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THE CDM PORTFOLIO: UPDATE ON NON-ELECTRICITY PROJECTS

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Organisation for Economic Co-operation and Development

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FOREWORD

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

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

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Executive Summary

The Kyoto Protocol's Clean Development Mechanism (CDM) has the dual purpose of "assisting Parties not included in Annex I in achieving sustainable development […] and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments". The aim of this paper is to provide an update on the composition of the CDM project portfolio, based on analysis of project-specific documentation for 201 proposed CDM projects, and to examine how additionality, baselines and co-benefits of proposed CDM projects have been treated. In particular, this paper focuses on proposed CDM project activities that mitigate greenhouse gas (GHG) emissions primarily through activities that do not involve electricity generation: previous work focused on electricity projects.

The CDM portfolio is growing and changing fast. Current proposals for CDM projects indicate that they expect to generate 352 million credits prior to 2012: 91.3 million credits pre- 2008 and a further 52.3 million per year (equivalent to the amount of Denmark's CO_2 emissions in 1990) during 2008-2012. This is more than triple the estimated size in December 2003. If these proposed projects and underlying baseline methodologies are all approved, the CDM will be well on track to meet its expected role of contributing 55-250 million credits per year to the 195-805 million ton CO_2-eq "gap" between the emissions and commitments of Annex I countries[1].

"Non-electricity" projects anticipate generating 39.9 million credits/year (75% of the total) during 2008-2012, up from 5 million credits/year (37% of the total) in September 2003. The largest emission reductions are expected from industrial end-of-pipe projects of a type not originally foreseen in the CDM portfolio: one that destroys N_2O from adipic acid production and two that decompose HFC23, a by-product of HCFC22 manufacture. Together, these three projects account for more than a quarter (29%) of expected credits from the entire CDM portfolio, compared to zero two years previously. Methane reduction from coal-mines, oil production or landfills is also an important source of expected credits. In contrast, the 13 proposed energy-efficiency projects expect to generate only 3% of total credits. Other "non-electricity" projects are in the energy, industry, transport and forestry sectors and mitigate emissions of CO_2, CH_4, N_2O, PFCs and/or increase sequestration of CO_2. Renewable electricity projects, which until recently accounted for the majority of expected CDM emission reductions, now represent 24% of the total CDM portfolio (from 106 projects).

Proposed CDM projects are planned or in place in 50 countries. However, the geographical spread is very uneven, with 58% of credits (30.1 Mt CO_2-eq) expected to be generated by projects in just four countries: Korea, India, Brazil and China. Indeed, the two projects in Korea are together expected to account for 27% of total credit volumes. In contrast, AOSIS countries are hosting 7 projects, which account for 1.1 % of total expected credits. At a regional level, projects in Asia are currently expected to result in 65% of the total number of credits and Africa 7%. Despite its early dominance, Latin America now accounts for slightly over a quarter of expected CDM credits. This regional disparity is partly because of the size and fossil-fuel intensity of many Asian countries. It is also partly because the potential for very large-scale projects, such as N_2O and HFC23 reduction, is concentrated in a handful of countries – mainly in Asia.

The Marrakech Accords include general guidance on how to assess whether the emission reductions of a project are additional, and therefore whether or not it is eligible to generate emissions credits. However, "additionality" has proven to be a difficult concept to put into practice. This is particularly true for projects that use technologies or systems that are sometimes implemented under business-as-usual (BAU) conditions (e.g. cement blending) or where projects involve changes to a complex system (e.g. transport infrastructure). To date, additionality for non-electricity CDM projects has been assessed in very different ways, often focusing on an investment analysis and/or a barrier analysis of varying degrees of rigour. Both these types of assessment involve some subjectivity, such as an appropriate level of discount rate or what constitutes a significant barrier. Nevertheless, additionality is relatively straightforward to demonstrate for

[1] Excluding the US and Australia, who have indicated that they will not ratify the Kyoto Protocol.

some types of projects, particularly where there are no national regulations constraining the GHG reduced and the project involves an investment whose only return is CERs (i.e. the CDM investment has no economic benefits other than CERs). In fact two projects of this type, i.e. HFC23-decomposition and landfill gas reduction, were the first to have their methodologies approved by the CDM EB, and have – unsurprisingly - been emulated since.

Guidance from the CDM Executive Board on how to assess additionality has evolved significantly over 2004. In particular, the CDM EB agreed an "additionality tool" in October 2004 which can be used to assess the additionality of a wide range of project types. One of the reasons behind the development of this tool was that revisions had been requested by the CDM EB to the additionality component of several of the previously-submitted baseline methodologies. The tool assesses additionality by undertaking, i.a. regulatory, barrier and/or investment, and common practice analysis. Using this tool to assess additionality should be helpful to project developers in reducing the time and uncertainty associated with methodology development.

A wide variety of approaches and methodologies have been used to calculate emission baselines for non-electricity projects. The resulting "shape" of individual baselines also varies substantially – reflecting differences in e.g. methodology, expected trends in a project's output, efficiency improvements. The CDM EB has approved baseline methods that cover several project types, such as landfill gas capture/use, fuel switch, manure management, HFC23 reduction, and other projects aiming to reduce the GHG-intensity of solid or liquid waste streams. Decisions for other project types, including N_2O reduction, are pending.

Although not explicitly prompted, documentation for many proposed CDM projects outline the expected direct and indirect sustainable development benefits of a proposed CDM project - usually in general terms only. These most commonly include environmental benefits (e.g. reduced water pollution) and/or increased employment. Some projects also indicated that their implementation would result in technology transfer. Earmarking a proportion (e.g. 1-5%) of CER revenue for the benefit of the local community is also planned for a few projects. However, publicly-available information on the direct non-GHG benefits of some projects is scarce - including for some very large-scale projects. Nonetheless, it is the prerogative of the host country to determine whether or not a proposed CDM project helps it assist with sustainable development. As no CDM project can go forward without the host country approval, all approved projects will have therefore been judged by the host country to assist it with sustainable development. Some host countries have established criteria on which to base this assessment.

The cost and investment needed to reduce GHG emissions through different project types – whether undertaken under the CDM or not - varies widely. Some project types, such as HFC-decomposition or N_2O reduction, have very low costs, require a relatively small investment, have low payback periods (e.g. <1 year for HFC23 projects) and low investment risks. This has led to considerable industry-led interest in developing these project types under the CDM. Such projects have the potential, in the handful of countries in which they occur, to satisfy a large majority of expected demand for CDM credits during the period 2008-2012. However, as these sectors account for only a small proportion of total anthropogenic GHG emissions, mitigation action in these areas can only have a limited effect on long-term GHG emission trends.

One potential downside is that the growing importance of low-cost end-of-pipe CDM projects in the CDM portfolio could result in a relatively low CDM "technology push" for low-GHG technologies and systems in important GHG-emitting sectors such as energy production and use. For example, it would take an additional 3 GW of wind capacity (a doubling of current non-Annex I wind electricity capacity) or 35 million energy-efficient fridges to generate 10.5 million credits per year: the expected amount from the proposed N_2O reduction CDM project in Korea. As there is a large and growing demand for energy goods and services, increased deployment of low-GHG energy technologies could have a significant impact on long-term GHG emission trends. However, the up-front investment to generate this level of emission credits through such investments is high relative to end-of-pipe CDM projects. Moreover, the transaction costs and risks of developing such energy-sector projects are also relatively high because they are smaller, may involve developing new sites and involve a greater number of stakeholders.

One lesson from the CDM as it is currently emerging is that different potential investors and/or CER buyers help shape the CDM portfolio through their priorities in terms of credit price, as well as in terms of project sector, location, and co-benefits. These priorities can differ markedly from one investor to another. Host country approval, or otherwise, of projects and project types can also have a significant effect on the total portfolio – and approval criteria can also vary widely between potential host countries. Another lesson is that renewable energy, energy efficiency and transport-sector projects are unlikely to occupy a majority share in markets designed to target least-cost GHG abatement options. Thus, the "technology push" benefits of the CDM may be slow to emerge in these sectors.

1. Introduction

The Clean Development Mechanism (CDM) was established in Article 12 of the 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). The purpose of the CDM is of "assisting Parties not included in Annex I in achieving sustainable development […] and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments". The CDM Executive Board (EB) was established by Parties to "supervise the CDM". It held its first meeting in 2001, approved some methodologies for small-scale project categories in 2002, and for some larger-scale project types in 2003 and 2004. Project development has been progressing alongside this development of CDM regulations and institutions. Indeed, 2004 should see the registration of the first CDM project activities.

The aim of this paper is to provide an update on the composition of the CDM project portfolio and to examine how additionality, baselines and co-benefits of proposed CDM projects have been treated. In particular, this paper focuses on project activities that generate emission reductions primarily through activities that do not involve electricity generation[2]. These project activities have been labelled "non-electricity" projects, and now account for the majority of expected emission reductions from proposed CDM projects[3]. This category encompasses a wide range of project types, including those that reduce emissions of CO_2, CH_4, N_2O, HFCs, PFCs and/or that increase sequestration of CO_2.

By September 2004, CDM project activities under development are expected to generate 52.3 Mt CO_2-eq of credits per year[4] during the Kyoto Protocol's first commitment period of 2008-2012, equivalent to Denmark's CO_2 emissions in 1990. A further 90.6 Mt CO_2-eq is expected to be generated before 2008. The size of this proposed portfolio is up from 32 Mt CO_2-eq/year in June 2004 and 27 Mt CO_2-eq/year in March 2004 (Ellis et al 2004) and more than triple the amount that was estimated less than a year earlier[5]. The majority of these emission reductions are expected to come from "non-electricity" projects.

This means that the development of the CDM market is on track to meet its expected role in 2010, which has been variously estimated at 250 Mt CO_2-eq (Haites 2004) and between 55-180 Mt CO_2-eq. for Annex I countries excluding US and Australia (Grubb 2003). The expected size of the CDM market is of course a small proportion of both the potential for CDM project activities, estimated at 468.6[6] Mt CO_2-eq in 2010 (Trexler 2004) just for energy-sector and gas flaring projects. In comparison, the "gap" between Annex I countries' emissions and commitments under the Kyoto Protocol has been estimated at 195 - 805 Mt CO_2-eq excluding the US and Australia (Grubb 2003).

[2] A similar study has been done for electricity-sector projects, see Ellis 2003.

[3] "Non-electricity" projects for the purposes of this paper are those that generate *most* of their credits from activities other than the production of electricity. This, however, does not mean a non-electricity project does not generate any electricity. For instance, many landfill gas projects produce electricity, but they have been classified here as non-electricity projects as most CERs will come from capturing CH_4 emissions. Indeed, several of the "non-electricity" project activities proposed to the CDM EB contain multiple components, and/or reduce multiple gases. For example, some projects in the cement sector increase the proportion of non-fossil fuel use, increase energy efficiency, and increase cement blending. Proposed manure management projects reduce emissions of both CH_4 and N_2O. In all cases, the authors have tried to classify projects according to their main expected mitigative effect.

[4] These figures represent the expected emission reductions from proposed CDM project activities as assessed by the project developer. EB review of these projects and/or their baseline methodologies may result in these proposed projects generating a different number of credits.

[5] The growth in the size of the CDM portfolio reflects both new project development, and increased availability of information on projects already under development but hitherto not public.

[6] This is the potential at \$5/t CO_2e-eq.

Section 2 of this paper gives an updated overview of developments in the CDM portfolio, with a specific focus on non-electricity projects. Section 3 examines the evolution of top-down and bottom-up guidance on additionality and baselines and, where possible, draws lessons from this experience. Section 4 outlines the technology and sustainable development (SD) benefits of proposed CDM projects, as described in their project design document, and the costs and potential for replication of common project types. Conclusions are presented in section 5.

2. Overview of CDM project portfolio

This section examines the portfolio of proposed CDM projects and highlights some recent changes. It then focuses on the portfolio of proposed non-electricity CDM projects. This paper bases its analysis on a study of 201 proposed CDM project activities in 50 countries, and their expected benefits. Information on these projects comes from publicly-available Project Design Documents (PDD) submitted to the EB or to validators, national or international CDM schemes, some Project Idea Notes (PIN) and other information (see Annex)[7].

2.1 Update on development of concrete project activities

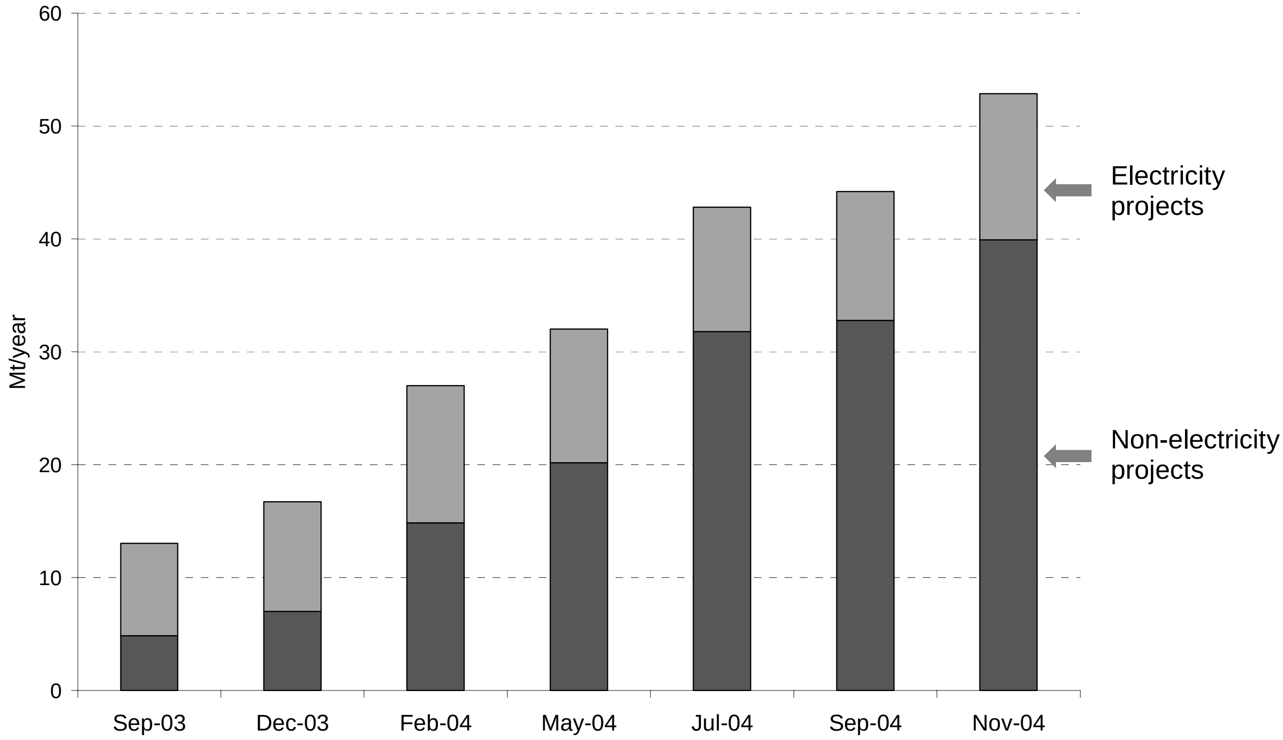
The CDM portfolio is growing and changing rapidly, and is now expected to generate over 52 Mt CO_2-eq/year of GHG emission reductions during the period 2008-2012. Reductions equivalent to a further 90.6 Mt CO_2-eq are also expected pre-2008. The total expected mitigative effect of CDM has increased by two-thirds since May 2004 (see Figure 1), as there are now some very large projects in the pipeline.

