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The Clean Development Mechanism: History, Status, and Prospects

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Introduction

The Clean Development Mechanism, or CDM, was a late invention in the negotiation of the Kyoto Protocol—so late, in fact, that it has been called the "Kyoto surprise" (Werksman 1998). In June 1997, only six months before the Kyoto negotiations, the Brazilian delegation proposed to create a Green Development Fund (GDF) that would be supported by countries out of compliance with their commitments, and that would support mitigation projects in developing countries. Though endorsed by the G77 and China, this proposal did not fly because developed countries were strongly opposed to penalties for noncompliance. Developing countries, on the other hand, were strongly opposed to any mechanism that would replicate the logic of the Activities Implemented Jointly (AIJ) of the UN Framework Convention on Climate Change (UNFCCC) (i.e., any mechanism whereby Annex I countries[1] could offset some of their commitments through emission-reducing projects in developing countries).

To reach an agreement, the United States and Brazilian negotiators suggested in November 1997 that the GDF be turned into a "positive" scheme whereby countries with commitments under the Kyoto Protocol would be allowed to exceed their emissions quotas

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[1]The Annex I Parties to the UNFCCC are Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Czech Republic, Denmark, Estonia, European Community, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and the United States of America.

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by supporting emission reduction projects in developing countries. Unlike AIJ, however, the new mechanism would put as much emphasis on "promot[ing] sustainable development" as on "help[ing] developed countries meet their commitments." After intense negotiations, the CDM was finally included as Article 12 of the Kyoto Protocol, signed 11 December 1997.

As often happens in international negotiations, the agreed text left many ambiguities unresolved. First, parties differed in their interpretation of the new emphasis on development. Most developed countries still viewed the CDM as a way to gain access to cheap mitigation opportunities in developing countries, and thus to reduce their mitigation costs. But developing countries were looking at the CDM as a new channel for development assistance (Grubb et al. 1999). These two interpretations of the CDM are not necessarily compatible.

A second glaring difficulty was that CDM projects would create new credits in countries without commitments, and would result in the transfer of those credits to countries with commitments, thereby increasing the total amount of emission credits in circulation. Such "money creation" carries obvious risks that were not lost to the negotiators. As the Chairman of the Kyoto Conference put it, "Though I did facilitate the approval [of the CDM], I did not like it.[. . .] I do not understand how commitments can be implemented jointly if only one of the Parties involved is committed to limit or reduce emissions." (Estrada-Oyuela 1998, p. 25).

Yet, despite these fundamental difficulties, and despite the vagaries of the international climate negotiations in the years following the signing of the Kyoto Protocol, in less than a decade the CDM has turned into a vibrant market. In 2005 alone, more than 180 transactions were recorded, channeling $2.5 billion of carbon finance to developing countries—an amount equal to 2.5 percent of total net Official Development Assistance (ODA) (Capoor and Ambrosi 2006a). The CDM now has a large number of stakeholders, both in the North and in the South. The CDM, furthermore, has been instrumental in the involvement of developing countries in the Kyoto Protocol, an outcome that was not obvious in 1997.

The objective of this article is to review how this remarkable turn of events unfolded, to examine whether and to what extent the CDM has overcome the structural difficulties highlighted above, and to discuss the future of the CDM in the context of global climate mitigation in the medium and long run. The article is structured as follows. It first reviews the history of the CDM from Kyoto to the present day. Then it describes the current status of the CDM. Next it assesses the relationship between the CDM and sustainable development. Finally, it discusses the remaining challenges and future prospects for the CDM.

A Brief History of the CDM

The Kyoto Protocol (KP) (1997) calls for industrialized countries and economies in transition—the so-called Annex B countries[2]—not to exceed certain greenhouse gas (GHG) emission targets during the first commitment period (2008–2012). In addition to domestic policies and measures, Annex B Parties can meet their targets by using three flexibility mechanisms: (i) purchasing Assigned Amount Units (AAUs)—emissions

[2]The list of Annex B countries is the same as the list of Annex I countries, except for Turkey, which is in Annex I but not in Annex B because it had not ratified the UNFCCC at the time the KP was signed.

allowances under the KP—from other Annex B Parties under International Emissions Trading (KP Article 17), (ii) contributing to emission-reducing projects in other Annex B Parties and acquiring Emission Reduction Units (ERUs) through Joint Implementation (JI) (KP Article 6), and (iii) contributing to emission-reducing projects in non-Annex B countries through the CDM (KP Article 12).

The Negotiations from Kyoto to Marrakesh (1997–2001)

Though Article 12 sets out important principles, the CDM was little more than an empty shell after Kyoto. The main operational guidelines of the CDM were agreed upon only in November 2001, as part of the Marrakesh Accords. And the process was only complete in 2003 with the agreement over the rules governing forestry-related CDM projects—the so-called Land Use, Land-Use Change and Forestry (LULUCF) projects.

The reasons why it took the international community four years to negotiate the Marrakesh Accords have been amply discussed elsewhere (e.g., Bodansky 2001; Hourcade 2002). They go far beyond the CDM and have to do with the stringency of the Kyoto targets, with the uncertainty over the costs of meeting these targets, and with a series of misunderstandings between the two major negotiating blocks, Europe and the United States. What matters here is that the debates leading to Marrakesh had a lasting influence on the rules and the operations of the CDM.

