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DISCUSSION PAPER

Measuring the Potential of Unilateral CDM - A Pilot Study -

Michael Jahn
Axel Michaelowa
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Measuring the Potential of Unilateral CDM - A Pilot Study -

ABSTRACT

The Clean Development Mechanism (CDM) was originally seen as an instrument with a bilateral character where an entity from an industrialised country invests in a project in a developing country (DC). Also, multilateral funds were envisaged that would bundle investments to spread project risks. The sluggish implementation of incentives for industrialised country companies to embark on CDM projects and low carbon prices led to a preference of just buying Certified Emission Reductions (CERs) instead of investing in projects. Thus a third option has gained prominence – the unilateral option where the project development is planned and financed within the DC. We propose that a project should be called "pure unilateral" if it involves no foreign direct investment (FDI), only has the approval of the Designated National Authority (DNA) of the host country and sells its CERs after certification directly to an industrialised country. Unilateral projects can become attractive if the host country risk premium for foreign investors is high despite a high human, institutional and infrastructure capacity and domestic capital availability. Moreover, transaction costs can be reduced compared to foreign investments that have to overcome bureaucratic hurdles. On the other hand, technology transfer is likely to be lower, capacity building has to be done by the host country and all risks have to be carried by host country entities.
The potential to carry out unilateral CDM projects strongly varies among DCs. Whereas several countries from Asia and Latin America might well be able to design projects autonomously, most of the Sub-Saharan countries rely on foreign support. International donors of capacity building grants should increasingly address those DCs that are not in the focus of foreign investors and support them in the design of projects.

JEL Classification: Q25, O13
Key words: Clean Development Mechanism, unilateral, institutions, project participants, financing, risk premium

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Abbreviations

$	Dollar
§	Paragraph
AAU	Assigned Amount Unit
AIJ	Activities Implemented Jointly
BCF	Bio Carbon Fund
CDCF	Clean Development Carbon Fund
CDM	Community Development Mechanism
CER	Certified Emission Reduction
CERUPT	Certified Emission Reduction Procurement Tender
CH_4	Methane
CO_2	Carbon Dioxide
COP	Conference of the Parties
COP/MOP	Conference of the Parties serving as the Meeting of the Parties to the Kyoto Protocol
DNA	Designated National Authority
ERU	Emission Reduction Unit
EU	European Union
FDI	Foreign Direct Investment
G	Giga
GHG	Greenhouse gases
GWh	Gigawatt hour
HFCs	Hydroflurocarbons
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
JI	Joint Implementation
k	kilo
KP	Kyoto Protocol
kt	kilotonne
kWh	kilowatthour
M	Mega
MA	Marrakech Accords
MW	Megawatt
N_2O	Nitrous oxide
NCDF	Netherland's Carbon Development Facility
NGO	Non Governmental Organization
OE	Designated Operational Entity
PCF	Prototype Carbon Fund
PDD	Project Design Document
PFCs	Perfluorocarbons
SF_6	Sulphurhexafluoride
TAC	Transaction costs
UNFCCC	United Nations Framework Convention on Climate Change
UNDP	United Nations Development Programme
WDI	World Development Indicators

1 Overview of the policy framework

1.1 International climate change policy – from Rio to Kyoto

During the 1980s first evidence of human influence on the climate system increased the awareness of climate issues among governments and organisations. In 1988 the World Meteorological Organisation and the United Nations Environment Programme created the Intergovernmental Panel on Climate Change (IPCC) to evaluate scientific information and to advise policy makers on this subject. In its first assessment report, published in 1990, the IPCC stated that climate change was a real threat. Later that year the Intergovernmental Negotiating Committee was formed to work out an international treaty addressing the problem of climate change. The treaty is known as the United Nations Framework Convention on Climate Change (UNFCCC) and was opened for signature at the Earth Summit in Rio de Janeiro in 1992. Since it came into force 1994 the Parties to the Convention meet annually at the Conference of the Parties (COP). According to the UNFCCC the industrialised countries pledged to reduce their greenhouse gas (GHG) emissions by the year 2000 to 1990 levels. As listed in Annex I of the Convention, this group of countries is known as Annex I countries. However, this self-commitment was not legally binding and it soon became clear that the reduction goals would not be attained.

At COP-3 held in Kyoto in 1997 the industrialised countries including the Eastern European countries with economies in transition finally adopted legally binding constraints by agreeing to reduce GHG emissions by 5.2 per cent below their 1990 level on average over a first commitment period 2008-2012. As listed in Annex B of the Kyoto Protocol (KP) this group of countries is known as Annex B countries[1] (see UNFCCC 2003a, p. 3ff).

1.2 The Kyoto mechanisms

In order to reduce emissions in a cost efficient way the KP provides three market-based flexible mechanisms. The three mechanisms are known as International Emission Trading (see UNFCCC 1997, Article 17 KP), which allows for emission trading of Assigned Amount Units (AAUs)[2] between Annex B countries, and the project-based mechanisms Joint Implementation (JI) (see UNFCCC 1997, Article 6 KP) and Clean Development Mechanism (CDM) (see UNFCCC 1997, Article 12 KP). Whereas JI refers to project activities within Annex I countries, the CDM allows for generating greenhouse gas emission credits through investment in emission reduction or sequestration projects in developing countries (DCs)

[1] Annex B consists of all of those countries listed in Annex I with the exception of Turkey and Czechoslovakia. New countries added to Annex B include Croatia, the Czech Republic, Liechtenstein, Monaco, Slovakia and Slovenia (see Michaelowa and Koch 2001, p.11).

[2] The Assigned Amount is a nation's emissions budget under the first commitment period, measured in tons of CO_2 equivalent. AAUs are the parts of that amount used for emissions trading (see Michaelowa and Koch 2001, p. 12).

(Non-Annex I countries) without emission targets. The emission credits generated through JI are called “Emission Reduction Units” (ERUs). Credits generated through the CDM are called “Certified Emission Reductions” (CERs) respectively. Annex B countries can reach compliance with their commitments by implementing domestic abatement measures or by using AAUs, ERUs and CERs[3].

[3] AAUs, ERUs and CERs are equal to one metric tonne of CO_2 equivalent (see UNFCCC 2001a, 17/CP.7, Annex A, §1).

2 The Clean Development Mechanism

2.1 Rules for the CDM

The KP and the decisions taken at the seventh Conference of the Parties (COP-7), known as Marrakech Accords (MA), lay down certain rules for the CDM. They have been refined by the CDM Executive Board (see 2.1.2).

2.1.1 Participation criteria

In order to be eligible for the CDM, both DCs that host a project activity and participating Annex B countries must have ratified the KP and have established a national focal point, called Designated National Authority (DNA), responsible for approving and evaluating CDM projects. Besides Annex B countries have to meet additional methodological and reporting criteria. Participation in a CDM project is voluntary (see UNFCCC 2001a, 17/CP.7, Annex F).

2.1.2 CDM institutions

The CDM is administered by two bodies, the Conference of the Parties serving as Meeting of the Parties (COP/MOP) and the Executive Board. The COP/MOP is the supreme body to the CDM. It shall provide guidance to the Executive Board and take decisions on modalities and procedures of the CDM (see UNFCCC 2001a, 17/CP.7, Annex B). The Executive Board shall supervise the CDM and is fully accountable to the COP/MOP. It is comprised by 10 members from Parties to the KP and charged with a number of approving and accrediting tasks to be performed during the preparation and operating time of a CDM project (see UNFCCC 2001a, 17/CP.7, Annex C).

2.1.3 Project eligibility criteria

A project activity has to result in the reduction or sequestration of GHG gases covered in Annex A of the KP (CO_2, CH_4, N_2O, SF_6, HFCs, PFCs). The emission reductions and thus the whole project activity have to be additional compared with a business as usual scenario which does not include the implementation of the CDM (see UNFCCC 2001a, 17/CP.7, Annex G, §43). In order to prove that emission reductions are additional, project developers have to draw up a baseline, i.e. a scenario which presents the GHG emissions that would occur in the absence of the project, and compare it with actual project emissions. Furthermore additionality has to be proved by identifying barriers that would have prevented the project from being implemented without the CDM. A distinction is drawn between technological, organisational, legal and financial barriers. Finally the project should meet the host country's sustainable development criteria (see UNFCCC 1997, Article 12.2 KP) and not result in unacceptable impacts on the environment.

2.1.4 Eligible project categories

All CDM projects aim at lowering the concentration of GHGs in the atmosphere. This can be reached by reducing/avoiding GHG emissions or by sequestering CO_2 through the process of photosynthesis. In the MA eligible project categories for the first commitment period have been restricted by the exclusion of certain sequestration project types and the decision not to use CERs from nuclear energy generation (see UNFCCC 2001a, 17/CP.7). The rules for forestry projects have been defined at COP-9 in Milan. Examples for eligible CDM project categories and specific types of projects are listed in the table below (see Eyzaguirre 2002, p. 75).

Table 1: Examples of eligible project categories and types

Project category	**Project type**
Energy generation	Renewable energy
	Co-generation
Energy efficiency	High efficiency lighting, cooling systems
	High efficiency motors
Transportation	Alternative fuel vehicles
	Mass transit improvements
Waste management	Methane capture from solid waste
	Methane capture from oil and gas production
Land use (CO_2 Sequestration)	Afforestation
	Reforestation

2.1.5 Small-scale projects

Among the eligible project categories small-scale projects are defined as:

- Renewable energy projects with a maximum output capacity of up to 15 MW
- Energy efficiency projects which reduce energy consumption by up to 15 GWh/year
- Other projects that reduce emissions and emit less than 15 kt of CO_2 annually

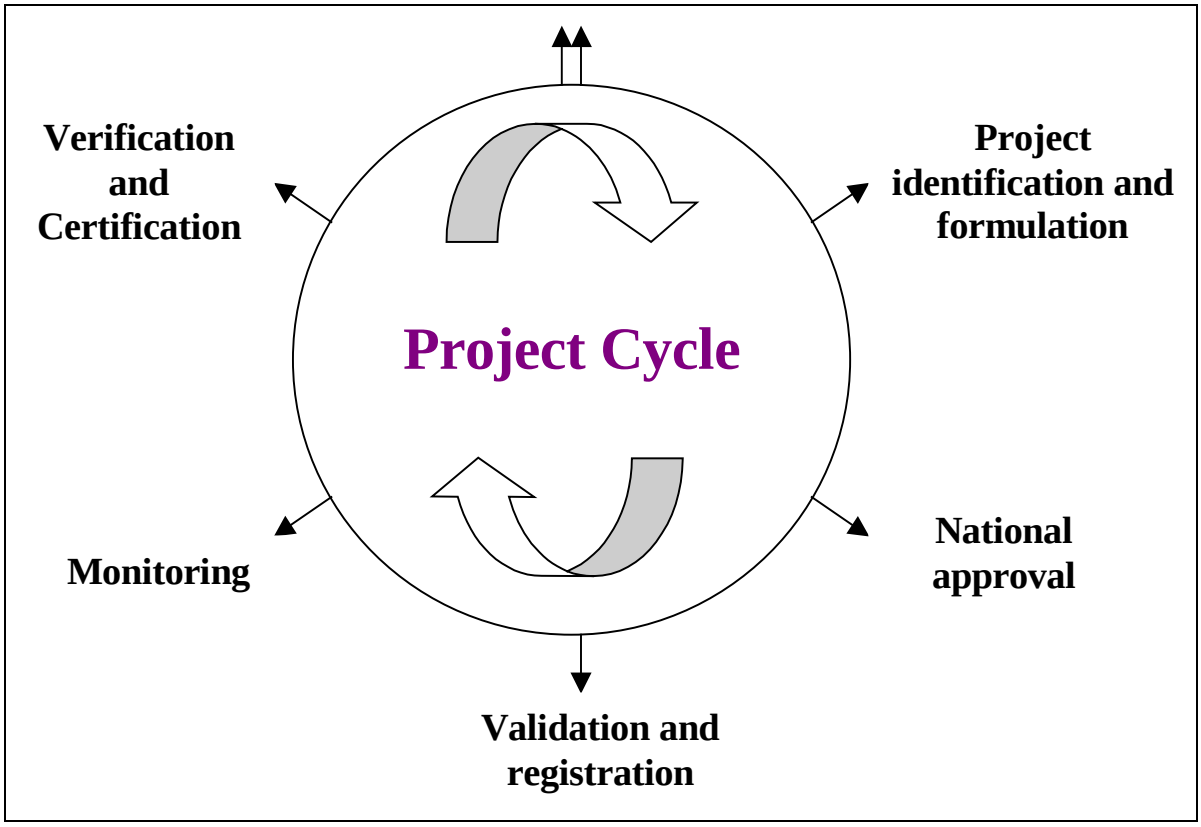
Compared with larger projects small-scale projects are subject to simplified procedures and modalities (see UNFCCC 2001a, 17/CP.7, §6).

2.1.6 The CDM Project Cycle

In order to allow for the creation of carbon credits, the reduction of GHGs that result from a project has to be measured and audited. Therefore all projects running under the CDM must follow a standardised procedure commonly known as the CDM Project Cycle. The Project Cycle has five basic stages: project identification and formulation, national approval, validation and registration, monitoring, verification and certification (see Figueres and Gowan

2002, p.24). A project is implemented after registration. So far no CDM projects have been registered yet.

Figure 1: Stages of the CDM Project Cycle



- **Project identification and formulation**

As a first step project developers have to identify their project idea. Once they have chosen to carry it out they have to formulate their intentions following a format established by the COP, the so called Project Design Document (PDD). It includes a description of the project, a presentation of the baseline[4], a description of how the project reduces GHG emissions below the baseline, an environmental impact assessment, comments of possibly affected groups and individuals and a monitoring plan[5]. Monitoring refers to the collection and archiving of all relevant data necessary for determining the baseline, and for measuring the GHG emissions occurring over the crediting period[6] of a project (see UNFCCC 2001a, 17/CP.7, Appendix B).

[4] If for a any project category a baseline is prepared for the first time, the project developers first have to submit a methodology to the Executive Board on how the baseline emission can be assessed. The Executive Board decides on whether the methodology will be approved or not (see UNFCCC 2001a, 17/CP.7, Annex G § 38).
[5] If for a any project category a monitoring plan is prepared for the first time, the project developers first have to submit a methodology to the Executive Board on how actual emissions can be assessed. The Executive Board decides on whether the methodology will be approved or not (see UNFCCC 2001a, 17/CP.7, Annex G § 38).
[6] The time over which a project generates CERs is called crediting period. The developer can chose between 10 and 7 years. A 7 years crediting period can be renewed for another two times so that the maximum crediting lifetime is 21 years (see UNFCCC 2001a, 17/CP.7, Annex G § 49). For forestry projects the crediting period is either 30 or 20 years, the latter renewable twice (see UNFCCC 2003d, -/CP.9, §23).

- **National approval**

Prior to registration, the host country's DNA has to give written approval that the project activity is consistent with the country's sustainable development goals. Moreover the DNAs of all (at this point of time) participating countries have to submit a declaration that they voluntarily participate in the project (see UNFCCC 2001a, 17/CP.7, Annex G, §40a).

- **Validation and registration**

Before a project can be registered an independent third party entity, called Designated Operational Entity (OE), has to assess whether the project reduces emissions as supposed by the developers and whether participation criteria are met. This procedure is called validation. Subsequently the OE submits a validation report to the Executive Board. If the Executive Board approves the report, the project is registered and can be implemented (see UNFCCC 2001a, 17/CP.7, Annex G).

- **Monitoring**

As soon as the project is operational actual GHG emissions have to be periodically calculated and documented according to the monitoring plan in a monitoring report that constitutes the basis of verification and certification (see UNFCCC 2001a, 17/CP.7, Annex H).