This increase in total expected emission reductions from the CDM portfolio is almost entirely due to new non-electricity projects. Comparing data from November 2004 to December 2003, electricity projects are expected to generate only about 3.2 Mt more emission reductions, whereas non-electricity projects are expected to generate 32.9 Mt more[8]. Non-electricity projects represent 75% of expected CERs from the current CDM portfolio and the number and scale of this type of projects are growing fast (see Figure 1). This growth may be an indication of a) the high mitigation potential - and therefore CERs – that can be generated by individual projects, b) the low cost of such reductions, and c) the relative ease to develop baseline and monitoring methodologies and assess additionality for such projects, which in turn has led to a relatively more rapid EB approval. The latter issue is discussed in section 3.

[7] This list of projects is not exhaustive, as information on some projects under development (e.g. for the Netherlands Clean Development Fund, the Italian Carbon Fund, and for many industry-led projects) is not publicly available until the project or its methodology has been formally submitted to the CDM EB. Nevertheless, an assessment based on over 200 proposed projects can help to identify trends in the rapidly developing CDM market.

[8] Moreover, several electricity projects have been withdrawn or cancelled (although reasons for such withdrawal are often not publicly available).

Figure 1: Evolution of the CDM portfolio, 2003-2004



Source: Project documentation detailed in Annex 1.

2.1.1 Geographical spread of projects

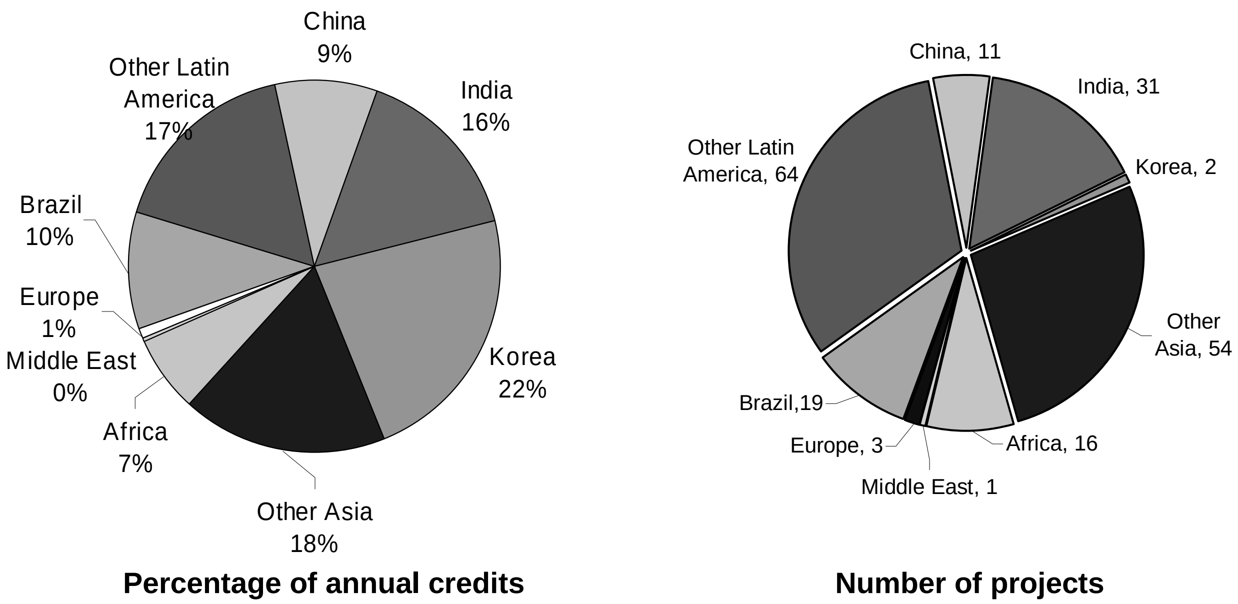
The number of projects has increased in all regions since May 2004 (Ellis et al. 2004). However, there is a widening gap between regions and countries in both the number of projects and expected reductions of proposed CDM projects. Despite many countries in Latin America being highly pro-active in setting up the institutions needed to process and approve CDM projects, and in being politically favourable to the CDM, the vast majority of credits are now expected to come from Asia[9]. Indeed, Asia increasingly dominates the picture both in terms of number of projects and expected emission reductions (see Figure 2), with its 98 projects expected to account for 65% of CDM reductions from the current portfolio. Much of this increase is due to a single project that is expected to generate 10.5 million credits per year (N_2O reduction in Korea) – i.e. about a fifth of the total expected CDM reductions. Latin America accounts for slightly more than a quarter of total expected credits, and Africa 7%.

Geographical disparities are even more evident when examining individual countries (see Figure 2). For instance, 5 countries (India, Brazil, Indonesia, China, Thailand) host 84 of the 201 proposed CDM projects. Moreover, 81% of expected CDM credits are from projects located in 10 countries (Figure 3). Indeed, expected emission reductions in Korea account for more than the total reductions in China and Brazil combined. This rather high concentration of projects in a small number of countries translates into few projects per country for the remaining 40 countries. Another point worth noting is that Korea and Mexico are the only two OECD countries eligible to host CDM projects;[10] yet there is a sharp contrast between the two countries as Mexico accounts for less than 1% of currently expected reductions from CDM whereas Korea accounts for 22%.

[9] As discussed later, this is partly because Asia has a higher potential for some large-volume potential project types (such as HFC23 reduction from HCFC-22 manufacture, and N_2O reduction from adipic acid manufacture).

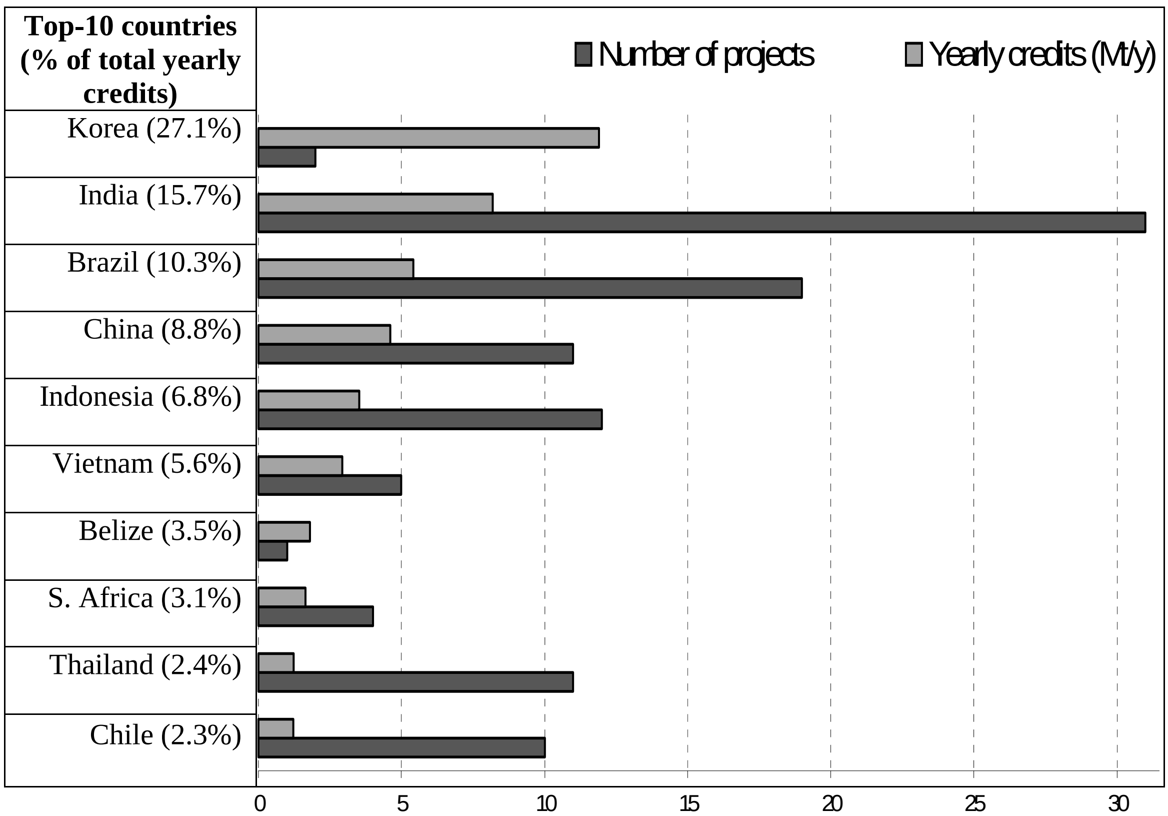
[10] While Korea and Mexico are not members of the Annex I of the UNFCCC (which includes, among its 41 Parties, the other 28 members of the OECD), they have joined the OECD since ratification of the UNFCCC.

Figure 2. CDM portfolio, November 2004 – relative importance of countries and regions



Source: Project documentation detailed in Annex 1.

Figure 3. Expected mitigation from and number of CDM activities in selected countries



Source: Project documentation detailed in Annex 1.

2.1.2 Diversity of project types

The CDM portfolio is becoming increasingly diverse. Non-electricity projects represent a considerable share of projects both in terms of expected CERs and number of projects (Figure 4). While most electricity projects reduce CO_2 emissions, non-electricity projects tackle CO_2 (sources and sinks), CH_4, N_2O, HFC and PFC emissions. (There are still no planned CDM projects reducing SF_6 emissions.)

Non-electricity projects occur across many sectors. However, the industrial sector is an especially important source of emission reductions from CDM projects. Project activities in this sector mainly seek to reduce F-gas, N_2O and non-landfill CH_4 emissions. There are also industry-sector projects that tackle CO_2 emissions from other industrial processes such as in the production of methanol, brick and cement, that switch fuels used in production of goods or, to a much lesser extent, improve energy efficiency.

A few very large non-electricity projects in the industry sector account for much of the reductions expected by CDM projects. In fact, the top-10 projects in terms of expected reductions are all non-electricity projects and account for 51% of total reductions expected by proposed CDM projects during the 2008-2012 period (see Figure 3). The Onsan N_2O-reduction project in Korea is by far the largest project, expecting to generate 10.5 Mt CO_2-eq/year in credits. Projects reducing F-gases and non-landfill CH_4 reductions each account for 10% of total expected reductions. The two HFC23-decomposition projects are expected to yield 3.4 and 1.4 Mt CO_2-eq/year. Some CH_4 reduction projects outside the landfill gas sector are also very large: the PCF project reducing emissions of coal-bed methane[11] and the Rang Dong associated gas recovery project[12] expect to yield 2.9 and 1.7 million credits/year respectively. There are also two large cement projects, expecting to generate about 1 Mt CO_2-eq/year each[13]. There are also a handful of very large landfill-gas projects expecting to generate more than a million credits/year. A large reforestation project expecting to generate 1.8 million credits/year has also recently (November 2004) been submitted to the CDM EB.

However, some industry-sector projects are smaller-scale. In particular, all energy efficiency and heating projects are expected to yield less than 100 kt CO_2-eq/year, with the exception of a heating project in Uzbekistan and a large (> 500 000 credits/year) “project” introducing mandatory energy efficiency standards in Ghana. The relatively small number of credits generated by most potential energy efficiency projects does not help their penetration in the CDM portfolio, as CDM transaction costs can be high, and thus a significant barrier. For example, a recent assessment (Haites 2004) indicates that projects delivering less than 100 000 CERs per year are unlikely to be cost-effective to pursue under the CDM[14].

Projects in other sectors – such as transport, forestry, agriculture, and waste – are expected to provide fewer emission reductions than those in the industry sector (Figure 4). Manure and wastewater treatment usually expect to generate reductions of less than 400 kt CO_2-eq/year. However, such projects are highly replicable and there is significant interest in their development (Nuon 2004). Landfill-gas capture and transport projects vary greatly in expected reductions and can offer large mitigative effects (from 3 kt to 1200 kt CO_2-eq/year and 2 kt to 690 kt CO_2-eq/year respectively).

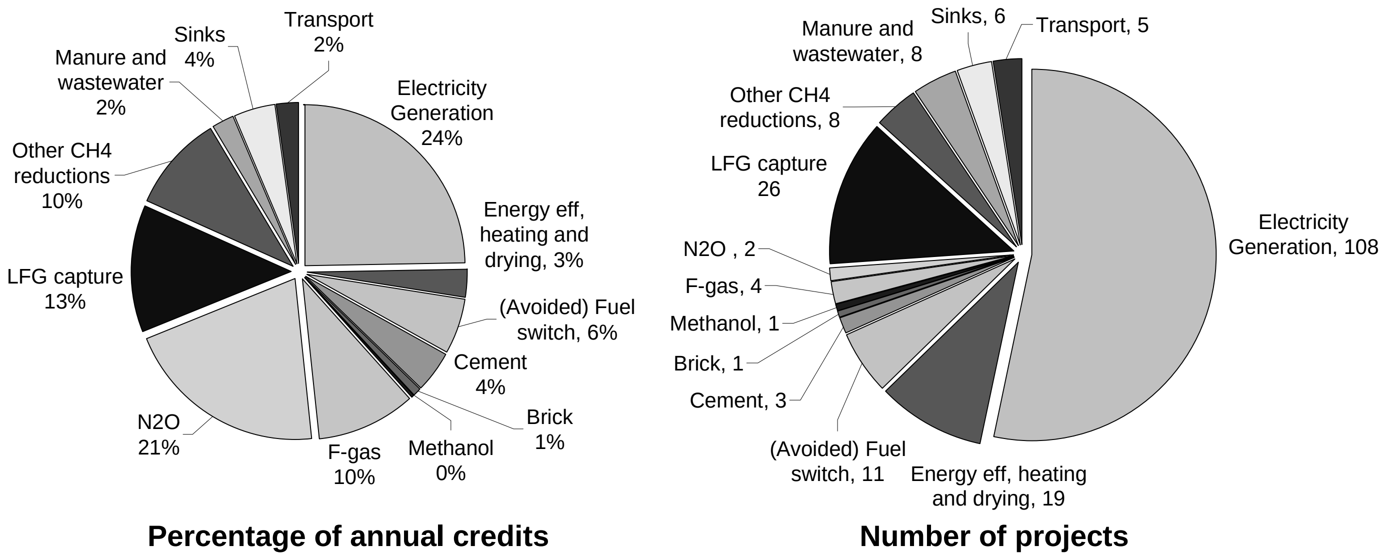
[11] http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3723

[12] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_785952467

[13] Other projects in the cement sector focus on energy efficiency and fuel switch measures, so they have been classified elsewhere.

[14] This figure may be lower for projects undertaken elsewhere then under the auspices of the World Bank carbon funds, who are at the higher end of CDM transaction cost estimates, and for whom (i.a.) this analysis was carried out.

Figure 4: CDM portfolio to date – relative importance of different sectors



Sources: Project documentation detailed in Annex 1.

2.2 Focus on non-electricity projects

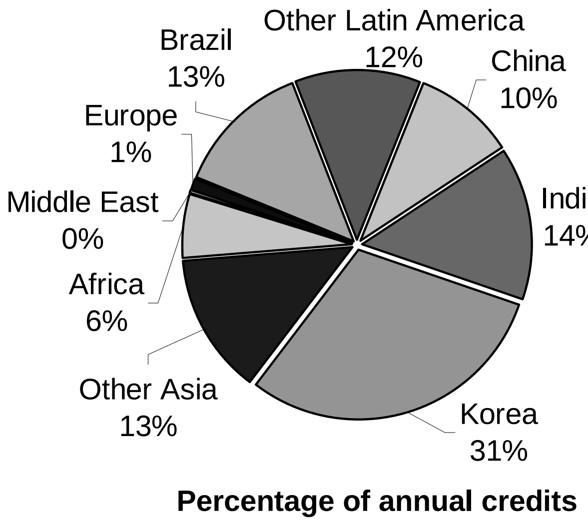
As the number of non-electricity projects and their share of total expected reductions from CDM projects are rapidly increasing (see Figure 1), focusing on non-electricity projects may give an indication of the likely future development of the CDM portfolio. As outlined above, many non-electricity projects are large scale, with more than a third (35 proposed project activities) expected to yield emission reductions above 200 kt CO_2-eq/year. Electricity projects have on average been much smaller, with only 19% (21) of proposed projects expecting to generate more than 200 000 credits/year.