The first key issue after Kyoto was that the flexibility mechanisms were strongly opposed by many stakeholders, notably a large number of NGOs and some of the Green Parties then in charge of climate negotiations in key European countries. These stakeholders saw flexibility as a way for industrialized countries to escape their obligations to reduce their domestic emissions. Their criticism of the flexibility mechanisms also reflected a broad anti-market rhetoric, particularly prevalent in Europe. Although these critics have achieved little of their policy agenda (e.g., a proposal for quantitative caps on flexibility was finally left out of the Marrakesh Accords), the Kyoto flexibility mechanisms in general, and the CDM in particular, still remain strongly suspect in many quarters.

Second, the CDM turned out to be particularly controversial among the flexibility mechanisms because, as noted above, it creates new emission credits. Article 12.5(c) of the KP states that only emission reductions that are "additional to any that would occur in the absence of the certified project" are admissible. But the counterfactual is by construction impossible to observe, and clearly open to strategic manipulations. Since both the buyer and the seller of emission reductions have an incentive to inflate the baseline, the risks are high that the CDM may open up a major loophole in the Kyoto Protocol. The pressure was thus very strong for the CDM to prove beyond a doubt that it was environmentally additional, which had two major consequences. First, it was decided that additionality would be tested on a project-by-project basis, and not at the program level as some had originally envisioned. Second, the Executive Board (EB) of the CDM, the body designated by the Kyoto Protocol to supervise the CDM, took a very conservative approach to the validation of emission reductions.

Not surprisingly, the balance between the mitigation and development objectives of the CDM was the subject of intense discussions. Of particular importance was the distribution of rents between the North and the South: the risk was that the North would purchase emission reductions cheaply by harvesting 'low-hanging fruits' from the South (Hourcade

and Toman 2000). However, specific proposals to regulate rent sharing in CDM projects were rejected. It was agreed that it would be left to the host country to determine whether a particular CDM project is compatible with its sustainable development priorities. As we will see below, however, the debate over the relationship between CDM and sustainable development is far from over.

Finally, LULUCF activities were often seen as particularly doubtful from an environmental standpoint because of measurement uncertainties. The suspicion over LULUCF was compounded by the fact that the scope of forest management under Article 3.4 of the KP was explicitly negotiated among Annex 1 parties as a means to relieve some of the pressure created by the Kyoto targets. LULUCF projects in the CDM faced even higher criticism from some stakeholders, notably environmental NGOs. LULUCF projects, critics argued, would be environmentally unsound, would flood the market with unsound credits, and would lead to environmental catastrophes in the South because they would favor fast-growing industrial plantations of alien species over community-based, sustainable forest management. This pressure led to a strict limitation of the scope of LULUCF projects under the CDM in the Marrakesh Accords, both from a qualitative point of view (only afforestation and reforestation projects are allowed) and from a quantitative point of view (the total amount of LULUCF Certified Emission Reductions [CERs] that can be obtained is capped). NGOs also succeeded in imposing the restriction that credits from LULUCF CDM projects cannot be imported into the EU Emissions Trading Scheme (EU-ETS).

As per the Marrakesh Accords, the CDM project cycle is as follows. First, the project proponent—for example, the project sponsor, one of the investors, the potential carbon buyer, or a third-party (e.g., a consultant company)—produces the Project Design Document or PDD. The PDD includes, *inter alia*, a description of the project, an explanation of how the baseline and monitoring methodology will be applied, a discussion of the environmental impacts of the project, and a compilation of stakeholders' comments, if any. In addition, the buyer(s) and the seller—even if they are private entities—must each get a Letter of Approval (LoA) from the entity in charge of reviewing CDM projects in their respective governments, the Designated National Authority or (DNA). The LoA states that the country approves participation in the project, and for the host country, that the project contributes to sustainable development.

Once finalized, the PDD and the LoAs are validated by an independent third party (typically an auditing company) accredited by the CDM EB—the Designated Operational Entity (DOE). By validating the project, the DOE determines that the project has been approved by the parties involved, and that it correctly applies the selected baseline and monitoring methodology. The DOE then submits the PDD to the CDM EB for registration. (If there is no off-the-shelf baseline and monitoring methodology available, the DOE first submits a new methodology for validation by the EB, and once the methodology is approved, the DOE submits the PDD.)

Finally, once the project is registered and has become operational, a second DOE is charged with reviewing and certifying the emission reductions generated by the project. The CERs are formally issued by the EB and transferred to the project participants' accounts. At that point, CERs are essentially fungible with other Kyoto allowances such as AAUs or ERUs.

The Emergence of a Market (1999–2005)

Interestingly, the CDM market emerged before the rules governing the CDM were finalized. In fact, when Russia agreed to ratify the Protocol in October 2004, thereby making it certain that the Kyoto Protocol would enter into force, more than 120 transactions had already been recorded (Lecocq 2005). Carbon projects had been tested even before the KP was signed, in the context of the Pilot Phase of the AIJ. But AIJ projects did not lead to transfers of credits, and were heavily criticized for poor environmental integrity (Michaelowa 1999). In the late 1990s and early 2000s, American and Canadian companies had also started to undertake carbon projects, often as part of company-wide voluntary commitments to limit greenhouse gas emissions. These projects, however, were not intended to be validated under the CDM and did not follow CDM guidelines.

