized and non-harmonized)	4a. Charges	No CDM in its current form [CDM could re-appear in the context of the charging structure]
			4b. Taxes on emissions	Same as above
			4c. Incentive based instruments	Same as above
	Sectoral	5. Sectoral agreements and initiatives (e.g. international agreements on energy efficiency)	5. Non-target based initiatives Establishment of a voluntary "no-lose" intensity targets	No CDM
	Financial Measures	6a. Mandatory financial contributions by developed countries to technology transfer funds for developing countries 6b. Mandatory multilateral fund to help disseminate and deploy new technologies in developing countries		No CDM
		7. Non-mandatory financial contributions by developed countries to technology transfer funds		No CDM
	Equity and development based	8. Sustainable development policies and measures: implementation of national policies for sustainable development		No CDM

4.2 Improving linkages between sustainable development and CDM

Leaders of wealthy nations have repeatedly made promises of large-scale international financial assistance for developing countries, from the 0.7 percent of GDP claim made in the 1970s to the Gleneagles Plan of Action promise of an additional $50 billion in aid to Africa by 2010. On the environment, promises were embedded in the Stockholm Declaration of 1972 and a Resolution on Institutional and Financial Arrangements. The "Grand Bargain" at Rio included promises of $141.9 billion a year in additional funding from the global North for sustainable development, of which $15 billion was supposed to be devoted to global environmental issues like climate change (Hicks et al., 2007). However most of these promises have never been met, as political and economic necessities close to home tend to drive official development assistance decisions. Some voluntary funds, including the three funds established under the UNFCCC, have barely been funded at all, and some pledges have not been met (Mueller, 2006). Since the mid 1990s the overall level of environmental funding has totaled about $8-10 billion from all donors to all recipients, and most of this is spent on water and sewage projects (Hicks et al., 2007). The CDM and the "Adaptation Levy" of 2 percent of CER revenues provides the first substantial flows of potential environmental funds from North to South, but as we saw above, these may be on the order of $300 million total until 2012, and only starting in 2010.

The levy on the CDM for adaptation to climate change could be raised through mandatory payments by Annex I countries (with real concerns of negotiation and enforcement). A "Development Levy" could be placed on all carbon trading, as China's DNA has done in claiming a share of the CER revenue from Chinese projects in the amount of 2% for renewable energy, methane and forestry projects, 30% for N_2O projects and 65% for HFC and PFC projects (see box 1). This money is earmarked to provide broader benefits from CDM projects and to build capacity in China's national, provincial, municipal and local agencies. We believe such a levy might be made globally uniform, and higher levels could be considered (Muller, 2007). A risk of such a levy is that some marginally profitable projects may be excluded from the process. Without minimum CDM requirements, projects may move to nations with weaker DNAs and lower expectations.

Looking ahead, a series of key issues must be negotiated and decided. Foremost is the question of whether to retain the explicit language linking sustainability with the CDM. If yes, other questions arise about how to implement this link in practice:

- Is there a way to restructure the markets so they deliver employment, social welfare, and local development benefits in addition to reductions in emissions?
- Should there be targets, proportional quotas, or incentive mechanisms to *ensure a better geographic spread* of CDM projects for those regions and nations not currently benefiting? Potential adjustments to the CDM could include providing extra CERs for projects in the most needy regions, and especially those providing needed sustainable development benefits.
- What is the possibility for market responses—such as the so-called "gold standard" third-party rating system—to incorporate different visions of sustainability in CDM projects?
- Should there be targets, quotas or incentive mechanisms *by project types*, to encourage those which are highest priority for the development of these needy and neglected sectors and regions? In particular, should renewables and energy

efficiency projects or those with documented long-term benefits for host country and the climate be prioritised?

Behind these problems lie even more fundamental questions of *who would decide* and/or regulate that CDM projects provide sustainable development benefits: the project host country, as at present, or should there be regulation through a UN mechanism? The latter option may clash with the concept of national *ownership* of development priorities.

Options for systematically addressing sustainable development benefits in the CDM include at least five alternatives:

Alternative 0: (current system) Nations determine their own sustainable development requirements effected by Item 40(a) of the Modalities and Procedures for a Clean Development Mechanism as defined by Article 12 of the Kyoto Protocol adopted by the parties as Decision 3 of COP 11/MOP 1 in Montreal in 2005. Continuing this approach protects national sovereignty but risks the "race to the bottom" of low expectations.
Alternative 1: Minimal global standards for SD benefits, for example that they generate employment or at least "Royalties" for local or national government services. These could include employment generation, local development, tax revenues, energy infrastructure development, etc. These minimal standards could be similar to the "Gold Standard" expectations of voluntary offset projects, or more carefully detailed.
Alterative 2: Establish a global checklist of SD benefits to which nations can add or waive certain types. This could be described as a system of "global norms with local flexibility."
Alternative 3: Establish a global point system for different types of beneficial development aspects of CDM projects. More points could be allotted to the most desirable projects, but all projects would have to reach a minimum number of points for sustainable development benefits to be accepted. Certain elements could be made mandatory if they were considered too important to be potentially left out.
Alternative 4: Policy-based adjustment *to CERs* to favour high sustainable development projects and provide disincentives to those with high CERs but low SD or distributional benefits. That is, certain types of projects in key regions or sectors could gain double or triple CERs, while others creating few SD benefits would be awarded half or a third of the number currently awarded. This would be an intentional distortion of the market to favour high-benefit projects, but would require a balance of projects with low and high CERs.

In all cases, the overall scientific/environmental integrity of the total amount of allotted CERs must be maintained, so some types of projects or locations would clearly have their CDM project profitability (and potential commercial viability) reduced. Some nations or industries with heavy involvement in these types of projects may (or may not) object to a policy-based re-allocation of CERs.

Moreover, while civil society participation is written in the CDM guidelines, participation has been sporadic. In going forward, negotiators might ask:

- Should there be U.N. rules to ensure civil society participation in the process of project approval or national CDM policy:
- How can the level of societal participation be evaluated and guaranteed?

- How can the capacity of NGOs be enhanced so they can make comments on CDM proposals in a timely and technically-informed manner? Does the amount of time for public comment need to be extended beyond the current 30 days?
- More broadly, who speaks for "civil society"? Can the group of potential commenting groups be expanded?

Critiques of the CDM and voluntary offsets and their lack of sustainable development benefits put the entire system at risk of collapse from citizen cynicism. Therefore it appears to be in the interest of CDM and Voluntary Carbon Offset firms to boost the sustainable development benefits and credibility of the carbon market. Real citizen participation is needed to drive sustainable development, but the capacity of NGOs clearly needs development. Here some lessons may come from the requirements by many international donors for local NGO participation in the creation, management and evaluation of regional development efforts.

4.3 Avoided Deforestation as a New Emissions Reduction Activity?

The recent discussion around avoided deforestation is relevant for the future of the flexible mechanisms in several regards. It has the potential to lead to emission reductions in developing countries on a great scale, it could become the first case of a sectoral, i.e. not project-based, "CDM", and it is intricately linked to questions of sustainable development.

Over the last two years, a series of publications and reports have drawn attention to the fact that deforestation contributes around 20 percent to global total GHG emissions and is the largest source of emissions from developing countries (Houghton, 2005; Santilli et al., 2005). After a period of relative calm surrounding the land use, land-use change and forestry (LULUCF) sector, "reducing emissions from deforestation and forest degradation" (REDD) resurfaced during COP 11/MOP 1 in Montréal in 2005. Since then, Parties and other stakeholders have been developing positions on this issue in response to a formal proposal by Papua New Guinea and the Coalition for Rainforest Nations, and several specialised meetings have been held (see Wittneben et al., 2006: 93). The proposal suggested compensating developing countries that succeed in voluntarily lowering their emissions from deforestation below a historical baseline with financial incentives, such as tradable carbon credits.

Earlier discussions of avoided deforestation followed the CDM model of providing credits to *projects* that protected pieces of forests. This model led to serious concerns about "leakage," wherein protecting one piece of forest merely shifted pressure to other nearby forests. This new concept of "compensated reductions" favours the use of baselines on a *national* level, which implies measuring and rewarding emission reductions across a whole sector in a country, rather than in a conventional project as is currently the case in the CDM. However, several countries have declared a preference for project-based approaches (partly because of governance issues); most of the forthcoming pilot schemes will similarly have a focus on conservation projects in key areas, and even under national baseline approaches spatially limited projects would likely play a strategic role. The final result might thus be a mixed approach of sectoral and project-based crediting mechanisms, or hybrid schemes, requiring significant institutional amendments to the present-day CDM, or an entirely new institutional framework in a post-Kyoto agreement.