- **Verification and certification**

The project operator has to submit the monitoring report to another OE that reviews and determinates the GHG reductions by subtracting the monitored emissions from the baseline emissions and thus verifies the achieved reductions. Finally the OE certifies the reductions by a written statement. Now the Executive Board can issue the Certified Emission Reductions to the registry account[7] of the project developer (see UNFCCC 2001a, 17/CP.7, Annex I).

2.2 Risks in CDM projects

CDM projects are subject to numerous risks. Beside the conventional project risks, additional risks arise from participating in the nascent carbon market. The risks can be categorised as follows (see Prototype Carbon Fund (PCF) 2002b, p. 1; Jablonski 2003, p. 29)

- **Conventional project risks**

Conventional project risks cover all the risks that are linked with the design and implementation of a traditional project activity. These risks relate to the construction, performance, financial engineering of a project, conclusion of enforceable contracts, creditworthiness of counterparties, environmental and social impacts and force majeure.

[7] The Executive Board will establish a register for the holding and transfer of CERs (see UNFCCC 2001a, 17/CP.7, Appendix D).

- **Kyoto risk**

The Kyoto risk relates to whether the KP will come into force and whether countries that participate in a CDM project will ratify and comply with its obligations. If the KP fails it is questionable if generated emission reductions through the CDM can be applied in Non-Kyoto emission trading regimes.

- **CER price risk**

The CER price risk relates to an uncertain market price for CERs. The market price is driven by the aggregate supply and demand for the amount of emission reduction credits (AAUs, ERUs, CERs). The demand side depends primarily on the number of countries making use of the Kyoto mechanisms. The Kyoto ratification of the United States, for example, would raise the demand significantly. The supply of emission reduction credits will strongly be influenced by the amount of surplus AAUs coming from the countries with economies in transition, also known as "hot air". Thus it is very difficult to forecast future prices for CERs (see 3.1).

- **CER quantity risk**

CER quantity risk means that the amount of CERs generated in a project can not be exactly determined ex ante. The amount of CERs is derived from the difference between actual emissions and baseline emissions. So the quantity of expected CERs may change for the following reasons (see Deodhar et al. 2003, p. 13):

- The baseline has to be adjusted during the crediting period due to technological innovation, new host country energy or environmental policy (baseline risk).
- Actual project emissions unexpectedly change due to changes in the activity level of the project. A change in the activity level could result from a change in demand for the project output, business interruption etc. (baseline emission risk).

  Imagine the baseline of a power plant being determined by an emission factor of 1kg of CO_2/kWh. The actual emission factor is 0.8kg of CO_2/kWh so that the emission reduction accounted for is 0.2kg of CO_2/kWh of generated power. If the power plant is shut down due to an unexpected interruption, the operator does not only lose the conventional power output, but also the associated emission reductions.

- **Country risk**

CDM projects are carried out in DCs, where the political, economic and financial situation generally is unstable compared with industrialised countries. Country risk contains the risk of expropriation, breach of contracts for political reasons and the risk that emission reductions might not be transferred to an Annex B country.

3 A look at the market for CERs

Having discussed the principles of how the CDM works and the associated risks we now have a look at the market for CERs. Under the first commitment period of the KP (2008-2012) AAUs, ERUs and CERs can be used by Annex B countries to reach compliance with their reduction goals. The credits are expected to be traded in an international carbon market, which has still to develop. Up to present the first national emissions trading schemes have been set up by countries like the United Kingdom and Denmark and an European Emissions Trading Scheme is scheduled to start in 2005. Until 2008 the respective schemes are supposed to be linked to the international Kyoto market.

3.1 The demand for CERs

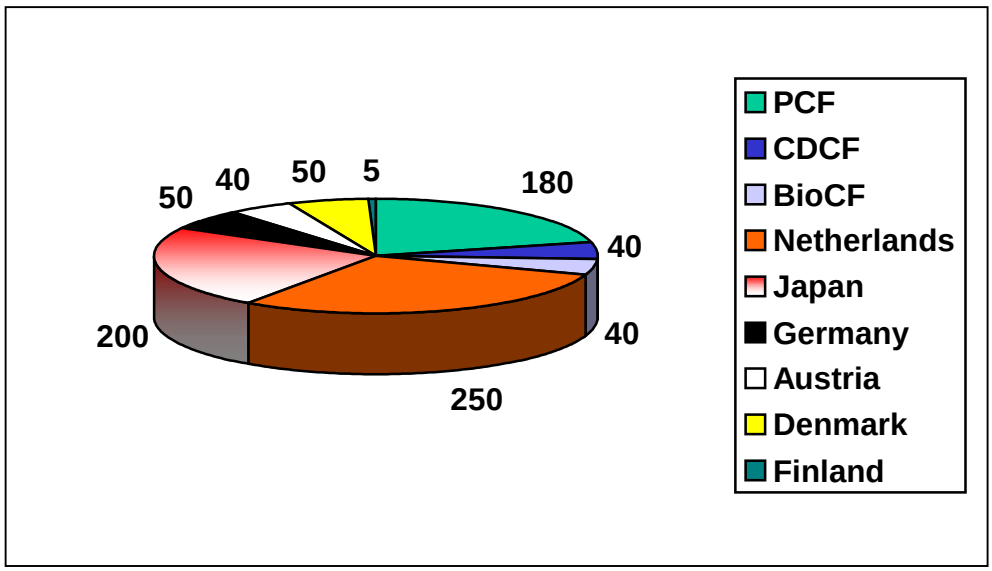
Under the Kyoto market the total demand of emission reductions would amount to 1.1 Gt CO_2/year[8], which equals the total emission reduction requirements of Annex B countries without the United States. Under a standard scenario about one third of the demand would be met by domestic abatement measures, about one third by the use of surplus AAUs coming from the countries with economies in transition (hot air), and one third by the use of credits accruing from CDM and JI. The pure CDM demand would amount to ca. 375 Mt CO_2/year (see Jotzo and Michaelowa 2002, p. 180-184).

In order to strengthen their market position several governments and multilateral institutions have already resumed negotiations with future CER suppliers. The World Bank's **Prototype Carbon Fund (PCF)** was launched by the World Bank in January 2000 and will terminate in 2012. It is funded by six governments and 17 private sector companies and disposed over a total capitalisation of $180 million by the end of 2002 for transactions under the CDM and JI (see PCF 2002a, p. 2). Besides, the World Bank initiated the **Community Development Carbon Fund (CDCF)**, a public/private cooperation, with the aim to purchase CERs from small scale projects that "measurably benefit poor communities and their local environment" (World Bank 2003a, p. 4). Another world bank fund called **Bio Carbon Fund (BCF)** aims at purchasing CERs from sequestration projects. Moreover single governments and other unilateral institutions like the German **Kreditanstalt für Wiederaufbau** have engaged in forward acquisitions of CERs or are actually preparing to do so. The biggest single market player so far has been the Dutch government. Through the **Certified Emissions Reductions Procurement Tender (CERUPT)** the Netherlands provided funds for the acquisition of CERs. The CDM tender was established by a company called Senter in late 2001 and closed in January 2002 because the Dutch government found the tender procedure of CERUPT too inflexible and costly. Together with the World Bank it established a new facility to purchase CERs, the **Netherlands Carbon Development Facility (NCDF)** (see World Bank 2003a, p.

[8] The annual demand refers to the 5-year commitment period between 2008-2012. The amount of necessary annual emission reductions was defined by the difference between business as usual CO_2 emissions in 2010, calculated by the US Department of Energy, and the Kyoto target.

3). Figure 2 below shows the current demand on the CDM and JI market (million $). The pure CDM demand is currently about $600 million, i.e. about 150 Mt CO_2 equivalent at prices of $3-5/t CO_2 equivalent.

Figure 2: Current demand on the CDM and JI market (million $)



3.2 Current supply of CDM projects

Until November 2003, 55 CDM projects have made public a PDD and a baseline study. The credits claimed by these projects over their total crediting lifetime amount to approximately 144 Mt/ CO_2 equivalent. The CERs generated by these projects until 2012, which can be used for the first commitment period, would cover about 89 Mt CO_2 equivalent.

Most of the future CERs generated by these projects will accrue to Japan, CERUPT and PCF (see Figure 4). Most of the projects are located in South America and Asia. Among the 55 projects 10 take place in Brazil, 8 in India and 6 in Costa Rica (see Figure 5). The greatest share of CERs will be generated by Brazil, South Korea[9] and India (see Figure 6). The predominant project types are renewable energy and gas capturing from landfills (see Figure 7). The greatest share of CERs will be generated by gas capture and fuel switching (see Figure 8) (see CDM Watch 2003).

[9] South Korea has a one project burning HFCs that generates almost 30 million CERs over its crediting lifetime.

Figure 3: Distribution of projects among CER buyers (number of projects)

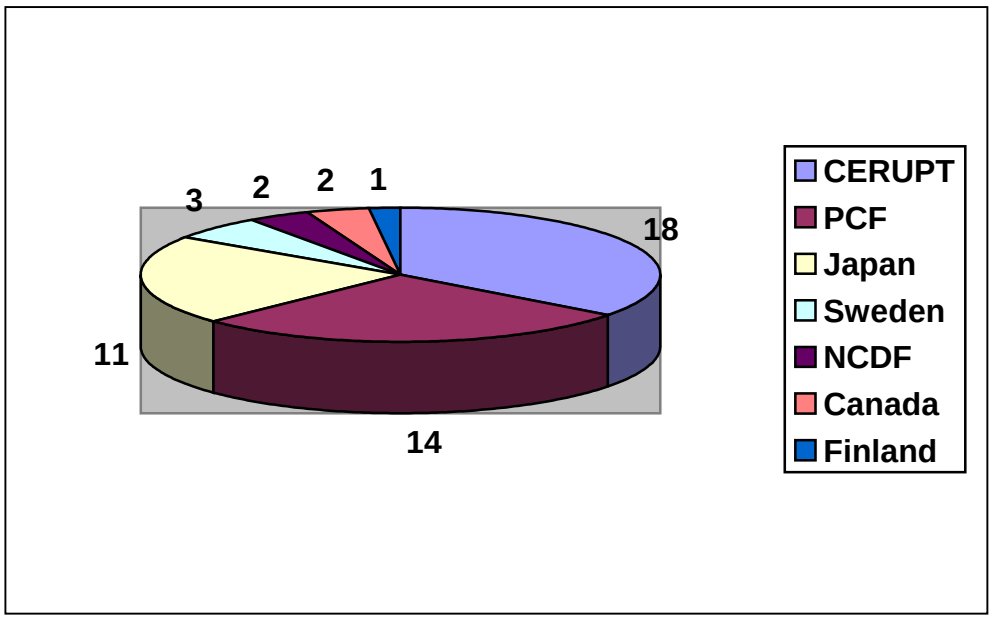


Figure 4: Amount of future CERs claimed by different buyers (Mt CO_2 equivalent)

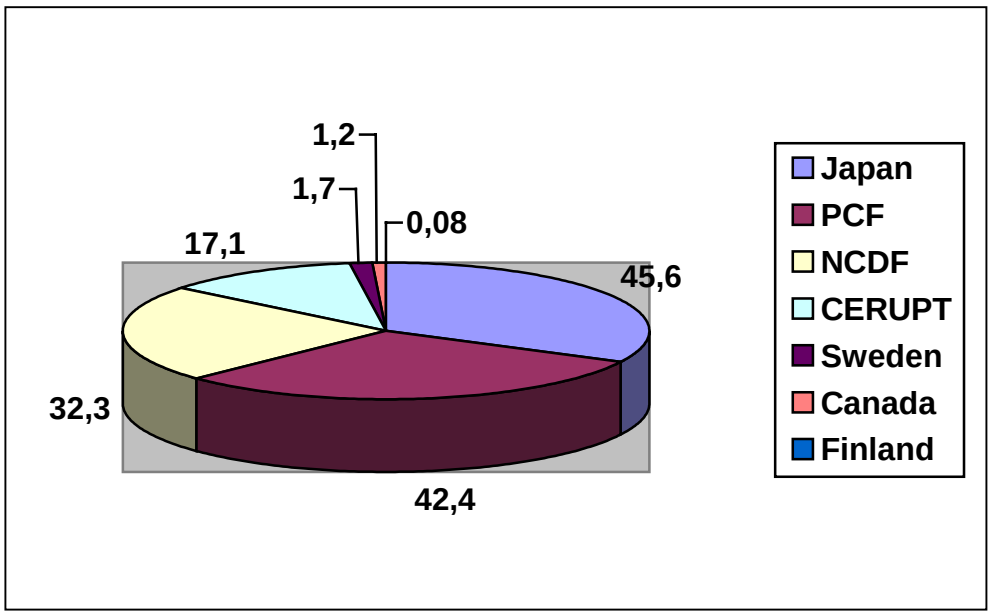


Figure 5: Distribution of projects among host countries (number of projects)

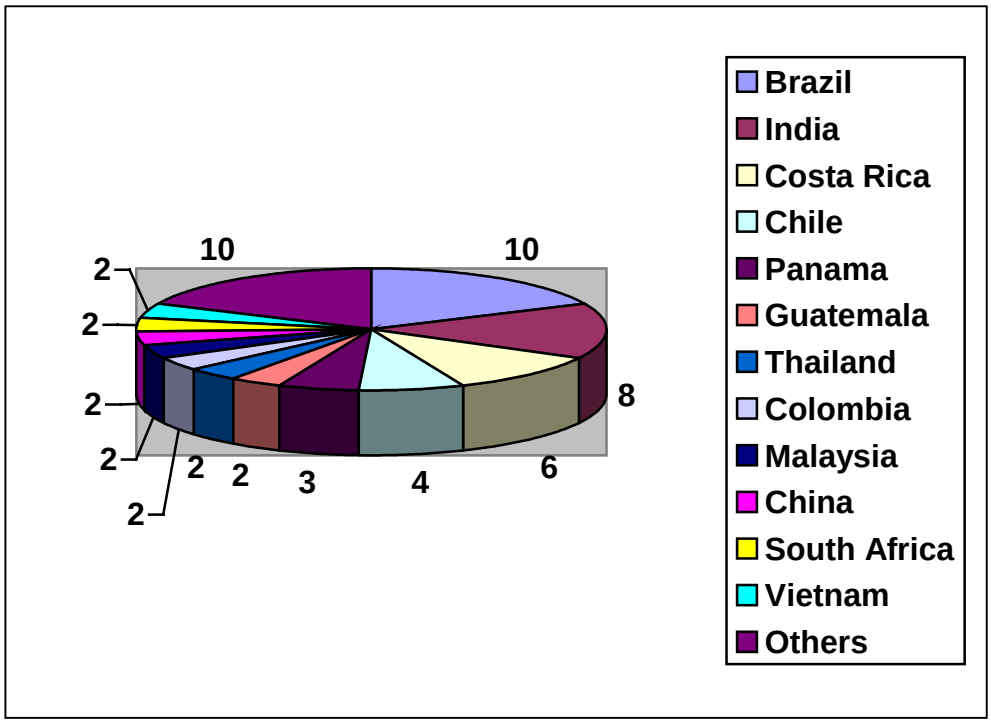


Figure 6: Amount of future CERs generated by host countries (Mt CO_2 equivalent)