The participants in the Prototype Carbon Fund (PCF), six governments and fifteen private companies, were the first investors in the CDM. The PCF is a closed $180 million mutual fund managed by the World Bank to purchase emission reduction credits under JI and the CDM. The PCF was established in 1999, became operational in April 2000, and signed its first emission reduction purchase agreement for a CDM project in Chile in 2002. The motivation of PCF participants included learning about this emerging market, gaining competitive and strategic advantage over competitors, influencing ongoing negotiations (the PCF was explicitly set up as a vehicle for informing negotiators about real-world implementation of CDM projects), and acquiring emission reductions. Although it invested very little of its own resources into the PCF, the World Bank saw carbon finance as an opportunity to channel additional resources, private resources in particular, to developing countries in a period of declining ODA. The PCF is also in line with the Bank tradition of innovation in financial markets.

Another key player in the early market was the Government of the Netherlands, which had decided early on to purchase emission reductions through flexibility mechanisms as part of a comprehensive strategy to meet its Kyoto target. In addition to participating in the PCF, the Government of the Netherlands also developed the first carbon tenders for CDM and JI (2001). In 2004, the two original players in the CDM market—the Government of the Netherlands and the World Bank (whose carbon finance activity had by then grown to include new funds besides the PCF)—still represented about a third of the total volume of project-based transactions (Lecocq 2005).

The adoption of the Marrakesh Accords in December 2001 led more players to move in. Private firms from Japan started to enter the market in 2002 and 2003, despite the absence of a domestic climate policy in Japan (the Japanese climate policy was approved only at the end of 2005). European firms followed about a year later, when it became clear (i) that the EU Emissions Trading Scheme (see the articles in this issue by Convery and Redmond, Ellerman and Buchner, and Kruger, Oates, and Pizer) would become operational, and (ii) that CERs would become eligible at least in part, under the EU-ETS. Among the most recent entrants in the market are Annex B Governments—some of which have earmarked massive amounts of money to purchase CERs—after entry into force of the KP. More recently, a wide range of buyers, such as banks or speculators, that do not need CERs for compliance but aim to trade them on the secondary market, have entered the CDM market. It is estimated that in at least one-third of all the project-based transactions concluded between January 2005

and April 2006, the buyer had the intention of selling some of the resulting CERs on the secondary market (Capoor and Ambrosi 2006a).

The regulatory buildup was slow to catch up with the explosion of the market, as the Executive Board and its technical panels were crippled by lack of resources in the face of a rapidly growing backlog of projects. Tensions over the ''regulatory bottlenecks'' have subsided somewhat as methodologies have been validated for a large range of project activities, and as regulatory resources have increased. An indicator of this improvement is the fact that, although the backlog of projects to the EB is still growing because of a rapid increase in the supply of projects, the average length of CDM project cycles is decreasing (Fenhann 2006). Overall, the international administrative framework that supports the CDM is now considered to be operational (UNDP 2006). In addition, DNAs have been set up in 112 countries, of which 91 are developing countries, thereby making project approval faster. Moreover, an increasing number of developing countries have set up mechanisms to promote project opportunities to the international CDM market.

The CDM Market Today

The CDM market cannot be understood independently of the broader ''carbon market'' to which it belongs. The carbon market is defined here as the sum of all transactions in which one or several parties pay another party or set of parties in exchange for a given quantity of ''GHG emission credits.'' The legal definition of these credits varies, but what is important is that they are transferred from the seller to the buyer. Payments can take various forms, such as cash, equity, debt, or technology transfer.

Carbon transactions can be grouped into two main categories:

1. Allowance-based transactions, in which the buyer purchases emissions allowances created and allocated (or auctioned) by regulators under cap-and-trade regimes, such as Assigned Amount Units (AAUs) under the Kyoto Protocol, or EU Allowances (EUAs) under the EU-ETS.
2. Project-based transactions, in which the buyer purchases emission credits from a project that reduces GHG emissions compared to what would have happened otherwise. Project-based transactions include CDM and JI transactions, but also non-Kyoto transactions such as voluntary transactions in Europe or in the United States (from entities seeking to offset emissions related to, *inter alia*, their business operations, a service they offer or an event), and projects related to non-Kyoto regulations in Australia and in some US States.

Allowance- and project-based transactions differ by the risks attached to them. In an allowance-based transaction, the asset being traded (the allowance) exists before the transaction. The main risk is therefore delivery risk. In a project-based transaction, the asset being traded is created during the process. So in addition to the delivery risk, there is a ''noncreation'' risk. For example, the project may underperform and not generate the expected amount of emission reductions (project risk), political or institutional problems may occur and put the project and the generation of emission reductions in jeopardy (country risk), or the regulator may refuse to certify the emission reductions (nonregistration risk). Of course, if the transaction is concluded after the issuance of the CERs, the risk of

noncreation no longer exists and the transaction is equivalent, in terms of risk, to an allowance-based transaction. Transactions of issued CERs on the secondary market are becoming more common. At the time of writing, however, secondary transactions are only forward. Spot transactions of issued CERs remain technically impossible because the International Transaction Log—which connects the CDM registry (where CERs are issued) to registries of Annex B countries (where, once transferred, CERs can be used for compliance or further transacted)—is not operational.

A Fast-Growing Market

Total volumes traded on the carbon market, excluding voluntary transactions, reached 717 million metric tons of CO_2 equivalent ($MtCO_2e$) in 2005, a 5.8-fold increase over 2004, and amounted to 1023 $MtCO_2e$ in the first three quarters of 2006. To put this in perspective, 717 $MtCO_2e$ represents about 6 percent of the total 1990 GHG emissions by KP signatories, or roughly the annual CO_2 emissions of France and Spain combined. Volumes exchanged through project-based transactions and allowance trading were still roughly equal in 2005 (332 $MtCO_2e$ versus 384 $MtCO_2e$) but allowance trading is now dominant with 74 percent of the volume exchanged in the first three quarters of 2006 (Capoor and Ambrosi 2006a, b).