In addition to representing a substantial and potentially low-cost mitigation opportunity, avoiding deforestation is linked to a host of potential co-benefits. These obviously include biodiversity, watershed, and soil conservation; however, some of the most interesting implications are linked to sustainable development. REDD has the potential to generate annual funds in the order of several billion US$, even under relatively conservative assumptions. This could open up alternative development pathways to many developing countries and if well designed, implemented and policed, could directly benefit rural and forest-dependent parts of their populations.

On the other hand, it is necessary to maintain a sober perspective on the potential of REDD to contribute to poverty alleviation and sustainable development (Estrada et al., 2007). Many countries with a high potential income from REDD score very low across a range of governance indicators (Ebeling, 2006). This implies that they might in fact never succeed in lowering their high deforestation rates, but it also means that they might be unable or unwilling to pass on monetary benefits from the national government to communities and other small stakeholders on the ground. The choice of possible policy tools - including direct payments, agricultural support schemes, law enforcement and anti-corruption measures – will be crucial in this regard. A market-driven scheme aiming for low-cost emission reductions could focus on different deforestation drivers and implementation options, but there will be a great need for influencing policies through co-financing and donors providing seed funds. In most places which currently have high deforestation rates, the capacity of NGOs, environmental enforcement agencies, and local judicial systems will have to be sharply increased. Again, this will have to occur in parallel or even before REDD projects and policies are instituted.

Given the broad support by most Parties, NGOs, and other stakeholders for this new idea, REDD stands a good chance to be included under forthcoming climate regimes, perhaps as early as the Bali COP/MOP. The remote-sensing community largely agrees that most of the necessary raw data exists on a global level, and could be made available relatively rapidly and at reasonable cost by processing existing satellite imagery. Other technical barriers could be overcome given sufficient political will.

Nonetheless, some key outstanding issues still need to be resolved. Among others, there is the question of how much money individual countries could potentially earn through carbon finance, and this depends directly on how much they have deforested (and hence emitted) in the past, and on whether that trend can be projected into the future. Several countries have made it clear that they want to receive rewards for past conservation actions (e.g. Costa Rica), and for increases in forest cover (e.g. India). This certainly raises concerns about the integrity and “additionality” of carbon credits (as discussed in Section 1.4), because such rewards may not reflect actual, additional emission reductions. Environmental NGOs will almost certainly oppose the creation of “hot air” (emissions credits of shaky legitimacy).

In addition, some observers are concerned about a potential “flooding” of carbon markets with cheap credits from avoided deforestation. Although some practitioners do not deem this to be a likely scenario (given significant governance challenges of addressing tropical deforestation), a pragmatic solution, such as a cap on the maximum use of REDD credits, may help to overcome existing concerns. On the other hand, many organisations stress the need for strong Annex-1 reduction commitments which would create the necessary demand for credits and drive up prices. Incorporating a potential supply of credits from REDD during the determination of global reduction targets could also circumvent one of the main fallacies of past LULUCF negotiations. During the original negotiations leading to the definition of eligible CDM activities, the inclusion forestry activities was suggested when Annex 1 reduction targets had already been agreed. A large number of credits deriving from such activities thus would have reduced the pressure for fossil fuel-based emission reductions (see Dessai et al., 2005).

Another issue is the larger question of longer-term emission targets for developing countries. Some governments are concerned that approaches which begin as "voluntary," such as the avoided deforestation proposal, may later pave the way for non-voluntary emission caps. Some also hope that it might pave the way for including more industrialised countries into future climate regime regimes. In particular the United States had stressed the importance of the land-use sector in contributing to emission targets during earlier negotiations, as well as the necessity of addressing emissions from developing countries. In this light, the discussion about avoided deforestation is not just about forests but is intrinsically linked to the future of the whole climate change regime.

Box 5: Land-use challenges for the CDM after 2012

In its first phase of the CDM, the land use, land-use change and forestry (LULUCF) sector has only played a limited role. Following a decision at COP7 in Marrakech in 2001, only two activities under article 3.3 – reforestation and afforestation – are eligible, whereas avoided deforestation and forest management are excluded. Article 3.4 activities such as the management of agricultural soils are excluded altogether. However, this could change after 2012. In fact there are three major uncertainties regarding LULUCF under a second phase: the inclusion or not of article 3.4 activities; the inclusion of avoided deforestation (often referred to as Reducing Emissions from Deforestation, RED); and the role biofuels will play.

Agricultural soils

Agricultural soils could have a significant mitigation potential. The soil organic carbon (SOC) pool is about 1,550 Pg (Follett 2001), twice the atmospheric carbon pool, which is 770 Pg (Lal, 2002); moreover, it is subject to disturbance through land-use change, ploughing and erosive processes that are mainly connected to agriculture. Lal and Bruce (1999: 178) estimate that agriculture may have caused the loss of as much as 55 Pg C since settled agriculture began by causing deforestation and the subsequent loss of SOC. However, they estimate that as much as 75% of this loss might be recoverable through alternative agricultural practices that could re-capture carbon into the soil. The FAO (2001) suggests that, by altering agricultural practice, 23-44 Pg C could be sequestered in agricultural soils over the next 50 years. This implies that agriculture could be of comparable significance to forests, the global sequestration potential of which has been estimated at 60-87 Pg C. Moreover, by increasing the content of organic matter in soils is raised and this improves their fertility and productivity.

The IPCC (2000) has suggested a range of article 3.4 activities that might be considered, including management practices such as appropriate rotations, cover crops and organic fertilisation, conservation tillage; , erosion control, rehabilitating degraded cropland and switching it to grassland, among else. But substantial methodological challenges would need to be met regarding additionality, baseline-setting, and measurement and monitoring. In the latter case, a stringent regime would require sampling on a scale that could render article 3.4 activities uneconomic (Smith, 2001). However, monitoring costs could be reduced using combinations of methodologies such as remote sensing.

Avoided deforestation

Credits for avoided deforestation would address the fact that 20-25% of CO2 emissions stem from tropical deforestation (Chomitz, 2007; Moutinho et al., 2006), an amount roughly equal to the emissions of the United States. The relatively high cost of reducing emissions from developed countries could make forest conservation an economically attractive mitigation option (Chomitz, 2006). There are again methodological issues, for example baselines reflecting high historical rates of deforestation which are unlikely to continue in a business-as-usual scenario could result in the creation of hot air. To address leakage concerns, among else, Santilli et al. (2005) argue that emission reductions should be accounted for at the national level. This would rule out an integration of avoided deforestation into the conventional CDM framework; however, a sectoral CDM might be an appropriate approach (Schlamadinger et al., 2005).

An interesting possibility is the integration of avoided deforestation with agricultural development. In 1990, five developing countries had 0.10 ha or less of arable land available per capita, and this was set to increase to 29 countries by 2025 (Lal, 1997). The resulting pressure on land is a driver for forest conversion and exacerbates degradation on land already farmed. It has been suggested that half of all tropical deforestation due to agricultural expansion in fact occurs to replace exhausted land,(Houghton 1994). Some believe that the answer to deforestation is to increase agricultural productivity through intensification, as an alternative to extensification (Chomitz, 2007; Vlek et al., 2004). At the same time, however, such intensification might increase profitability and give an extra incentive to convert more forest to agriculture (Carpentier et al., 2000). This complex relationship between farming and forests could demand an integrated approach, for which a national or regional sectoral CDM might be appropriate.

Biofuels

A third land-use question after 2012 will be the role of biofuels. This word is sometimes used interchangeably with biomass, but is defined here as “liquid fuels produced from biomass with the purpose of utilisation in vehicle engines” (Bakker, 2006). Of course biomass can be used to produce energy in other ways, and several such CDM projects are in progress, but less has been done to produce approved methodologies for biofuels (ibid., UNEP/Risø, 2007), although unlike agricultural soils they are not excluded in the first reporting period.

But there is already a huge potential market for biofuels. Brazil has produced ethanol from sugarcane for many years, but other countries are now following suit; the EU’s recent Biofuels Directive calls for 5.75% biofuels in transportation by 2010 (Jürgens et al., 2006). There is concern that biofuels could compete with food production and could also drive deforestation. In the case of the CDM, however, there are sustainable development criteria, defined by the host nation (Bakker, 2006); these should prevent such perverse outcomes. In any case, biofuels are not strictly a LULUCF question as credits would accrue not to the farmer but to the end user, as fossil-fuel substitution. The real challenge for the CDM may lie in competition between biofuels and sinks in the LULUCF sector. But the CDM could harness the market forces behind biofuels for its own ends; for example, restoration of degraded land could become economic for suitable crops, perhaps as an alternative to afforestation. This might be assisted by payments for avoided deforestation but also for carbon sequestration, as the sink function of previously degraded farmland would be enhanced.