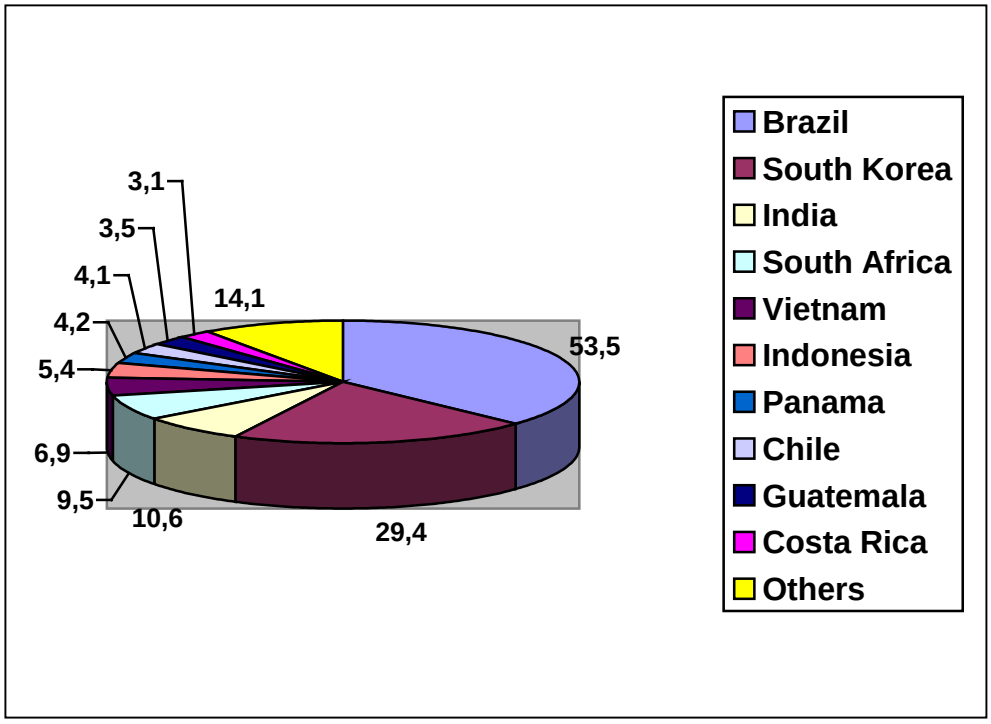


Figure 7: Share of different project types (percentage)

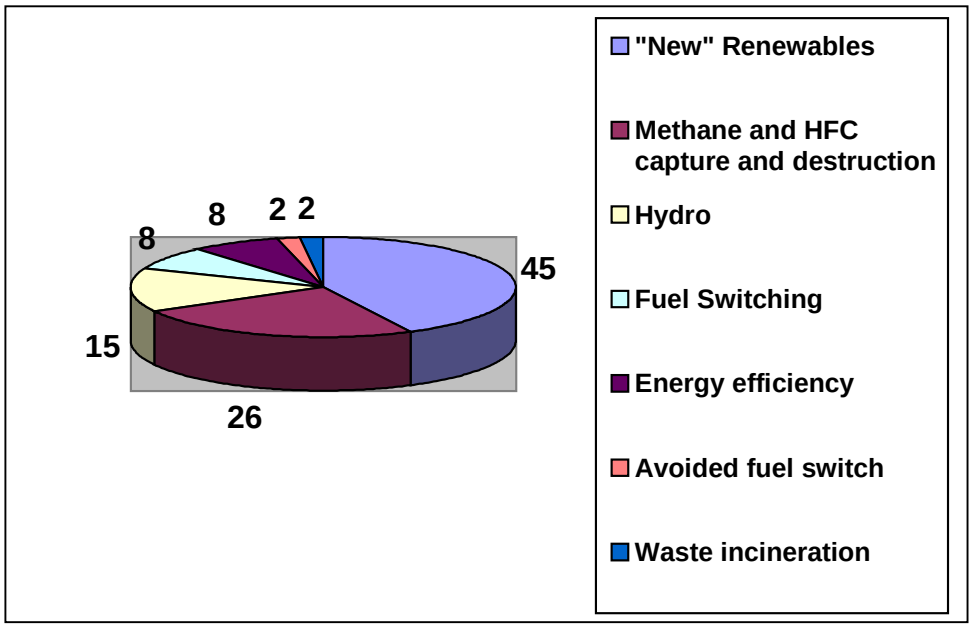
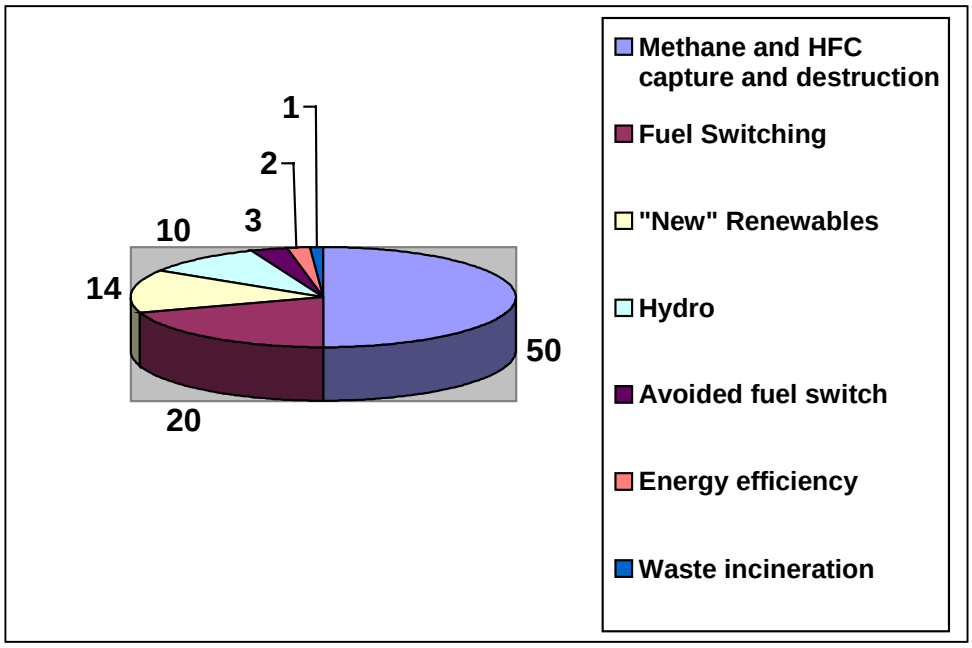


Figure 8: Share of future CERs generated by a specific project type (percentage)



4 Approaching the unilateral design

4.1 Unilateral CDM in the international rules

Originally the CDM was designed to initiate joint ventures between partners from a industrialised country and a DC in a bi- or multilateral institutional framework. In a bilateral design an Annex B entity directly invests in the project and in return receives CERs, which can be used against the domestic GHG reduction commitment. In the multilateral approach Annex B entities deposit their money in a centralised investment fund which invests the money in a portfolio of projects. The depositors would receive generated CERs proportional to their share in the fund (see Baumert et al. 2000, p. 3ff). As industrialised countries hesitate to **invest**[10] in CDM projects the question has gained prominence if CDM projects can be developed and implemented by DCs unilaterally and the resulting CERs be retained and sold without any involvement of industrialised countries.

In the run-up to COP-6, 2nd part in 2001, it was still discussed whether there should be an explicit reference as to whether or not unilateral CDM projects are permitted and three variants of text were proposed. It was clearly stated that "in the absence of a provision, unilateral projects would not be excluded" (UNFCCC 2001b, p. 12). The decision at COP-7 (17/CP.7) on the CDM judiciously avoided any text that could be seen as embracing or excluding a specific institutional interpretation. In line with the interpretation given by UNFCCC (2001b), this means that unilateral projects are allowed. Nevertheless, the wording of the MA has given room for different interpretations and still some governments maintain that unilateral CDM is not allowed. The key clause in the MA reads as follows (UNFCCC 2001a, 17/CP.7, Annex G, §40a): "The designated operational entity shall prior to the submission of the validation report to the executive board, have received from the *project participants* written approval of voluntary participation from the designated national authority of each Party involved, including confirmation by the host Party that the project activity assists it in achieving sustainable development." The apparent reference to "project participants" might create an impression that two parties in a bilateral arrangement are required to approach the Executive Board of the CDM for the registration of the project. However, the clause could not have been drafted in the singular, as this would have excluded bilateral projects, which was not the intention. We know that the political intent of the procedures was not to exclude the unilateral format, and so the clause appears to be a shortcut for the understanding that the text should be read as "the project participant or participants".

A proof for the legality of unilateral projects can be found in the Executive Board's template for the Project Design Development, which clearly refers to the possibility of there being only one project participant and one Party. The exact wording reads as follows: "Please list **Party**(ies*)* and private and/or public entities involved in the project activity..." **(**UNFCCC 2003c, A.3.).

[10] The CER demand described in section 3.1 expresses itself mainly as interest to **buy** CERs.

4.2 The history of the debate on unilateral CDM

As at Kyoto and the years leading up to COP-7 the CDM was believed to lead to a lot of foreign direct investment (FDI) towards DCs, the majority of policymakers and researchers saw the possibility for DCs to carry out CDM projects on their own was as an idea without much relevance. Nevertheless, many DCs, especially from South America argued early in the process to be able to invest in projects and sell the resulting CERs to Annex B countries (see International Institute for Sustainable Development (IISD) 2000). Within the so called Activities Implemented Jointly (AIJ), a first pilot phase for CDM and JI launched in 1995 after COP-1, Costa Rica pioneered this approach with the creation of "Certified Tradable Offsets"[11] in 1996 (see Roveda and Merenson 1999, p. 22f). The advocates of unilateral CDM (see Stewart et al. 1999, p. 28) argued that this approach could minimise transaction costs due to the fact that barriers are better known to the domestic actors than to foreign investors and can be overcome more easily by the former. A few countries attractive for FDI such as China opposed unilateral CDM (see UNFCCC 2000, p. 49), because they are interested to benefit from technology transfer in the CDM context and possibly fear that unilateral CDM worsens their comparative CER market advantage. On the other hand South Korea, a country with a lot of FDI, has been the most vocal supporter of unilateral CDM[12]. Zhang (2001) assumes this is due to the fact that Korea wants to bank CERs for the time when it takes up an emission target. Other participants, especially environmental Non Governmental Organizations (NGOs), have argued that unilateral CDM is going against the spirit of cooperation between North and South and thus should not be allowed. While Greenpeace (1999) initially accepted all three models, it later became an opponent of unilateral CDM fearing that it could be used to get nuclear energy in the CDM. Moreover, it was felt that the risk of non-additional projects could be higher under unilateral CDM (see Liu 2001).

Experience has shown that hardly any FDI has been channelled into the CDM by Annex B countries. Instead Annex B countries like the Netherlands and multilateral CDM funds such as the PCF of the World Bank have been seeking to purchase generated CERs by concluding forward agreements with project developers in CDM host countries (local project developers). There are even reasons why Southern project developers may not wish to go the bilateral route from the very beginning or altogether: an example is that an investor from an Annex B country may be motivated by technology export incentives (as with Japanese CDM investors), whereas the host country developer may have home-grown technology. Moreover it is believed that bilateral project negotiations may lead to CER prices that are much too low, compared with the prices that might be achieved through selling of CERs by the host country project developers after issuance.

[11] Certifed Tradable Offsets are units of GHG emissions reduced or sequestered by an AIJ project, verified and certified by the government of Costa Rica in 1996. Eventually the use of such credits will be permitted for the first commitment period of the KP under the UNFCCC.

[12] "Korea strongly believes it is necessary to allow developing countries to initiate their own host-generated unilateral CDM projects" (Kim 2000)

So there has been a controversial debate on unilateral CDM going on for a long time. Further it has become evident, that - regardless of whether unilateral CDM is considered on par with the other designs - it has already taken an important position within the CDM.

4.3 Triggers for unilateral CDM projects

As there are links between the three basic CDM approaches, i.e. bi-, multi- and unilateral CDM, it is difficult to define thresholds at which we can call a project unilateral. In effect there is a smooth transition from a locally developed CDM project – which may end up as a unilateral CDM project – to a bilateral or multilateral CDM project. It can be observed that most (so called) bilateral or multilateral projects are maturing out of earlier locally developed project initiatives.

So far the unilateral design has been defined by analysts by the condition that the actors in the host country develop, implement and finance a project on their own (see Baumert et al. 2000, p. 6). This definition is not sufficient to describe the characteristics of unilateral CDM and other aspects have to be considered such as the source of investment and the design of purchase agreements. The following section suggests criteria for unilateral projects.

4.3.1 Origin of Investment

Investment here is defined as equity capital for the project which might either be entirely provided by Annex B investors (FDI) or by host country investors (domestic investment). There is also the possibility that both host country companies and foreign companies invest in the same project, acting together in a joint venture. The starting criteria for a unilateral project would be that all equity is coming from host country entities.

4.3.2 Purchase agreements

Local project developers have to decide whether they want to bank future CERs or to sell them to Annex B entities.

- **Banking**

The banking may be most relevant for newly industrialised countries that expect commitments in the near future. Another reason for banking CERs could be that the project developers have not found a buyer yet or assume a higher future market price for CERs. The CERs not sold immediately to an Annex B country need to be registered. Public and private entities from a DC can open an account in the CDM registry of the Executive Board. Without any doubt the banking option corresponds well to the idea of a unilateral project as it does not involve any foreign entities.

- **Direct Purchase Agreement**

Instead of banking the project developers might want to sell CERs directly ex post after issuance at the end of the project cycle on an open market. By doing this they would significantly improve project revenues. Such a contract is called Direct Purchase Agreement (DPA). Before the sale, it is not clear which Annex B country is to get the credits. Thus this situation is clearly unilateral even if it finally leads to a bilateral transaction. It is unilateral, because all the necessary project cycle activities are under the host country developer's responsibility or initiated through him.

- **Emission Reduction Purchase Agreement**

So far no CDM projects have been registered and no CERs have been issued yet. Therefore all existing purchase agreements between host country project developers and buyers from an Annex B country involve a forward transaction. Such contracts are called Emission Reduction Purchase Agreements (ERPAs). With the conclusion of an ERPA the buyer commits to purchasing a certain amount of possibly future generated CERs at a specific price on CERs.
Whether a project designed under such a structure can still pass for a unilateral project is debatable. By all means it can not be seen as a "pure" unilateral project because the ERPA assigns the price risk and the Kyoto risk to the Annex B buyer (see PCF 2002b, p.3). Furthermore an ERPA may have a strong influence on the financial closure of a project in the case it provides up-front payment that is used by the local project developers for financing the project's assets. In addition ERPAs are usually signed according to the interests of Annex B buyers, which means they set low carbon prices, eventually involve huge penalties in the case of non-delivery of CERs and stipulate that the transaction costs, faced by the buyer (e.g. costs for risk assessment studies or costs for supervision of the project activity), can be deducted from the payments to the seller. From this perspective projects involving an ERPA could be regarded as non-unilateral.

However, it was mentioned that an ERPA can be concluded at any point of time before issuance of CERs. As the project cycle proceeds, the influence that can be exerted and the risks that can be assumed by an Annex B buyer are reduced. Thus projects that involve a "late" ERPA better relate to the unilateral idea. In this respect registration can be seen as a critical threshold. If an ERPA is negotiated prior to registration, the buyer will make high demands on the baseline- and monitoring plan and eventually participate in their preparation. Doing so the buyer wants to reduce the risk that the project will not be registered. Under such a structure a project could be considered as bilateral or multilateral. If an ERPA is negotiated after registration, the project has already been developed independently by the local project developers. The buyer can be assured that the project activity will be implemented and does not need to conduct an as comprehensive risk assessment study as in the former case. Here the project could still be regarded as unilateral.

4.3.3 DNA approval

Any project only approved by a host country DNA can be seen as unilateral. The question is whether buyer countries' DNAs have to approve projects from which they buy CERs. This is currently unclear. The Dutch government, for example, acting as a forward buyer of CERs, has signed Declarations of Approval for the projects, for which an ERPA has been prepared (see Ministry of Housing, Spatial Planning and the Environment of the Netherlands 2003). Contrary, projects of the PCF are without exception only approved by host country DNAs up to the present. The PCF has sought guidance from the UNFCCC secretariat asking for clarification on this issue (see PCF 2003b). We list possible options on how the DNA approval could be managed for multilateral funds in Box 1.