The rapid growth of the carbon market is a direct consequence of the entry into force of the EU-ETS (January 1, 2005) and the Kyoto Protocol (February 16, 2005). Both boost demand for CDM projects, because CERs can be used to comply with Kyoto obligations and with EU-ETS obligations. As a result, the EU-ETS market also has a strong price effect on the CDM market.

The total volumes traded through project-based transactions in the carbon market are growing rapidly: 24 $MtCO_2e$ in 2002, 51 $MtCO_2e$ in 2003, 110 $MtCO_2e$ in 2004, 384 $MtCO_2e$ in 2005, and 234 $MtCO_2e$ in the first three quarters of 2006 (Lecocq and Capoor 2005; Capoor and Ambrosi 2006a,b). These volumes represent the total amounts of emission reductions that sellers are planning to deliver up to 2012 based on transactions signed during the year in question. The volumes of emission reductions that effectively changed hands each year are much lower. These numbers are conservative because carbon traders are under no obligation to record CDM transactions before registration, hence some transactions may not have been accounted for.

The growth of the CDM market can also be seen in the annual number of projects submitted for validation. This number has grown exponentially from 5 in 2003 to 58 in 2004, 491 in 2005, and 676 in the first three quarters of 2006 (Fenhann 2006). Overall, a total of 386 projects totaling some 660 $MtCO_2e$ have been registered as of the end of October 2006 (http://cdm.unfccc.int/Statistics). Yet another indication of the rapid growth of the CDM market is the capitalization of carbon funds worldwide, which has surged from approximately $275 million in January 2004 to an estimated $4.6 billion in April 2006 (Bulleid 2006), and to an estimated $6.4 billion in September 2006 (New Carbon Finance 2006). There is thus no shortage of demand for projects-based emission reductions.

Who Is Buying?

Figure 1 shows the share of market buyers in the total volume of carbon traded from January 2005 to September 2006. In this chart, emission reductions purchased by funds

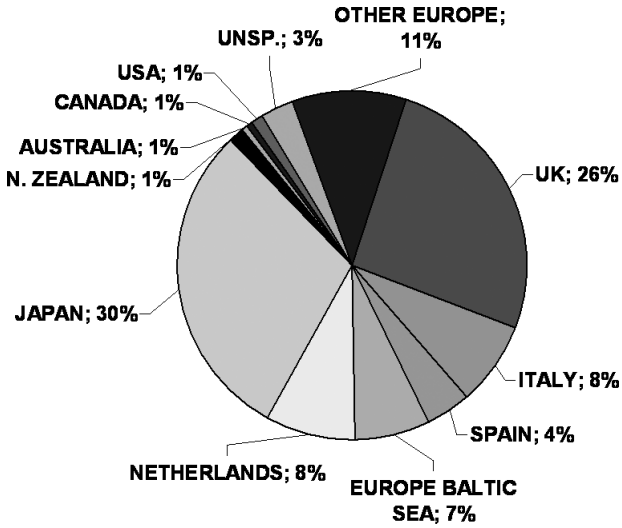

Figure 1. Major buyers in project-based transactions (as a share of total volume exchanged, vintages to 2012) from January 2005 to September 2006. EUROPE-BALTIC SEA refers to Finland, Sweden, Norway, Germany, Denmark, and Iceland. OTHER EUROPE refers to France, Portugal, Switzerland, Austria, Belgium, Luxembourg, and Greece. UNSP. refers to purchases where the origin of buyers could not be verified.

Source: Capoor and Ambrosi, 2006b.

are allocated to fund participants *pro rata* their shares. The market is overwhelmingly dominated by European (64 percent) and Japanese (30 percent) buyers. Overall, the private sector is dominant, with more than 80 percent of the volumes purchased. However, the share of the private sector may diminish in the future as the large commitments recently made by governments result in actual transactions.

Canada's very small share (1 percent) may come as a surprise as Canada's emissions in 2004 were 33 percent above its KP target. The continuing uncertainty over Canadian climate policies may explain this low number. The small volume of purchases from the United States and Australia relate to non-Kyoto projects.

Finally, as noted above, an increasing number of buyers purchase for resale. Japanese firms, but also funds based in the United Kingdom and even the United States, some of which are speculative, have entered this rapidly developing market. In particular, purchases for resale, much more than domestic needs, explain the United Kingdom's large share of purchases.

Who Is Selling?

