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ORIGINAL PAPER

Unilateral CDM—can developing countries finance generation of greenhouse gas emission credits on their own?

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Abstract The Clean Development Mechanism (CDM) was originally seen as an instrument with a bi- or multilateral character where an entity or fund from an industrialised country invests in a project in a developing country. The sluggish implementation of incentives for industrialised country companies to embark on CDM projects and low carbon prices led to a preference for 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 developing country. 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 infrastructural 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 undertaken 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 host countries. Whereas several countries from Asia and Latin America can design and implement projects autonomously, most of the Sub-Saharan countries rely on foreign support. International donors of capacity building grants should increasingly address those countries that are not presently focused on by foreign investors and support them in the design of local projects.

Keywords Clean Development Mechanism · Unilateral · Institutions · Project participants · Financing · Risk premium

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List of abbreviations

AAUs	Assigned Amount Units
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
COP	Conference of the Parties
DNA	Designated National Authority
DOE	Designated Operational Entity
ERPA	Emission Reduction Purchase Agreement
ERUs	Emission Reduction Units
PDD	Project Design Document
UNFCCC	UN Framework Convention on Climate Change

1 International climate policy and the Clean Development Mechanism

International climate policy has developed in a series of international agreements over the last 15 years. The original treaty, the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992. Since it entered into force in 1994 the Parties to the Convention meet annually at the Conference of the Parties (COP). In the framework of the Kyoto Protocol negotiated in Kyoto in 1997 the industrialised countries—also known as Annex B countries as they are listed in Annex B of the Kyoto Protocol—finally adopted legally binding quantitative constraints, in which they agreed to reduce greenhouse gas emissions by 5.2% below their 1990 level on average over a first commitment period of 2008–2012. In order to allow Annex B countries to achieve their emission targets in a cost-effective manner, the Kyoto Protocol provides three flexible mechanisms: International Emissions Trading (Article 17), which allows for trading of Assigned Amount Units (AAUs)[1] between Annex B countries, and the project-based mechanisms Joint Implementation (JI) (Article 6) and the Clean Development Mechanism (CDM) (Article 12). Whereas JI refers to project activities between Annex I countries, the CDM generates greenhouse gas emission credits (''Certified Emission Reductions'', CERs) through investment in emission reduction or sequestration projects in developing countries without emission targets. The emission credits generated through JI are called ''Emission Reduction Units'' (ERUs). Annex B countries can using AAUs, ERUs and CERs[2] to reach their commitments. It took 4 years for the international community to agree on detailed rules for the implementation of the Kyoto Protocol in the so-called Marrakech Accords. The Kyoto Protocol finally entered into force in February 2005.

In order to be eligible to participate in the CDM, the country that hosts a project as well as participating Annex B countries must have ratified the Kyoto Protocol and established a Designated National Authority (DNA), responsible for approving and evaluating CDM projects and defining the host country's sustainable development criteria. A CDM Executive Board supervises the CDM and accredits Designated Operational Entities (DOEs) for independent evaluation of project proposals. In order to generate CERs, the reduction of greenhouse gases that results from a CDM

[1] The Assigned Amount is a nation's emissions budget for the first commitment period, measured in tonnes of CO_2 equivalent. AAUs are the parts of that amount used for emissions trading.

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

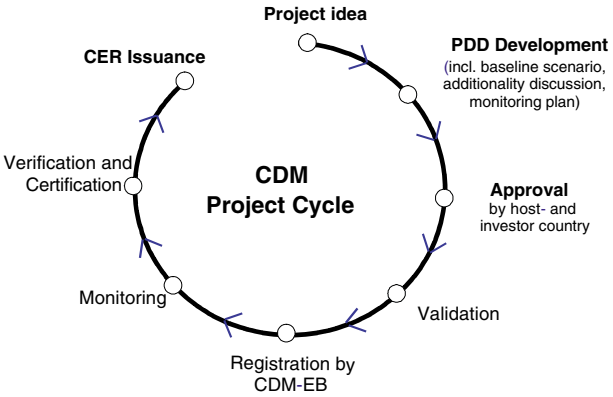

Fig. 1 The CDM project cycle

project has to be measured and audited. Hence, a standardised procedure commonly known as the CDM Project Cycle was defined. It has five basic stages (see Fig. 1).