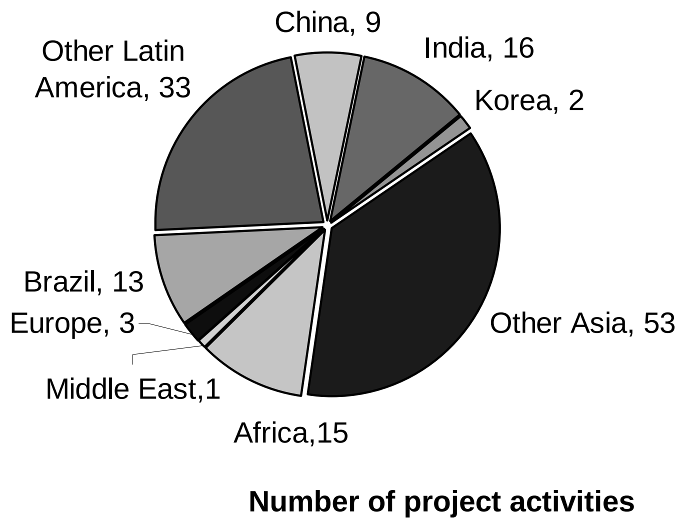
The uneven geographical distribution of projects is even more marked when examining the non-electricity CDM project portfolio (Figures 5 and 6). Asia accounts for 68% of all credits expected to be generated non-electricity projects in 2008-2012 (Figure 5), and Korea alone accounts for 31%, again mainly because of its large N_2O project. Yet, even without this project, Asia would still dominate the picture in terms of expected credits from non-electricity projects as India and countries in the 'Other Asia' category[15] together expect to generate more CERs than all of Latin America combined.

Latin America (excluding Brazil), Africa and Europe represent 12%, 6%, and 1% respectively of all credits from non-electricity projects (Figure 5). Africa's small share of the CDM portfolio is slightly weighted towards non-electricity projects, largely because of the recent development of a large landfill gas project in South Africa. Latin American countries other than Brazil have an almost even split in the number of electricity and non-electricity projects (31 and 33 respectively), although the non-electricity projects are expected to generate significantly more credits.. Brazil is the country that attracts most non-electricity projects in Latin America. It has five large landfill gas projects (200-1100 thousand credits expected per year), and two large projects involving charcoal use for pig iron production (approximately 900 000 credits/year each). In total, non-electricity projects in Brazil are expected to yield 5.1 Mt CO_2-eq/year, compared to 0.3 Mt CO_2-eq/year from electricity projects (Figure 6). Some of these projects appear to be solely host-country driven (e.g. Lara landfill) with the non-Annex 1 implementing company also identified as the investor.

[15] Bangladesh, Bhutan, Indonesia, Kazakhstan, Kiribati, Malaysia, Papua New Guinea, Philippines, Mongolia, Nepal, Niue, Samoa, Solomon Islands, Sri Lanka, Thailand, Uzbekistan, and Vietnam.

Figure 5. CDM non-electricity portfolio to date – relative importance of countries and regions

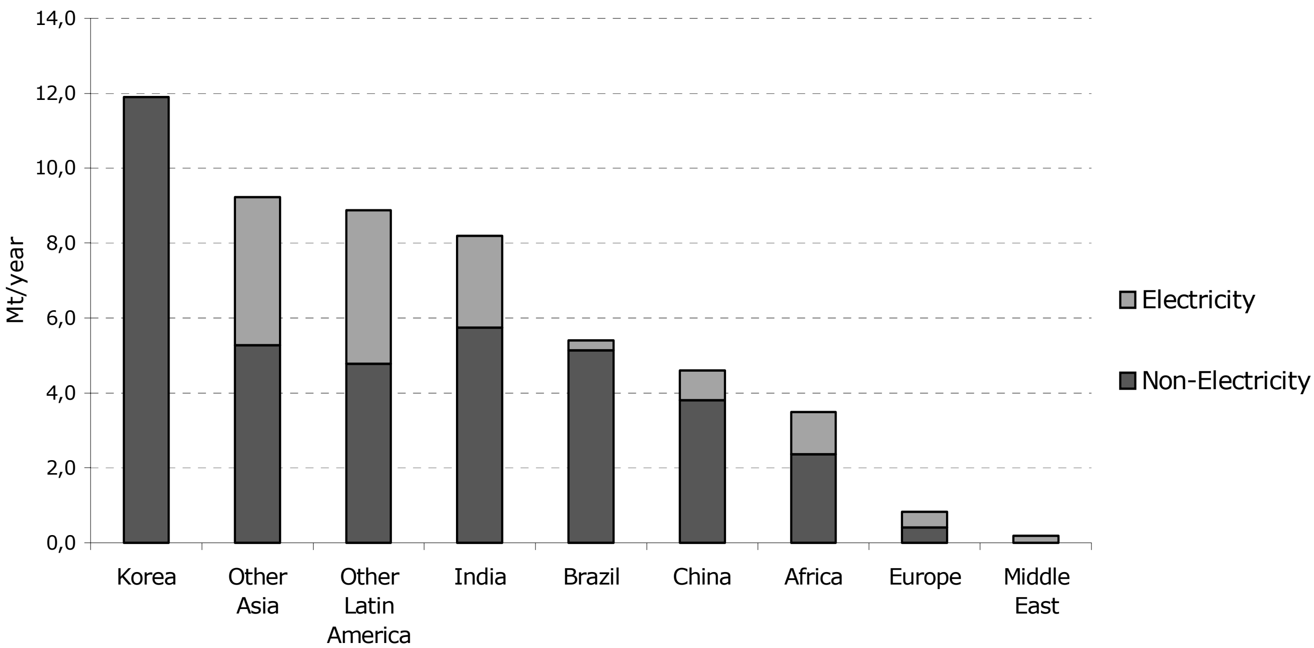




Sources: Project documentation detailed in Annex 1.

Remarkably, despite its large potential but current reluctance to accept F-gas decomposition projects in its CDM project portfolio[16], China's CDM reductions are still expected to come overwhelmingly (83%) from non-electricity projects (Figure 6). In particular, China's current CDM portfolio is dominated by one large-scale project (2.9 Mt CO_2-eq/year) reducing CH_4 emissions from coal mining. The contribution of non-electricity projects in terms of expected CERs is higher in China than in India, Africa, as well as the categories 'other Asia' and 'other Latin America', except Brazil and Korea (Figure 6).

Figure 6. Electricity vs non-electricity projects in terms of their expected emission reductions for countries and regions



Sources: Project documentation detailed in Annex 1.

[16] China has decided to prioritise energy-sector CDM projects.

3. Additionality and baselines

Assessing whether or not a project is additional, and if so, how many credits it should generate is an important issue as it determines how many emission credits a proposed project activity will generate. However, it also involves making assessments about a hypothetical non-project situation. Difficulties with and/or variations in "estimating the unknown" have been widely assessed both at an overall and sector-specific level (e.g. Carter 1997, OECD/IEA 2000, Kartha et al 2002, Ellis 2003). Different views on particular projects' additionality or otherwise, or on how to assess baselines, is sometimes still controversial (e.g. CERUPT 2003, JIQ 2003). Guidance on additionality has evolved since its definition in the Marrakech Accords and experience with determining baselines has grown significantly. This section examines such guidance, and, where possible, draws lessons from experience with implementing the guidance.

3.1 Evolving guidance on additionality

CDM projects can only generate emission credits if they are "additional", i.e. if they are a more GHG-friendly option than that expected to occur in the baseline scenario. However, the Marrakech Accords do not provide precise instructions on how to assess and demonstrate a project's additionality.

Additionality is difficult to gauge, especially for new projects that use technologies or systems that are sometimes installed under BAU conditions (e.g. renewable electricity generation). There are several actors involved directly or indirectly in assessing whether a particular project is additional, and if so, how many credits it generates. As outlined in the Marrakech Accords, these include the:

- host country, which needs to approve a proposed project's contribution to sustainable development[17];
- project validator, who assesses that the methodology has been applied correctly for the project;
- stakeholders and other members of the public, who can provide comments on proposed projects and methods; and
- CDM EB, which can accept or reject the methodology used to assess and quantify additionality for a project type; and
- CDM EB, and Parties involved in a proposed CDM project, who can object to the registration of a particular project.

Further, the donor country, CER buyer or other intermediary (e.g. a carbon fund) can screen proposed projects and opt to take forward only a selection. The ease or otherwise with which a proposed CDM project obtains approval from each actor above will vary by project type and location, will be influenced whether it is the first project to propose the methodology, and will also differ depending on the differing priorities of the actors involved. Failing one of these steps can result in a project not being accepted as a CDM project and therefore not generating any credits. The Marrakech Accords stipulate a timeline for comments on the proposed project, as well as for CDM EB acceptance of the project and consideration of a new method. Nevertheless, not all methods have been considered within the 4 months stipulated[18]. For

[17] Depending on procedures within a host country, such approval may or may not include a detailed assessment of a project's additionality, contribution to sustainable development or technology transfer aspects.

[18] This is partly due to the heavy work-load of the Methodology Panel, and partly because many of the methodologies have needed to be revised, resubmitted and re-examined by the Methodology Panel before being forwarded to the CDM EB.

example, an initial methodology for the proposed "avoided fuel switch"[19] project in Brazil was submitted for EB consideration in April 2003 and a revised version in September 2003. As of November 2004, no recommendation has been published on this particular methodology. General guidance from the EB - on whether such projects that expect to generate credits via a continuation of existing activities are eligible to do so – is also pending. Other proposed new methodologies (NM) have also not been considered by the 4 month deadline, e.g. NM38 (methane capture at wastewater plants) and NM36 (Zafarana wind electricity). NM40 (fuel switch in cement plants) was submitted in July 2004 and was discussed in November 2004 by the CDM's Methodology Panel[20]. In some cases, delays at the national level (e.g. in approving the project) can also be significant.

Box 1. Additionality – Evolving guidance

November 2001: "A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in the absence of the registered CDM project activity" (Marrakech Accords, 17/CP.7).

August 2002: "…. no further work is required regarding this issue" (CDM EB05).

March 2003: "When proposing a new methodology, the following… shall be …reported. … Explanation of how, through the methodology, it is demonstrated that a project is additional and therefore not the baseline scenario…" (CDM EB08)

June 2003: EB09 does not approve, or requests revisions to, several of the first round of methodologies submitted to it for approval. Many of these methods do not include an assessment of how to assess a project's additionality.

July 2003: "Clarifications on how …it may be demonstrated that a project… is not the baseline scenario. Examples of tools that may be used … include a flow chart or series of questions … and/or … quantitative or qualitative assessment of different potential options … and/or … quantitative or qualitative assessment of barriers … and/or an indication that the proposed project activity is not common practice…" (CDM EB10)

June 2004: EB discussion of a "consolidated" additionality tool: "…the Meth Panel shall… continue work … on the additionality assessment tool…" (CDM EB14)

July 2004: Meth Panel finalises draft recommendation to CDM EB on an additionality tool that could be applied for different project types.

Sept. 2004: EB discussion of the proposed additionality tool: public comments requested (CDM EB15).

October 2004: EB agreement on an additionality tool (CDM EB16).

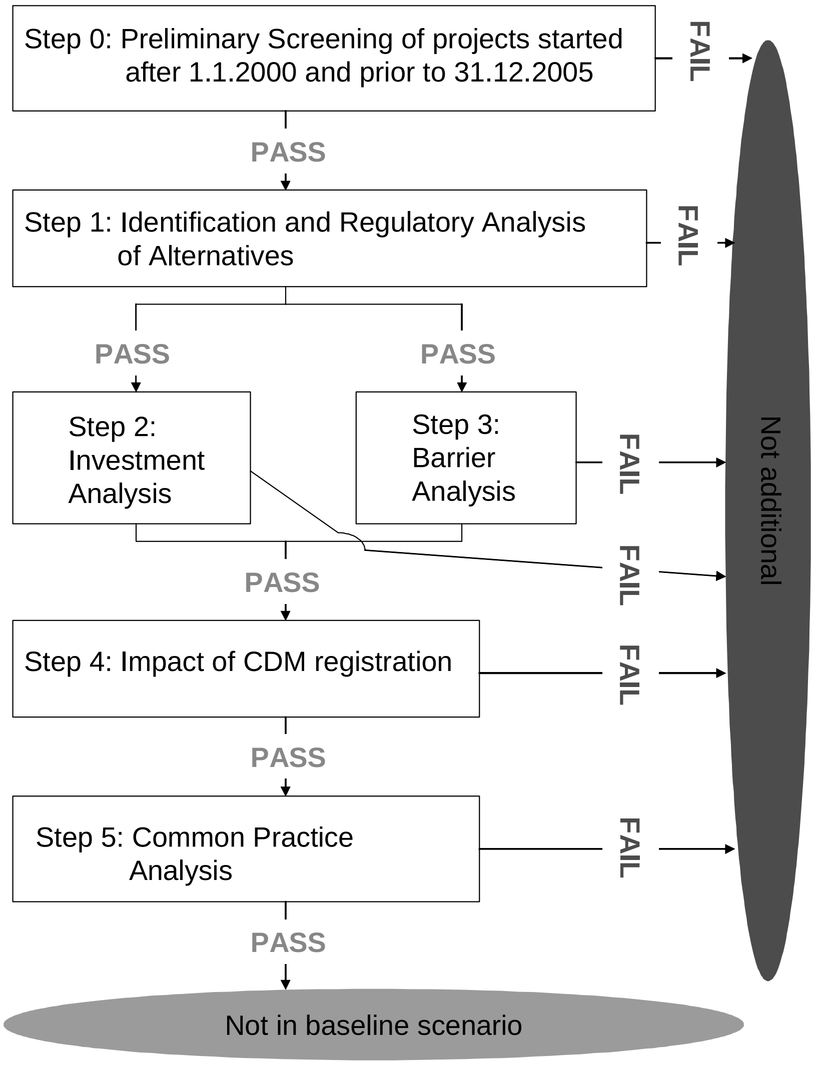
Detailed guidance on how to demonstrate a project's additionality is needed, and a tool by which to do this was agreed by the CDM EB in October 2004 (see Box 1). This tool is based on methodologies previously submitted to the CDM EB and also incorporates public comments. Work on this tool was started in early

[19] This project, called V&M, is expected to generate emission reductions from continuing its current practices (use of charcoal in steel production) rather than switching to using coke as a fuel. Credits would be generated by avoiding this fuel switch.

[20] The Methodology Panel made an initial draft recommendation on NM0040 in November 2004, and could discuss it again in January 2005 if the project participants provide comments. This means that the EB will not consider this methodology until February 2005 at the earliest.

2004, as it became apparent that additionality was a key sticking point for many of the baseline methodologies proposed to the CDM EB. An agreement on such a tool should work to increase the consistency and transparency of additionality assessments.

Figure 7: The "consolidated" additionality tool



Source: UNFCCC 2004

The tool (Figure 7) involves the following steps:

0. Preliminary Screening of projects started after 1.1.2000. This step is to demonstrate eligibility for activities started before their registration as a CDM project.

1. Identification and Regulatory Analysis of alternatives. This step identifies realistic and credible alternatives to the proposed CDM project that are in compliance with applicable legal and regulatory requirements.