As Figure 2 shows, China captured nearly two-thirds of the market for project-based transactions from January 2005 to September 2006. Latin America (16 percent) and the rest of Asia (12 percent) account for most of the remainder, well beyond Africa (4 percent). Projects in other regions relate either to JI or to non-Kyoto projects. These aggregates, however, are strongly influenced by the conclusion of a handful of "mega-deals" for trifluoromethane (HFC-23) destruction in China. HF-C23 is a powerful greenhouse gas, one ton of which is equivalent to 11,700 tons of CO_2. When HFC-23 deals are taken out

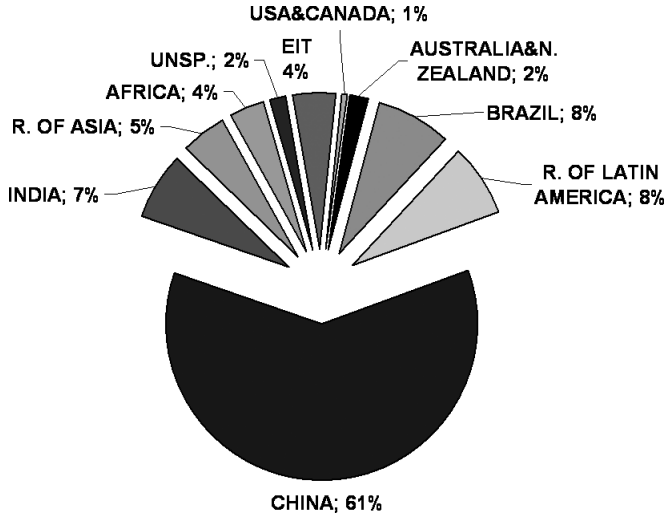

Figure 2. Major sellers in project-based transactions (as a share of total volume exchanged) from January 2005 to September 2006.
Source: Capoor and Ambrosi 2006b.

of the picture, China's share of supply, though still dominant, falls to about 40 percent. This distinction is important because most of the opportunities for HFC-23 destruction worldwide appear to have now been exploited.

With or without HFC-23, the market is concentrated in large countries. Three countries (China, Brazil, India) account for nearly 80 percent of the supply (about half without HFC-23), even though 37 countries have at least one project registered at the time of writing (Fenhann 2006). With about 4 percent, the small share of African countries in total supply is particularly striking. In fact, registered projects exist only in South Africa and in the Maghreb. And apart from South Africa, the Maghreb countries and a few sub-Saharan countries, Africa is essentially absent from the CDM portfolio (Fenhann 2006).

Balance among Technologies

As indicated in Figure 3, HFC-23 destruction projects largely dominated the volumes sold (52 percent) between January 2005 and September 2006. Methane capture from landfill gas (LFG) and coal mines (CMM) form the second largest group (13 percent), and renewable energy projects (wind, hydro, biomass, other renewables) constitute the third (12 percent). Energy efficiency (6 percent), which includes fuel switching, and N_2O destruction (5 percent) follow. Overall, projects abating gases other than CO_2 account for at least 70 percent of the volume. This is a totally unexpected outcome, as most commentators anticipated fuel switching, energy efficiency and LULUCF projects to constitute the bulk of the CDM.

The main reason for this distribution is that, at carbon prices below $\$5/tCO_2e$, carbon revenues have only a marginal impact on the internal rate of return of energy efficiency or renewable energy projects (Bishop and Lecocq 2004). Even with the higher carbon prices observed now, the carbon revenue effect is diluted by the fact that these projects typically require 5 to 7 years before they can be implemented, thus limiting the volume of credits

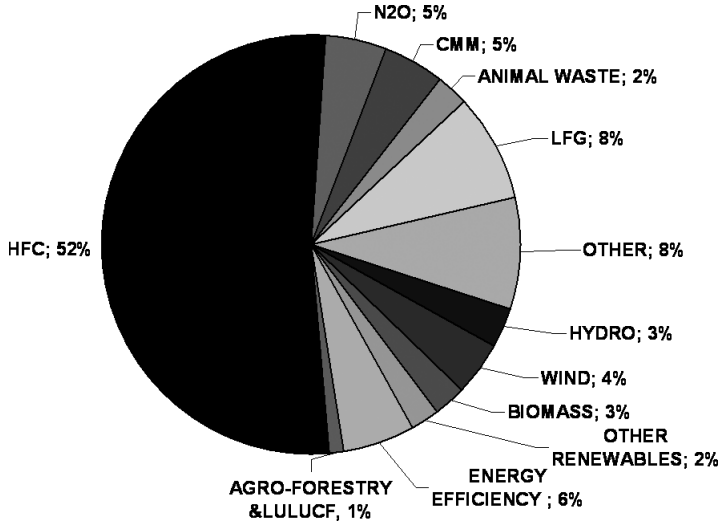

Figure 3. Distribution of technologies in project-based transactions (as a share of total volume supplied) from January 2005 to September 2006.
Source: Capoor and Ambrosi 2006a, b.

they can generate before 2012 and, consequently, the amount of carbon revenues they can obtain. Noncarbon projects, on the other hand, benefit from a much higher price per metric ton of gas avoided because of the conversion factors used in the Kyoto Protocol (e.g., HFC-23 is 11,700 times as potent as CO_2, and is thus worth 11,700 times as much), shorter construction periods before implementation, lower upfront investment, and lower performance risk (especially for the early vintages that are most valued by buyers).

Structure of Contracts and Price of Carbon

In line with the development objective of the CDM, it was anticipated that the CDM would essentially follow an investment model, with the developed country entity investing equity or debt in the project and receiving emission reductions (instead of or in addition to returns and debt service) in exchange. But an alternative commodity model has emerged whereby the buyer simply purchases the emission reductions produced by the project without providing equity or debt.

The commodity model is now dominant, mostly because the skills required to purchase carbon (evaluating baselines, etc.) are different from the skills required to invest in projects. Also, firms that invest in projects in developing countries do not necessarily need credits, or if they do, do not necessarily invest in the classes of projects that produce emission reductions at the lowest cost. Conversely, carbon buyers are in most cases not in the business of investing in developing countries. As a result, carbon contracts today are usually akin to a power purchase agreement in the energy sector, with strong implications for financing (see next section).