Bakker, S. (2006) *CDM and biofuels: Can the CDM assist biofuel production and deployment?* (Petten, The Netherlands: Energy Research Centre of The Netherlands.)
Carpentier, C., Vosti, S. and J. Witchover (2000) *Intensified production systems on western Brazilian Amazon settlement farms: could they save the forest?* In: *Agriculture, Ecosystems and Environment 82*: 73–88.
Castro, F. (2007) *Condenados a muerte prematura por hambre y sed más de 3 mil millones de personas en el mundo*. In: *Granma*, March 29 2007 (in Spanish).
Chomitz, K. (2007) *At Loggerheads? Agricultural Expansion, Poverty Reduction, and Environment in the Tropical Forests.* (Washington DC, USA: The World Bank.)
FAO (2001) *State of the World's Forests.* (Rome, Italy: FAO.)
Follett, R. (2001) *Soil management concepts and carbon sequestration in cropland soils*. In: *Soil & Tillage Research* 61: 77-92.
Houghton, R. (1994) *The worldwide extent of land-use change*. In: *BioScience* 44: 305–313.
IPCC (2000) *Land use, Land-use Change and Forestry*. (Cambridge, UK: Intergovernmental Panel on Climate Change.)
Jürgens, I., Schlamadinger, B. and P. Gomez (2006) *Bioenergy and the CDM in the emerging market for carbon credits*. In: *Mitigation and Adaptation Strategies for Global Change* 11: 1051-1081.
Lal, R. & Bruce, J. (1999) *The potential of world cropland soils to sequester C and mitigate the greenhouse effect*. In *Environmental Science & Policy* 2: 177-185.
Lal, R. (1997) *Residue management, conservation tillage and soil restoration for mitigating greenhouse effect by* CO_2 *enrichment*. In: *Soil and Tillage Research 43,* 81-107.
Lal, R. (2002) *Soil carbon dynamics in cropland and rangeland.* In: *Environmental Pollution* 116: 353–362.
Santilli, M., Moutinho, P., Schwartzman, S., Nepstad, D., Curran, L. & Nobre, C. 2005 Tropical Deforestation and the Kyoto Protocol. *Climatic Change* 71, 267-276
Schlamadinger, B., Ciccarese, L., Dutschke, M., Fearnside, P., Brown, S. and D. Murdiyarso (2005) Should we include avoidance of deforestation in the international response to climate change? *In:* Moutinho, P. and S. Schwartzman [eds.] 2005. *Tropical Deforestation and Climate Change* pp47-53 (Belém, Brazil/Washington DC, USA: Instituto de Pesquisa Ambientalda Amazônia, Belém, Brazil/Environmental Defense.)
Smith, P. (2001) *Verifying Sinks under the Kyoto Protocol*. VERTIC Briefing Paper 01/03. (London, UK: The Verification Research, Training and Information Centre).
UNEP/Risø (2007) *CDM/JIPipeline Overview of CDM & JI projects*. April 2007 update.
Vlek, P., Rodríguez-Kuhl, G. and R. Sommer (2004) *Energy use and CO2 production in tropical agriculture and means or strategies for reduction or mitigation.* In: *Environment, Development and Sustainability* 6: 213-233.

4.4 Remaining Technical and Institutional Issues

The above broad questions of the role of sustainable development criteria and civil society participation may set the direction for the CDM post-2012. However, a series of important but perhaps more technical and "architecture" questions must be hammered out, and these will make significant difference for the CDM's future. For example, should the CDM remain as a project-level mechanism, or should "sectoral or programmatic CDM" be included or even become the dominant part of the CDM? Should new sectors and technologies be accepted under the CDM? Apart from avoided deforestation, discussed above, the main candidate in this regard is carbon capture and storage (CCS), i.e. the capture of CO2 from combustion processes at source and its burial under ground. Rather than switching from fossil fuels to renewable energy, CCS would allow the "greening" of the former, creating energy sources such as "clean coal". This has raised criticisms from those concerned about locking in existing energy structures, as well as about the security and permanence of the stored carbon. On the other hand, the realistic potential that many countries will rely to a great extent on fossil fuels for their projected economic growth leads others to view CCS as a necessary component of climate change mitigation. In particular, China possesses vast reserves of coal and current developments indicate that its use could more than negate emission reduction efforts in many other areas.

Several other key issues addressed above remain to be addressed. First, integrating the so-called 'Plus 5' [9] nations into a quantified emission limitation scheme might vastly change the availability and marketability of CERs, and participation in CER markets if those nations became buyers, rather than sellers, of CERs. Second, the CDM is currently a short-term arrangement (5-7 year periods), but investment decisions in large infrastructure (energy for example) need long-term continuity. Third, the relationship between CDM and voluntary emissions reductions (offsetting) is entirely unspecified.

On whether regional carbon trading systems (such as between US states, etc.) should be included or linked to the CDM, three points arise. First, the CDM is a product of the Kyoto Protocol negotiations and was created by Article 12 of the final Kyoto Protocol. Many parties are implementing their Kyoto Protocol obligations through domestic or regional trading mechanisms, including European Union Emissions Trading Scheme ("EU ETS"). It is important that these schemes link into the future CDM (and other flexibility mechanisms of the Kyoto Protocol) to preserve the integrity of the CDM and to avoid mismatches between national Kyoto Protocol commitments and individual domestic or regional commitments. The EU ETS is a model for policymakers (but also holds many lessons in how *not* to establish trading schemes). The EU ETS implemented what is known as the Linking Directive, allowing CERs to be used as credits against EU ETS obligations since 2005 and ERUs from 2008. In time, the Linking Directive could help to create a single market for carbon while offering a cost-effective way for EU Member States to meet their Kyoto Protocol commitments.

The EU ETS is open to other linking schemes in its push for a global market. The EU ETS is currently eyeing the California Climate Action Registry and the New South Wales Abatement Scheme, largely due to their similarities with the EU ETS in terms of basic requirements for reduction targets with a compliance system. Similar links between other national and regional emissions trading schemes and the CDM would increase the flow of CDM investment and create a single, stronger market for CERs, would allow host countries to implement a single project approval process and would result in a single trading system for the resulting credits (CERs).

Voluntary Emissions Reductions cannot currently be traded within either the Kyoto or the EU ETS systems. Unless a category of VERs, or some other project-based mechanism, is developed that furthers the broad objectives of the Kyoto Protocol, uses shared standards, contains an appropriate validation, approval, verification and monitoring regime, and otherwise builds on the developments in project-based flexibility mechanisms that have occurred over the past ten years, it is difficult to foresee any resulting credits being accepted within the EU ETS or Kyoto Protocol schemes.

What relation should CDM projects have with Voluntary (or Verified) Carbon Offsets (VCOs)? An early critique of the CDM process is its complexity, and associated high transaction costs, which is a huge deterrent to project developers to take on small-scale projects. By contrast, many private voluntary carbon offsetting projects are very agile, providing streamlined processes to get sometimes beneficial projects up and running. One possibility which should be considered would be to enhance and simplify further the registration requirements for small-scale project activities, including an expansion of the applicable project activities, in order to streamline processing and approval through official

[9] China, India, South Africa, Mexico and Brazil

CDM channels further, while large-scale project activities continue to undergo the full assessment. It is essential that small-scale project activities continue to be “bundled” to allow a streamlining of their approval, but even this increases transactions costs and reduces profitability.

A final possibility is to remove the CDM from the overall Kyoto structure, placing it directly under the UNFCCC, which served as a guiding new treaty without specific national targets. This might enable the renegotiation of a treaty that places the CDM at the centre of an effort to bring sustainable development to poorer nations while designing a new strategy for reducing global emissions. The broadest question, then, is whether the CDM should be included under alternative Kyoto futures, such as the expansion of ‘Kyoto-style’ absolute emission targets to rapidly developing countries. And will the CDM survive in the many architectures based on flexible types of emission targets?

Conclusion

In our endeavour to examine the status of the CDM, perspectives, and possible CDM futures we conclude that the CDM, in its current form, is not bringing the kind of sustainable development envisaged in its creation. For instance, the distribution of CDM projects has largely been concentrated in two continents: Asia and Latin America. Only 4 percent of CDMs have been established in Africa and the dominant project types are HFCs and N2O projects, with half of all HFC projects located in China. From an illustrative review of 10 CDM projects, we suggest that further research is needed in planned and existing projects to provide important insights into the improvement of future the CDM after 2012.

Perspectives on the CDM vary from optimistic to sceptical. From a business perspective the CDM in its current form presents disincentives affecting the absolute quantity of projects that are submitted for certification, in addition to the host country and type of project. The equity perspective highlights particular unresolved tensions between market efficiency and the often non-market improvements in human welfare. The CDM also presents opportunity for groups like the Green Belt Movement, a community based network of women farmers in Kenya, to engage in the carbon market. From a donor perspective the CDM presents opportunity to build capacity and project development. A number of donors have engaged enthusiastically with the CDM, yet the high transaction costs coupled with the bureaucratic nature of projects has also given rise to criticism.