2. Investment Analysis. If undertaken, this optional step should identify whether or not the proposed CDM project is the most economically attractive option, and therefore likely to occur in the baseline scenario.

3. Barrier Analysis. This can be carried out instead of, or as well as, the investment analysis step, and outlines how to identify and document relevant investment, technological, prevailing practice or other barriers to the proposed CDM project activity.

4. Impact of CDM registration. This step should outline how the approval and registration of the project as a CDM activity alleviates the economic/financial hurdles and/or other barriers identified above.

5. Common Practice Analysis: This step is used as a "credibility check" to complement the results from steps 2 and 3.

3.2 Demonstrating additionality for selected non-electricity projects

The most common types of "non-electricity" project in the current CDM portfolio, as measured by numbers of projects brought forward, are projects that reduce emissions of landfill gas[21] and energy efficiency projects. This section examines how additionality has been assessed for common project types (e.g. energy efficiency and landfill gas), and project types that are expected to generate significant emission credits (e.g. reduction of N_2O and HFC emissions).

While determining additionality is often uncertain, assessments are relatively simple for some project activities in certain circumstances. This is particularly true for CDM project activities whose only "output" is GHG credits, e.g. projects that involve HFC-decomposition, thermal/catalytic destruction of N_2O, and/or CH_4 capture/flaring[22]. For example, it is a straightforward exercise to demonstrate that continuing as before is the most likely baseline scenario where a project activity involves an investment that would bring no financial benefits other than those associated with CER generation, where the current installation is already emitting GHG emissions at a higher level, where no regulations on the particular source of GHG emissions are expected, and where some (even small amounts of) investment is needed to reduce GHG emissions[23]. This type of simple cost analysis has been used to demonstrate the additionality of proposed CDM projects that install equipment to reduce emissions of HFCs or N_2O[24]. Landfill gas projects have also used similar types of additionality arguments, particularly where there are no or only limited requirements to capture and flare landfill gas produced.

On the other hand, subjective assessments form part of an additionality assessment for the majority of proposed projects. This holds for projects undertaking an investment analysis other than the simple "incremental cost" assessment outlined above (for example, different assumptions can be made as to the appropriate level of a discount rate). It is equally true for projects using barrier analysis: reluctance to use new technologies (e.g. in energy efficiency projects), lack of awareness/know-how for the project operators (e.g. for process change projects), and consumer preference for more GHG-intensive goods (e.g.

[21] Some, but not all, of these projects also involve electricity generation, but the latter account for only small portion of the emissions reduction.

[22] It is important to remember that for the proposed HFC-decomposition and N_2O reduction projects, and for some landfill gas projects, the entire CDM project activity consists of reducing a waste stream. It does not include the larger system (e.g. a factory producing HCFC22 or a landfill site) that was already in operation prior to the development of the proposed project. Thus the "CDM project activity" produces only GHG credits and nothing else.

[23] In such a situation, i.e. where investment is needed to reduce GHG emissions, and where this investment is not required by legislation and produces nothing other than GHG credits, it is a trivial exercise to show that continued non-investment in GHG-mitigation systems is the likely baseline scenario.

[24] This argument has been accepted by the CDM EB for HFC-reduction projects and has also been proposed for the proposed project on N_2O reduction from adipic acid production. However, unlike for the HFC-reduction projects, this argument may be more difficult to be accepted for N_2O, as "all major adipic acid producers have implemented N_2O abatement technologies" (IPCC 2000) and "with currently installed abatement facilities, 81% of by-product N_2O produced by all adipic acid manufacturers in the year 2000 will be destroyed rather than released to the atmosphere" (Reimer et al 2000).

ordinary Portland cement rather than blended cements) are all difficult to ascertain objectively in most circumstances. Nevertheless, they will prevent increased uptake of GHG-friendly technologies.

Indeed, the importance of barriers to energy efficiency activities have been well documented (e.g. UNESCAP undated, IEA 2003, Teri 2003). These barriers can include inefficient pricing of fuels; lack of awareness, education or training; the small scale of systems; lack of access to efficient technologies; regulatory biases or absences; infrastructure constraints; lack of access to capital. It is therefore not surprising that the proposed energy efficiency projects often use barrier analysis to demonstrate their additionality. For example, the project aiming to optimise steel production (NM59) suggests using discussion of an investment barrier ("a financially viable alternative to the project would have led to higher GHG emissions") to assess additionality. Another energy efficiency project, Karnataka wastewater (NM42), highlights several barriers including high transaction costs and the difficulties of arranging financing. First-of-a-kind projects, particularly those that represent an economically attractive course of action, can convincingly point to the existence of barriers impeding their uptake. Nevertheless, such barriers may also inhibit development of subsequent projects, although at some level of deployment the technology will become more mainstream.

An assessment of “common practice” is often carried out to complement investment and/or barrier analysis, and also forms part of the suggested consolidated additionality test. There is also a subjective element in determining what represents common practice. This is shown by the widely differing levels of thresholds used to assess it. For example, one proposed project on energy efficiency in steel manufacture[25] uses a prevailing practice threshold of 50% (i.e. the project is additional if less than 50% of companies in similar area using the same type of technology). Other proposed projects[26] suggest a threshold of 30% (nationwide) below which the use of blended cements is not assessed as common practice. Much lower thresholds have also been used in proposed projects, e.g. 20% for Birla cement[27]. The proposed methodology for the Jepirachi electricity project[28] suggested using a threshold of <5% (for the fuel source or technology) from at least 5 plants.

[25] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_924318202

[26] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_264632344. Different types of cement can have different proportions of clinker. The most common type of cement (Ordinary Portland Cement) often contains approximately 95% clinker.

[27] NM0045, http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_74292326

[28] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_837711305

Table 1: Additionality assessments for selected projects

Project type	Expected credits (000' /y)	Project participants	Additionality assessment	Comments
N_2O reduction (1 project: Korea)*	10 500	French parent company is investor, project occurring at partially-owned subsidiary	• No controls or obligations to reduce emissions of N_2O emissions in host country • Economic/financial barrier: equipment needed for N_2O decomposition "requires significant investment without additional economic benefits"	Manufacturers accounting for 80% of global adipic acid production capacity "currently treat N_2O emissions"**
HFC decomposition (2 projects: Korea, India)*	1 400, 3 380	Japanese company is investor and technoloty provider (Ulsan), in partnership with a Korean company. Another project occurring at an Indian company.	• Current situation is venting of HFC23 • No regulation on emissions of HFCs in host country (but HFC23 produced as a byproduct of HCFC22, for which Montreal Protocol stipulates phase-out by 2040), so no rationale to undertake project other than for GHG reasons • Economic/financial barrier: equipment needed to decompose F-gases entails capital and operating expenses	Very large potential (particularly in China) for low-cost emission reductions from this project type.
Energy efficiency in industry (several projects)***	22.8 – 79.8	Various: an energy service company and PCF involved in one project. Annex I investor/participant not identified in 3 projects.	• Barrier analysis, including investment barriers, a common theme amongst industrial energy efficiency projects • Common practice analysis (i.e. proposed project type does not normally occur) also a common theme	Many different project types under the "energy efficiency" heading.
Ind. energy efficiency	88.8	Office Chérifien des Phosphates	• Economic/financial barrier: equipment in good working order so investment only justified if CER revenue	Project documentation notes that it is "Auto-financed 100%".
Cement sector (2 projects)	917, 1045	PCF and host country co. majority-owned by a German co. for one project. Another identifies the host country project proponent as the investor.	• Common practice analysis: in the host country cement blending occurs to a lesser extent than in the proposed project • Barrier analysis: lack of information/awareness about the properties of blended cement, no legislation in place requiring increased blending	2 other projects take place in the cement sector but focus on energy efficiency or fuel switch.
Landfill gas (26 projects)	3 - 820	Various, with investors including Annex I and non-Annex I companies as well as carbon funds.	• No or limited (often safety-related) requirement to capture and flare emissions in host country • Economic/financial barrier: equipment needed to capture LFG requires investment only justified with CER revenue • Common practice analysis also frequently mentioned	

Sources: * = Project documentation from http://cdm.unfccc.int/, ** http://www.ghgprotocol.org/standard/Current_Tools/adipic_guidancev1.0.doc, *** = projects included with methodology submissions NM17, 37, 42, 59

3.3 Baselines

The majority of non-electricity projects are "brownfield" projects, i.e. they involve retrofitting an existing facility in order to reduce the GHG-intensity of the project's output or waste streams. It is difficult to draw detailed conclusions about the baselines of different types of non-electricity projects because there are often only a few projects of a particular type, except for energy-efficiency projects or projects capturing landfill gas. Moreover, there can be significant variations in different project activities even within a given type, which means that it is difficult to make generic assessments of the baselines developed. For example, proposed CDM "energy efficiency" activities include those that: improve the efficiency of existing equipment (e.g. engines and pumps); change the process by which a particular output is made (e.g. ammonia and cement); capture and combust waste gas streams, and increase the use of waste heat/steam already generated in a process. The method used to define the baselines for these projects therefore varies according to the project type. For instance, baselines can be defined from the change in kWh used per litre of water pumped, the change in kg steam used to remove a specific volume of CO_2, or the amount of electricity conserved/year.

The approach used to determine the baseline of many of these project activities is based on "existing or historical emissions", as outlined in paragraph 48a of the Marrakech Accord's decision 17/CP.7. This can be a fairly straightforward baseline to define and justify for project activities that involve alterations at a particular site, such as an individual landfill site, farm, or factory.

Baselines established using an "existing or historical emissions" approach have been used for proposed CDM project activities that reduce emissions of HFC or N_2O, that involve a fuel switch or energy efficiency activities. Baselines for these projects[29] are in this case often defined *ex ante*, and in terms of a rate (e.g. HFC23/HCFC22 production ratio or number of kWh/litre of water delivered). This rate can be kept constant during the crediting period, as in Figure 8, graph A (e.g. for the Karnataka or Indo Gulf efficiency projects, which have determined a representative pre-project efficiency level) or capped at a particular level, which may or may not vary during the project's crediting lifetime (e.g. the Ulsan HFC-reduction project uses the lower of the observed historical or IPCC default HFC23/HCFC22 production ratios). Depending on changes in a project's activity levels, measured *ex post*, (e.g. HCFC22 production, amount of water delivered) the number of emission reductions generated during the crediting lifetime could increase, decrease or stay constant from historical or existing emission levels. Some of the proposed methods using such a baseline have been accepted by the EB[30], while others have been assessed as needing revision before acceptance.

Baselines for other projects using the same approach (i.e. that outlined in paragraph 48a of 17/CP.7) can be somewhat more complex. For example, the Indocement project (blending component[31]) includes a baseline methodology where some assumptions stay constant over the crediting period (e.g. clinker to cement ratio), some change (e.g. due to autonomous energy efficiency improvements) and some that will be monitored *ex post* (e.g. power consumption/ton of clinker produced). This leads to a different-shaped baseline, shown in part B of figure 10. The Transmilenio transport project (part C, figure 8) which uses the "existing or historical emissions" approach also has a baseline that includes several different factors that affect both public and private travel, some of which are assumed as remaining static over the crediting lifetime of the project (e.g. average distance travelled, average length of journey, percentage of people

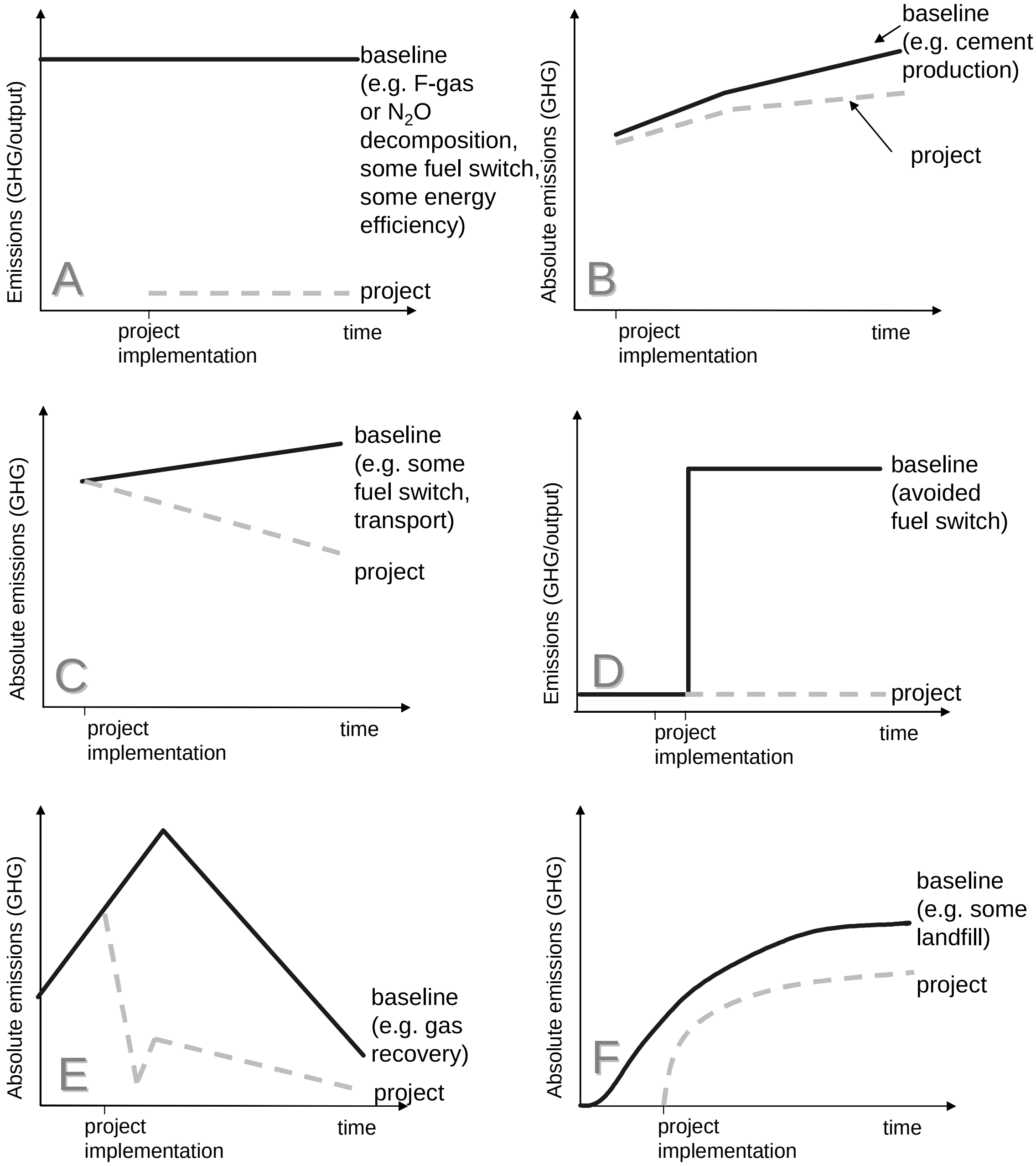
[29] Projects using this type of baseline include the Ulsan HFC-decomposition project and the Karnataka efficiency improvement in water pumping. Both are outlined in table 3. The HFC-decomposition project measures *ex post* the quantity of HFC23 decomposed. However, the emission reductions claimed are capped at the HFC23/HCFC22 production ratio, which is measured *ex ante*.

[30] However, the EB decided at its 14th meeting (September 2004) to put the HFC-23 baseline methodology on hold for four months due to new information that had arisen.

[31] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_264632344

switching from private to mass-transit system) and some in which changes are expected (e.g. number of buses, fuel efficiency)[32].

Figure 8: Baselines used in selected proposed CDM projects (not to scale)



Source: project documentation, www.unfccc.int

Many proposed CDM project activities have also used a baseline developed from another approach, i.e. “emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment”, as outlined in paragraph 48b of the Marrakech Accord’s decision 17/CP.7. This has resulted in baselines of widely different “shapes” (shown in D-F of Figure 8) and types.