Within these broad parameters, the structure of CDM contracts has evolved very rapidly over the past year. Between the end of 2004 and early 2005, most transactions were forward purchases with payment on delivery at a fixed price per ton of CO_2e, over a period of a few to ten years (and usually no later than 2012). The key differentiation across contracts was the

sharing of the nonregistration risk. Some buyers were ready to pay for emission reductions as soon as they were verified by a DOE, whereas other buyers insisted on getting *certified* ERs, with punitive provisions (e.g., fines) in case of default. The price per ton was naturally higher when the registration risk was borne by the seller (Lecocq and Capoor 2005).

As of late 2006, the fixed-priced forward contract is no longer the dominant contract on the market. A flurry of new contractual structures has been introduced, with no clear standard emerging. Prices, let alone contractual structures, are rarely made public, so the following is based on interviews with market players and may not reflect the full diversity of contractual structures. This evolution results from two major trends on the market: a perception of reduced registration risk but of increased delivery risk, and the unexpectedly high price levels in the EU-ETS, at least until late April 2006 (see Convery and Redmond 2007). We discuss the implication of each trend in turn.

First, with the approval of a large number of methodologies for determining whether a project is additional in 2005 and the acceleration of CDM projects registration, the risk of nonregistration—perceived and real—has decreased substantially. Sellers are increasingly confident about selling CERs, and verified emission reductions contracts have all but disappeared. On the other hand, there are indications that performance and delivery risks are perceived with renewed acuity by market players, possibly because some early projects delivered fewer CERs than expected. For example, it is estimated that the CERs that have been certified so far represent 70 percent of the CERs that should have been generated over the same period according to the PDDs (Fenhann 2006). So, CDM projects are still perceived as risky, but for performance rather than registration issues. And registration and performance risks are different. In fact, specialists in the Kyoto Protocol are necessary to manage registration risks, whereas many people and institutions already manage performance risks for specific countries and/or types of projects. As a result, though they are still perceived as risky, CDM projects now attract a wider range of (possibly less carbon-savvy) investors.

To hedge against performance risk, two main routes are being followed. First, complex contractual structures have been built that involve not only carbon but also other attributes, such as, *inter alia*, access to technology, access to debt and/or equity, financial engineering or even agreements to operate projects. Pre-existing relationships between buyers and sellers are of particular importance in such deals. Second, guarantee structures for the provision of CERs, which, as noted above, already existed, have become more common. For example, a creditworthy seller may guarantee that it will replace a fraction of the CERs exchanged in the contract, typically 1/4 to 1/2, in case of nondelivery (e.g., by purchasing compliance units on the market). Such guarantees are reputed to command high premiums (four to six dollars /tCO_2e), and they pave the way for the creation of a secondary market for CERs, as buyers may then immediately sell back the secured credits—which become "quasi EUAs" because of the guarantee—on the EU-ETS market.

The second trend that has affected contractual structure is the price differential between the spot price in the EU-ETS (as high as €30/tCO_2 in June 2005) and the price of forward contracts for CERs ($3 and $7.15/$tCO_2e$ for the period January 04 to April 05 (Lecocq and Capoor 2005), which has generated tension on the CDM market. Sellers pushed for better deals, and some even decided to hold onto their assets in the hope of selling at better terms later. In addition, the price differential led to an increase in demand for CERs from firms under the EU-ETS and from speculators who saw opportunities for arbitrage—all that *in*

addition to the increased demand for CERs triggered by the entry into force of the Kyoto Protocol. As a result, the price of CERs has soared, to a range of $3–24/tCO$_2$e on the primary market, and of $21–27/tCO$_2$e on the secondary market between January 2005 and the first quarter of 2006.

Another consequence of the discrepancy between prices on the EU-ETS and prices on the CDM has been the generalization of contracts in which the price of the CERs is indexed to the price of EUAs. Some indexed contracts include floor prices. Others have ceiling prices beyond which buyer and seller share the upside risk. Initial evidence suggests that projects with indexed prices, especially those without floor prices, suffered strong losses when the price of EAUs fell by more than 50 percent at the end of April 2006. Some small-scale projects, in particular, may no longer obtain sufficient carbon revenues to remain in operation. As a result, indexed pricing may become less common in the future, at least for primary deals.

The overall value of the carbon market was about $10 billion in 2005, and it is estimated to be $21.5 billion in the first three quarters of 2006. The EU-ETS accounted for 75 percent of the total market value in 2005 and 87 percent in the first three quarters of 2006. In other words, the total value of project-based transactions was about $2.8 billion in 2005 and about $2.4 billion in the first three quarters of 2006, of which 94 percent is CDM (Capoor and Ambrosi 2006a, b).

Development and the CDM

The discussion above should leave no doubt that the CDM will substantially "assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments" (KP 12.2). Contracted CDM projects may already supply some 680 MtCO$_2$e, that is, 17–19 percent of a total expected shortfall of 3.6 to 4 billion tons of CO$_2$e for Europe, Japan, Canada, and New Zealand over 2008–2012,[3] and CDM projects already in the pipeline could already double that amount. But does the CDM meet its other objective to "assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention?"