Box 1: DNA approval options for multilateral funds

1. **Only host country approves**
   This option reflects the present situation.

2. **Only one buyer DNA approves**
   In this option the host DNA and one representative Annex B DNA would approve the projects. This option seems to be reasonable, because it respects approval criteria of a buyer country but at the same time keeps bureaucracy within a limit.

3. **DNAs of all buyer countries have to approve**
   In this case the host DNA and all buyer DNAs would have to approve the projects, which would without a doubt raise transaction costs, delay the whole approval procedure and increase bureaucracy.

4.4 Unilateral projects under the current circumstances

According to the above mentioned criteria a "pure" unilateral CDM project does not involve any FDI, only has the approval of the host country DNA, and does not involve Annex B buyers prior to certification.

Among the CDM projects that have already reached an advanced stage of preparation (available PDD and baseline study) such pure unilateral projects are hardly represented (see CDM watch 2003). Though most of the projects show unilateral character to some extent. In many cases the project has been prepared by local project developers involving domestic investment and home grown technology like it is the case with Indian CDM projects (see

Krey 2003, p. 70). This heavily promotes the idea of a unilateral project. However, in order to reduce the associated risks, the project developers have concluded ERPAs with Annex B buyers at a very early stage of the project cycle (before registration), which adds a bi- or multilateral component to the originally locally designed project.

Most of such purchase agreements have been signed under the Dutch CERUPT programme and the World Bank's PCF. Compared with Senter (i.e. the company that established CERUPT on behalf of the Dutch government), the World Bank is more active in preparing projects because PCF members reserve the right to procure consultancy, to commission the baseline study and monitoring plan and to supervise the participants in project preparation. (see PCF 2003a, p. 4). In contrast, Senter remains passive in preparing projects, conceding a higher grade of autonomy to the project developers (see Liese 2001, p. 16-19). In case of non-delivery of CERs Senter imposes a penalty against the contracted entities, which puts additional pressure on them (see Deodhar et al., p. 15), whereas no penalisation mechanism is implemented into PCF contracts. From this it can be seen that Annex B buyers differently influence and promote locally designed CDM projects. Table 2 below briefly compares the PCF with CERUPT in this respect.

Table 2: Influence of Annex B buyers on locally developed projects – PCF and CERUPT

Criteria	**PCF**	**CERUPT**
Direct investment/technology transfer	no	no
Agreement design	ERPA	ERPA
Project Supervision	yes	yes
Support in baseline and monitoring plan preparation	yes	no
Contractual fines	no	yes
Buyer Country Approval	no	yes

In the future more "pure" unilateral projects may emerge if the risks related to the carbon market such as the Kyoto- and price risk decrease or entirely disappear as the market matures. Then local project developers might be more willing to assume all the associated risks on their own and to carry out a project without involving any Annex B entity before the project has generated the first CERs.

5 Advantages of unilateral CDM

5.1 Lower risk perception by the host

CDM projects are considered to be risky as they do not only bear general project risks but also risks linked with the carbon market. This is one of the reasons why foreign investors have been reluctant to invest in CDM projects so far. Contrary, entities from a DC have been more willing to invest in CDM projects as risks are perceived lower. Compared with local investors, foreign investors face the additional risk that the host country could breach existing contracts (e.g. for political reasons) and not honour the commitment to transfer CERs (see PCF 2002b, p. 2). Moreover local investors can better assess the economic and political situation of their country and thus better foresee possible threats like strikes, riots and civil unrest.

Therefore foreign investors prefer investing in countries with low country risk. They will only invest in projects in high risk countries if they realise a higher internal rate of return (IRR) compared to low risk investment options. For example, an investor building a power station may be content with an IRR of 5% in Switzerland while he will ask for 30% in India. Many CDM projects in high-risk countries probably will not be able to deliver a return that is high enough to compensate the high country risk. So the barriers to mobilise foreign capital for projects in countries with a high perceived country risk are huge. Our above-mentioned power station investor asks for 30% IRR in India because depending on a favourable and unfavourable risk assessment he expects the IRR in a corridor of 15 to 30%, so that the risk is compensated. Being conservative, he chooses 30% as a threshold. However, a local power plant investor has a much lower IRR "risk spread" of 18 to 22% and thus applies 22% as his threshold, which results in a risk premium of the foreign investor of 8%[13] (30% - 22%). This is why local companies and banks are more likely to invest equity or to provide loans. In the case of public investors, positive externalities accruing to the host country might help to dismantle barriers to mobilise local capital as well.

We now assume that the power plant is able to deliver an IRR of 25%. While the foreign investor (with a threshold of 30%) would not be willing to participate in the project activity anymore, the host country investor on the other side (with a threshold of 22%) would not hesitate to provide his capital. The example shows that the aversion of foreign financiers to invest in countries with a high perceived country risk would exclude a big number of countries from bi- and multilateral CDM projects. Unilateral CDM is a chance for those countries to participate in the CDM and to widen up the international distribution of projects. Bilateral CDM only flowing to a few participants countries would give rise to questions concerning equity and the purpose of CDM.

[13] A lower risk perception by local project developers can also be demonstrated by a lower marginal abatement cost curve for the host country. See Appendix A for this approach.

5.2 Reduction of transaction costs

Transaction costs (TAC) of CDM projects can be defined as the costs that arise from search and negotiation activities performed by the participants of a project activity (market TAC) and as the costs that arise from the tasks to be performed during the project cycle (CDM project cycle TAC) (see Krey 2003, p.39).

Table 3: Transaction cost groups of CDM projects and their cost components

Market Transaction Costs	CDM Project Cycle Transaction Costs	
	Pre-implementation Phase Transaction Costs	Implementation Phase Transaction costs
Search costs	PDD Costs	Monitoring Costs
Negotiation Costs	Approval Costs	Verification Costs
	Validation Costs	Certification Costs
	Registration Costs	Adaptation Fee
		Administration Costs

Source: Krey, 2003, p. 39

To facilitate the investigation on unilateral TAC we assume the model of a "pure" unilateral project, where CERs are sold after issuance via a DPA.

5.2.1 Market transaction costs

According to Krey market TAC consist of search and negotiation costs. In the context of unilateral projects search costs are defined as "the costs that accrue to the seller and the buyer of CERs as they seek out partners for a mutually beneficial exchange of CERs" (Krey 2003, p.40). They contain costs for the search activity and for the early project documentation. Search costs for unilateral projects are assumed to be low as:

- An Annex B entity, buying CERs via a DPA, may require less project documentation compared to the case where it concludes a forward agreement (ERPA) or directly invests in the project. The reason is, that the buyer does not have to fear that the project will not be registered, implemented or create the expected amount of CERs (see Krey 2003, p. 43). PCF and CERUPT projects, for example, face very high TAC in this respect because they are charged with detailed documentation (project idea note, project concept note (only PCF), letter of endorsement, letter of intent). Moreover the management of CERUPT and PCF has to find viable projects amongst a great number of proposals which creates additional costs.
- With growing maturity and standardisation of the carbon market, the transfer of unilaterally generated CERs toward Annex B countries may be simplified and not lead to major costs (see Krey 2003, p. 42).

Negotiation costs are the costs that arise when local project developers and the Annex B buyer negotiate the purchase agreement for the CERs, or, if an Annex B entity directly invests in a project, the costs that accrue when Annex B investor and local project developers negotiate how they can realise the project together (see Krey 2003, p. 45).
Unilateral projects' negotiation costs are likely to be lower as:

- Concluding a DPA business partners only have to bargain price and quantity of CERs.
- An ERPA would further need stipulations for the case the project fails
- Negotiation costs for projects involving FDI would contain costs for the agreement on project financing, development, construction, sharing of benefits and the detailed obligations of the parties (see Krey 2003, p. 46).

5.2.2 Project cycle TAC

These are costs that accrue from the project cycle activities listed in the table above. They are the same for unilateral projects as well as for other models, because project cycle activities are legally binding for all CDM projects. However project cycle TAC could be lower for the unilateral design if host country project developers have access to local OEs, which are responsible for validation, verification and certification. So far only Annex B entities have applied for becoming a OE. For the future local OEs are likely to emerge in host countries with a high number of CDM project activities and the necessary human and organisational capacity.

5.3 More small-scale projects

With intent to generate a maximum amount of CERs foreign entities mostly prefer to invest in large-scale projects whereas unilateral CDM might encourage the development of smaller ones. In many respects small-scale projects are better suited to contribute towards sustainable development in the host country than large ones. Integrated in a community such projects obviously improve the living conditions and provide access to basic needs like energy supply without having negative externalities (see Tippman and Medina-Gómez 2003, p. 12). More smaller projects instead of a unique large one also enhance a well-balanced geographical distribution of projects inside a country. However, small scale projects face higher specific transaction costs, as, compared with large scale projects, absolute transaction costs do not differ considerably but the amount of generated CERs is much lower[14]. The simplified procedures and modalities for small-scale projects are not able to reduce the absolute transaction costs enough to fully compensate for their disadvantage.

[14] Imagine the design of a small hydro powerplant faced with TAC of $97,000 reducing 240kt of CO_2 over the crediting lifetime. The specific TAC would be $0.41/t$CO_2$. Contrary the design of a biomass power plant faced with TAC of $364,000 reducing 5000kt of CO_2 would result in $0.07/t$CO_2$, which is almost factor 6 below. These are actual Indian examples (see Krey 2003, p. 102).

Project developers of unilateral projects are faced with low transaction costs as explained above. Moreover they usually do not have the financing and investing capacity for capital intensive large projects. Therefore unilateral CDM can better integrate small scale projects.

5.4 Keeping CDM rent in host countries

In unilateral projects CERs and other returns accrue to the host country project owner. Thus the CER rent which is the difference between the market price and the costs for generating CERs is kept by the host country. Outside financing always results in a transfer of at least part of the benefits towards the joint venture partner, like it is the case with bi- or multilateral projects. However, the CER rent will be squeezed by strong competition among sellers. This is currently the case due to a demand shortage[15]. Of course this situation may change in the future.

[15] The demand shortage for CERs mainly results of the cheap supply of Russian hot air, the exit of the United States from the KP and the stringent rules imposed on the CDM by the MA.

6 Disadvantages of unilateral CDM

6.1 Higher Kyoto risk

Like the other flexible Kyoto mechanisms CDM bears the risk of the KP not coming into force. The Russian hesitation shows that this risk is non-negligible. If Kyoto fails, some domestic climate policy instruments such as the EU emissions trading system will still be implemented. It is likely that CERs generated by investors from the countries implementing these instruments can be used while CER import from unilateral projects might not find much support. The voluntary Chicago Climate Exchange trading scheme in the United States, for example, only accepts certain projects from DCs.

6.2 Downward CER price risk for local project developers

Downward price risk can be a significant problem for unilateral developers. While foreign investors facing a domestic GHG constraint will always profit from any deal that is lower than their marginal abatement cost at home, the unilateral seller will face the full brunt of the price decrease. Assume that marginal abatement costs in Germany are 50 €/t CO_2 for a large emitter. This emitter invests in a CDM project at costs of 7 €/t. Even if the price now falls to 3 €/t, the investor still has a cost savings of 43 €/t compared to opportunity costs of 4 €/t if he had invested at the lower price. Contrary for local project developers who want to sell CERs after certification, an unexpected decrease in the CER price may end up in a disaster, especially if the project is not financially viable anymore without the expected CER return and loans can not be repaid. For this reason local project developers are used to conclude ERPAs that set up a fixed price and thus reduce the downward price risk but at the same time prevent that local project developers might benefit from upward price movements. Therefore some more elaborate ERPAs constitute the purchase of a basic amount of CERs at a low price and further include an option to buy additional CERs at a higher price. This limits downward price risk and allows project developers to participate in upward price movements.

6.3 Capacity building costs to be borne by host country

Currently, we see several countries (Canada, Denmark, Japan, Netherlands) providing capacity building[16] to countries from which they want to buy CERs (see Ministry of Foreign Affairs 2002, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) 2003, Bhandari 2003). In a unilateral design the host country would take more responsibility in providing the necessary capacity building and thus be faced with higher costs. This is particularly true for the smaller, less developed countries not seen as attractive CDM suppliers, which results in a lack of capacity building activity by foreign donors. Even those donor programmes that do not explicitly aim at buying CERs concentrate on the potentially large CDM suppliers like

[16] Capacity building refers to activities that aim at increasing skilled personnel and technical and institutional capacity.

India and China (for China see Anon. 2003, for India Bhandari 2003). Only some multilateral donors like the United Nations Development Programme (UNDP) look at smaller host countries.

6.4 Less technology transfer

As there is no FDI provided by developed countries one justifiable criticism of unilateral CDM consists in the assertion of non-existing technology transfer from North to South (Liu 2001). It could be argued that local project developers still have the possibility to buy foreign technology on a global market, but usually most of them cannot provide sufficient capital to purchase foreign technology and do not have the expertise in choosing, adapting and maintaining it. Therefore local project developers are likely to deploy home-grown technology in unilateral projects. Sometimes the use of home-grown technology even is preferred to foreign technology as the host country participants do not want to depend on foreign investors concerning consultance, maintenance of the project, spare parts ect.. In most cases however local project developers are searching for foreign investors. For the unilateral design technology transfer could consist in technical assistance and capacity building activities granted by foreign donors.

6.5 Delay of financial inflows

In the unilateral model the host country project developer has to bear the costs for project preparation and design, transaction costs and costs for marketing the CERs on his own. All these costs arise before the project owner receives any revenues. That means he may need to have access to financial markets to get sufficient additional capital for his CDM project activity. Being the only one in charge of the project, he runs the full financial risk. In case the project fails or does not generate the expected amount of CERs, the local project owner will be into serious financial difficulties.

6.6 Risk of more non-additional projects

Some observers felt that unilateral projects would lead to more non-additional projects as host country investors might try to carry out business as usual projects under the CDM in order to improve the project revenues. It might be questionable, if local project developers are willing to set up a project, that is only economically viable with the expected CER revenues, which cannot be guaranteed before Kyoto has not come into force (see Point Carbon 2003, p. 2). The same arguments however, apply for any investor, also a bilateral one. As the CDM Executive Board is applying a quite tough policy concerning additionality determination and asks for specific additionality tests the risk of non-additional projects is considerably reduced.

7 Requirements for unilateral CDM

The design of unilateral projects offers the possibilities to reduce costs and to increase project returns. On the other side it requires sufficient capacity in the host country. The following section will discuss the requirements of DCs for unilateral CDM.

7.1 Mobilisation of domestic capital

In many DCs, like in several Asian countries, foreign sources, such as foreign bank loans or FDI, finance only a small share of gross capital formation. So it is obvious that a large part of CDM projects will have to be financed by domestic sources. (see Janssen 2002, p. 46).

The mobilisation of domestic capital requires:

- Joint action of financial institutions and establishment of financial standards
- The capability to handle project risks
- The development/use of financing tools, specific to the needs of project participants and to the type of project
- Financial capacity building for local developers and financing institutions

7.1.1 Joint action of financial institutions and establishment of financial standards

In several DCs, the awareness of the CDM among financial institutions is growing, but a general practice and a concerted action for financing projects does not exist. For the case of India, financial institutions discuss to standardise the risk assessment procedures. Such standards would allow possible investors to rate and rank CDM projects and thus dismantle local investment barriers (see Deodhar et al. 2003, p. 22).

7.1.2 Project risk management capability

As outlined before CDM projects are subject to a variety of conventional and unconventional project risks, that have to be borne entirely by the host country participants in a pure unilateral design. In order to mobilise the necessary capital it is of great importance for local project developers to be able to handle the associated risks. A successful risk mitigation strategy could contain the following components:

- Portfolio risk diversification

Investing in a portfolio of locally developed projects reduces overall investment risks. If possible, the diversification should be “along the sectors and sources (energy, industrial processes, agriculture, sinks and waste)” and “the technology (energy-efficiency improvement, fuel switching, decarbonisation, CO_2 storage and sequestration and switching to renewable energy)” (Deodhar et al. 2003, p.14). A diversification along host countries at first glance would not be possible in a unilateral design. However, CDM project developers in DCs could also invest in unilateral projects in other DCs, a possibility that has been

mentioned in some debates in Korea. Finding a term for this type of projects is a challenge, maybe “bilateral developing country CDM project”.