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32 This methodology was not accepted by the CDM EB.

In particular, several of these baselines have been developed on an absolute emission level – such as that for the Rang Dong associated gas recovery project[33] (part E of Figure 8) and the Salvador de Bahia landfill gas project (part F, Figure 8). These baselines both increase over time, reflecting an increase in project output/activity during the crediting lifetime, and both have been approved by the CDM EB. A sudden rise in the baseline proposed for the V&M do Brasil avoided fuel switch project (part D, Figure 8) is also noted. This reflects a baseline scenario which anticipates a fuel shift from charcoal to coke in the absence of the proposed project. (In this case, the project activity would be for a company that has been using charcoal in the production of pig iron since the 1960s (V&M do Brasil 2003) to continue to do so). As yet, no proposed baseline methodologies where the project activity represents a "continuation of existing activities" (as opposed to where the baseline scenario represents a continuation of historical emission levels, as discussed above and shown in part A of figure 8) have had a baseline methodology approved by the CDM EB. This is in part because of the "moral hazard" associated with project participants developing this type of baseline[34].

Few proposed projects have used the third baseline approach outlined in the Marrakech Accords, i.e. "the average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20% of their category". Moreover, the proposed methods using this approach (e.g. for a methanol plant[35], NM0003 or Birla cement, NM0045) have not (yet) been accepted by the CDM EB. In both cases, this is partly due to the difficulties inherent in such an approach of obtaining the necessary underlying data (for the methanol project, the data for "similar" performance was estimated by the project proponents).

This relative simplicity in determining both the project baseline and its additionality for some types of projects has contributed to the relatively quick approval time taken for some new methodologies of this type[36]. Table 2 outlines the baseline methods that have been approved for non-electricity projects, their applicability and the time taken to obtain EB approval of the method. This approval has taken 3 months for a couple of cases (above), but is generally much longer – stretching to over a year in some cases.

Once approved, methodologies can be used to determine the baseline for other project activities. For example, by November 2004, five proposed landfill gas capture CDM project activities are planning to use AM0003 (developed for the NovaGerar project, outlined in NM0005), and two proposed F-gas projects are using AM0001. The ability to use a pre-approved baseline reduces the time, cost and uncertainties associated with CDM project development. This may be part of the reason for the rapid expansion of the CDM portfolio in project types for which methodologies have already been adopted, including landfill gas projects and HFC-decomposition projects. These types of CDM projects are also more economically attractive, expecting to generate large volumes of credits and low costs.

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[33] Outlines of the Rang Dong and Salvador de Bahia projects, for which the baseline methodologies have been approved by the EB, are given in table 3.

[34] This "moral hazard" was noted by the CDM EB's Methodology Panel in November 2003 (http://cdm.unfccc.int/EB/Panels/meth/Meth08rep_ext.pdf). Accepting this type of baseline would allow e.g. operators of all biomass or gas-fired systems to generate credits by not changing their current practices to switch to coal. Such a baseline, if accepted, could in theory also be extended to other activities, such as consumers generating credits for not increasing their consumption of goods or services (e.g. electricity, transport, cement). This could make artificial inflation of the baseline (or "gaming") relatively easy, as it may often be difficult to verify the internal decision-making process of a private operator, particularly if such a decision has no immediate investment ramifications and is not documented. As well as these baseline issues, demonstrating the contribution of such project activities to technology transfer would be challenging. Guidance for proposed CDM project activities where the project activity represents a continuation of existing practices is pending from the Chairs of the Methodology Panel and Executive Board.

[35] NM0003, http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_555005147

[36] The process for approving methodologies is described on the UNFCCC website: http://cdm.unfccc.int/.

Table 2: Accepted non-electricity methodologies: applicability and time for approval*

Methodology number	Project type	Applicability conditions	Time between submission and EB approval
NM 4, 5, 10, 21 (AM 2, 3, 10, 11) and consolidated methodology.	Capture and combustion of landfill gas	The “consolidated methodology” ACM0001 applies to projects that either flare or combust the captured landfill gas for energy purposes. The individual methodologies have a more restricted applicability.	3-6 months
NM0007 (AM0001)#	HFC-23 decomposition	HCFC22-producing facilities	3 months
NM0016rev (AM0008)	Fuel switch to natural gas	Already-operating industrial facilities	4 months
NM0017rev**	Energy efficiency (steam traps)	Steam efficiency improvements through replacement and repair of steam-traps and condensate, where fossil fuels are used for steam generation.	n/a: submitted Aug 2003
NM0022rev (AM0006)	Swine manure treatment	Range of on-farm waste-management activities for cattle, buffalo and swine kept in confined conditions.	9 months
NM0026 (AM0009)	Associated gas recovery and use	Projects where the associated gas is flared and used to displace other energy sources	6 months
NM0028 (AM0007)	Fuel switch to biomass	Already-operating fossil fuel-fired boilers	9 months
NM0032 (AM0012)	Municipal Solid Waste treatment	Municipal waste management with biogas collection in India, as long as monitored compliance with domestic MSW rules is <50%.	6 months
NM0034 (AM0016)	Animal Waste Management Systems	Applicable to confined animal waste management systems for swine, dairy cows, beef cattle, poultry.	13 months
NM0037**	Energy efficiency (steam optimisation)	Production processes with homogeneous outputs (e.g. ammonia) and relatively constant output levels with continuous monitoring of steam output	n/a: submitted Feb 2004
NM0038**	Methane gas capture at wastewater plant	Existing water treatment plants where sludge is degraded in open pits.	n/a: submitted Feb 2004
NM0039 (AM0013)	Methane extraction and power generation	Existing waste water treatment plants where sludge is degraded in open sludge pits	7 months

Source: www.unfccc.int, * = time between initial submission (not revision) and EB approval, # = This methodology was put on hold in September 2004 by the EB due to the submission of new information, ** = Recommended for EB approval by the Methodology Panel in November 2004.

4. Co-benefits of non-electricity projects

While one of the drivers for establishing the CDM was its cost-effectiveness, both the Kyoto Protocol and the Marrakech Accords emphasise that project activities developed under the CDM are expected to have benefits other than generating emission reductions. In particular, the Kyoto Protocol outlines that CDM "shall", as one of its two purposes, assist non-Annex I Parties in achieving sustainable development. Further, the Marrakech Accords indicate that the CDM "should" lead to technology transfer[37]. Yet, the dual objective of achieving these co-benefits and reducing the costs of emission constraints may sometimes require tradeoffs between the aims of investors and host countries (Mathy 2002). This section outlines the technology and sustainable development benefits of proposed CDM projects, as described in their project design document (PDD), the interactions between these co-benefits, costs and other characteristics of CDM projects, and the potential for replication of common project types.

4.1 Overview of technology and sustainable development benefits of projects

The form in which proposed CDM projects are described, i.e. the "CDM Project Design Document" (PDD), explicitly requires information on technology transfer - although no criteria on how to assess it has been developed. However, information on sustainable development (SD) is not explicitly required in the PDD, as assessing whether or not a proposed activity helps achieve sustainable development is the prerogative of the host country and is not verified by a designated operational entity nor examined by the CDM EB. Table 1 provides an overview of information on sustainable development benefits provided in PDDs of a selection of proposed CDM projects. This highlights that the information provided on SD benefits of a project's implementation was often rather generic or limited. For example, the Transmilenio transport project[38] indicates that the project "should contribute to a noise level reduction in the city main roads" and should reduce traffic accidents and hold ups. The Rang Dong gas recovery project[39] indicates that it "contributes to a reduction in import dependency" as well as reducing emissions of greenhouse gases.

Given that the PDD is the public face of the project, developed for or by the project participants, any "spin" it puts on the expected effects of a project is likely to be positive. Since sustainable development is one of the two stated purposes of the CDM, it is surprising that the description of the SD benefits of projects is often limited and/or does not mention significant benefits of the project other than GHG emission reductions. However, some project participants may consider that if there are no mandates nor criteria to assess the SD benefits other than GHG reductions – except at the host country level - then it is not useful to spend time describing them.

Most PDDs examined specifically state that the proposed project is expected to have a positive, direct effect on sustainable development. Fewer PDDs explicitly state impacts on technology transfer although this information is explicitly requested. Technology and sustainable development benefits identified by project developers include those related to: the environment (at the project site, at local level, or at a wider scale); the economy; technology transfer (including knowledge); improved health; social benefits (other

[37] IPCC defines "technology transfer" as "a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entity, financial institutions, NGOs […]. It encompasses diffusion of technologies and technology cooperation across and within countries. […] It comprises the process of learning to understand, utilise and replicate the technology […]" (IPCC 2000). The FCCC more specifically refers to technology transfer as between Annex 1 and Non-Annex 1 countries.

[38] NM0052, http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_66405654

[39] NM0026, http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_785952467

than employment, and particularly for the local community); employment; and education, information and/or awareness of clean technology and practices (Table 1).

Environmental benefits (as well as GHG emission reductions) are the most widespread sustainable development aspects of proposed CDM projects identified (Table 1). These include, for example, reductions in emissions to air, land and/or water, or reduction in waste generation. Many PDDs also indicate that the project will have positive non-environmental SD impacts, especially for employment.

The type, scope and magnitude of SD benefits as described in the PDD can vary widely, including within a particular project type. This is particularly marked for landfill gas projects, with many, but not all, such projects anticipating direct health, employment and technology transfer benefits. The description of the Lara landfill project[40] goes even further and indicates not only which SD benefits are expected, such as increased jobs and decreased leachate from the landfill (which reduces groundwater pollution), but that these sustainable development benefits will be monitored. There is also a great difference between the PDDs for energy efficiency projects. The project 'Optimisation of steel production'[41] is expected to reduce non-GHG emissions, and explains how it aims to provide good working conditions for its employees. The Cartago project[42] expects to create up to 500 jobs. The PDD of the Orissa Sponge Iron Limited (OSIL) project[43] states that it will reduce emissions of some non-GHG gases.

Nevertheless, the PDDs of some project types are less divergent in terms of expected SD benefits. For example, the two cement projects expect to create employment and have a direct environmental impact, mostly by reducing waste disposal. PDDs for the two projects on gas pipelines (Rang Dong and Metrogas) also suggest the only direct impact will be through atmospheric emission reductions. Reductions in emissions of VOC and CO are the only SD benefits highlighted in the OnSan N_2O reduction project.

Some of the proposed projects plan to enhance their SD impact by earmarking a small proportion of funds from CER sales to undertake activities with direct SD benefits for the local community. For example, some low-cost project types, particularly landfill gas projects (e.g. Salvador de Bahia, Lara, and Olavarria), as well as the HFC-reduction project in India (Gujarat) and the Korat waste-to-energy project, plan to earmark part of the revenues from CERs to local development projects. Another project (NovaGerar) indicates that 10% of electricity it generates will be given to the local community. One of the World Bank carbon funds, the Community Development Carbon Fund, has been set up specifically to initiate projects that have a significant local development component[44].

Technology transfer is seen as the main non-GHG benefit of the two projects that reduce emissions of HFCs (Ulsan and Gujarat). However, this is outlined only in general terms, with other SD benefits not explicitly mentioned in the PDD for Ulsan[45]. The Gujarat project, however, states that it will create new jobs and will also allocate approximately 1% of its CER revenues to projects with direct, local sustainable development impacts.

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[40] http://www.dnv.com/certification/climatechange/Upload/PDD_Lara%20Landfill_2004-05-08.pdf

[41] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_924318202

[42] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_153118358

[43] http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_98716985

[44] http://carbonfinance.org/cdcf/router.cfm?Page=About

[45] Nevertheless, the contribution of the Ulsan project to sustainable development was assessed based on information in the project design document (Suh, 2004).

Table 3: Direct and indirect sustainable development benefits of selected proposed CDM projects as presented in their PDD

Project	Project summary	Direct and indirect non-GHG SD or technology benefits						
		Environment	Economic	Technology transfer	Health	Social (other than employment)	Employment	Education/ awareness
OnSan (N_2O)	Involvement of either thermal or catalytic destruction of N_2O, a by-product of adipic acid production. Several plants currently operate using both (proven) technology types.	✓						
Gujarat (F-gas)	Development of a system to decompose HFC23, as used in Ulsan Project. Commitment to a fund of EUR 1.375m (approx 1% of CER revenues at 3 EUR/t CO_2) to spend on selected community development activities once CER revenue begins.	*	(✓)	✓	*	*	✓, *	
Ulsan (F-gas)	Installation of technology used by Japanese investor company to decompose HFC23.			✓				
Rang Dong (gas recovery)	Construction of gas pipeline and compressor to capture and use on-shore gas currently flared 140km offshore. The CERs will be transferred to the project participants, including host country firms.	✓	(✓)					
Metrogas pipeline rehabilitation (Gas leakage prevention)	Refurbishment of a pipeline that distributes gas to reduce leakage	✓	(✓)				(✓)	
Birla (cement)	Reduction in the proportion of GHG-intensive clinker in cement by increased blending with flyash (waste) from coal-fired power plants.	✓, (✓)			(✓)		✓[1]	
Indocement (cement)	Installation of facilities to enable increased cement blending and use of alternative fuels in clinker production (3 sites).	✓					✓	
Cartago (energy efficiency)	Retrofit of existing cement plant to increase energy efficiency, allow for increased use of "alternative fuels" and increase blending.	(✓)	(✓)				✓[1]	
Optimization of steel production (Energy efficiency)	Installation of gas recovery system and optimise the operational control of the electric equipment of the steelmaking shop.	✓			✓[1]	✓[1]		✓

OSIL (Energy efficiency)	Recovery and utilization of heat contained in the waste gases generated in sponge iron making in a coal based rotary kiln for generation of electrical energy.	✓					✓	
Hou Ma (Heating)	Energy efficiency improvements of heat supply in the city of Hou Ma by establishing a new district heating system (technology proven in W. Europe but not traditionally used in host country).	✓			✓			✓
NovaGerar (LFG)	Installation of landfill gas collection system and use gas to generate electricity (12 MW) or flare. 10% of electricity generated will be given to the local community.	✓	(✓)		✓	✓	✓	(✓)
Salvador de Bahia (LFG)	Installation of CH_4-destruction equipment (comparable to that used in the investor company's European operations) to flare LFG. Project sponsor will allocate 5% of net CER proceeds "to activities that would benefit the local community".	✓	(✓)	✓		*		(✓)
Lara (LFG)	Installation of landfill gas capturing and flaring system with a pilot electricity generator (1 MW, up to 10 MW in 2nd phase). Project sponsor "intends to share parts" of the CER revenues with local stakeholders through various programmes.	✓	(✓)	✓		*	✓	*
Organic Green Waste (LFG)	Installation of the first large-scale plant in host country to produce compost and capture methane from organic green wastes.	(✓)		✓			✓	
Chisinau (LFG)	Capture and combustion of CH_4 from landfill	✓						(✓)
Olavarría's landfill (LFG)	Capture and destroy CH_4 from municipal landfill. Project sponsors intend to use part of the income from CER to install a safe and reliable water distribution system in a village close to Olavarría.				*	*	✓[1]	(✓)
V&M (avoided fuel switch)	Avoid a switch from coal (from sustainably managed tree plantations) to coke in a steel plant. Improve the carbonisation installations to reduce CH_4 emissions. The PDD states that "no new technology [is] needed at this stage"	✓			✓[1]		✓	
Lafarge cement (fuel switch)	Installation of a new feed system at a cement plant to allow kernel shells to be used as well as coal.	No SD benefits mentioned. The new technology developed for the project is exclusive to Lafarge (Lafarge UK developed technology, Lafarge Malaysia is implementing the project).						
TransMilienio Project (Transport)	Addition of over 1000 articulated buses for public transport in Bogotá.	✓, (✓)				✓		

Korat waste-to-energy (Wastewater treatment)	Removal of organic material in the wastewater of a starch production facility. Biogas used to dry starch instead of fossil fuel and to generate electricity. A foundation will be created and funded by CER proceeds to finance local projects.	✓	(✓)			(✓)	(✓)	✓
M5000 (Methanol production)	Improvement of methanol production to reduce CO_2 emissions						✓	
Mountain Pine Ridge Reforestation	Reforestation, tending and protection of part of a reserve in Belize.	✓		✓		✓	✓	

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

Source: Project design documents for proposed CDM project activity.