In terms of *total flows* to developing countries, the CDM certainly plays a small but non-negligible role in providing finance to developing countries. As noted above, the carbon contracts signed in 2005 are worth about $2.5 billion or 2.5 percent of net ODA for that year. Since carbon buyers are for the most part private companies that are not in the business of investing in developing countries, most of this capital is probably "additional," in that it would not have gone into developing countries in the absence of the CDM. In addition, by facilitating the financial closure of capital intensive deals, the CDM leverages additional capital into developing countries. The ratio between the amount of carbon finance and the total capital needs of the project is estimated between 1:3 and 1:5 for renewable energy and LFG to energy projects.

[3] The shortfall is estimated by taking the latest available emission levels for Annex B countries (usually 2004) and applying to these levels the projected annual rate of increase in emissions between 2000 and 2010 as per the latest national communications. The high/low range relate to the "with measure" and the "with additional measures" scenarios in the national communications.

The *nature* of CDM flows is also very important. The fact that payments for CERs usually come on delivery provides higher incentives for the project to perform than traditional ODA. The flip side of the coin is that on-delivery carbon finance provides little relief to project developers often seeking upfront financing to close the financial structuring of their deals. As a result, project developers have had to use carbon contracts as collateral to obtain upfront financing from banks or other financial institutions.

Here, the *quality* of CDM payments helps. Since carbon payments are payable in strong currencies (typically, dollars, euros or yen) and usually originate from buyers with high credit ratings, they are in general more efficient ways to raise capital or contract debt than local purchase agreements. This leverage effect of carbon finance, anticipated by Mathy et al. (2001), has proven effective in some cases. In the Plantar project in Brazil, for example, the PCF is purchasing emission reductions related to the substitution of coal by sustainable charcoal for pig-iron production. To finance the initial investments, Netherlands-based Rabobank granted the pig-iron producer a five-year loan with repayments scheduled against the anticipated carbon revenues. The carbon payments are not made directly to the company, but are paid to an escrow account in a developed country bank, thereby avoiding the two currency risks associated with channeling the money in (to pay for the CERs) and then out of (to service the debt) the country. Pig-iron producers in the state of Minas Gerais typically obtain loans that extend no longer than two years, and the exceptional terms of that particular arrangement are directly linked to the presence of an emission reduction purchase agreement signed by the World Bank.

This project, however, is the exception rather than the rule. In fact, most commercial banks remain unwilling to use carbon contracts as collateral. Niche financial institutions such as mezzanine financiers partially fill the void by granting loans against carbon-purchasing contracts, for example, though quasi-equity or subordinated debt. Some carbon purchasers also offer advance payments of carbon credits, with a significant discount. But if these solutions do contribute to the financial structuring of some projects, the involvement of large financial institutions remains necessary for a large-scale development of the CDM.

As noted above, the *direction* of the flows raises strong distributional concerns about the CDM. China, Brazil, and India account for the majority of the volume traded and the carbon revenues generated by the CDM, while the most capital-constrained countries—most notably those in Sub-Saharan Africa—are left out. Although this outcome is consistent with the distribution of Foreign Direct Investment flows, and may reflect well-known differences in investment climate, it also derives from CDM-related issues. First, Sub-Saharan Africa has a limited supply of large-scale projects, energy or LFG capture, and no HFC-23 or nitrous oxide (N_2O) destruction opportunities. Second, LULUCF activities—the supply of which may be large in Sub-Saharan countries—are *de facto* barred from the market because of their exclusion from the EU-ETS, which not only dries up demand from European firms, but also from non-European buyers who may be afraid that LULUCF credits have a lower resale value on the secondary market.

Of course, financial transfers *per se* do not constitute sustainable development. What matters is how these resources are used. Here, CDM projects may contribute to sustainable development in two ways: the project activity may contribute directly to sustainable development, and/or the revenues that the project generate may be recycled into activities conducive to sustainable development. Most of the literature focuses on the first of these

two connections (i.e., the direct contribution of CDM projects). In fact, several methods have been proposed to assess the sustainable development "score" of CDM projects (e.g., Thorne and La Rovere 1999; Sutter 2003; The Gold Standard 2006). Overall, there seems to be broad consensus to consider that renewable energy and energy efficiency projects tend to contribute to sustainable development. On the other hand, HFC-23 or N_2O destruction are generally considered to have very little sustainable development impact per se. In the middle is a large gray zone of controversial classes of projects, such as LFG capture, hydro or LULUCF, that are hotly contested.

But the direct contribution of a project to sustainable development is not the end of the story. The rents generated by the project may also be used in a manner conducive to sustainable development. For example, the 65 percent tax on the emission reductions generated by HFC-23 projects levied by China will go into a special fund to finance climate change-related activities. Similarly, the additional revenues that municipalities draw from LFG capture may be used to improve municipal waste collection services. The recycling of CDM rents, however, remains virtually undocumented at this time. This makes the overall contribution of CDM projects to sustainable development very difficult to assess.

Sustainable development can also be approached from a *procedural* point of view. For example, does the Letter of Approval by DNA constitute a sufficient test of sustainability? Or does the CDM provide for fair consultation of stakeholders? There has been a substantial amount of debate on these issues, and the responses in the literature seem overall to be negative. For example, Beg et al. (2002) question DNA capacities to assess whether a project indeed meets the country's own sustainable development criteria. Burian (2006) proposes improvements to the stakeholders' consultation process so that it is more inclusive and provides for more back-and-forth discussions. The aforementioned NGO-backed standards for CDM projects all propose some degree of procedural improvements as well.