As the CDM continues into a new phase, we proposed five alternatives (pp.33) for systematically addressing sustainable development benefits of the CDM post 2012. The most likely scenario is one that lies in between “not doing anything” to “politically favouring” CERs which ensure high sustainable development projects. Further hopes are pinned on the financial and governance opportunities that could be opened up by avoided deforestation and “compensation reductions”. There remain, however, a range of highly technical and institutional challenges to be addressed by the international community. These relate above all the broad questions of sustainable development and civil society participation in setting the direction for the CDM post 2012, the relationship between voluntary markets, EU-ETS and the CDM and whether the CDM should be considered at all under some possible alternative future Kyoto architecture. These issues will be among the many others on the table for forthcoming negotiations.

References

Anger, N. (2005). *Economic and Environmental Effects of Linking the European ETS in the Context of Global Reduction Targets*. Paper presented at the UNFCCC COP/MOP1, Montreal.

Aukland, L., Moura Costa, P. & Brown, S. 2003 A conceptual framework and its application for addressing leakage: the case of avoided deforestation. *Climate Policy* 3, 123-136.

Bachram, H. (2004). Climate Fraud and Carbon Colonialism: The New Trade in Greenhouse Gases. *Capitalism Nature Socialism*, 15(4).

Baker, J., Ochsner, T. and Venterea, R. (2007). Tillage and Soil Carbon Sequestration—What Do We Really Know? *Agriculture, Ecosystems and Environment*, 118: 1-5.

Bayon, R., Hawn, A., and Hamilton, K. (Eds.). (2007). *Voluntary Carbon Markets: An International Business Guide to What They Are and How They Work.* London: Earthscan.

Begg, K. and Horst, D.V.D. (2004). Preserving Environmental Integrity in Standardised Baselines: The Role of Additionality and Uncertainty. *Mitigation and Adaptation Strategies for Global Change*, 9: 181-200.

Begg, K., Wilkinson, R., Theuri, D., Gitonga, S., Mathenge, M., Amissah-Arthur, H., Atugba, S., Ackon, S., Ageby, S., Meena, H., Mwakifwamba, S., and Mwakasonde, S. (2003). Encouraging CDM energy projects to aid poverty alleviation. Final report of project R8037 under the DFID KAR programme.

Bernow, S., Kartha, S., Lazarus, M. and Page, T. (2001) Cleaner generation, free-riders, and environmental integrity: clean development mechanism and the power sector. *Climate Policy* 1**,** 229-249.

Bernow, S., Kartha, S., Lazarus, M. and Page, T. (2001). cleaner generation, free-riders, and environmental integrity: clean development mechanism and the power sector. *Climate Policy* 1, 229-249.

Bodansky, D. (2004). International Climate efforts beyond 2012: A survey of approaches. Prepared for the Pew Center on Global Climate Change

Bozimski, A., Lemos, M.C., Boyd, E. Flexing Kyoto's 'Surprise': Is the CDM a win-win tool? (in prep).

Brunt, C. and Knechtel, A. (2005). Delivering Sustainable Development Benefits through the Clean Development Mechanism. Canada, The Pembina Institute.

Boyd E., May, P., Veiga, F., Chang, M. (2007a) Exploring socioeconomic aspects of forest based mitigation projects in Bolivia and Brazil. *Environmental Science and Planning* (in press).

Boyd, E., Gutierrez, M., Chang, M. (2007b) Adapting small-scale CDM to low income communities. *Global Environmental Change* (in press).

Boyd, E., Corbera, E., Gutierrez, M., Estrada, M., Kjellen, B. (2007). The 'politics' of sinks and the CDM: A process tracing of the UNFCCC negotiations. *Forthcoming in International Environmental Agreements*.

Boyd, E. (2003). Forests Post Kyoto: Global Priorities and Local Realities. PhD, School of Development Studies, University of East Anglia, Norwich.

Brown, K. and Corbera, E. (2003). A Multi-Criteria Assessment Framework for Carbon-Mitigation Projects: Putting "Development" in the Centre of Decision-Making. Tyndall Centre Working Paper 29. (Norwich, UK: The Tyndall Centre.)

Brown, K., Adger, W.N., Boyd, E., Corbera-Elizalde, E. and Shackley, S. (2004). How Do CDM Projects Contribute to Sustainable Development? (Tyndall Centre Technical Report No. 16). Norwich: Tyndall Centre (available online at http://www.tyndall.ac.uk/research/theme2/final_reports/it1_13.pdf, last visited on 21 March 2007).

Bumpus, A.G. and Liverman, D.M. (2007). Accumulation by decarbonisation and the governance of carbon offsets. *Forthcoming*.

Capoor, K. and Ambrosi, P. (2006) State and Trends of the Carbon Market. Washington, D.C., IETA and The World Bank.

Carbon Finance (2006). What Montreal did for the CDM. *Carbon Finance*, pp. 14 - 15.

Carpenter, R. (1989). Do we know what we are talking about? *Land Degradation & Rehabilitation* 1(1) 1-4.

Cheng, H. and Kimble, J. (2001). Characterization of Soil Organic Carbon Pools. In: Lal, R., Kimble, J., Follett, R. and B. Stewart (eds.) (2001) Assessment Methods for Soil Carbon pp117-130. (Boca Raton, USA: CRC Press LLC.)

Chomitz, K. M. 2002 Baseline, leakage and measurement issues: how do forestry and energy projects compare? *Climate Policy* 2, 35-49.

Cole, J. C. (2006). Social Development Aspects of Kyoto Protocol Clean Development Mechanism Projects: A Review of Four Hydroelectricity Projects in Brazil and Peru. Oxford, Oxford University Centre for the Environment.

Corbera, E. and Brown, K. (2007) Building institutions to trade ecosystem services: Marketing forest carbon in Mexico. *Forthcoming in World Development*.

Corbera, E., Brown, K., Adger, N. (in press) The equity and legitimacy of markets for ecosystem services. Development and Change.

Corbera, E. (2005) Interrogating developments in carbon forestry activities: a case study from Mexico. PhD, School of Development Studies, University of East Anglia, Norwich.

Cosbey, A., Parry J-E., Browne, J., Babu, Y.D., Bhandari, P., Drexhage, J., Murphy D., (2005). Realizing the Development Dividend: Making the CDM Work for Developing Countries. Phase I Report. International Institute for Sustainable Development.

Cosbey, A., Murphy, D., Drexhage, J., and Balint, J. (2006) Making Development Work in the CDM. Phase II of the Development Dividend Project. International Institute for Sustainable Development.

Desanker, P. (2005). The Kyoto Protocol and the CDM in Africa: a good idea but… In: Unasylva 222(56): 24-26.

Diakoulaki, D., Georgiou, P., Tourkolias, C., Georgopoulou, E., Lalas, D., Mirasgedis, S. and Sarafidis, Y. (2007). A multicriteria approach to identify investment opportunities for the exploitation of the clean development mechanism. *Energy Policy*, Vol 35, 2.

Dutschke, M and Michaelowa A., (1998). Creation and Sharing of Credits through the Clean Development Mechanism under the Kyoto Protocol. HWWA Discussion Paper 62

Dutschke, M. (2002). Fractions of permanence – squaring the cycle of sink carbon accounting. In: *Mitigation and Adaptation Strategies for Global Change* 7: 381–402, 2002.

Ebeling, J. (2006) Tropical deforestation and climate change. Towards an international mitigation strategy. Dissertation for the degree of Master of Science in Environmental Change and Management, University of Oxford. Oxford, UK.

Egenhofer, C., Van Schaik, L., and Cornland, D. (2005). improving the clean development mechanism. European climate platform.

Ellis, J., Winkler, H., Corfee-Morlot, J. and Gagnon-Lebrun, F. (2007). CDM: Taking stock and looking forward. *Energy Policy* 35: 15-28.

Ellis, J. (2006). Issues related to a program of activities under the CDM, OECD

Ellis, J., and Bosi, M. (1999). Options for Project Emission Baselines, OECD and IEA Information Paper, Paris.

ENB (1997). Report of the Third Conference of the Parties to the UNFCCC: 1-11 December 1997, Vol.12, no. 76. International Institute for Sustainable Development (IISD).

Estrada, M., Corbera, E., Brown, K. (2007) Reducing greenhouse gas emissions from deforestation in developing countries: climate policy proposals and scientific gaps. *Forthcoming in the Tyndall Centre Working Paper Series.*

European Union. (2004). Directive 2003/101/EC of the European Parliament and of the council. *Official Journal of the European Union*.