- Insurance

The insurance of a CDM project against different risk components is a suitable strategy of risk mitigation. According to Janssen (2001) the risk components that can be covered by insurance are baseline emission risk and conventional technological and equipment failure risks. However, insurance providers are not active in many of the less developed countries, so that many developers of unilateral projects are likely to face a disadvantage compared to large multinational investors with a big project portfolio.

- “Late” ERPAs

So far ERPAs have been concluded at a very early stage of project preparation mainly respecting buyers requirements. Through the early negotiations Annex B entities have been involved in the design of locally developed projects to a great extent, so that projects under such a structure cannot be called unilateral anymore. For the future it seems possible, that ERPAs are signed at a later point of time, after the project has been registered. The conclusion of an ERPA after registration would still reduce the price risk and the Kyoto risk but also guarantee a greater independence for the host country participants and thus eventually allow for contractual conditions that respect well the needs of the host country participants.

- Competent local project developers

Local project developers, that are not well informed about the CDM, run a higher risk of baseline methodology or PDD rejection by the validator or the Executive Board compared to bilateral investors with high-quality consultants. So far host country project developers have done a good job as their submissions to the CDM Executive Board were not generally worse than those of bilateral investors.

7.1.3 Financing instruments

In many DCs capital markets are underdeveloped and do not provide alternative financial instruments (see Janssen 2002, p.20). In order to get local investors and lenders on the CDM track, financing tools, which suit best for financing locally developed CDM projects, have to be established.

Examples for project specific financing options for unilateral CDM are:

- Host country CDM funds

According to the model of carbon funds in the industrialised countries, private and public sector entities in a host country could establish a national CDM fund, which provides soft loans to local project developers or directly invests in the equity of a project (equity versus debt fund). In return the fund members would receive a portion of the CERs (see Gonzales

2001, p.45). Providing loans or equity to several projects would ensure financial risk diversification.

- CDM bonds

After a due diligence and risk assessment of a portfolio of CDM projects in a host country financial institutions might develop and float specific CDM project bonds and sell them on the capital market (see Deodhar et al. 2003, p. 21). The bonds would be secured by the projects' assets. The funds that are mobilised through the sale of the bonds would be used to finance the projects. The interest coupons of the bonds could consist of CERs. The purchase of CDM bonds with such CER units would be an interesting investment option for all entities that face an emission cap in their home country and are allowed to use CERs for compliance.

7.1.4 Financial capacity building for local developers and financing institutions

Unilateral project design requires the establishment of financial standards, an effective risk management and the awareness of different financing options. Otherwise host country investors and lenders will not recognise the CDM as a lucrative activity field and the scarce resources of DC economies will not be mobilised. In order to attain these goals, financial capacity building activities should target domestic financial institutions and project developers and contain the following activities:

- Improving the general understanding of the CDM process as a whole
- Establishing risk rating practices on the national level
- Building the expertise on risk mitigation options
- Building the expertise on different financing options and CDM specific insurance products

7.2 Minimum human, infrastructure and institutional capacities

Besides the availability of domestic capital, CDM projects developed and designed in the host country require a minimum of human, infrastructure and institutional capacities whereas bilateral projects can be "parachuted" into a country to some extent. Most of the projects are in need of highly qualified manpower like engineers and financial experts and basic infrastructure like transport ways or connection to a power grid. Furthermore host country project development needs an adequate institutional framework motivating national stakeholders to take action on their projects. This requires that existing structures dealing with climate change policy are linked in a functioning network and that local project developers are willing to work together with these institutions including the host country government (see Capacity for Sustainable Development 2003, p. 2).

The most critical institutional requirement for the design of unilateral projects is the establishment of a proactive DNA. "Proactive" means that the function of a DNA is not only restricted to the approval of projects but includes additional tasks, such as providing technical

and financial expertise, organising capacity building activities for project participants and marketing generated CERs. Good examples of proactive DNAs can be found in Latin America (see Figueres and Olivas 2002, p. 33-51). However the promotional role of a DNA has to be seen as separate. Its principal duty always consists in assessing whether a project contributes to national sustainable development.

7.3 Project experience

Countries that want to implement unilateral CDM can greatly benefit from experiences gained in former project activities in the area of climate change. In countries with on-going bi- and multilateral CDM projects, for example, local entities become familiar with the mechanism and the problems it involves. After they have learnt from foreign investors how to finance and to realise a project local developers might want to start their own activity. Contrary, in countries having little experience with climate change projects it will be much harder for local developers to carry out a viable project activity. Therefore the providers of capacity building should increasingly address countries, which have so far not been in the focus of foreign project developers.

8 Measuring the potential of unilateral CDM

In the preceding sections unilateral CDM has been theoretically described, the chances and pitfalls as well as the requirements to carry out unilateral projects have been highlighted. However, it is an open question if there is sufficient potential among DCs to carry out CDM projects on their own. In order to solve this question the following section will develop a methodology to estimate the potential of unilateral CDM in a DC, which will be applied to some DCs.

8.1 Methodology

The methodology shall facilitate a comparison among host countries. At first empirical indicators are selected in order to quantify a country's potential of unilateral CDM. Secondly the data are collected for several countries. As a next step, for most of the indicators the collected data are converted to a continuous scale (1 to 10) in order to facilitate a comparison among countries. Finally the findings will be demonstrated by the use of some case studies. It must be emphasised, that this approach is a first attempt in order to measure the potential of unilateral CDM. It is not free of subjective assumptions. Particularly the selection of suitable indicators and the scaling of the collected data has been difficult.

8.1.1 Selection of empirical indicators

By the use of empirical indicators a country's unilateral CDM potential shall be quantified. It is obvious that such indicators cannot be selected arbitrarily. Most importantly an indicator has to provide information about the potential of unilateral CDM. As already outlined before this potential depends on various variables like availability of domestic capital or human capacity. Therefore our indicators cover all the different fields that are important for estimating the potential of unilateral CDM (diversification). For this approach indicators have been selected out of the following categories: Awareness of climate change, availability of domestic capital, human capacity, project experience, creditworthiness of host country. Moreover it has to be assured that data are available and that they are up-to-date. Finally one has to think about the appropriate number of indicators. The more indicators are selected, the more aspects can be taken into account and the more differentiated the analysis will be. However complexity has to be kept within a limit. We have finally chosen 10 indicators.

Unfortunately the selection of empirical indicators involves some problems which cannot easily be solved. The explanatory force of indicators is restricted as only measurable values can be recorded. Sometimes one indicator has to be used in combination with other indicators in order to derive a reliable statement. The application of indicators to countries of different size and with different geographical and cultural background could also lead to questionable results. Therefore we have used relative and absolute indicators.

The following indicators have been chosen:

Table 4: Selection of empirical indicators

Category	Indicator
Awareness of climate change	Kyoto Ratification (yes or no)
	DNA operating (yes or no)
Availability of domestic capital	Gross fixed capital formation (current US$)
	Gross fixed capital formation (% of GDP)
	Domestic Credit to private Sector (% of GDP)
Human capacity	Scientists and technicians in research and development (per million people)
	Number of nominated UNFCCC experts
Project experience	Number of realised AIJ projects
	Number of CDM projects baseline study and PDD
Creditworthiness of host country	Institutional Investor Credit Rating

Both the **Ratification of the KP** and the establishment of a DNA are legal requirements for participating in the CDM. However, several countries have started to develop projects without having a DNA. As many project developers see the CDM as a bottom-up approach they believe that once projects are being designed the government will put a DNA into operation.
Kyoto ratification and **DNA operation** indicate whether the government of a DC is willing to take action against climate change respectively whether it has already implemented the CDM by establishing a DNA.
With regard to economic requirements it seems most important that a DC is able to make investments and to finance projects and on its own. **Gross fixed capital formation** (also gross domestic fixed investment) indicates whether a host country is able to invest in capital intensive projects. It includes plant, machinery, and equipment purchases, land improvements (fences, ditches, drains, and so on), the construction of transport infrastructure, the construction of private, commercial, industrial and public buildings (see World Development Indicators (WDI) 2003). Here it is important to look at both the absolute value **(current US$)** and the specific value **(% of GDP)**. If a country, for example, has huge absolute investments because of its huge population but the investments represent only a very small share of GDP it is likely that those investments are just influent for basic infrastructure needs and hardly for CDM projects. On the other hand if investments represent a great share of GDP but are relatively small in absolute terms (below one billion $ annually in many DCs) it is clear that at least large scale CDM projects (which can for example reach a capitalisation of several 100 million $ in the energy sector) are not part of the national investment portfolio. Thus the two indicators have to be used in combination with each other. A high investment potential demands both high absolute and specific values. It has to be added that gross capital

formation does not exclude FDI. As a unilateral project was defined by the exclusion of FDI it would have been logical at first glance to deduct FDI from gross capital formation. However a country with a lot of FDI would profit from bilateral technology transfer and as a next step could deploy the new technology in unilateral projects. Therefore FDI may be considered by measuring the potential of unilateral CDM.

Most of the investments for unilateral CDM projects are undertaken by the private sector. Thus unilateral CDM can only be successful if the private sector has access to project finance on the domestic capital market. In DCs the funds are raised rather by borrowing (debt finance) than by share issue (equity finance). Therefore the **domestic credit to private sector ratio (as percentage of GDP)** indicates well whether the private sector in a DC is able to acquire the necessary financing. Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment (see WDI 2003).

In order to carry out CDM projects independently, an economy needs well trained manpower. The **number of scientists and engineers in research and development per million people** can be used as a measure for the human resources of a country. More specifically, the **number of nominated experts in the UNFCCC roster** is a measure for the human capacity of a country on climate change issues. Experts are nominated for the domains of technology and technology transfer, methodological issues and in-depth review of National Communications (i.e. GHG inventories). These three rosters build the unified UNFCCC roster of experts (see UNFCCC 2003c). The number of UNFCCC experts is given in absolute terms because it is very low, indeed zero for many countries.

The project experience a country has already gained through GHG emission abatement projects is measured by the **number of realised AIJ projects** and by the **number of CDM projects with available baseline study and PDD**. AIJ activities have been carried out since 1995 through partnerships between an investor from an Annex I country and a counterpart in a host country. and represent a pilot phase for CDM and JI. The purpose was to test the challenges involved in implementing joint projects and to foster technology and know-how transfers albeit without crediting emissions reductions (see Michaelowa et Koch 2001, p. 7). In our days the first real CDM projects are being developed which have to follow the rules outlined in the MA. It is obvious that countries which have already successfully implemented AIJ projects or which are preparing to host CDM activities are more likely to be able to carry out a CDM project all by themselves.

Finally we look at the creditworthiness of a country which is measured by the **Institutional Investor Country Credit Rating**, based on information provided by leading international banks. The creditworthiness of countries is rated on a scale of 0 to 100 (highest risk to lowest) and ratings are updated every six months (see WDI 2003). This indicator does not really measure the potential of a country to carry out projects unilaterally. It rather indicates whether a country is able to attract foreign investors. A high risk country with a low index value might not be able to get any FDI and therefore be restricted to the unilateral option, whereas a low

risk country with a high scale value might attract foreign companies that invest in CDM projects. For the latter countries unilateral CDM could play a minor role.

8.1.2 Collection of data

Data have been collected for DCs from four regions: Asia and Pacific, Latin America and Caribbean, Sub-Saharan Africa, North Africa and Middle East. In order to limit the number of countries for this analysis, only those countries have been selected that **overcome a threshold of one billion $ of gross fixed capital formation**. Furthermore the city states Hong Kong and Singapore have not been included as they were thought not to be representative for Non-Annex I countries. Overall data for 61 DCs have been collected. The main source has been the World Bank's World Development Indicators 2003, which represents a structured compilation of data from different sources, and the UNFCCC web site which provides actual information on climate change issues and the Kyoto mechanisms.
Appendix B shows the data for the respective countries and indicators as well as the data source and the date of data collection for each indicator.

8.1.3 Scaling of data

For each indicator, except for Kyoto ratification and DNA operation, the data have been converted using a continuous scale from 1 to 10. This operation makes it possible to make up concise indicator profiles[17] which facilitates the comparison among countries a lot.
As the scaling of the data is based on threshold values chosen by the authors it is very important that it is comprehensible and transparent. It works as follows:

- The indicator scale is defined using a maximum and a minimum value, which indicate, from the authors' point of view, a high, respectively a low potential of unilateral CDM. Average indicator values for high, middle and low income countries, the highest and lowest values within the selected countries and the average value of all selected countries are used to define the maxima and minima. In case the average values for high, middle and low income countries have not been available other orientation values have been considered. However the determination of the maximum/minimum values does not rely on a specific calculation rule and has to be justified for each single indicator. As the determination of these threshold values represents an important and critical step in the analysis it will be addressed in a separate section.
- The maximum value equals index value 10, the minimum value index value 1. Below the minimum value the index is 0.
- The scaling has to point out the differences in the values among countries in a an adequate manner. Therefore it has to be decided for each indicator on whether the scale shall be proportional, logarithmic or based on another scaling scheme. For this analysis the scaling scheme for all indicators is directly proportional.

[17] Such indicator profiles will be used for the case studies.

- The scaling of all relevant data, the determination of maximum/minimum values and the average indicator values are documented in Appendix B.

Usually indicators are of different importance and therefore have to be weighted differently (for example by the multiplication with a weighting factor). In this study the indicators have not been weighted because it was believed to be too subjective to weight indicators of a very different nature (different categories, absolute and specific indicators). This implies that the single scale index values should not be added up to an aggregate potential of unilateral CDM. Instead only comparisons between single indicators may be drawn. For example the scale index value for domestic credit to private sector is 3 for one country and 7 for another country. Thus the latter country is by far better able to provide credits to its private sector. Moreover, the index for nominated UNFCCC experts amounts to 8 for the first country and to 2 for the second, which means the first country has much more experts. In any case the values may not be added up (9 respectively 11) because domestic credit and the number of experts might be of different importance with respect to the overall potential of unilateral CDM.

The scaling represents a transformation of the original data into index values which facilitates to draw comparisons between countries with regard to single indicators. It cannot be used to form a basis of an objective evaluation in order assess the aggregate potential of unilateral CDM. Nevertheless it allows at least for some assessment of the aggregate potential of unilateral CDM:

- If a country has high scale values (approaching 10) for all indicators, it is likely to have a high aggregate potential to carry out unilateral projects. A country with a low scale value for every single one indicator is likely not to be suited for the unilateral CDM design.
- As the indicators cover different categories which are all important for the design of unilateral projects we feel it is important, that **all** indicators reach a preferably high index value. It would be no use if for example a country attained high values for economic indicators while it completely lacked the awareness of climate change, project experience and the needed human capital, expressed by low index values. On the other side a country that consistently attains medium index values for all indicators, shows that it has some basic potential in all for unilateral CDM relevant fields and thus might better cope with its multifaceted requirements.

8.1.4 The determination of threshold values

We now discuss the choice of thresholds for each indicator. In the case of **Gross fixed capital formation (current US $)** the maximum value was chosen at 50 billion $ which is situated between the average values for middle and high income countries. The minimum value of 5 billion $ is average for low income countries. Thus a proportional scale index with steps of 5 billion $ can be used. This scaling represents a kind of compromise as some densely populated, large countries like China or India by far exceed the maximum value of 50 billion

$ while many small countries have investments of only about 1 billion $ or even less. The majority of the countries that are subject to this study however ranges between 5 and 50 billion $.