Finally, the impact of CDM projects must also be discussed dynamically. Because a project has to be additional to what would have happened otherwise, the CDM may provide a strong disincentive for countries to adopt environmental policies that would make some activities ineligible for the CDM. However, the presence of a regulation has not always been interpreted as making the project nonadditional, as long as it can be demonstrated that the regulation is not followed in practice (e.g., by looking at comparable projects around the country). In addition, two decisions by the EB make it clear that the existence of regulatory frameworks that encourage the implementation of clean energy projects, such as renewable energy targets or feed-in tariffs, may not be taken into account in developing a baseline scenario, provided they have been implemented after the adoption of the Marrakesh Accords in November 2001. But the risk still exists that a country will not pass "good policies" in order not to lose the opportunity to attract CDM resources. This calls for periodic reassessments of baselines at the country level.

Unresolved Issues and Future Prospects

The CDM is the result of a compromise between Annex 1 Parties eager to get access to lower-cost emission reductions in developing countries and developing countries eager to get additional financing for development. Nearly a decade later, the bargain has been met,

to a degree. On the one hand, Annex B countries have gained access to emission reductions at lower prices than domestic abatement costs, although the market price of CDM assets is substantially higher than expected. On the other hand, major emitters among non-Annex B countries will receive substantial carbon revenues. Although a handful of chemical producers (and the Chinese Government with its tax on HFC-23 project) extract most of the rent, it can be argued that the CDM has contributed to keeping developing countries, and in particular the strategically important large emitters among them, involved in the global carbon market. The CDM has also contributed to increasing awareness about mitigation in developing countries, and given a large number of stakeholders in the developing world a sense of involvement in the Kyoto Protocol. This outcome was far from obvious after the Kyoto negotiations, during which the G77 and China were mostly sidelined by Europe and the United States. And from a development perspective, the CDM has proven, albeit on a small-scale, that it can channel substantial private capital into clean energy projects, with strong leverage effect.

From the perspective of the political economy of the Kyoto Protocol, the CDM may also provide the EU and Japan the necessary flexibility to actually meet their targets without relying too heavily on politically unpalatable purchases of hot air—that is of 'excess' AAUs from countries, such as Russia or Ukraine, which are likely to emit much less than their Kyoto targets between 2008 and 2012. The issue of greening hot air, however, remains critical given that the CDM is not likely to supply more than 20–25 percent of the total expected demand for CERs (World Bank 2004). The ultimate success of the Kyoto Protocol still remains very much in the balance.

Looking ahead, it is becoming increasingly clear that meeting the climate challenge will require substantial cuts in emissions in developed and developing countries alike by the middle of the century. Of critical importance is avoiding the lock-in of long-lived capital stocks—yet to be built in China and India—into carbon intensive paths. Doing so will require the implementation, on a very large scale, of a combination of policy changes (e.g., power pricing reforms), technology transfers, investment, and possibly complementary international agreements to, for example, guarantee safe access to energy resources (Heller and Shukla 2003; Hourcade and Shukla 2006; Newcombe 2005; Victor 2006). A comprehensive approach will also be required to address deforestation—which accounts for twice as much emissions as transport (Chomitz 2007).

The CDM is currently ill-equipped to fulfill this task. The additionality concept, in particular, may be impossible to operate for countrywide policy reforms. In addition, bringing about systemic change requires concentrated action in a single sector or country, whereas at the heart of the CDM is the logic of targeting the lowest cost opportunities regardless of where they appear.

Does this mean that there is no scope for the CDM in the future? We do not believe so. If large-scale agreements on clean energy are a priority in large developing countries (China, India, Brazil, Mexico, possibly South Africa, Korea and maybe a few others), the vast majority of developing countries have emissions that are simply too low to justify a separate treaty or instrument. Yet these countries often have non-negligible emissions, are usually capital-constrained, and could thus well remain involved in an (improved) CDM in the near future.

Three issues, however, need to be resolved. First, additionality remains a weak link. On the one hand, there are indications of strategic behavior by chemical producers to increase revenues from CERs (Wara 2006), an extremely disturbing finding given the predominance of these projects in the CDM portfolio. On the other hand, the additionality test remains an obstacle to the development of grid-connected clean energy projects (such as fuel switching or renewable energy) over individual gas destruction projects.

A related issue is that project-by-project analysis does not allow for the consideration of policies and programs under the CDM, and may even lead to inconsistent results as individual baselines over the same grid have little reason *a priori* to be mutually consistent. The development of sectoral approaches to the CDM, such as sectoral benchmarks, with less-constraining requirements for the additionality of clean energy projects is a possible way forward (e.g., Schmidt et al. 2006).

Third, the dynamic effects of the CDM on regional or national policies have to be addressed. Since there is no way to determine what policy is additional and what is "business-as-usual," negotiations over CDM projects should directly internalize the policy component by treating it as part of the negotiation package.

Our final point is that maintaining the momentum of the CDM until 2012 may not be easy. The growth of the CDM market has been remarkable over the past few years, but as we get closer to 2008 or 2009, the window of opportunity to register projects will close because the time necessary to finalize the transaction and build the project will be too long to generate any meaningful emission reductions before the end of 2012. Yet it is not clear that the post-2012 climate policies will be agreed upon by that time (in fact, negotiations on post-Kyoto climate policies will start only in 2008), and without a clear price signal for post-2012 credits, buyers are much less likely to invest in CDM projects. The risk is thus that the CDM will lose momentum in that interim period, even though the voluntary market and several regional initiatives in the United States and Australia may to some degree support the CDM market.

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