FAO (2006) Reducing Emissions from Deforestation in Developing Countries. Submission to the UNFCCC. (Rome, Italy: FAO.)

Fearnside, P. (2002). Why a 100-year Time Horizon Should Be Used for Global Warming Mitigation Calculations. In: *Mitigation and Adaptation Strategies for Global Change* 7: 19–30.

Fearnside, P. M. (2001). Saving tropical forests as a global warming countermeasure: an issue that divides the environmental movement. *Ecological Economics* 39:167–184.

Fearnside, P. M. (2003). Conservation policy in Brazilian Amazonia: Understanding the dilemmas. *World Development* 31 (5):757-779.

Figueres, C. (2005a). Opening the CDM to the yet Unrealized Goal of Sustainable Development, *International journal of Sustainable Development Law & Policy* 2: 5-27.

Figueres, C. (2005b). Programmatic CDM project activities: eligibility, methodological requirements and implementation, Carbon Finance Business Unit of the World Bank.

Fischer, C. (2005). Project-based mechanisms for emissions reductions: balancing trade-offs with baselines. *Energy Policy*, 33, 1807-1823.

Fogel, C. (2005). Biotic Carbon Sequestration and the Kyoto Protocol: The Construction of Global Knowledge by the Intergovernmental Panel on Climate Change. *International Environmental Agreements*, 5:191-210.

Gold Standard (2006) The Gold Standard - Homepage. Retrieved 10 October, 2006, from http://www.cdmgoldstandard.org/

Global Environment Facility (2006) GEF Annual Report 2005.

Global Environment Facility (2007) The GEF Adaptation Funds.

Gundimeda, H. (2004). How ‘sustainable’ is the ‘sustainable development objective’ of CDM in developing countries like India?, *Forest Policy and Economics* **6** (2004), pp. 329–343.

Hampton, K. (2007). From continuity to step change. *Carbon Finance* Retrieved 21 March, 2007, from http://www.carbon-financeonline.com/index.cfm

International Energy Agency (2006) World Energy Outlook 2006. Paris, Organisation for Economic Cooperation and Development.

Jotzo, F. & Michaelowa, A. (2002) Estimating the CDM market under the Marrakech Accords. *Climate Policy* 2, 179–196.

Jung, M. (2006) Host country attractiveness for CDM non-sink projects. *Energy Policy*, 34:2173-2184.

Kartha et al (2003).

Kägi, W. and D. Schöne (2006) Forestry Projects Under the CDM: Procedures, Experiences and Lessons Learned. Forests and Climate Change Working Paper No. 3. (Rome, Italy: FAO).

Kearney, A. T. (2004) FDI Confidence Index. The Global Business Policy Council.

Krey, M. (2004). Transaction Costs of CDM projects in India -An Empirical Survey. H.I.O.I. Economics. Hamburg, Hamburg Institute of International Economics: 17-18.

Krey, M. (2005) Transaction costs of unilateral CDM projects in India—results from an empirical survey. *Energy Policy* 33, 2385-2397.

Kyoto Protocol to the United Nations Framework Convention on Climate Change, 10 December 1997, UN Doc. FCCC/CP/1997/Add.1, reprinted in 37 I.L.M. 22 (1998).

Lal, R. (2003) Soil erosion and the global carbon budget. In: *Environment International* 29(4): 437-50.

Lambert, S., and Grashof, K. (2007). Capacity Development for the Clean Development Mechanism. Lessons Learned in Ghana, India, Indonesia, South Africa and Tunisia. German Technical Cooperation (GTZ).

Lecocq, F. & Capoor, K. (2003) State and Trends of the Carbon Market. Washington D.C., The World Bank.

Liverman, D. (2006) Conventions of climate change: constructions of danger and the dispassion of the atmosphere. Paper presented at the Plenary Session RGS-IBG; copy available from D. Liverman, ECI, OUCE, South Parks Road, Oxford, UK.

Lohmann, L. (2006) Carbon Trading. A critical conversation on climate change, privatisation and power. Uppsala, Dag Hammarskjöld Foundation.

Lohmann, L. (2001). Democracy or Carbocracy? Intellectual Corruption and the Future of the Climate Debate. Briefing No. 24, The Cornerhouse, UK.

Lohmann, L. (1999). The Dyson Effect Carbon "Offset" Forestry and the Privatization of the Atmosphere. Briefing No.15, The Corner House, UK.

Matsuhashi, R., Fujisawa, S., Mitamura, W., Momobayashi, Y. & Yoshida, Y. (2004) Clean development mechanism projects and portfolio risks. *Energy*, 29, 1579-1588

May, P., Boyd, E., Veiga, F., and Chang, M. (2004) Local sustainable development effects of carbon forests in Brazil and Bolivia: a view from the field. Markets for Environmental Services: No.5, International Institute for Environment and Development.

Meinhausen, M and Hare, B (2003) Sinks in the CDM: After the climate, biodiversity goes down the drain, an analysis of the CDM sinks agreement at COP-9.

Meinshausen, M. and B. Hare (2002) Temporary Sinks Do Not Cause Permanent Climatic Benefits. Achieving Short-Term Emission Reduction Targets at the Future’s Expense.Greenpeace Background Paper. (Amsterdam, The Netherlands: Greenpeace International.)

Michaelowa, A., and Michaelowa, K. (2007). Climate or development: is ODA diverted from its original purpose? *Climatic Change*. (in press)

Michaelowa, A. (2006). Climate Policy after 2012-Cutting the Gordian Knot. Intereconomics, March/April 2006.

Michaelowa, A. (2005a). Determination of baselines and additionality for the CDM. A crucial element of credibility of the climate regime. In: Yamin, F. (ed.) Climate change and carbon markets. A handbook of emission reduction mechanisms, Earthscan, London 2005, p. 289-304.

Michaelowa, A. and Jotzo, F. (2005b). Transaction costs, institutional rigidities and the size of the clean development mechanism. *Energy Policy*, 33, 511-523.

Michaelowa, A. (2005c). CDM: Current status and possibilities for reform, Hamburg Institute of International Economics, Paper No.3

Michaelowa, A. (2004) CDM Incentives in Industrialized Countries – The Long and Winding Road. *International Review for Environmental Strategies*, 5(1):217-231.

Muller, A. (2007). How to make the clean development mechanism sustainable—The potential of rent extraction. *Energy Policy*, 35(6): 3203-3212.

Murdiyarso, D. (2004) Implications of the Kyoto Protocol: Indonesia’s Perspective. International Review for Environmental Strategies 5, 145-156.

Nelson, K. and de Jong, B. (2003). Making Global Initiatives Local Realities: Carbon Mitigation Projects in Chiapas, Mexico. *Global Environmental Change* 13: 19–30.

OECD (2002) Foreign Direct Investment for Development: Maximising Benefits, Minimising Costs. Paris, Organization for Economic Development and Cooperation.

OECD (2006) Statistical Annex of the 2006 Development Co-operation Report Table 19.

OECD (2007) Development aid from OECD countries fell 5.1% in 2006.

Olsen, K. H. (2007) The Clean Development Mechanism's Contribution to Sustainable Development: a review of the literature. *Climatic Change.* (In press)

Parikh, J. & Parikh, K. (2004) The Kyoto Protocol: An Indian Perspective. *International Review for Environmental Strategies* 5, 127-144.

Pearson, B. (2007) Market Failure: Why the Clean Development Mechanism won’t promote clean development. *Journal of Cleaner Production* 15:247-252.

Poussart, J-N, Ardö, J. and Olsson, L. (2004). Effects of Data Uncertainties on Estimated Soil Organic Carbon in the Sudan. *Environmental Management* 33 (Supplement 1): S405–S415.

ProBase (2002) Procedures for Accounting and Baselines for JI and CDM Projects, EU Fifth Framework Programme, Sub-programme: Energy, Environment and Sustainable Development, Brussels

Río, P. D. (2007). Encouraging the implementation of small renewable electricity CDM projects: An economic analysis of different options. *Renewable and Sustainable Energy Reviews*, 11(7):1361-1387.

Roberts, J.T. and Parks, B.C. (2007). A Climate of Injustice Global Inequity, North-South Politics, and Climate Policy. Cambridge, Mass.: MIT Press.

Shrestha, R. M., S. Sharma, et al. (2005). Baseline Methodologies for Clean Development Mechanism Projects, UNEP: 203.

South Pole Carbon. (2007). First Certified Emissions Reductions from a Gold Standard validated CDM project (Email correspondence).

Sterk, W. and Wittneben, B. (2005): Addressing Opportunities and Challenges of a Sectoral Approach to the Clean Development Mechanism, JIKO Policy Paper 1/2005.