Maximum and minimum values for the specific **Gross fixed capital formation as percentage of GDP** conform to the highest and lowest value that could be found within the selected countries, which is 42 respectively 9% of GDP. Defining 10% as a minimum value and 37% as a maximum value allows for a proportional scaling with steps of 3%.

The values of the **domestic credit for private sector** vary between 2 and 149% of GDP within the selected countries. The average value of all selected countries is 38% which is situated between the average value for middle income and low income countries. It seemed to be reasonable to apply a proportional scaling with a maximum value of 95 and a minimum value of 5% which implies steps of 10% of GDP for each index point.

The **number of scientists and engineers in research and development per million people** varies between 24 and 2799 within the selected countries. The average value for middle income countries is 778. For this indicator we set the maximum at 1500 and the minimum at 150 so that 750 is considered to be a medium value. One index point equals 150 persons.

The **total number of nominated UNFCCC experts** lies between 0 and 58 within the selected countries. However only three countries have more than 20 nominated UNFCCC experts and the average value of all selected countries is 5 so that the maximum value was set at 20, the minimum value at 2. The scaling is once again proportional and involves steps of 2 UNFCCC experts.

The **number of AIJ** as well as of actual **CDM projects with existing baseline study and PDD** is very low or even equals zero in the majority of countries. There are only 3 countries where the number of AIJ projects exceeds 4. The same is true for CDM projects. Therefore for both indicators 4 has been chosen as maximum value. One project equals 2 index points.

The original **Institutional investor country credit rating** index ranges from 0 to 100. The lower a country's original index value, the worse its investment climate and the more it relies on unilateral CDM. Therefore for this indicator a scale index has been applied which is inverse compared with the original Institutional investor index. Scale index value 10, indicating a high dependency on unilateral CDM, refers to 16 Institutional Investor rating points, which is in the range of the average value for low income countries (18). Scale index value 1, indicating that a country has good chances to attract foreign investors for bi- and multilateral CDM projects, refers to 70 Institutional investor rating points which is slightly below the highest rating within the selected countries (79.2). One index point equals 6 Institutional investor rating points.

8.2 Data evaluation

Having explained the procedure in assessing a country's potential of unilateral CDM we now present the empirical results. At first a distinction is drawn between the four groups of DCs that have been subject to this analysis belonging to the regions of **Asia and Pacific, Latin**

America and Caribbean, North Africa and Middle East, Sub-Saharan Africa. Subsequently of each of the four regions one country is taken out as a case study. For the case studies index values for the indicator profiles are derived.

8.2.1 Regional differences in the potential of unilateral CDM

A look at the data demonstrates that the indicator values and thus the potential to carry out unilateral projects strongly differ among the selected DCs.
As the countries have been categorised by four regions it is useful to examine whether there are regional differences before analysing the potential of single countries.

Regarding the figures it is striking that the awareness of climate change within the four groups differs strongly. Almost all selected Latin American countries have ratified the KP and most of them have already established a DNA. Also many of the selected Asian countries have ratified and put a DNA into operation. On the other side the Sub-Saharan countries show deficits in this respect. Though several of them have ratified Kyoto there is only one among the selected countries that has an operating DNA, namely Mauritius. Accordingly in this region the CDM will not be successfully implemented before the countries have taken more action in taking the legal and institutional foundations. An interesting situation exists in the oil exporting states of North Africa and the Middle East. Most of these countries have not ratified Kyoto. Nevertheless some countries that have not ratified (Yemen, Syria, Egypt, Lebanon) have already established a DNA. Once the first CDM projects being developed in these countries are ready for registration by the Executive Board the governments will be under high pressure to ratify the Protocol.
Equally striking are the differences in project experience. Once again the Latin American and Caribbean countries are leading, which is not surprising considering that AIJ projects and the first CDM projects have only been developed in the countries that ratified Kyoto. Though this region is hosting 36 AIJ projects and 31 CDM projects the projects are concentrated in a few countries such as Brazil, Costa Rica, Mexico or Chile. There are some countries with no project experience at all like Peru, Paraguay or Uruguay. Hosting 13 AIJ projects and currently 19 CDM projects Asia has already gained substantial experience with projects. Similar to the Latin American case the projects are not equally distributed among the countries. At present China, India and Indonesia host most of the projects. The regions of North Africa and Middle East, actually hosting 2 AIJ and 1 CDM projects within the selected countries and Sub-Saharan Africa, hosting 6 AIJ and 4 CDM projects hardly have any experience with projects. Some countries of the former region at least could be expected to develop more CDM projects in the future as the DNAs have been established. Among the Sub-Saharan countries it is South Africa, Mauritius and Uganda that are hosting projects, among the North African and Middle East countries it is Egypt, Morocco and Jordan.
With respect to the availability of domestic capital the regional differences are not as great as with the awareness of climate change and with project experience. In each region countries

with high absolute and specific investments and good access to domestic project finance as well as countries with bad investing and financing options can be found. However, the highest absolute gross fixed investments are found in Asian countries (China, South Korea, and India) as these countries are highly populated. Considering that in some of these countries like China or South Korea the gross fixed investments also reach a high specific value (38% of GDP in China, 27% in South Korea) and that even the credit to private sector ratio exceeds 100% of GDP (127% for China, 108%) it becomes evident, that the Asian newly industrialised countries have the best potential to finance and invest in local CDM projects. Also several states of Northern Africa and the Middle East can finance and invest in own CDM projects. The Republic of Iran has the best absolute and specific values for gross fixed investment (around 35 billion $ equalling 30% of GDP) within this group. The best value for domestic credit for private sector is found in Lebanon (91%). The situation in Latin America strongly differs from country to country. There are some large states with high absolute gross fixed investment like Brazil and Mexico (both around 100 billion $) that have ordinary specific investment values (around 20% of GDP) which might well be able to invest in projects. The same is true for a few small states with low absolute investment but high specific values like Jamaica and Panama (30 respectively 26 % of GDP). Jamaica is also the country with the highest domestic credit to private sector ratio within this group (126% of GDP). Compared with Asia and North Africa and Middle East the average values for specific gross investment and domestic credit are lower. The group of Sub-Saharan countries again ranks on the last place among the four groups in this category. Particularly the absolute investments and the credit to private sector ratio are very low almost among all selected countries. The exceptions are South Africa and Mauritius. South Africa has the highest absolute investments (17 billion $) and the highest ratio of domestic credit to private sector (149% of GDP!) within this group. In Mauritius, a very small country, absolute investments still exceed 1 billion $ equalling 23% of GDP, which is above-average and the domestic credit is 63% of GDP, the second best value after South Africa.

The highest human capacity regarding scientists and engineers in research and development and nominated UNFCCC experts can be found in Asia. Apart form South Korea the former Soviet countries Azerbaijan and Uzbekistan host the most engineers and scientists per million people. This is due to the well developed educational system of the former Soviet Union. It is questionable whether theses countries can maintain such a high standard in the future. Regarding the absolute number of nominated UNFCCC experts China has taken the lead with 58 experts followed by Thailand with 15 and Indonesia with 13. In specific terms however the picture would change in favour of the less populated countries.

Some of the North African and Middle East countries also show considerable human capacity. While Jordan impresses with almost 2000 scientists and engineers per million people the Iran and Lebanon have nominated a high number of UNFCCC experts (23 respectively 10). In those Latin American countries, for which data have been available, the number of scientists and engineers is generally situated in the range of 100 to 500 per million people. There are some countries with a considerable number of UNFCCC experts like Brazil, Chile and

Uruguay (35, 14 and 13). Other countries within this group, though having ratified Kyoto, have not nominated any UNFCCC expert yet. For the Sub-Saharan countries the availability of data concerning scientists and engineers in research and development has been insufficient. Data were only available for South Africa, Mauritius and Uganda (992, 360 and 24 per million people). Compared with the other groups the number of nominated UNFCCC experts among these countries is very low. The highest value is found in Ethiopia with 8 experts.

Finally looking at the perceived country risk of the selected countries within the four regions indicated by the Institutional investor credit rating it becomes evident that the risk perception strongly varies from country to country due to different political, economic and financial situation. While several states in Asia, North Africa and the Middle East and Latin America reach acceptable values exceeding 50 Institutional investor points, almost all Sub-Saharan countries are represented with very low values below 30 points except for Botswana, South Africa and Mauritius (62.2; 54.6; 53.9).

This means that the Sub-Saharan countries are at a double disadvantage by taking part in the CDM. Firstly most of these countries will not be able to attract foreign investors for CDM projects in a bi- or multilateral design because of the high perceived country risk. Secondly they might not be able to carry out unilateral projects because they have (according to this study) insufficient potential in nearly all relevant fields.

To summarise the regional differences among the four groups of countries we find that several countries in Asia and Latin America are most likely to be able to carry out unilateral CDM projects. Asian countries particularly take the lead in human capacity and investment in new capital. Latin American countries have been the first to ratify Kyoto and to put up DNAs. So far they have gained considerable project experience. Although several countries in North Africa and the Middle East have enough domestic and skilled manpower, most of them seem not to be very ambitious to implement the CDM.

In case of the oil exporting countries this reluctance is certainly related to the concern not to foster the substitution of fossil fuels through the implementation of the CDM. However it is not likely that the CDM is really going to affect the demand for crude oil. Thus the oil exporting countries could embark on a double tracked strategy: Promoting oil products on the one hand and implementing measures to reduce GHG emissions under the CDM on the other hand. One example for the combination of oil production and CDM could consist in capturing and using associated gases that arise from oil production instead of flaring them. Most of the Sub-Saharan countries score low in all indicator categories. If CDM shall take off in these countries enormous efforts have to be made by local stakeholders and foreign donors. As foreign investors might shun many Sub-Saharan countries due to the high perceived risks, unilateral CDM might remain as the only option.

8.2.2 Case studies

Having discussed the regional differences we now choose one country out of each region and assess the potential of unilateral CDM for these countries on the basis of the collected indicator values. The use of indicator profiles will facilitate the comparing between countries.

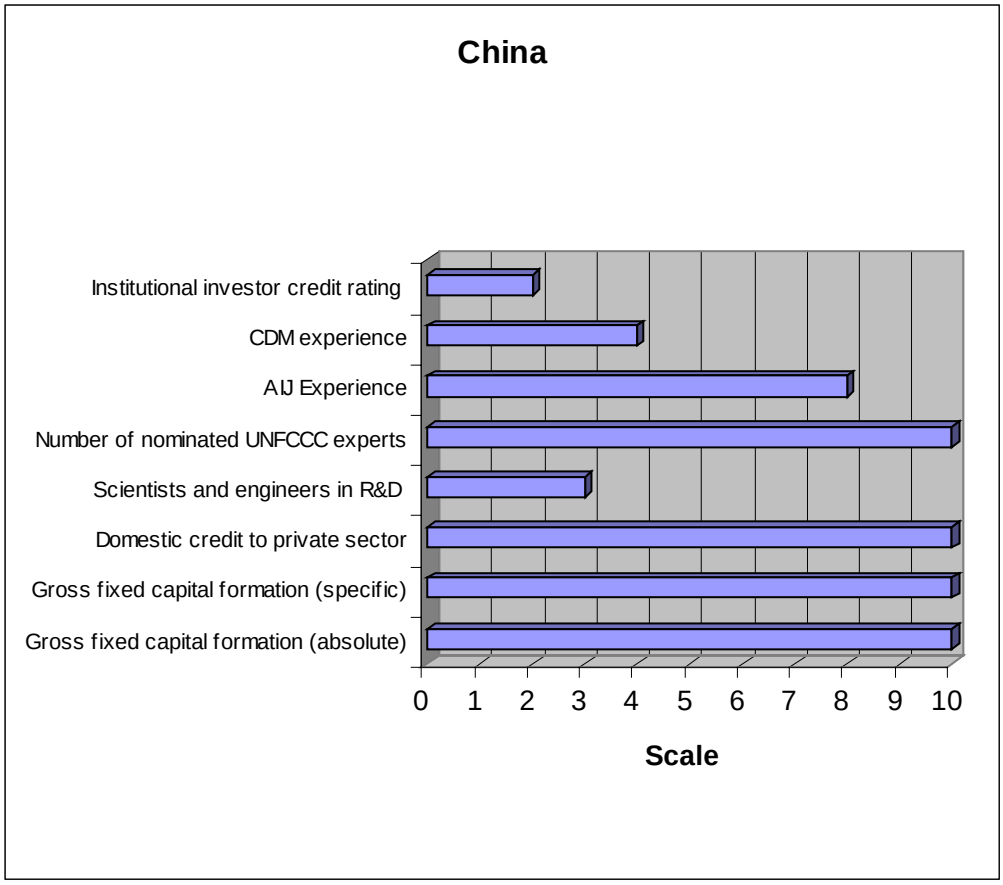
- **China**

China is today the most populous country on earth and one of the largest economies. Its massive economic progress is attributable to the consistent economic restructuring and reforming process over the last two decades.

China's energy use relies heavily on coal. Thus the CDM options for China primarily consist in the substitution of coal by other less carbon intensive fuels, in increasing energy efficiency and in introducing renewable energies. China is believed to host a great share of future CDM projects (see Jotzo and Michaelowa 2002, p. 187), but so far China has not put a DNA into operation which is a requirement for the registration for a CDM project by the Executive Board.

China's indicator profile looks as follows:

Figure 9: Indicator profile – China



As it can be seen from the figures, China reaches high levels for many of the indicators. It is particularly characterised by high absolute and specific gross investment (444 billion $

equalling 38% of GDP) and a high credit to private sector ratio (127% of GDP). China has also nominated the most UNFCCC experts among all DCs (58). However, the number of scientists and engineers in research and development per million people (545) is not outstanding but still higher than in many other DCs. China has already gained some project experience (4 AIJ projects and 2 CDM projects, for which a PDD has been made public).
Other countries like Brazil and India have been more active in designing CDM projects. Therefore it is very likely that at least for the short run China is not going to be the market leader for the CDM as it was believed by many observers for a long time. As China is able to attract many foreign investors (institutional investor credit rating of 59.9) unilateral CDM represents only one possible option to implement the CDM in this country. Bi- and multilateral projects might play a bigger role. We conclude that China has a high potential to carry out CDM projects autonomously because it shows substantial potential in all relevant categories and even excellent potential in four categories.