4.2 Interaction between co-benefits, costs and other CDM project characteristics

Information on the costs of GHG mitigation from different CDM project types is scarce[46]. However, some information on mitigation costs for individual projects or project types is available from other sources (e.g. IPCC 2001, 3E (2003), UNFCCC 1999). This information, table 4, indicates that some types of non-electricity projects often have very low mitigation costs (excluding CER revenues) and/or a significant benefit (excluding or including CER revenues). This is the case, for example, of industry projects such as cement blending, which have a net economic benefit or that reduce HFC23, which have a small cost (excluding CER revenue) and a large net benefit (including CER revenue).

Table 4: Abatement costs of different proposed CDM project types

Project type	**Emission reduction cost** ($ or EUR/t CO_2-eq)	**Investment costs** ($ or EUR 000)	**For comparison: estimated cost of reduction in EU[6]** (EUR/t CO_2 eq)
N_2O reduction from adipic acid production	$0.06-0.17[1] (excluding CER income)	n/a	0.1
HFC23 reduction from HCFC22 production	$<1[2] (excluding CER income)	$1 000-10 000	0.2 (oxidation of HFC23)
Landfill gas reduction	$1 or less[3] (excluding CER income)	$14 000 (Lara), $1 700 (Morocco)	n/a
Gas capture from wastewater treatment plant	6.4 EUR for a 7y crediting period (Chisinau)	EUR 3 200 (Chisinau)	n/a
Cement blending	-3.1 for a 14y crediting period (-2.9 for a 7y crediting period)[4]	n/a	-34
Cement (technology improvements in process)	21.4-26.2 if a 14y crediting period	n/a	-10 to -34
Energy efficiency in industry (heat recovery, efficient evaporation etc.)	n/a	n/a	-8 to -31
Energy efficiency improvements in district heating (including new substations, piping etc.) (China)	4.8[5] for a 10y crediting life	14 770 (of which 4 890 from Annex I investor)	n/a
Energy efficiency (motors in pulp and paper industry, China; efficient motors in industry, Thailand)	21.1 if 7y crediting period, 0.91 if 14y crediting period[4]; -20.8[7]	n/a	n/a
Grid-connected renewable electricity	Very variable, e.g. 5.5 EUR[5] (CERUPT price 3.5-5.5 EUR)	n/a	n/a
100 MW retrofit in coal power stations	8	n/a	n/a

Sources: [1] IPCC 2001; [2] UNFCCC 1999, Matsuo 2004, Ineos Fluor 2000; [3]Lara landfill PDD, Cogen et al 2003, Agoumi 2003 [4] 3E project ; [5] Brodman 2003; [6] de Beer et al 2001; [7] ADB 1998

[46] The CDM-PDD does not require project participants to provide cost/investment information on the proposed CDM project.

While the CDM project portfolio is very diverse, much interest and recent rapid growth has focused on projects that reduce emissions of waste gases (N_2O, HFCs and CH_4). Although these projects do have a net cost, the payback period can be short, e.g. less than one year[47]. It is also a small investment compared to the investment required to set up and run the whole adipic acid or HCFC-22 unit that produces N_2O or HFC23 as a by-product, so the investment risk can also be relatively low[48]. This investment also generates large volumes of CERs, in part because the emission reductions are for gases with a high global warming potential. The low cost and high credit volume of these project types are likely to be major reasons for their increasing popularity. Moreover, the fact that these projects require an up-front investment with no economic benefits other than CERs to the investor facilitates their additionality argument and therefore reduces their risk of non-acceptance by the CDM EB. (Nevertheless it is interesting to note that similar activities are much less widespread among proposed Joint Implementation projects[49]. It is also noteworthy that similar N_2O and HFC reduction activities in Annex II countries have already occurred either voluntarily, e.g. for HFC23 reduction in Japan, or under business-as-usual activities, e.g. from Dupont adipic acid manufacturing plants).

Unsurprisingly for a market mechanism, there is a slower development (in terms of expected emission credits) of proposed CDM projects that have a higher net cost of emission reductions such as renewable electricity. This is especially marked for projects developed after agreement of the Marrakech Accords (as early project development focused on renewable electricity projects) and accelerated after the CDM EB started approving CDM baseline and monitoring methodologies (Figure 1).

However, development of projects that have a net economic benefit irrespective of CER income is also relatively slow. This is not altogether surprising, as both economic and non-economic barriers inhibit the development of cost-effective energy efficiency and other activities (both in Annex I and non-Annex I countries). Income from CERs from such projects may not be enough to overcome these barriers, which have been widely documented elsewhere (e.g. Violette et al 2000, IEA 2003). Moreover, CDM transaction costs are relatively more important for energy efficiency projects than for large single-site industrial projects, as energy efficiency projects are often small or medium size (e.g. generating <15 Mt CO_2-eq or <50 Mt CO_2-eq reductions per year). Project management and monitoring can be relatively complex for energy efficiency projects, especially for those involving many actors and sites - with corresponding complexity implications for the writing of contracts for GHG savings from energy efficiency projects. There are also significant barriers to the more widespread acceptance of blended cement which can inhibit development of such cost-effective opportunities in the cement sector. Indeed, one proposed of the CDM projects in this sector, Indocement, contains an information/awareness-raising component.

Revenues from CERs are likely to benefit different types of actors for different projects. For example, some proposed CDM projects in the industry sector involve non-Annex I investors only (e.g. the Birla cement project in India, the Lara landfill project in Brazil, a heat-recovery project in Morocco). Any CERs and associated revenue generated from these projects will therefore accrue to these non-Annex I entities.

[47] For example, the Ulsan HFC-decomposition facility has investment costs of approximately US$3m, yearly operating costs of approximately 0.3 m USD (Matsuo 2004) and expects to generate 1.4 million CERs/year. This corresponds to an income of 4.2 m USD in the first year (assuming $3/CER).

[48] It is important to note that for some CDM project activities that occur on an already-existing site, the investment associated with the CDM project activity is the incremental investment of the GHG-reducing equipment, not for the whole site on which the project activity occurs. The expected SD or technology transfer aspects of the CDM project activity thus also corresponds to the incremental CDM component only, and not the whole site.

[49] Information available indicates that while the number or emission reductions generated by JI projects is expected to be substantially lower than that generated from CDM projects, the majority of the JI portfolio is likely to be made up of renewable electricity/fuel switch and other energy-sector projects. Landfill gas projects are expected to generate approximately 25% of credits, and no HFC-reduction projects have been identified by the authors.

Credit sharing between different actors can also occur e.g. for Prototype Carbon Fund (PCF) projects, as the PCF does not contract to buy all expected credits from a project. (PCF may contract to buy part of the credits from a project, an individual PCF investor could opt to buy a further part. Some host countries may even negotiate for a share of the credits[50].) In contrast, private sector Annex I investors are the main economic beneficiaries from other proposed projects, such as the proposed HFC-reduction project in Korea, for which the Japanese investor company has already forward-sold two million credits (Ineos Fluor 2004). The community in which the proposed CDM project is situated may also benefit directly from CER sales as some projects plan to earmark a part of the CER revenues to local development programmes.

Similarly to the economics of proposed CDM projects, the co-benefits of different proposed CDM projects can also differ widely. These co-benefits can include expected sustainable development benefits (outlined above) or other benefits. This is particularly true for CDM project activities whose main focus is to produce goods or services as well as CERs as many of these proposed project activities expect an increase or improvement of service as a result of implementing the proposed CDM project. For example, the Hou Ma district heating project should lead to the extension of the central heat distribution system to reach more buildings, the Karnataka water pumping project should enable increased water distribution and reduced water leaks; the Cartago cement project is expected to lead to increased cement production capabilities, the Transmilenio transport project will increase the availability of public transport systems. For proposed CDM projects that foresee no increase in "service" or outputs, and where current GHG emissions do not have local health or safety implications, the scope for co-benefits is more limited.

4.3 Replicability and CDM 'technology push'

The majority of proposed CDM project activities involve project types that could be replicated in many sites within many different countries. For example, any non-Annex I country could, in theory, host energy-efficiency, transport or electricity generation CDM projects. Landfill projects could also be implemented widely. Cement manufacture occurs in over 80 countries. These sectors emit a large proportion of total global GHG emissions. Thus, increasing the deployment of low-GHG technologies in the energy, transport, cement and/or waste sectors could help deliver substantial long-term GHG-reductions, as demand for energy, transport, construction and waste disposal facilities are all expected to increase.

In contrast, some proposed CDM projects occur in sectors that account for only a small proportion of global emissions (e.g. emissions of N_2O from industry) and/or where other regimes should constrain the growth in GHG emissions. For example, HFC emissions account for only a very small proportion of global anthropogenic GHG emissions. Moreover, the Montreal Protocol requires non-feedstock use of HCFC-22 consumption to be totally phased out by 2040 or before (depending on the country[51]). Thus, independent of the UNFCCC, Kyoto Protocol or CDM, emissions of HFC23 from HCFC22 manufacture should, in the medium-term, be limited by Montreal Protocol requirements concerning "emissive" uses of HCFC22 (i.e.

[50] However, information on credit sharing is scarce, as there are no rules for the sharing of proceeds from the sale of CERs between different participants involved in a CDM project (including the host country), nor is there an obligation to divulge that information.

[51] The Montreal Protocol differentiated commitments on the basis of consumption of ozone-depleting substances (ODS). "Annex 5" countries (including OECD countries) need to phase out production and consumption of different ODS at different times, e.g. CFCs by 1996. HCFC22 has two main uses: as a feedstock, and as a refrigerant. Use as a feedstock is growing, but will not lead to HCFC22 emissions. Thus, this use of HCFC22 is not regulated by the Montreal Protocol The Montreal Protocol stipulates that consumption of HCFCs (as a refrigerant) needs to be phased out by 2030, although some "Annex 5" countries have set themselves an accelerated phase-out schedule.. Non-Annex 5 countries are allowed to produce and consume ODS for longer, but need to stabilise HCFC22 consumption as a refrigerant at 2016 levels and phase out completely by 2040.

as a refrigerant). The geographical replicability of potential CDM projects involving HFC23 reduction from HCFC22 production or N_2O reduction from adipic acid production is also very limited, and concentrated on a few countries in Asia, as adipic acid and HCFC-22 production facilities are in place in only a handful of non-Annex I countries[52]. Thus, even if all available HFC23 reduction opportunities are taken up, this would not be sufficient to deliver large and long-term emission reductions.

Of course, a "market pull" or "technology push" for GHG-friendly technologies could be given by several different national and international measures. Depending on the size and composition of the CDM portfolio, the CDM could account for a greater or smaller proportion of this "pull". The CDM does offer an opportunity to substantially increase the deployment of GHG-friendly technologies, particularly for project types that are easily replicable such as in the energy sector, which accounts for a large proportion of total emissions, and where demand is growing rapidly. For example, it would need an additional 176 million energy-efficient fridges, or 720 million energy-efficient light bulbs or 15 GW of wind capacity to generate 53 million CERs[53], the lower range of estimates for demand for CERs in 2010 (Grubb 2003). Increased deployment of widely-applicable GHG-friendly technologies could help a "virtuous circle" of reduced costs and increased demand for such technologies, which in turn could help reduce GHG emissions in the long-term. While the current CDM portfolio indicates that these types of energy-sector projects are unlikely to account for the majority of CER generation, it illustrates the impact that even a low demand for CDM credits could have on the deployment of particular technologies[54].

Put in other terms, it would take an additional 144 million energy-efficient lightbulbs, 35 million energy-efficient fridges or 3 GW of wind capacity to generate as many credits as the proposed N_2O reduction CDM project in Korea (which alone expects to generate 10.5 Mt CO_2-eq credits per year and accounts for 20% of Grubb's lower estimate of CDM demand). However, the investment needed to generate this volume of credits from energy-sector projects – and the associated investment risk - can be significantly higher than for some industrial-sector end-of-pipe CDM projects. Moreover, the relative importance of transaction costs for these smaller-scale, energy-sector projects is higher. While there are only a few very large-scale (> 1 million CERs/year), limited-replicability CDM projects being proposed, they already account for a large proportion of the CDM portfolio and could satisfy the entire demand for CDM credits[55]. Indeed, their importance in the CDM portfolio is likely to grow as although they have limited replicability, they have the short-term potential to offer large volumes of credits at low cost, and with relatively low investments and transaction costs.

[52] For example, F-gas decomposition projects – which have mitigation potential concentrated in China, with some in Korea, India, Mexico and Venezuela. Projects that reduce N_2O from adipic acid production are possible only in the few factories in non-Annex I countries that produce adipic acid. There are 24 of such factories worldwide and the only non-Annex I producers are China, Korea, Brazil, and Singapore (IPCC GPG), and Singapore's plant was built with N_2O reduction facilities.

[53] Assumptions: generating 1 kWh emits 1 kg CO_2, 40% capacity factor for wind, that energy efficient fridges consume 300kWh less per year than an average fridge, that energy-efficient bulbs save 50W per bulb and are operated 4h/day.

[54] For comparison, current (2003) wind electricity capacity in non-Annex I countries is 3 GW (NZWEA 2004), and there is significant capacity for expansion (e.g. the potential in India alone is estimated at 45 GW, Winrock (undated)). The AIJ Illumex project installed 1.7 million energy-efficient lightbulbs.

[55] Although of course if the price of CERs drops substantially, demand may increase.

5. Conclusions

The number of projects proposed under the Kyoto Protocol's Clean Development Mechanism is increasing. Although there are not yet any registered CDM projects, several methodologies for a wide variety of project types have been approved, many projects put forward for public comment, and five projects submitted to the CDM Executive Board for registration (from September 2004 onwards). This paper explores recent developments in the CDM portfolio, focusing on proposed non-electricity projects, and examines the way that individual projects have assessed baselines and additionality and presented their sustainable development and technology transfer co-benefits.

The size of the CDM portfolio is growing and its composition is changing fast. Current proposals for 201 CDM projects have been examined, and indicate that these projects expect to generate 52.3 million credits/y during the period 2008-12, and a further 90.7 million credits prior to 2008, i.e. a total of 352 million credits by 2012. While in 2003 the majority of GHG emission credits expected from CDM projects in 2008-2012 were from electricity projects, 2004 has seen a dramatic increase in the number of credits from proposed projects in other sectors. These "non-electricity" CDM projects are a very diverse set. They include projects in the energy sector (e.g. heat production, energy efficiency), industry sector (e.g. reducing end-of-pipe emissions of N_2O, HFCs, and PFCs and reducing the GHG-intensity of a product), waste sector (e.g. reducing emissions of CH_4 from landfills), agriculture and forestry (e.g. changing manure management practices, reforestation) and transport.

The geographical spread of CDM projects is very broad, with proposed projects planned or in place in 50 countries. Proposed non-electricity projects occur in 31 countries and their number is growing very rapidly, with projected emission reductions from these project types quadrupling between September 2003 and May 2004, and doubling again since May 2004. Non-electricity projects now account for three-quarters (or 39.9 million credits/year during 2008-12) of emission reductions from proposed CDM projects. In contrast, the number of credits expected from electricity projects between 2008-2012 has increased only 9% between May and November 2004.