Streck, C. (2004) New Partnerships in Global Environmental Policy: The Clean Development Mechanism. *Journal of Environment & Development* 13, 295-322.

Stroosnijder, L. (2005) Measurement of Erosion: Is It Possible? *Catena* 64: 162-163.

Sutter, C. (2003) *Sustainability Check Up for CDM Projects: Multicriteria Assessment of Energy Related Projects under the Clean Development Mechanism of the Kyoto Protocol*. Berlin, Wissenschaftlicher Verlag Berlin.

Szymanski, T. (2002). The Clean Development Mechanism in China. The China Business Review. The US-China Business Council.

The Climate Group. (2006). The Voluntary Carbon Standard Proposed Version 2 Consultation. Retrieved 19 January, 2007, from http://www.theclimategroup.org/assets/VCS%20V2%20consultation%20letter%20final.pdf

Thompson, A. (2005). The Rational Choice of International Institutions: Uncertainty and Flexibility in the Kyoto Regime. Presented at the Colloquium on Positive Political Economy, Department of Political Science, Ohio State, January 21, 2005.

United Nations (1972), Report of the United Nations Conference on the Human Environment 1972, Stockholm Declaration of the United Nations Conference on the Human Environment, U.N. Doc. A/CONF. 48/14/Rev. (1973), reprinted in 11 I.L.M. 1416 (1972) ("Stockholm Declaration").

UNCTAD (2006) World Investment Report 2006.

UNCTAD (2005) World Investment Report 2005.

UNEP-RISOE (2007) CDM Pipeline Overview.

UNFCCC (2006), Project Design Document Form (CDM PDD) – Version 03.1 (effective 28 July 2006). (available at http://cdm.unfccc.int/Reference/Documents/cdmpdd/English/CDM_PDD.pdf, last visited 21 March 2007.)

UNFCCC (2002) Report of the Conference of the Parties on its Seventh Session, held at Marrakech from 29 October to 10 November 2001. Add 1 to 4.

UNFCCC (2001) The Marrakech Accords.

Van Schaik, L. and Egenhofer, C. (2005). The State of the CDM Debate. European Climate Platform, Background Paper No.1

WARA, M. (2007). Is the global carbon market working? *Nature*, 445**,** 595-596.

World Bank. (2007). *State and Trends of the Carbon Market 2007*. Washington D.C.: The World Bank.

Zeng, L. & Yan, J. Y. (2005). Policy, institutional, and market barriers to the implementation of the clean development mechanisms (CDM) in China. *International Journal of Green Energy*, 2, 259-271.

Zhang, Z. X. and Maruyama, A. (2001). Towards a private—public synergy in financing climate change mitigation projects. *Energy Policy* 29, 1363-1378.

Appendix: Legal and Financial Aspects

Legal Aspects

CDM projects involve compliance with two, often separate and distinct, legal frameworks. The first is the domestic law of the host country. The second is the international climate change framework, in particular the Kyoto Protocol to the United Nations Framework Convention on Climate Change, the UNFCCC itself, the decisions of the Conferences of Parties to the UNFCCC, in particular at Marrakech in 2001 providing the mechanisms for the development and operation of CDM projects (the “Marrakech Accords”), the Meetings of Parties to the Kyoto Protocol and the various decisions of the UNFCCC Executive Board.

Article 12 of the Kyoto Protocol established the CDM. Its stated purpose is to assist Kyoto Protocol parties not listed in Annex I in achieving sustainable development, to contribute to the ultimate purpose of the UNFCCC and to assist Kyoto Protocol parties listed in Annex I to comply with their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol.

The Kyoto Protocol requires that participation in CDM projects be voluntary, be approved by each country involved, and that each country involved be a party to the Kyoto Protocol. It states that CDM projects must result in real measurable and long-term benefits related to the mitigation of climate change, and reduce emissions that are additional to any that would occur in the absence of the CDM project. The Kyoto Protocol specifically endorses private party participation in CDM projects.

Entities Involved

Establishment and registration of a CDM project requires coordination among a variety of entities and the submission of multiple documents. The first are the *project participants*. Project participants include the owners of the project, any forward purchasers of the CERs and other parties that are listed in the project design document.

The *designated operating entity* (“DOE”) is a third-party organization with sufficient technical skills to validate the baseline and monitoring methodologies proposed by the project participant as well as much of the other information included in the project design document (“PDD”) and to verify the actual emissions reductions and to provide the corresponding certification. The DOE must be qualified as such by the UNFCCC. The DOE is liable for the value of CERs wrongly issued due to its misdeeds.

Each country that is a party to the Kyoto Protocol wishing to participate in the CDM must appoint or create a *designated national authority* (“DNA”). The DNA acts as the gatekeeper for CDM transactions in or involving that country, and are the means by which a host country government participates in multilateral decisions about possible projects. DNAs are usually ministries within a host country’s government, most often the Ministry of Environment.

The UNFCCC has a variety of entities that may become involved in a project. The highest authority of the Kyoto Protocol is the Conference of Parties serving as the Meeting of the Parties to the Kyoto Protocol ("COP/MOP"), where all parties participate. Prior to the Kyoto Protocol becoming effective on 16 February 2005, this annual meeting was the Conference of Parties ("COP") to the UNFCCC. The Kyoto Protocol COP/MOP functions are similar to those carried out by the COP for the UNFCCC. The COP and the COP/MOP now meet together annually. The COP/MOP held its first meeting (COP/MOP 1) in Montreal in 2005, in conjunction with the eleventh COP.

The CDM is supervised by the *CDM Executive Board* which itself operates under the authority of the COP/MOP (a role performed by the COP until 2005). There are 10 Executive Board members and 10 alternates. They act in their personal capacities but are drawn from a diverse cross-section of the Kyoto Protocol Parties.

The *Methodologies Panel* (the "Meth Panel") makes recommendations to the Executive Board on guidelines for baseline methodologies and monitoring plans and makes recommendations on proposals for new baseline and monitoring methodologies. The CDM *Registration and Issuance Team* (the "RIT") assists the CDM Executive Board by reviewing requests for registration of project activities and requests for issuance of CERs and making recommendations. The RIT is chaired by a member of the Executive Board on a rotating basis.

Project Development and Validation

The first step to developing a CDM project is identifying the project, completing any negotiations and documentation to obtain adequate rights to the project or some type of commercial agreement whereby the owner remains a project participant. Once completed, the project participants must begin to prepare the PDD, initiate the stakeholder consultations and comply with any threshold country-specific requirements. The PDD must be in the form specified by the UNFCCC. It serves as written evidence that the project reduces greenhouse gas emissions in compliance with the Marrakech Accords' additionality requirements, indicates the UNFCCC approved methodology, baseline and monitoring methodology to be applied by the project and designates the project's start date and project participants. As the PDD moves beyond the draft phase a DOE must be engaged to validate the PDD and the project activity, including the baseline methodology and monitoring plan, the stakeholder consultations and the other matters in the PDD to ensure compliance with the CDM project requirements. The DOE issues a Validation Report with its findings.

A CDM project activity must employ an approved baseline and monitoring methodology. This can be an existing, non-project specific methodology or a new or revised methodology. Use of an existing methodology saves considerable time in the approval process, as it can take twelve months (or more for complicated methodologies like biofuels) to obtain CDM Executive Board approval for a new or revised methodology. For small-scale projects, the project participants may use the corresponding simplified methodologies.

The next step involves obtaining a Letter of Approval from the host country DNA. Most DNAs require that the PDD and Validation Report be completed and submitted as part of the materials supporting the application for a Letter of Approval. Obtaining a Letter of Approval from the DNA is a domestic law issue in the individual host country so each DNA may structure its approval process in its sole discretion. The letter must be included in the registration materials sent to the UNFCCC and constitute the host country's written approval of voluntary participation. It must also confirm that the project activity will assist it in achieving sustainable development. Each host country has reserved the right to define sustainable development for itself, a principle arising from the 1972 Stockholm Declaration (Principle 21, Stockholm Declaration, 1976). Many DNAs have sustainable development criteria and other procedures and criteria for issuing Letters of Approval, and these procedures and criteria vary quite substantially from country-to-country. Brown et al.'s (2004) review of forestry CDM projects in Belize, Bolivia, Brazil and Mexico indicates that DNAs apply a host of differing criteria to their determination of whether the project furthers sustainable development.

Once the Letter of Approval is received the project participants may register the project with the UNFCCC. Registration is automatic eight weeks after the CDM Executive Board receives a Validation Report from a DOE, unless either a party to the project activity or three members of the CDM Executive Board request a review of the project activity. A review triggered by the CDM Executive Board must pertain to the validation requirements and must be finalized no later than the second meeting following the request for review. Project activities not accepted may be reconsidered for validation and registration after coming into compliance.