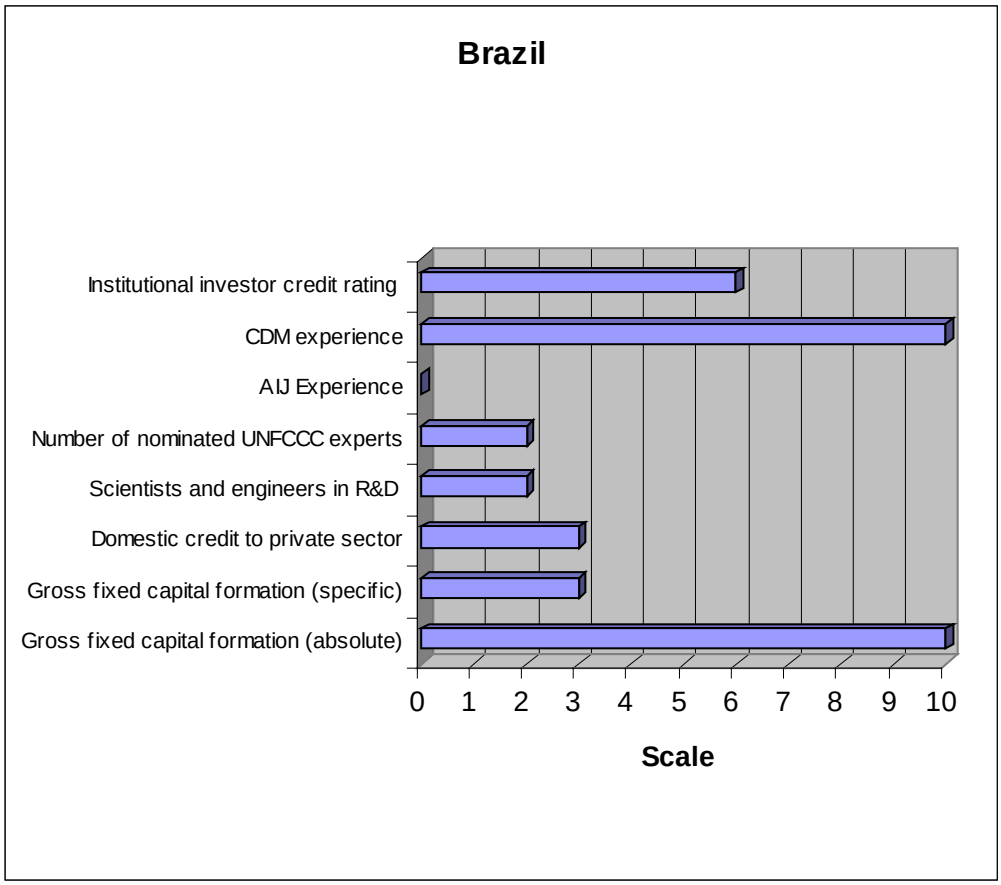
- **Brazil**

Brazil is South-America's largest country. The economic development in the past was hampered by high inflation and foreign debt. Economic reforms during the 1990s like the opening of its markets and privatisation were able to stabilise the country's finances.
The main potential for CDM projects in Brazil can be found in the forestry sector. Especially plantations seem to be a suitable measure for carbon sequestration. There is a huge supply of unused or only extensively used land. In the energy sector CDM options are scarce as hydro power is the main source of energy (see Jotzo and Michaelowa 2002, p. 187). Thus e.g. fuel substitution projects like in China where coal power plants can be substituted by natural gas-fired ones are not possible on a large scale in Brazil. At least there is some CDM potential in the energy sector consisting in the application of co-generation and renewable energies (see Austin and Faeth 2000, p. 7). Like many of the Latin American countries Brazil has ratified Kyoto and established a DNA.

Concerning the potential of unilateral CDM it can be seen from the indicator profile that being a large country Brazil has high absolute but only average specific gross investment (98 billion $, 19% of GDP). The lower specific gross investment can be ascribed to the high debt service Brazil has to bear (11% of Gross National Income in 2001) (see WDI 2003). However it can be assumed that Brazil has sufficient potential to invest in CDM projects taking into account that forestry projects do eventually not require as much capital as investments in the energy sector. The domestic credit to private sector ratio (35% of GDP) is slightly better than the average value for low income countries (24% of GDP). With 323 scientists and engineers per million people and 6 nominated UNFCCC experts there is some human capacity to design own projects. Brazil's big advantage over other countries is project experience. Though Brazil did not host any projects during the AIJ phase, there are now already 10 CDM projects that have reached an advanced stage of preparation. This is rank two after India with 11 advanced CDM projects. The Institutional investor credit rating of 37.1 points indicates that Brazil is

perceived as a quite “risky” country among foreign investors. Thus unilateral CDM could play a bigger role than it is supposed to play in the first case study China. It could be stated that Brazil has sufficient potential of unilateral CDM, as it achieves medium scores in all relevant categories. The establishment of a DNA and the initiated project activities show that there is high awareness and fast growing experience with the CDM, which is very important for unilateral project design.

Figure 10: Indicator profile - Brazil



- **South Africa**

The middle income country South Africa disposes of well developed financial, legal, communications, energy, and transport sectors. However the economy faces a high unemployment rate, high crime and AIDS infection rates and problems that remain from the apartheid area.

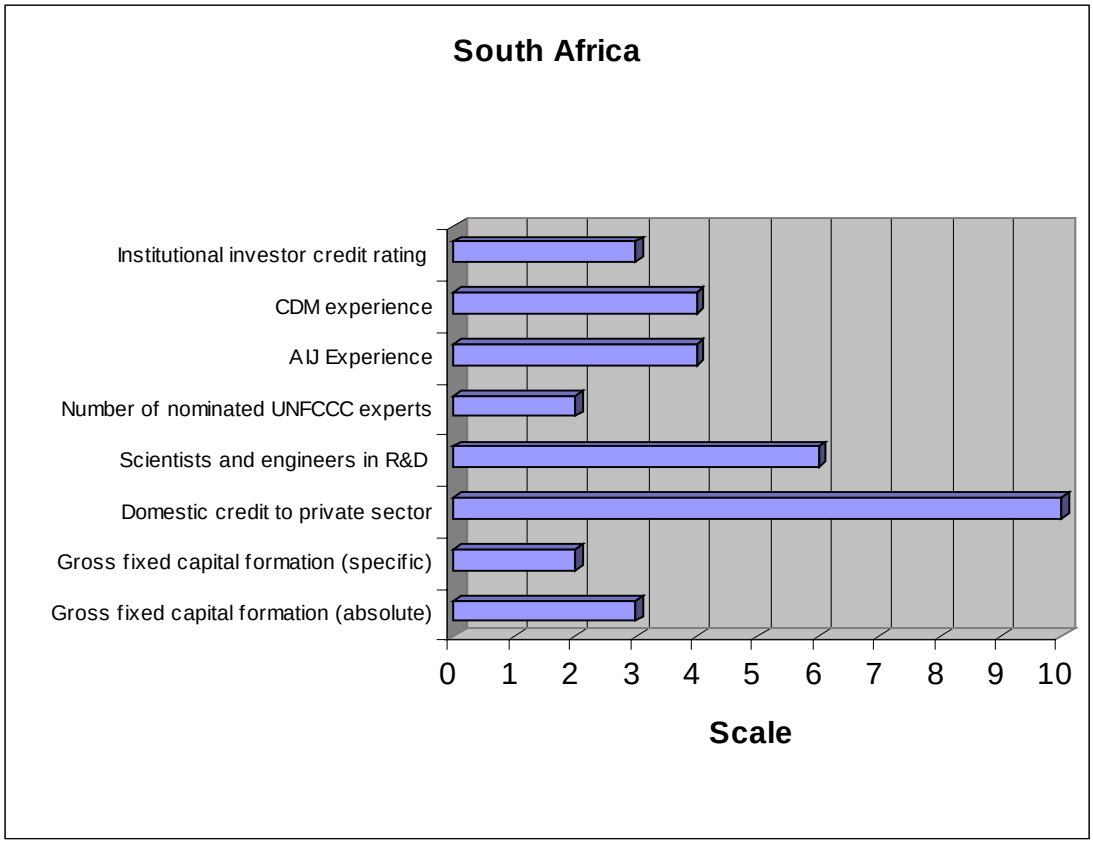
There is a wide range of options for CDM projects in South Africa in the energy sector, transport, coal mining, industry and agriculture. The first projects are being developed in the energy sector for example in the recovery and use of landfill gas, energy efficiency measures, the use of clean coal technologies and of renewable energies (see World Bank 2002, p. 196ff). Having ratified Kyoto South Africa still needs to set up its DNA.

The absolute gross fixed capital formation in South Africa was about 18 billion $ in 2001 equalling 15% of GDP. This is a very high value compared with all other selected Sub-

Saharan countries. The average value for this group was only about 3 billion $. Due to the very well developed financial sector in South Africa, private entities are able to get bank loans from the domestic financial institutions. With 149% of GDP the domestic credit to private sector ratio even exceeds the average value for high income countries (137%). Thus there should be substantial potential to finance and invest in CDM projects within the private sector.

This thesis is proved by looking at the actual development. Though there are only 2 CDM projects listed with available PDD, which is the best value for Sub-Saharan Africa, there are several other CDM projects being developed at the moment, and most importantly all of these projects are developed locally, which means that no foreign investor has been involved in these projects so far. Taking also the 2 AIJ projects into account that have been carried out South Africa has gained sufficient project experience to carry out CDM projects autonomously. 992 scientists and engineers per million people and 5 nominated UNFCCC experts indicate a considerable human capacity for unilateral CDM. Because of the high Institutional investor credit rating (54.6 points) it is likely that South Africa will not have to rely on the unilateral design but might also attract foreign investment through the CDM in the future. South Africa has potential in all categories relevant for unilateral CDM. Unilateral CDM in this country particularly benefits from good financing options for private companies and a high share of scientists and engineers.

Figure 11: Indicator profile – South Africa



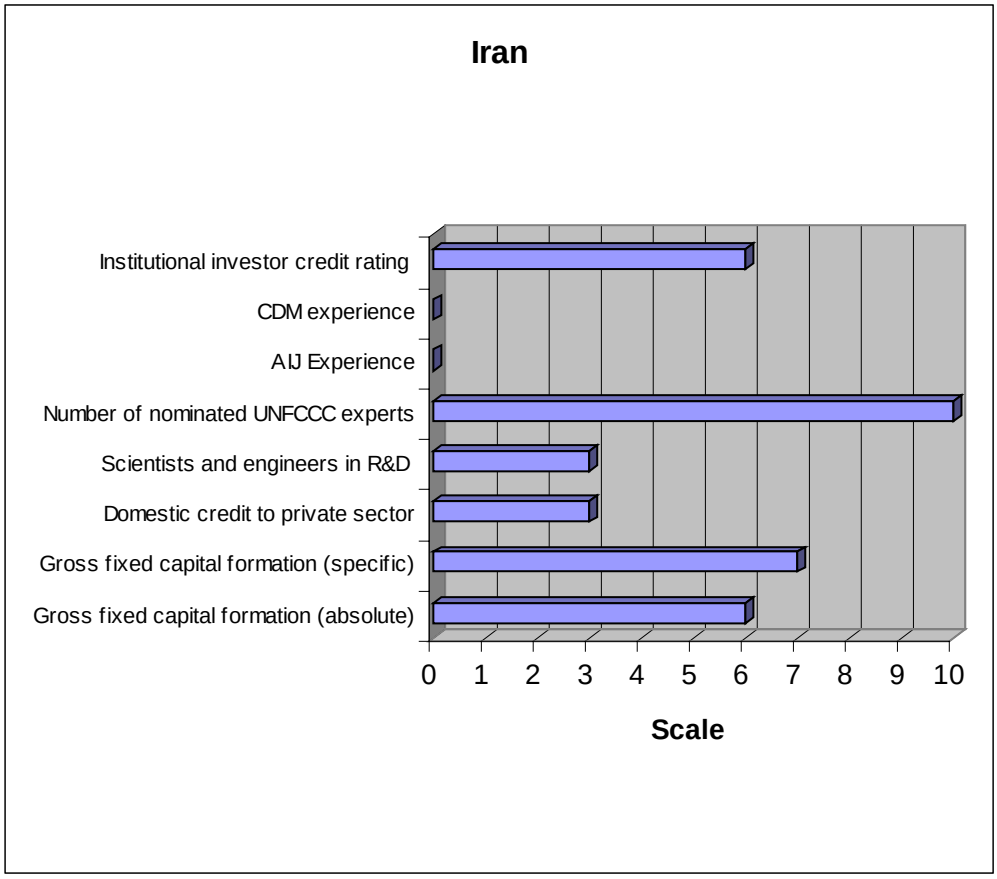
- **Iran**

Iran's economy is mainly driven by oil exports to other countries and little progress has been made to diversify the economy. Though being a rich country with huge foreign exchange reserves Iran faces structural problems like high unemployment and inflation.

With regard to climate policy Iran shows two faces. On the one hand the political awareness of climate change and of the CDM seems to be low like in almost all oil exporting countries as Iran has neither ratified Kyoto nor established a DNA. On the other side there are many Iran scientists dealing with climate change and lately some of them have - which is exceptional among the Middle East countries - conducted an assessment study of Iran's CDM potential (see Soltanieh 2003). According to this study there is a high potential to reduce GHG emissions in the energy sector (solar and wind energy, geothermal plants, hydro power, energy efficiency measures), the industrial sector (recovery and use of associated gases from oil production, fuel switch) and forestry sector (stopping desertification through reforestation and afforestation activities).

Though there are many possibilities for CDM activities it is questionable if Iran (after having ratified the Protocol and established a DNA) would be able to carry out projects without foreign support. Without any doubt Iran has the potential to invest in CDM projects which is indicated by high absolute and specific values for gross fixed capital formation (35 billion $ equalling 30% of GDP). However the private sector is underrepresented in the economy and the few big companies are linked to the oil business. Thus the highest potential to invest in capital intensive assets lies with those who might want to maintain and strengthen the oil-based economy and who might have little incentive to promote the CDM, namely government and oil companies. The domestic credit to private sector ratio of 33% of GDP is in the range of the average value of all selected countries (38%). Further more the question arises whether a country relying on oil like Iran has been active in the research of new technologies like renewable energy technology which is needed for certain CDM projects. The high level of monetary reserves would allow to purchase foreign technology and expertise from other countries, too. In any case Iran has considerable human capacity. Beside 590 scientists and engineers per million people there are 23 nominated UNFCCC experts, which is rank three after China and Brazil. Iran's big deficit consists in the lack of project experience. There have been neither AIJ projects taken place in this country nor are any CDM projects actually prepared. Thus the strategy for Iran should be (after ratification and DNA establishment) first to host some bi- or multilateral projects, which could be difficult, but not impossible, taking into account a country credit rating of 36.6 points, to gain project experience and get technology transfer (especially important for CDM projects with high technology demands). Consequently private and public entities might invest in own unilateral projects. There is high human capacity and potential for investments. The state dominated structure of the economy however might hamper investments in CDM projects.

Figure 12:Indicator profile - Iran



9 Conclusion and recommendations

Many of the currently proposed CDM projects are designed locally, because foreign investors are reluctant to invest in projects with perceived high risks and transaction costs. Though locally developed CDM projects do usually not involve FDI and do not promote technology transfer, they are not necessarily at a disadvantage compared with the other designs. They may imply a reduction in transaction costs and be better integrated into a national sustainable development strategy. Even if projects are locally developed, Annex B investors or buyers might still become involved until CERs accrue. Therefore donors should help Non-Annex I countries to develop projects locally and at the same time help to cross the threshold that makes their projects attractive for Annex B investors or buyers. This requires a capacity building strategy according to the needs of the development of local CDM projects on the one hand, and a strategy to dismantle investment barriers for Annex B investors on the other hand.

Regarding locally developed CDM projects it is most important

- to develop proactive DNAs and to evaluate and link existing institutional structures
- to foster the understanding of financing mechanisms among the host country participants in order to mobilise domestic capital
- to identify suitable host country project options
- to motivate public and private entities to engage in locally developed projects
- to offer capacity building activities increasingly to countries that are so far excluded from bi- and multilateral CDM project development, but have sufficient domestic capacity to develop projects locally.