Proposed non-electricity CDM projects range from small to large scale, but clearly outweigh electricity projects in terms of the credits they expect to generate pre-2012, due to a few very large scale projects (> 1 million credits per year). For instance, the ten largest projects in the CDM portfolio are all non-electricity projects and account for more than half (26.8 million CERs/year) of total expected emission reductions from the current portfolio. This includes the largest proposed project (Onsan N_2O reduction in Korea) which is expected to generate more credits per year than the combined credits of all 96 proposed hydro, biomass, solar and wind electricity projects.

Despite Latin America's early moves to set-up CDM institutions, Asia now dominates the CDM portfolio in terms of emission reductions and it also attracts more non-electricity projects than any other region. Five of the six largest projects (in terms of credit generation) that expect to generate more than 1.4 million CERs/year during the period 2008-2012 are located in Asia. The country accounting for the largest proportion of the CDM portfolio, almost a quarter (22%) of credits from all proposed CDM projects, is Korea, now an OECD country. India ranks second, with 16%. In contrast, 27% of credits from the portfolio of proposed CDM projects is expected to come from projects located in Latin America – almost half of these from Brazil- and only 7% from projects in Africa.

Despite accounting for a relatively small proportion of total expected credits, Latin America's political keenness to attract CDM investors has borne fruit in terms of the numbers of projects being developed. 83 proposed projects are located in Latin America and 98 in Asia. (Seven of these projects are in AOSIS countries and account for 1% of expected credit generation.) However, the potential for very large-scale projects to reduce HFCs and N_2O is concentrated in a handful of countries, mainly in Asia. Nevertheless, this potential may not all be tapped. For example, China's decision to not proceed with F-gas decomposition projects may significantly reduce the potential "slice" that such projects could take in the longer term in the CDM market. Despite this, the majority of China's CDM reductions are still expected to come overwhelmingly (83%) from non-electricity projects.

Additionality for non-electricity projects is assessed in very different ways. Assessments are often based on an investment analysis and/or on barrier analysis. In general, additionality has proven a difficult concept to put into practice. Nevertheless, it is relatively straightforward to demonstrate for some types of projects, particularly where there are no national regulations constraining the GHG reduced and the project involves an investment whose only return is CERs (i.e. the CDM investment has no economic benefits other than CERs). In fact two projects of this type were the first to have their methodologies approved, and have (unsurprisingly) been emulated since. Additionality determination for other project types is more difficult, for example when it involves changes to a system that happens in some countries or in some companies under BAU (e.g. cement blending) or where it involves changes to a complex system (e.g. transport infrastructure).

Guidance on how to assess additionality has evolved since the agreement of the Marrakech Accords, and, until very recently, was still evolving in the CDM Executive Board. However, the CDM EB agreed an "additionality tool" in October 2004, following public comments. This tool assesses whether or not a project is additional by examining issues related to i.a. regulatory analysis, barrier analysis and/or investment analysis, and common practice analysis. Agreeing this tool should be helpful to project developers in reducing the time and uncertainty associated with methodology development, and indeed has already been incorporated into new baseline methodologies recently submitted to the EB for approval.

The projects examined in this paper demonstrate a wide variety in the approach and methodology used to calculate baselines for different project types. Baselines have also been assessed on an absolute and on a rate basis, and their "shape" varies widely. This variation reflects many factors, including variations in project output (e.g. cement manufacture, oil production, HCFC22) and expected autonomous efficiency improvements. Similar methodologies have been developed (and approved) for very similar project types, in particular for landfill gas capture and/or use. This has led the CDM EB to request a "consolidation" of such baseline methodologies, and such a methodology was approved by the CDM EB at its September 2004 meeting[56].

As well as projects capturing and flaring or using landfill gas, approved baseline methodologies covering several other types of "non-electricity" projects have now been approved by the CDM EB. This interest in projects that reduce both CO_2 and non-CO_2 gases demonstrates the wide variety in potential mitigation measures across sectors. These include energy-sector projects such as a fuel switch to natural gas or biomass, industry-sector projects such as HFC-reduction[57] or projects reducing the GHG-intensity of solid or liquid waste streams, agriculture-sector projects such as improving animal waste management schemes, and other methane-reducing projects. In November 2004, two methodologies for energy-efficiency projects were also recommended for EB approval by the Methodology Panel. Many other project types have submitted baseline methodologies that have not yet been assessed and/or approved by the EB, e.g. for N_2O destruction, cement blending, district heating. This latter category includes methodologies for projects where the proposed project activity involves a continuation of existing practices. (Guidance on how to deal with such cases is awaited from the Chairs of the CDM EB and the Methodology Panel).

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[56] Either the consolidated methodology or the individual underlying methodologies can now be used to assess baselines for proposed landfill gas CDM projects.

[57] However, the CDM EB decided at its September 2004 meeting to put this methodology on hold, although it can still be used for two projects currently under reviewon.

Delays in methodology approval are widespread: the quickest approval time (3 months) was for a HFC-reduction and landfill gas methodology, but 6-9 months is more common. This is mainly due to the time needed to revise and approve original submissions: methods are not currently required to undergo an external quality check (e.g. by the validator) prior to submission to the CDM EB. In many cases, this results in proposed new methodologies not following already-published recommendations or guidance by the CDM EB. However, in a few cases, methods have not been considered by the EB or its Methodology Panel for more than four months after they were submitted.

In general, the non-GHG benefits of proposed CDM projects receive much less attention from the international community than the GHG benefits of a proposed project. This is partly because the Marrakech Accords decided that determining whether a project helps a host country in achieving sustainable development is the prerogative of the host country. Moreover, there is also no guidance on how sustainable development should be assessed. However, despite not being explicitly prompted, many CDM project design documents outline the expected effects of a project on sustainable development. For example, some projects outline that they will have positive effects on the environment (e.g. reduced water pollution, waste production or emissions of non-GHG) and/or employment effects. Other positive effects, e.g. on health, are also identified by projects, although less frequently. This information is usually rather generic, although a small number of proposed projects quantify the expected effect (e.g. 20 jobs created, checking workers' health records pre and post-project). Such benefits are highlighted for several different types of projects, including those involving energy efficient technologies, renewable energy and improved animal husbandry. Project documentation for a handful of projects also indicates that registering the proposed project as a CDM project will have indirect SD benefits, as a proportion (e.g. 1-5%) of CER revenue or project output (e.g. 10% of landfill-gas generated electricity) is earmarked for the benefit of the local community.

Publicly-available information on the direct non-GHG benefits of some projects is, however, scarce - including for some end-of-pipe projects that are expected to deliver large quantities of emissions credits at very low prices. Nevertheless, in all cases, for activities to be eligible as CDM projects the host country will have judged them to contribute to sustainable development.

The cost of emission reductions from some proposed project types, e.g. HFC-decomposition and N_2O destruction from adipic acid plants is very low (Table 5). These sectors currently account for only a small proportion of total anthropogenic GHG emissions. Moreover, production facilities are located in just a handful of non-Annex I countries (mainly China, Korea, India, Mexico, Brazil). Thus, these projects are also of limited replicability and geographical spread. Nevertheless, there is a large amount of interest in these project types, which have the potential to satisfy a large proportion of the expected size of the CDM market in 2008-2012. If growth continues in such project development, the potential of these projects to generate emission credits is sufficient to allow them to account for a large majority of the CDM market.

There is much that is positive about the current development of the CDM portfolio. This includes that industry (both Annex I and non-Annex I) are now becoming directly involved as investors in and developers of CDM projects: earlier interest in the CDM was led by governments and by carbon funds with mixed public/private participation. Indeed, industry-led projects are expected to generate more than a third of total credits (> 17 million credits per year) from CDM projects in the first commitment period. Some of these proposed CDM projects are from activities not originally anticipated, and from sectors that could by themselves satisfy a large proportion of expected demand for CDM credits in 2008-2012, i.e. HFC-decomposition and N_2O reduction projects. Moreover, some of these industry-led projects expect to deliver large numbers of credits at very low cost, and with relatively low investments. This should help Annex I countries reduce the cost of meeting their short-term emission commitments as laid out in the Kyoto Protocol.

Table 5: Summary characteristics of selected project types

Project type	Emission reduction cost (\$/t CO_2-eq)	Replicability of project type	Current share of CDM portfolio (%)
N_2O reduction from industrial processes	0.06-0.17	Very low (3 countries)	21
HFC23 decomposition from HCFC22 production	<<1	Low, <10 countries	10
Landfill gas capture	<1	Very high	3
Energy efficiency, heating and drying	Variable: net benefit to net cost	Very high	3
Transport	Variable	Very high	2
Cement blending	Few estimates, including net benefit	Medium	4

However, one potential downside is that the growing prevalence of low-cost end-of-pipe projects in the CDM portfolio could significantly reduce a CDM "technology push" for climate friendly technologies and systems in high-emission sectors such as energy production and use. Increased deployment of such systems is needed in the energy sector in order to move countries to a low-emissions pathway in the longer term. For example, it would take at least an additional 3 GW of wind capacity (a doubling of current non-Annex I wind electricity capacity) or the installation of 35 million energy-efficient fridges to generate as many credits (10.5 million/year) as that from the proposed N_2O reduction CDM project in Korea.

One lesson from the CDM as it is currently emerging is that different potential investors and/or CER buyers help shape the CDM portfolio through their priorities in terms of credit price, as well as in terms of project sector, location, and co-benefits. These priorities can differ markedly from one investor to another. Host country approval, or otherwise, of projects and project types can also have a significant effect on the total portfolio – and approval criteria can also vary widely between potential host countries. Another lesson is that energy-sector (particularly energy efficiency projects) and transport-sector projects are unlikely to account for a significant proportion of total credits to be generated. The contribution of renewable electricity projects is also likely to be relatively small. Thus, the “technology push” benefits of the CDM may be slow to emerge in these sectors.

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Annex 1: Project names, country and detailed reference

Project	Country	Source
FaL-G brick units	India	http://carbonfinance.org/cdcf/router.cfm?Page=DocLib&Dtype=19&ActionType=ListItems
Birla (NM45)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_74292326
Indocement (NM 47 and NM48)	Indonesia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_102355876
Ramla Cement Plant (NM 74)	Israel	http://cdm.unfccc.int/UserManagement/FileStorage/FS_835381103
Renewable agro-industry	Indonesia	http://www.cdm.or.id/en/project/?pid=5
Vale de Rosário (NM1)	Brazil	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_408387121
Koppa (NM11)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_631281350
Haidergarh Cogeneration (NM30)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_919393961
Off-season Bagasse Cogeneration	India	http://carbonfinance.org/router.cfm?Page=Projects
TA Sugars (NM35)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_323322936
Lucknow (ABIL) (NM32)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_415553625
SRS bagasse	India	http://www.cdmwatch.org/project_details.php?ID=195
Agrinergy	India	http://www.pointcarbon.com/article.php?articleID=3111&categoryID=147
Ratchasima SPP	Thailand	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_29342638
Cellulose Irani	Brazil	http://www.dnv.com/certification/climatechange/Upload/SSC-PDD_Irani_June%202004.pdf
Biogas and biodiesel for power	Brazil	http://www.southsouthnorth.org/
Barreiro	Brazil	http://www.dnv.com/certification/climatechange/Projects/ProjectDetails.asp?ProjectId=58
Trupán biomass plant (NM 81)	Chile	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_97764878
Electrica del Norte	El Salvador	http://global.finland.fi/english/projects/cdm/PIN-EEN-FINAL.doc
Ingenio da Cabana	El Salvador	Personal communication with Lorenzo Eguren, C.
Raghu Rama (in Tamilnadu) (NM25)	India	http://www.dnv.com/certification/climatechange/Upload/PDD_RRREL_2004-01-20.pdf and http://www.stem.se

Biomass gasifiers	India	http://global.finland.fi/english/projects/cdm/projects.html and http://www.dnv.com/certification/climatechange/Upload/PDD_Biomass%20Power%20Plants_2003-11-14.pdf
Ethanol Fuel Production	India	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Ind-Barath	India	http://www.cdmwatch.org/project_details.php?ID=114
Balrampur biomass project	India	http://www.cdmwatch.org/project_details.php?ID=155
Kalpa Taru	India	http://www.cdmwatch.org/project_details.php?ID=120
Clarion	India	http://cdm.unfccc.int/Projects/Validation
Rice Husk Power	Indonesia	http://www.cdm.or.id/en/project/?pid=4
Carbonization and Power Generation - South Sumatra	Indonesia	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Bumibiopower (NM39)	Malaysia	http://www.dnv.com/certification/climatechange/Upload/PDD_Bumibiopower%20Biomass_2004-03-19.pdf
Kunak Palm oil mill	Malaysia	http://www.dnv.com/certification/climatechange/Upload/PDD_Kunak%20Bio%20Energy_2004-04-27.pdf
Panay	Philippines	http://www.ieta.org/About_IETA/Events/Manila03/Sep12/Stowell.PDF
A.T. Biopower (NM19)	Thailand	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_102028254
Yala Rubber Wood	Thailand	http://www.dnv.com/certification/climatechange/Upload/Yala%20PDD.pdf
Thai Biomass Electricity (around Bangkok)	Thailand	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Dan Chang (NM60)	Thailand	http://cdm.unfccc.int/
AyP gas plant	Bolivia	Lorenzo Eguren, C. (2004). El Mercado de carbono en America Latina y el Caribe: Balance y perspectivas. CEPAL.
Metrogas Package Cogeneration (NM18)	Chile	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_915399236
Jindal Vijayanagar Steel Plant (NM 49, 71)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_306915788
NEDO	Kazakhstan	http://www.nrcan.gc.ca/es/etb/cetc/cep/Canada%20Kazakhstan%20business%20opportunities.pdf and http://www.iisd.ca/climate-l/Climate-L_News_6.html#14
Unocal's Sarulla geothermal project	Indonesia	http://www.cdm.or.id/en/project/?pid=2
Lumut Balai	Indonesia	http://www.cdm.or.id/en/project/?pid=6
Darajat Unit III	Indonesia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_663898431
Lihir Geothermal power plant	Papua New Guinea	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_568754781
Micro-hydro project	Bhutan	Personal communication, Satoko Otani 10.05.2004
Energy efficiency	Brazil	http://www.ahk.org.br/cdmbrazil/projectsearch.htm