Once registered with the UNFCCC, the project participants must implement the validated monitoring plan included in the PDD. This is a condition precedent to the verification, certification and issuance of CERs.

Periodically the project participants will engage the DOE to perform an independent review of the project to undertake verification. This involves an audit of the monitoring reports and other information to confirm the accuracy of those reports. Once verification is completed, the DOE certifies the monitoring reports' accuracy. The DOE then prepares a Verification Report confirming the greenhouse gas emission reductions achieved. This is followed by a Certification Report, certifying that during the specified time period the project activity achieved the enhanced reductions of greenhouse gas emissions, as verified, and requesting that the corresponding number of CERs be issued. This report is also sent to the CDM Executive Board. Both the Verification Report and the Certification Report are publicly available.

CERs are issued 15 days after the receipt of the Certification Report unless either a party involved in the project activity or three members of the Executive Board request a review. If this occurs, the CDM Executive Board must consider whether the proposed issuance of CERs should be approved and inform the project participants of the outcome within 30 days, making both the review and the outcome public.

Small-scale Project Activities

Simplified procedures exist for certain categories of small-scale CDM project activities. These provide a simplified PDD, a separate simplified baseline and monitoring methodology, simplified environmental impact analysis provisions and the possibility of bundling multiple projects that, together, fall within the small-scale criteria in order to decrease transaction costs. The timeframe for registration of small-scale project activities with the CDM Executive Board has been reduced from eight weeks to four weeks.

There are three types of projects that qualify for treatment as small-scale projects:

- renewable energy projects of a maximum output capacity equivalent to 15 MW
- energy efficiency improvement projects reducing energy consumption (supply and/or demand) by up to 15 GWh per year

- projects that reduce anthropogenic emissions by sources and emit less than 15 kilotonnes of CO_2e annually.

Project activities that are deemed to constitute *debundling* are not eligible for these benefits. Debundling is deemed to have occurred when the small-scale activity is within one kilometre of the project boundary of another project activity involving the same project participants in the same project category and the same technology, which was registered within the previous two years, when the combined project activities exceed the maximum criteria for small-scale project activities.

Current Institutional Issues

Three sets of issues have arisen regarding the establishment of CDM projects. One is the time it takes to complete the project registration requirements, especially when new methodologies are involved. Another involves the transactions costs involved in the establishment, validation, DNA approval and registration processes. Finally, concerns have been expressed over the varying DNA requirements and sustainable development benefits provided by some projects.

Methodologies/Time Frames

An initial difficulty that project participants encountered was the extended timeframe required to obtain approval for a new baseline and monitoring methodologies from the Methodology Panel and the CDM Executive Board. The development of a pool of approved methodologies has ameliorated this problem, as has an increase in Methodology Panel staff. But for projects which do not adhere to an existing methodology, this continues to present a lengthy project development timetable.

The methodology is critical to determine a proper determination a CDM project’s contribution to greenhouse gas emissions reductions, if any. A key component is the baseline, which is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the project activity. It may include a scenario where future anthropogenic emissions are projected to rise above current levels due to the specific circumstances of the host country. The baseline must be set in a way that CERs cannot be earned for decreases in activity levels outside the project activity or due to force majeure events.

The Marrakech Accords require that methodologies promote consistency, transparency and predictability, provide rigour to ensure that net reductions in anthropogenic emissions are real and measurable, and represent accurate reflections of what has occurred within the project boundary and address the additionality requirement. The Marrakech Accords provide for methodologies to be standardised to allow a reasonable estimation of what would have occurred in the absence of a project activity, but such standardisation must be conservative so as to prevent overestimation of emission reductions.

Selection of a baseline methodology involves application of one of three approaches. The first is using existing historical data on greenhouse gas emissions. The second references the emissions that would derive from an economically attractive course of action, taking into account barriers to investment. The third approach involves an analysis of similar project activities undertaken the previous five years in similar circumstances, and whose performance is in the top 20% of their category. Project proponents must justify their choice among these three alternatives.

The additional time period to achieve acceptance of a new or revised methodology has the effect of making new ideas more costly to implement. While close regulatory oversight of new methodologies is necessary, from a policy standpoint it begs the question of whether this burden is best shouldered by the project developer seeking to further the purposes of the UNFCCC and the Kyoto Protocol.

Transaction Costs

Michaelowa (2005b) provides an overview of the historical transaction costs for CDM projects and the former 'Activities Implemented Jointly' projects, noting that development of a baseline methodology and monitoring plan, UNFCCC registration, verification and certification are particularly likely to entail considerable costs. This can be particularly harsh for small projects as many costs are fixed. Projects that qualify as small-scale projects can get some relief, as described above, but other small projects must bear high fixed costs. There are also digressive and proportional transaction costs which depend on economies of scale with regard to CER generation. Economies of scale thus render smaller, more sustainable development oriented projects with lower CER potential, longer lead-times, and more transaction costs very unattractive. This affects the overall share of CDM in the market. Projects further up the marginal cost curve have higher transaction costs and thus transaction costs not only shift the CDM supply curve upward, but also tilt it upward, contributing to even a lesser share in the market that might be assumed if transaction costs were all fixed (Michaelowa and Jotzo, 2005).

Varying DNA Requirements

Each DNA is free to implement its own requirements and criteria, including sustainable development criteria, taxing a portion of the CER revenue, local ownership requirements, and requirements that a portion of the CER revenue or any power generated be donated to public or charitable institutions. These are just examples of the types of requirements developing country DNAs have implemented.

The varying DNA requirements could result in changes in investment flows. Such disparities need to be balanced against the CDM's goal of attracting foreign investment in sustainable development infrastructure throughout the global South, accompanied by a transfer of technology. As we review the DNA sustainable development requirements below, there is great uncertainty whether an ad hoc approach to DNA regulation (like Peru's) inhibits investment any more than a checklist approach (like Brazil's) increases investment.

As CDM projects only occur in developing countries, investors must grapple with the corresponding legal and political risks. The rule of law is well developed in relatively few developing country judicial systems, so the DNA requirements are often applied in a fluid manner. This can create flexibility and may seem attractive to some developers, but may seriously undercut the underlying intent of the CDM. The tension here is the balance between the individual developing country sovereignty to determine its own sustainable development path, on the one hand, and the need for some form of standardization to avoid a race to the bottom, on the other.

Sinks and non-permanence

Permanence of emission reductions was one of the main issues of controversy during earlier design stages of the Kyoto-Regime when the inclusion of carbon sinks was debated. The concern is the following: when emissions are reduced by implementing a fuel-switch or an energy efficiency measure in the field of fossil-fuel consumption, this will have a permanent impact. Even if, for example, an installation producing electricity from solar energy goes out of service after several years and the old oil-fired power station comes back online, the emission reductions that have been achieved will not become undone and there is – permanently - less CO_2 in the atmosphere (see Chomitz, 2002). In contrast, planting a forest as a carbon store carries with it a reversal risk: if the newly created sink burns or is logged, the sequestered CO_2 will be released back into the atmosphere and there will be no net emission reduction in the end.

Offsetting fossil-fuel based emissions through forest plantations, critics claim, therefore creates a liability for the future rather than representing a "sustainable" climate mitigation strategy. Offsetting the emissions from fossil fuel burning by building up a carbon sink in the form of a forest plantation would allow the initial emitting activity to continue. In case of a destruction of the carbon sink through human activities or non-anthropogenic causes (e.g. droughts, fires, pests, storms), the emissions that the planted trees meant to offset would have increased atmospheric GHG concentrations to which the temporarily stored forest carbon would be added.

For sinks projects, therefore, temporary carbon emission reductions, or T-CERs, can be issued. To prevent double-counting, both T-CERs and Long-Term CERs or L-CERs can be used. T-CERs correspond with the net GHG removal since the project start-date and expire at the end of the commitment period subsequent to the one in which the T-CERs are earned. LCERs correspond with the net GHG removal in each verification period and expire at the end of the project's crediting period. Project participants can choose from two crediting period options: 20 years, renewable twice provided the DOE re-validates the baseline, or at most 30 years. (Kägi and Schöne, 2006). An alternative might be a form of carbon leasing based on the timescale of a tonne of carbon's radiative forcing potential (Dutschke, 2002), which is theoretically more accurate, but complicated. Even this is based on the assumption that temporary removal of a tonne of CO_2 does have mitigation value. Probably it does (Chomitz, quoted Dutschke, 2002), but this is not unquestioned (see for example Meinshausen and Hare, 2002). This exemplifies the unknowns that surround some aspects of climate mitigation.