In order to get more foreign investors on the CDM track, it might be useful

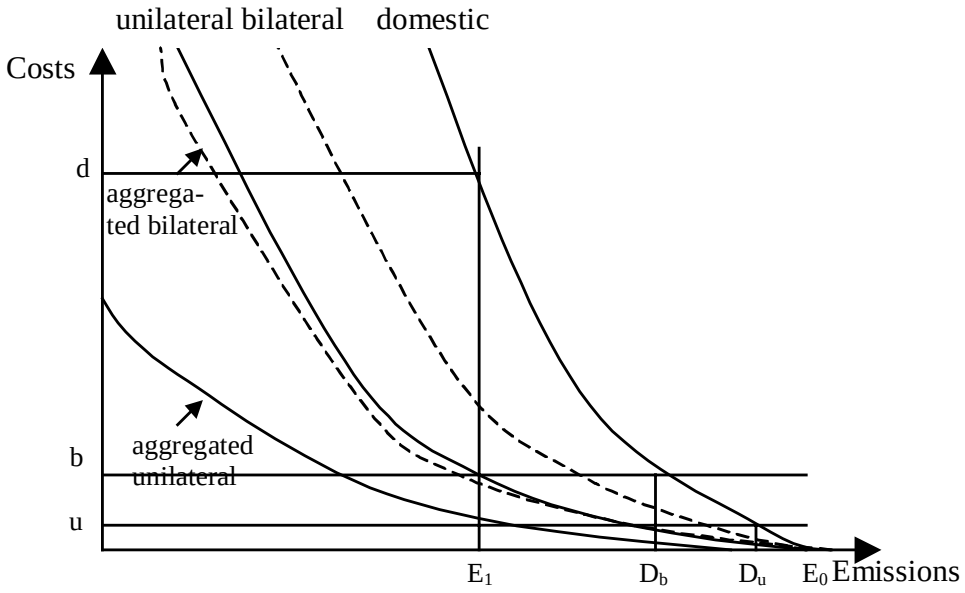
- to increase the awareness of the CDM in the Annex B private sector, especially by providing incentives
- to enable an objective risk assessment by providing detailed information on the economic and political situation of a host country
- to install an information platform, where host country project developers can contact potential Annex B investors

Appendix A: Impacts of a different risk perception on mitigation projects

The impacts of a lower risk perception by local project developers are demonstrated by the use of a model illustrated in Figure 13 and Figure 14. It is based on the following assumptions:

- Due to a different risk perception the host investor has lower return expectations for CDM projects than the foreign investor. This can be demonstrated by a higher marginal abatement cost curve for bilateral CDM than for unilateral CDM. The risk premium is reflected by the difference of the two curves and is positive. Thus the bilateral CDM marginal abatement cost curve is always higher than the unilateral one.
- The Annex B investor currently emits E_0, faces domestic emission constraint E_1 and can use CERs to offset domestic excess emissions.

Figure 13: Effects of risk premium for foreign CDM investment

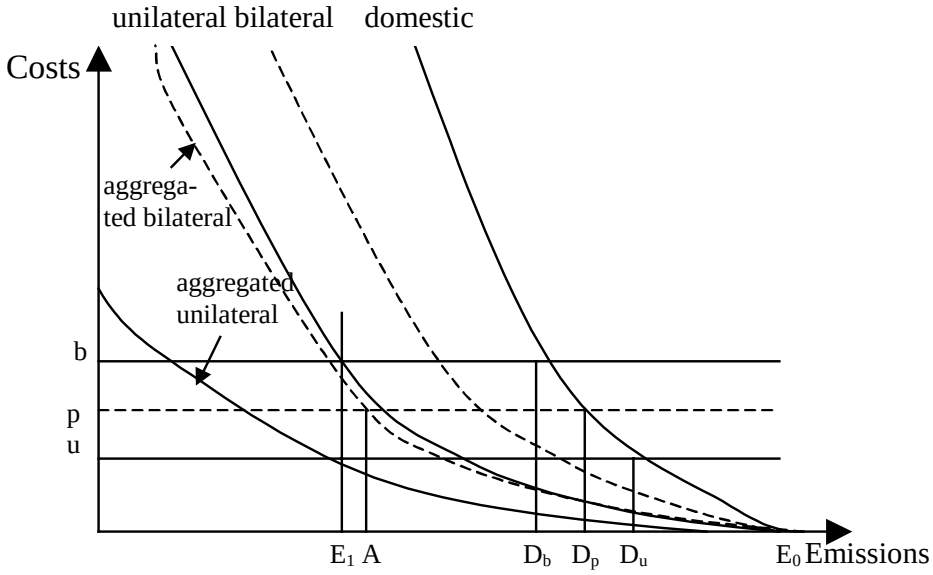


The marginal abatement costs are d for a purely domestic reduction, b for a combination of domestic reduction and bilateral CDM and u for the optimum mix of unilateral CDM and domestic reduction. The amount of bilateral CDM is the distance E_1–D_b while domestic reduction is D_b-E_0. For the unilateral solution, unilateral CDM amounts to E_1–D_u and domestic reduction to D_u-E_0. Unilateral CDM thus leads to lower abatement costs and a greater share of reductions in DCs.

Let us now assume that both countries face an exogenous world market price p. As long as p is above b, there is no change from the situation shown above. If p is between b and u (see Figure 14), domestic reduction falls from D_b-E_0 to D_p-E_0. Bilateral CDM amounts to A-D_p and acquisitions on the world market to E_1-A. Whether the amount of CDM de- or increases,

depends on the slope of the curves. For the unilateral case nothing changes until p becomes lower than u. Then the same reasoning applies as in the bilateral case.

Figure 14: Exogenous world market price and bi- vs. unilateral CDM



Appendix B: Data collection and scale index values

Appendix B: Data collection - North Africa and Middle East

Country Name	Kyoto Ratification	DNA operating	Gross fixed capital formation (current million US$)	Gross fixed capital formation (% of GDP)	Domestic credit to private sector (% of GDP)	Scientists and engineers in R&D (per million people)	Number of nominated experts in UNFCCC roster	Realised AIJ projects	Number of CDM projects with PDD and baseline study	Institutional Investor credit rating
Algeria	no	no	12059	22	8	...	0	0	0	41,6
Egypt, Arab Rep.	no	yes	14794	15	62	493	7	0	1	41,1
Iran, Islamic Rep.	no	no	34621	30	33	590	23	0	0	36,6
Jordan	yes	yes	2288	26	75	1948	2	1	0	38,5
Kuwait	no	no	2825	9	69	212	2	0	0	79,2
Lebanon	no	yes	3117	19	91	...	10	0	0	25,2
Morocco	yes	yes	8350	24	54	...	1	1	0	49,4
Saudi Arabia	no	no	33808	18	55	...	1	0	0	52,4
Syrian Arab Republic	no	yes	4131	21	8	29	5	0	0	22,7
Tunisia	yes	no	5220	26	68	336	0	0	0	52,6
Yemen, Rep.	no	yes	1812	20	6	...	0	0	0	24,3
Highest value within the group	...	...	34621	30	91	1948	23	1	0	79,2
Lowest value within the group	...	...	1812	9	6	29	0	0	0	22,7
Average of all selected countries of the group	...	...	11184	21	48	...	5	0,2	0	42,1
Data source	UNFCCC	UNFCCC	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	UNFCCC	UNFCCC	CDM watch	Institutional investor country credit rating
Year of collection	Dec 03	Dec 03	2001	2001	2001	1990-2000 (latest year available)	Nov 03	Dec 03	Dec 03	Sep 03

Appendix B: Data collection - Asia and Pacific

Country Name	Kyoto Ratification	DNA operating	Gross fixed capital formation (current million US$)	Gross fixed capital formation (% of GDP)	Domestic credit to private sector (% of GDP)	Scientists and engineers in R&D (per million people)	Number of nominated experts in UNFCCC roster	Realised AIJ projects	Number of CDM projects with PDD and baseline study	Institutional Investor credit rating
Azerbaijan	yes	yes	1185	21	5	2799	6	0	0	30,4
Bangladesh	yes	no	10783	23	27	51	0	0	0	28,6
China	yes	no	443647	38	127	545	58	4	2	59,9
India	yes	yes	103126	22	29	157	6	1	11	48,0
Indonesia	no	no	30300	21	20	...	13	4	1	30,3
Kazakhstan	no	no	5073	23	16	716	7	0	0	41,4
Korea, Rep.	yes	no	114252	27	108	2319	10	0	1	68,5
Malaysia	yes	yes	21931	25	149	160	3	0	2	61,7
Nepal	no	yes	1058	19	32	...	0	0	0	23,8
Pakistan	no	yes	8384	14	28	69	7	0	0	26,2
Philippines	yes	no	12546	18	40	156	5	0	0	43,8
Sri Lanka	yes	yes	3505	22	28	191	10	1	0	34,1
Thailand	yes	no	26732	23	98	74	15	1	2	56,9
Turkmenistan	yes	no	2139	36	a) 2	...	0	0	0	20,8
Uzbekistan	yes	no	2196	19	...	1754	2	0	0	20,5
Vietnam	yes	yes	9449	29	39	274	0	2	0	37,7
Highest value within the group	...	...	443647	38	149	2799	58	4	8	68,5
Lowest value within the group	...	...	1058	14	2	51	0	0	0	20,5
Average of all selected countries of the group	...	...	49769	24	47	712	9	0,8	1	39,5
Data source	UNFCCC	UNFCCC	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	UNFCCC	UNFCCC	CDM watch	Institutional investor country credit rating
Year of collection	Dec 03	Dec 03	2001	2001	2001	1990-2000 (latest year	Nov 03	Dec 03	Dec 03	Sep 03

a) only available for 2000

Appendix B: Data collection - Latin America and Caribbean

Country Name	Kyoto Ratification	DNA operating	Gross fixed capital formation (current million US$)	Gross fixed capital formation (% of GDP)	Domestic credit to private sector (% of GDP)	Scientists and engineers in R&D (per million people)	Number of nominated experts in UNFCCC roster	Realised AIJ projects	Number of CDM projects with PDD and baseline study	Institutional Investor credit rating
Argentina	yes	yes	37916	14	21	713	6	3	0	18,4
Bolivia	yes	yes	1124	14	55	98	2	5	1	27,5
Brazil	yes	yes	97637	19	35	323	6	0	10	37,1
Chile	yes	yes	14240	21	66	370	35	4	4	65,2
Colombia	yes	yes	11120	13	25	101	14	0	2	37,2
Costa Rica	yes	yes	2901	18	28	533	1	9	6	44,4
Dominican Republic	yes	no	4894	23	38	...	0	0	0	36,6
Ecuador	yes	no	4107	23	33	83	0	2	0	24,2
El Salvador	yes	yes	2265	16	a) 42	47	0	0	1	46,4
Guatemala	yes	no	3558	17	20	...	0	3	2	32,3
Haiti	no	no	a) 1.081	a) 27	15	...	0	0	0	15,8
Honduras	yes	no	1533	24	41	...	0	4	0	25,3
Jamaica	yes	yes	2329	30	13	...	3	0	1	27,8
Mexico	yes	no	121178	20	11	225	3	5	1	54,8
Panama	yes	yes	2620	26	126	124	0	1	3	45,0
Paraguay	yes	no	1649	23	26	...	4	0	0	22,4
Peru	yes	yes	9908	18	24	229	3	0	0	38,3
Trinidad and Tobago	yes	yes	1689	19	42	145	3	0	0	54,2
Uruguay	yes	yes	2267	12	54	219	13	0	0	27,3
Venezuela, RB	no	no	20543	16	12	194	0	0	0	27,1
Highest value within the group	...	...	121178	30	126	713	35	9	10	65,2
Lowest value within the group	...	...	1081	12	11	47	0	0	0	15,8
Average of all selected countries of the group	...	...	17174	18	34	...	5	1,8	1,6	35,4
Data source	UNFCCC	UNFCCC	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	UNFCCC	UNFCCC	CDM watch	Institutional investor country credit rating
Year of collection	Dec 03	Dec 03	2001	2001	2001	1990-2000 (latest year available)	Nov 03	Dec 03	Dec 03	Sep 03

a) only available for 2000

Appendix B: Data collection - sub-Saharan Africa

Country Name	Kyoto Ratification	DNA operating	Gross fixed capital formation (current million US$)	Gross fixed capital formation (% of GDP)	Domestic credit to private sector (% of GDP)	Scientists and engineers in R&D (per million people)	Number of nominated experts in UNFCCC roster	Realised AIJ projects	Number of CDM projects with PDD and baseline study	Institutional Investor credit rating
Angola	no	no	3217	34	4	...	0	0	0	17,0
Botswana	yes	no	1314	25	16	...	1	0	0	62,2
Cameroon	yes	no	1513	18	10	...	0	0	0	19,9
Ethiopia	no	no	1124	18	28	...	8	0	0	16,1
Gabon	no	no	1323	31	12	...	0	0	0	22,7
Ghana	yes	no	1256	24	a) 14	...	1	0	0	25,8
Kenya	no	no	1388	12	25	...	2	0	0	24,6
Mauritius	yes	yes	1057	23	63	360	3	2	1	53,9
Mozambique	no	no	1500	42	3	...	0	0	0	20,6
Nigeria	no	no	11399	28	18	...	5	0	0	20,2
South Africa	yes	no	17518	15	149	992	5	2	2	54,6
Sudan	no	no	2071	17	3	...	3	0	0	10,5
Tanzania	yes	no	1570	17	5	...	0	0	0	21,8
Uganda	yes	no	1114	20	6	24	0	2	1	20,1
Highest value within the group	...	...	17518	42	149	992	8	2	2	62,2
Lowest value within the group	...	...	1057	12	3	24	0	0	0	10,5
Average of all selected countries of the group	...	...	3383	23	24	...	2	0,4	0,3	27,9
Data source	UNFCCC	UNFCCC	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	World Bank's World Development Indicators 2003	UNFCCC	UNFCCC	CDM watch	Institutional investor country credit rating
Year of collection	Dec 03	Dec 03	2001	2001	2001	1990-2000 (latest year	Nov 03	Dec 03	Dec 03	Sep 03

a) only available for 2000

Appendix B: Conversion of data into scale index values

Index values	Gross fixed capital formation (current million US$)	Gross fixed capital formation (% of GDP)	Domestic credit to private sector (% of GDP)	Scientists and engineers in R&D (per million people)	Number of nominated experts in UNFCCC roster	Realised AIJ projects	Number of CDM projects with PDD and baseline study	Institutional Investor credit rating
0	x<5000]	x<10]	x<5]	x<150]	x<2]	x<1[	x<1[	x>70[
1	[10000>x>5000[	[13>x>10[	[15>x>5[	[300>x>150[	[4>x>2[	...	...	[70>x>64[
2	[15000>x>10000[	[16>x>13[	[25>x>15[	[450>x>300[	[6>x>4[	x=1	x=1	[64>x>58[
3	[20000>x>15000[	[19>x>16[	[35>x>25[	[600>x>450[	[8>x>6[	...	...	[58>x>52[
4	[25000>x>20000[	[22>x>19[	[45>x>35[	[750>x>600[	[10>x>8[	x=2	x=2	[52>x>46[
5	[30000>x>25000[	[25>x>22[	[55>x>45[	[900>x>750[	[12>x>10[	...	...	[46>x>40[
6	[35000>x>30000[	[28>x>25[	[65>x>55[	[1050>x>900[	[14>x>12[	x=3	x=3	[40>x>34[
7	[40000>x>35000[	[31>x>28[	[75>x>65[	[1200>x>1050[	[16>x>14[	...	...	[34>x>28[
8	[45000>x>40000[	[34>x>31[	[85>x>75[	[1350>x>1200[	[18>x>16[	x=4	x=4	[28>x>22[
9	[50000>x>45000[	[37>x>34[	[95>x>85[	[1500>x>1350[	[20>x>18[	...	...	[22>x>16[
10	x>50000[	x>37[	x>95[	x>1500[	x>20[	x>4[	x>4[	x<16]
Maximum value chosen	50000	37	95	1500	20	4	4	16
Minimum value chosen	5000	10	5	150	2	1	1	70
Mode of scaling	directly proportional	directly proportional	directly proportional	directly proportional	directly proportional	directly proportional	directly proportional	directly proportional
values of orientation								
Low income country (average)	3482	20	24	...				18,0
Middle income country (average)	14022	23	58	778				39,0
High income country (average)	97582	22	137	3281				87,0
Highest value within selected countries	443647	42	149	2799	58	9	10	79,2
Lowest value within selected countries	1057	9	2	24	0	0	0	10,5
Average of all selected countries	21478	21	38	...	5	0,9	0,8	36,0
Other orientation values					458 nominated experts of 51 Non-Annex I countries	70 projects in 31 Non-Annex I countries	59 projects in 23 Non-Annex I countries	

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