Aquarius hydroelectric project	Brazil	http://www.dnv.com/certification/climatechange/Upload/PDD_Aquarius_2003-04-17.pdf
PCH Passo do Meio (NM 51)	Brazil	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_719247698
Chacabuquito (NM 83)	Chile	http://cdm.unfccc.int
Guardia Vieja	Chile	Personal communication with Lorenzo Eguren, C.
Run-of-river (Xiaogushan)	China	http://carbonfinance.org/router.cfm?Page=Projects
La Vuelta and La Herradura Hydroelectric Project (NM20)	Colombia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_995480628
Rio Amoya	Colombia	Personal communication with Lorenzo Eguren, C.
Umbrella Project - Hidroelectrica de Cote	Costa Rica	http://carbonfinance.org/pcf/router.cfm?Page=DocLib&Dtype=1&ActionType=ListItems
Umbrella Project - Chorotega	Costa Rica	http://carbonfinance.org/pcf/router.cfm?Page=DocLib&Dtype=1&ActionType=ListItems
Rio General hydroelectric project	Costa Rica	Personal communication with Lorenzo Eguren, C.
Guachala	Ecuador	Personal communication with Lorenzo Eguren, C.
Perlabí	Ecuador	Personal communication with Lorenzo Eguren, C.
Sibimbe	Ecuador	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_364460132
Hidroelectrica Pilalo 3	Ecuador	Personal communication with Lorenzo Eguren, C.
Sabanilla	Ecuador	Personal communication with Lorenzo Eguren, C.
Sigchos 1	Ecuador	Personal communication with Lorenzo Eguren, C.
El Canadá (NM6)	Guatemala	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_820863530
Hidroelectrica Candelaria hydroelectric project	Guatemala	http://www.dnv.com/certification/climatechange/Upload/PDD_Candelaria_2003-03-17.pdf
AHPPER	Honduras	Personal communication, Kari Hämekoski, 8.12.2003
Zacapa	Honduras	http://www.dnv.com/certification/climatechange/Upload/PDD_Zacapa_2004-06-10.pdf
Yojoa (AHPPER)	Honduras	http://www.dnv.com/certification/climatechange/Upload/PDD_Yojoa_2003-09-24.pdf
Cececapa (AHPPER)	Honduras	http://www.dnv.com/certification/climatechange/Upload/PDD_Cececapa_2003-09-24.pdf
Rio Blanco	Honduras	http://www.dnv.com/certification/climatechange/Upload/PDD_Rio%20Blanco_2004-05-19.pdf
La Esperanza	Honduras	http://cdm.unfccc.int/Projects/DNV-CUK1098894708.4/view.html
Cortecito and San Carlos	Honduras	http://www.dnv.com/certification/climatechange/Upload/Cortecito%20and%20San%20Carlos%20PDD%20SSC.pdf
Guyamapa	Honduras	http://cdm.unfccc.int/Projects/DNV-CUK1098283126.83/view.html

Dehar	India	http://www.dnv.com/certification/climatechange/Upload/SSC%20PDD%205MW%20APIL.PDF
Parpikala	India	http://www.dnv.com/certification/climatechange/Upload/SSC-PDD_Parpikala_2004-09-04.pdf
Micro-hydro project	Indonesia	http://www.cdmwatch.org/project_details.php?ID=11
INELEC -El Gallo (NM23)	Mexico	http://www.dnv.com/certification/climatechange/Upload/PDD_El%20Gallo_2004-04-21.pdf
INELEC - Trojes	Mexico	http://cdm.unfccc.int/Projects/Validation
INELEC - Benito Juarez	Mexico	http://cdm.unfccc.int/Projects/Validation
INELEC - Chilatán	Mexico	http://cdm.unfccc.int/Projects/Validation
Fortuna	Panama	Lorenzo Eguren, C. (2004). El Mercado de carbono en America Latina y el Caribe: Balance y perspectivas. CEPAL.
Bayano	Panama	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_650592459
Esti	Panama	http://www.cdmwatch.org/project_details.php?ID=104
Poechos	Peru	http://www.fonamperu.org/general/mdl/documentos/01comercio-fonam.pdf
SIIF Andina S.A.	Peru	http://www.fonamperu.org/general/mdl/documentos/01comercio-fonam.pdf
Tarucani	Peru	http://www.fonamperu.org/general/mdl/documentos/01comercio-fonam.pdf
Huanza	Peru	http://www.fonamperu.org/general/mdl/documentos/01comercio-fonam.pdf
Small hydro	Sri Lanka	Personal communication with Lorenzo Eguren, C.
Hydro	Swaziland	Personal communication with Lorenzo Eguren, C.
West Nile hydropower	Uganda	http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3108
Lwakela	Zambia	http://global.finland.fi/english/projects/cdm/PIN_Lwakela-Finnish.doc
Osborne Dam	Zimbabwe	http://www.cdmwatch.org/project_details.php?ID=67
Biogas Program for the Animal Husbandry Sector	Vietnam	http://carbonfinance.org/cdcf/router.cfm?Page=Projects&ProjectID=3399
APCL in Tamilnadu	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_2636082
Pangkalan Brandan palm oil waste power plant	Indonesia	http://www.teriin.org/climate/indonesia.pdf
Xiaogushan	China	http://carbonfinance.org/docs/China010Xiaogushan0Hydro0PIN.pdf
New solar power	Kiribati	http://gec.jp/gec/en/Activities/cdm/FS200107SE.pdf
Small-scale CDM project	Samoa	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Huitengxile	China	http://www.cdmwatch.org/project_details.php?ID=117
Jepirachi (NM24)	Colombia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_837711305

Umbrella Project - Vara Blanca	Costa Rica	http://carbonfinance.org/pcf/router.cfm?Page=DocLib&Dtype=1&ActionType=ListItems
Salinas	Ecuador	Lorenzo Eguren, C. (2004). El Mercado de carbono en America Latina y el Caribe: Balance y perspectivas. CEPAL.
Zafarana (NM36)	Egypt	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_338682488
Wind farm - Francisco Morazan	Honduras	http://carbonfinance.org/pcf/router.cfm?Page=DocLib&Dtype=1&ActionType=ListItems
Wind in Tamil Nadu	India	http://www.netinform.de/KE/files/pdf/PDD%20Small%20scale%20wind%20project%20Tamil%20Nadu.pdf and http://www.senter.nl/asp/page.asp?alias=erupt&id=i001310
Sankaneri Wind	India	http://www.cdmwatch.org/project_details.php?ID=147
Wigton (NM12)	Jamaica	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_490736191
Cruz azul (Fuerza éolica del Istmo - in Oaxaca)	Mexico	http://carbonfinance.org/pcf/router.cfm?Page=DocLib&Dtype=1&ActionType=ListItems
Office National d'Electricité	Morocco	http://www.dnv.com/certification/climatechange/Upload/ONE%20PDDFinal11nov.pdf
New wind plant	Niue	http://gec.jp/gec/en/Activities/cdm/FS200107SE.pdf
North Wind Bangui Bay	Philippines	http://www.klima.ph/cd4cdm/
Conversion to combined cycle (NM 78)	Ghana	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_820863530
Co-generation using bagasse and rice husk (Ratchaburi)	Thailand	http://gec.jp/gec/en/Activities/cdm/FS200201SE.pdf
Moldova wastewater (NM38)	Moldova	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_669737503
Optimisation of steel production (NM59)	Brazil	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_924318202
Steam efficiency improvements (NM17)	China	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_29878484
Furatena	Colombia	http://carbonfinance.org/cdcf/router.cfm?Page=DocLib&Dtype=19&ActionType=ListItems
Energy efficiency in ammonia plant (NM37)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_481802349
Karnataka wastewater (NM42,44)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_803854940
Improve efficiency of power transmission	Tonga	http://gec.jp/gec/en/Activities/cdm/FS200107SE.pdf
Improve efficiency of fossil fuel plants	Tonga	http://gec.jp/gec/en/Activities/cdm/FS200107SE.pdf
Tazama pipeline	Zambia	http://www.cdmwatch.org/project_details.php?ID=189

Office Chérifien des Phosphates	Morocco	www.pointcarbon.com/article.php?articleID=3128&categoryID=147
OSIL waste heat (NM31)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_98716985
Energy efficiency standards (NM72)	Ghana	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_820863530
Kuyasa housing	S. Africa	www.southsouthnorth.org
PFC - Hirakud	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_294374829
Gujarat fluorochemicals	India	http://www.sgsqualitynetwork.com/tradeassurance/ccp/projects/GHG%20Emission%20Reduction%20By%20Thermal%20Oxidation%20Of%20HFC%2023/Gujarat%20Fluorochemicals%20Ltd%20PDD%2024November2003.pdf
Ulsan (NM0007)	Korea	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_195550909
Aluar (NM 68)	Argentina	http://cdm.unfccc.int
V&M (NM0029)	Brazil	http://www.dnv.com/certification/climatechange/Upload/Revised%20PDD-V&M-2003-03-27.pdf
Plantar	Brazil	http://www.cdmwatch.org/project_details.php?ID=12
Lafarge cement (NM40)	Malaysia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_703284656
Shell Fuel Switching in co-generation (NM 77)	Argentina	http://cdm.unfccc.int
Planta Graneros (NM16)	Chile	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_180615177
Smallholder Tea	Kenya	http://carbonfinance.org/cdcf/router.cfm?Page=DocLib&Dtype=19&ActionType=ListItems
Guaracachi (NM 70)	Bolivia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_959312249
Biodiesel production (NM 69)	India	http://cdm.unfccc.int/
Fuel switching at Essar power station (NM 73)	India	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_306915788
Khon Kaen (NM 82)	Thailand	http://cdm.unfccc.int/methodologies/PAmethodologies/process?OpenRound=8&OpenNM=NM0082&cases=B#NM0082
Siam cement biomass gasifier	Thailand	http://www.denmark-embassy.or.th/danida/cdm.htm
Hou Ma District Heating (NM58)	China	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_890263868
Ulaanbaatar	Mongolia	http://carbonfinance.org/cdcf/router.cfm?Page=DocLib&Dtype=19&ActionType=ListItems
Andijan	Uzbekistan	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_910284580
Tashkent	Uzbekistan	http://carbonfinance.org/pcf/router.cfm?Page=DocLib&Dtype=1&ActionType=ListItems
Waste Heat Recovery and Utilisation (NM 79)	China	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_890263868

Biogas recovery	Costa Rica	http://global.finland.fi/english/projects/cdm/projects.html
Organic green waste composting	Bangladesh	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_626438617
Olavarria Landfill	Argentina	http://www.dnv.com/certification/climatechange/Upload/PDD_Olavarria_2004-05-21.pdf
Villa Dominico	Argentina	http://www.sgsqualitynetwork.com/tradeassurance/ccp/projects/Landfill%20Gas%20Extraction%20on%20the%20Landfill%20Villa%20Dominico/PDD%20AR%20FINAL%2020040729.pdf
Gramacho Sanitary Landfill	Brazil	http://www.centroclima.org.br/english/biogas_biodiesel.pdf
Lara landfill	Brazil	http://www.dnv.com/certification/climatechange/Upload/PDD_Lara%20Landfill_2004-05-08.pdf
Salvador da Bahia (NM0004)	Brazil	http://www.dnv.com/certification/climatechange/Upload/PDD_Salvador%20de%20Bahia_2003-10-15.pdf
São João	Brazil	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Onyx Landfill gas recovery (NM21)	Brazil	http://www.dnv.com/certification/climatechange/Projects/ProjectDetails.asp?ProjectId=96
MARCA Landfill Gas	Brazil	http://www.dnv.com/certification/climatechange/Upload/PDD_Marca%20Landfill_2004-04-15.pdf
Nova Gerar (NM5)	Brazil	http://www.dnv.com/certification/climatechange/Upload/PDD_NovaGerar%20_2004-02-13.pdf
Anding	China	http://www.dnv.com/certification/climatechange/Upload/Anding-PDD.pdf
SARET Rio Azul	Costa Rica	http://www.cdmwatch.org/project_details.php?ID=137
Solid Waste Management - Chennai	India	Personal communication with Lorenzo Eguren, C.
Air Hitam landfill gas capture project	Malaysia	http://www.cdmwatch.org/project_details.php?ID=47
Krubong Melaka	Malaysia	http://www.cdmwatch.org/project_details.php?ID=292
Chisinau landfill	Moldova	http://www.dnv.com/certification/climatechange/Upload/PDD_Chisinau%20Landfill_2004-07-27.pdf
City Council of Rabat	Morocco	www.pointcarbon.com/article.php?articleID=3128&categoryID=147
Durban (NM10)	S. Africa	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_311161298
Power Generation by Landfill Gas	Thailand	http://gec.jp/gec/en/Activities/cdm/FS200201SE.pdf
Thuong Ly	Vietnam	http://global.finland.fi/english/projects/cdm/PDD_draft_viet.pdf
Grontmij Landfill	Vietnam	http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3144
Santa Cruz	Bolivia	http://www.dnv.com/certification/climatechange/Upload/PDD_Santa%20Cruz%20Landfill_August%202004.pdf
Phnom Penh	Cambodia	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List

Landfill gas recovery and power generation	Philippines	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Belleville	S. Africa	www.southsouthnorth.org
Biogas	Nepal	http://carbonfinance.org/cdcf/router.cfm?Page=Projects&ProjectID=3404
Corneche + Los Guindos	Chile	http://www.dnv.com/certification/climatechange/Upload/PDD_Corneche%20y%20Los%20Guindos_2004-08-27.PDF
Peralillio (NM22)	Chile	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_97764878
Pocillas + La Estrella	Chile	http://www.dnv.com/certification/climatechange/Projects/ProjectDetails.asp?ProjectId=95
Granja Becker (NM34)	Brazil	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_959312249
M5000 (NM03)	Trinidad & Tobago	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_555005147
N2O Removal	Chile	Personal communication with Lorenzo Eguren, C.
OnSAN (NM61)	Korea	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_736849192
Dalian	China	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Mondi Kraft Biomass	S. Africa	http://www.southsouthnorth.org/
Metrogas pipeline rehabilitation (SSC)	Chile	http://www.dnv.com/certification/climatechange/Upload/PDD_Metrogas%20Methane%20Recovery_2003-09-30.pdf
Coal-bed methane	China	http://carbonfinance.org/router.cfm?Page=Projects
Rang Dong (NM26)	Vietnam	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_785952467
Pansan coal-mine methane (NM 75)	China	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_890263868
Nanshan	China	http://cdm.unfccc.int/methodologies
Swine manure management	Thailand	http://www.denmark-embassy.or.th/danida/cdm.htm
Forest Plantation - East Kalimantan	Indonesia	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Soil Conservation Project	Moldova	http://carbonfinance.org/pcf/router.cfm?Page=Projects&ProjectID=3133 and http://www.cdmwatch.org/project_details.php?ID=196
Mountain Pine Ridge	Belize	http://cdm.unfccc.int
Reforestation project on Lombok	Indonesia	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Reforestation	Solomon Islands	http://gec.jp/gec/en/Activities/cdm/FS200107SE.pdf
Bagepalli	India	message to climate-l, 28.10.04

Production of ethanol-containing gasoline	Vietnam	http://gec.jp/gec/gec.nsf/en/Activities-Feasibility_Studies_on_Climate_Change_Mitigation_Projects_for_CDM_and_JI-List
Battery-powered vehicles	Bangladesh	http://www.southsouthnorth.org/
Biodiesel for transport	Brazil	http://www.southsouthnorth.org/
Urban mass transportation system (TransMilienio)	Colombia	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_66405654
Urban Buses in Yogyakarta	Indonesia	http://www.cdm.or.id/en/project/?pid=1
Vinasse aerobic treatment	Nicaragua	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_884731547
Korat waste-to-energy (NM41)	Thailand	http://cdm.unfccc.int/methodologies/UserManagement/FileStorage/FS_942091788
Feldar Lepar Hilir (NM13)	Malaysia	http://gec.jp/gec/en/Activities/cdm/FS200202SE.pdf

Glossary

AM	Methodology (to determine a project's baseline and monitoring) that has been approved by the CDM EB
AOSIS	Alliance of Small Island States
CDM	Clean Development Mechanism, defined in Article 12 of the Kyoto Protocol.
CER	Certified Emission Reduction (credits generated by CDM project activities)
CH_4	Methane
CO_2	Carbon dioxide
DOE	Designated Operational Entity
EB	The Executive Board of the Clean Development Mechanism
ERU	Emission Reduction Unit (credits generated by JI projects)
GHG	Greenhouse gas
HFC	Hydrofluorocarbons
Methodology Panel	Advisory panel to the CDM EB on baseline and monitoring methodologies.
Mt	Million (metric) tons
OECD	Organisation for Economic Co-operation and Development
NM	New Methodology (submitted to the CDM EB, but not yet approved, or approved but not yet reformatted).
N_2O	Nitrous oxide
PDD	Project design document (form used to describe a proposed CDM project)
PFC	Perfluorocarbons
SD	Sustainable development
UNFCCC	United Nations' Framework Convention on Climate Change