Carbon markets and CER trading

There has been a market for CERs since the details of the Clean Development Mechanism were fleshed out at the Marrakech Accords in 2001 and the first CDM projects were developed. However, the market has evolved since then, to the point where in May 2007 there were in excess of 650 CDM projects registered with the Executive Board and over 45m CERs issued by the UNFCCC Secretariat.

Early development and the primary market

As discussed in Section 1, to pass the test of additionality, projects need to demonstrate that proceeds from the sale of CERs are instrumental for the project's financial success. Prior to the ratification of the Kyoto Protocol in March 2005 and the start of the European Emissions Trading Scheme (EU ETS) in January 2005 and therefore the emergence of credible end markets, this required long term off take contracts or Emission Reduction Purchase Agreements (or ERPAs). These ERPAs that drove the early development of the CDM process were made possible by early movers in the carbon market such as the World Bank and some Annex 1 Kyoto parties such as the Netherlands and Denmark. While CDM project lifetimes extended to 21 years, these have mostly extended out only to the end of the first Commitment Period to 31 December 2012.

The forward purchase of CERs through ERPAs remains the most common structure for project entities to monetise the value of their project CERs. The market from its early stage has contained intermediaries and brokers that have assisted with the development of the projects as well as the commercialisation of CERs providing much needed liquidity in it early stages. As the market has grown in size and scope, the variety and volume of buyers has also grown significantly to include more intermediaries, compliance buyers, governments and financials. Transaction and pricing structures have recently become more sophisticated in the primary market, with some ERPAs containing a floating price element (generally using the price of EU Allowances (EUAs) from the EU ETS as a benchmark for prices.)

The emergence of a secondary market in CERs

The advent of the EU ETS bought into existence a large number of sophisticated counterparties trading emission products on a daily basis to manage their exposure under the scheme. Particularly, large European utilities that have the largest requirement to buy allowances have embraced CERs as an opportunity to purchase lower priced compliance instruments. The volumetric uncertainties typical in primary market contracts has led to the development of a market for secondary CERs with fixed volumes to be delivered at fixed dates in the future. Project aggregators, compliance buyers and financials now all operate in this market with increasing value for the volumes traded as shown below in Table 1. There is now a standardised contract for trading in the secondary market that has been introduced and is now being modified by the trade body, the International Emission Trading Association (IETA).

Table 1: Carbon Market at a Glance, Volumes & Values in 2005-06

	2005		2006	
	Volume ($MtCO_2e$)	Value (MUS$)	Volume ($MtCO_2e$)	Value (MUS$)
Allowances				
EU ETS	321	7,908	1,101	24,357
New South Wales	6	59	20	225
Chicago Climate Exchange	1	3	10	38
UK-ETS	0	1	na	na
Sub total	**328**	**7,971**	**1,131**	**24,620**
Project based transactions				
Primary CDM	341	2,417	450	4,813
Secondary CDM	10	221	25	444
JI	11	68	16	141
Other compliance	20	187	17	79
Sub total	**382**	**2,894**	**508**	**5,477**
TOTAL	**710**	**10,864**	**1,639**	**30,098**

Table 5 Recent carbon market statistics according to asset class, platform, and legal instrument. *(IETA and The World Bank, May 2007)*

The increasing volume of CERs issued by the CDM Executive Board has led to the emergence of a market for issued (or spot) CERs, both through brokers and directly between project entities and end users. The key infrastructural element that links the registry of the Executive Board where the CERs are issued and then forwarded to project participants and National Registries of compliance buyers, the International Transaction Log (ITL), is not complete as of April 2007 or linked up to all registries. This has prevented the development of a fully functioning spot market to date and issued CERs are traded for delivery 10 business days following full functionality of the ITL.

CERs relative to other marketable carbon securities

CER compliance within the EU ETS is enabled by a 'Linking Directive' that allows CERs to be used in compliance against specified emissions reductions under the EU ETS and in the first commitment period of the Kyoto Protocol (European Union, 2004). The inclusion of the linking directive provided increased incentives for companies to invest in CDM projects in order to generate cheap emissions reductions that can then be traded across the EU markets. This is both for emissions reduction compliance and for profitable arbitrage across credit types. Investment in the CDM has also been used to hedge risk for emissions reduction compliance because CERs are transferable into phase II of the EU ETS (2008 – 2012), whereas the credits issued by the EU for trading (European Union Allowances; EUAs) are to be retired at the end of Phase I of the scheme in 2007.

The use of CERs for compliance in the EU ETS is limited and according to the linking directive, must be supplemental to domestic actions for emissions reductions. However, others have shown unlimited use of the CDM would substantially lower compliance costs, but increasingly move abatement away from Europe and into developing countries (Anger, 2005). The CDM therefore sits at the juncture between debates on where emissions reductions should be made and policy choices regarding ultimate costs of abating emissions.

The CDM was created to assist developed countries with Kyoto compliance and to provide an abatement system that also aimed to help the developing world through technology transfer. As a result of the mechanism's focus on Kyoto and its business-orientation, the CDM has largely received investment for projects that deliver CERs with vintages only up until 2012. As Hampton (2007) notes, investment in the CDM is expected to fall in 2007 as new projects are unlikely to deliver sufficient returns before the end of Kyoto's first commitment period in 2012. Uncertainty in post-2012 scenarios poses a major issue for current investors in the CDM (Carbon Finance, 2006), although this may be cushioned by the fact that the EU ETS and the CDM linking directive do not 'expire' as Kyoto does in 2012. In the short-term, certainty that some kind of binding emissions reductions agreement, which include the use of CERs for compliance, is key for avoiding a decline in CDM investment just as a post-2012 compliance regime is being negotiated (Hampton, 2007).

Voluntary carbon offsets

The use of the CDM to offset carbon emissions in developed countries through investment in developing countries is now increasingly being mirrored by a voluntary carbon offset (VCO) market that seeks to use carbon finance for emissions reduction projects for companies and individuals that are not covered by Kyoto, and who may want to go 'carbon neutral' for public relations, marketing or other reasons. The institutional development of rules and procedures for the CDM has influenced recent growth of the VCO market which at present is unregulated. The voluntary market has been growing organically through the actions of environmental organizations increasingly turning to forms of market environmentalism to further their aims. The private sector has also seen the opportunity to profit from both the creation of VCO offset projects and the retail sale of their resultant credits, and now through the institutional investment for voluntary emissions reductions (20 MT CO2 in 2006) (World Bank, 2007, pg.41).

Due to the reduced verification and standardization required in VCO projects, some argue that more innovative carbon projects can be promoted through the voluntary markets (Bayon, Hawn, & Hamilton, 2007). However, in addition to such advantages, the unregulated nature of the VCO market means that understanding carbon reductions and the development attributes of VCO offset projects is not always clear. As a result of the potential opportunities and problems with unstandardised voluntary projects, and the limitations of the CDM due to its high complexity (Bumpus & Liverman, 2007), offset project developers are increasingly using both mechanisms to address variable client demand for different types of offset credit.

Both the CDM and VCO markets are also increasingly veering towards the use of self-imposed standards. Key issues of additionality, leakage, and standards of verification and monitoring seen in the CDM are now becoming the accepted practice within VCO developers and sellers in an attempt to maintain rigour and confidence in the voluntary market (The Climate Group, 2006). CDM project developers are also using standards for projects with additional sustainable development benefits in addition to emissions reductions, and as a result, claim a premium price on emissions credit sales. The Gold Standard, for example, has been supported by a number of NGOs to incorporate increased sustainable development attributes into CDM and VCO projects (Gold Standard, 2006). However despite the supposed support for such standards, their realization has been difficult with the first Gold Standard CDM project issuing credits in March 2007, two years after the first GS was launched (South Pole Carbon, 2007).

Future developments

The full operability and linking of National Registries to the ITL and therefore the CDM registry, anticipated in the latter part of 2007, will enormously increase liquidity in both the forward markets and most importantly allow for the emergence of a genuine spot market for CERs. This liquidity will be boosted further as other end markets emerge for CERs, potentially in North America and also in the voluntary sector. An increasing number of businesses are looking to offset emissions and given uncertain credibility in the VER sector are increasingly looking to buy and retire CERs as a more credible off set. This combination of factors are likely to drive up volumes in both the primary and secondary markets.

The market for both primary market and secondary market CERs is wholly OTC (over the counter) for the moment and therefore pricing remains relatively opaque relying on a number of brokers. However, several Exchanges active in the market for emissions and EUAs are currently evaluating the possibility to introduce a standardised CER contract. There are difficulties in this given the non-standard element to CERs from specific projects with different approvals, however it is anticipated that this will emerge in the second half of 2007.

The carbon market is already seeing more sophisticated contract structures emerging in the form of both EUA and CER derivatives. EU ETS participants have actively contracted for EUA / CER swap contracts and the number of such contracts as well as CER option contracts will increase over time in both standardised and tailored forms.

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