After developing a project idea, the project participants have to write a Project Design Document (PDD) to be submitted for approval by the DNAs of the involved countries and validation by a DOE. Once this is achieved, the project can be submitted to the CDM Executive Board for registration. Once a project has been registered and is being implemented, its greenhouse gas emission reductions are monitored by the project participants. A DOE verifies and certifies these reductions, before CERs are issued by the CDM Executive Board.

Originally the CDM was designed to initiate joint ventures between partners from a industrialised and a developing country 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. In the multilateral approach Annex B entities subscribe shares in a centralised fund which invests the money in a portfolio of projects. The subscribers would receive CERs proportionally to their share in the fund (Baumert, Kete, & Figueres, 2000, p. 3ff).

As industrialised countries hesitate to invest in CDM projects due to the high perceived risks involved in implementing projects in developing countries but instead prefer to just buy CERs, the question was raised by project developers whether CDM projects can be developed and implemented by host countries unilaterally and the resulting CERs be sold. This article describes the history of the debate on unilateral CDM, proposes a clear definition and analyses which countries could be the main beneficiaries of unilateral projects.

2 The history of the concept of unilateral CDM

Within the so-called Activities Implemented Jointly (AIJ), a first pilot phase for CDM and JI launched in 1995 after COP-1, Costa Rica had pioneered a unilateral approach with the creation of "Certified Tradable Offsets"[3] in 1996 (Roveda & Merenson, 1999, p. 22f). After 1997, many potential CDM host countries, especially from South America, proposed that they would invest in projects and sell the resulting CERs to Annex B countries (see International

[3] Certified 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.

Institute for Sustainable Development (IISD), 2000). China opposed unilateral CDM (UNFCCC, 2000, p. 49), because it wanted to benefit from technology transfer in the CDM context and possibly feared that unilateral CDM worsens its 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.[4] Environmental non-governmental organisations (NGOs) argued that unilateral CDM was going against the spirit of cooperation between North and South. While Greenpeace (1999) initially accepted all three models, it later became an opponent of unilateral CDM fearing that it would be used to promote nuclear energy through the CDM.

In the run-up to the second part of COP-6 in 2001, there were still discussions 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 interpretation. Only in February 2005, the CDM Executive Board clearly stated that unilateral CDM projects were allowed. Subsequently, it confirmed that host countries can transfer the CERs gained if a DNA from an Annex B country provides an approval letter. However, transfers will only be possible once the International Transaction Log overseen by the UNFCCC Secretariat is operational.

3 What is a unilateral CDM project?

As there are links between the three basic CDM approaches, i.e. bi-, multi- and unilateral CDM, it is difficult to define thresholds within 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 bilateral or multilateral projects mature out of previously developed local project initiatives. So far the unilateral design has been defined by analysts as actors in the host country developing, implementing and financing a project on their own (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.

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. 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 comes from host country entities.

[4] ''Korea strongly believes it is necessary to allow developing countries to initiate their own host-generated unilateral CDM projects'' (Kim, 2000). Zhang (2001) assumes that this is due to the fact that Korea wants to bank CERs for the time when it takes up an emission target.

3.2 Purchase agreements

Local project developers have to decide whether they want to bank CERs or to sell them to Annex B entities. Banking may be most relevant for newly industrialised countries that expect commitments in the near future. Another reason for banking 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 developing country 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.

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. 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, because all the necessary project cycle activities are under the host country developer's responsibility or initiated through him.

All existing purchase agreements between host country project developers and buyers from an Annex B country involve a forward transaction and are called Emission Reduction Purchase Agreements (ERPAs). With the conclusion of an ERPA the buyer commits to purchasing a certain amount of future CERs at a specific price. Whether a project designed under such a structure can still pass for a unilateral project is debatable. By all means it cannot be seen as a ''pure'' unilateral project because the ERPA assigns the price risk and the Kyoto risk to the Annex B buyer (PCF, 2002, p. 3). Furthermore an ERPA may have a strong influence on the financial closure of a project in cases where 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 after the interests of Annex B buyers are met, which means that they set low carbon prices, set 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, 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 have high expectations regarding the quality of the baseline and monitoring plan and eventually participate in their preparation. The buyer does so 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 as comprehensive a risk assessment study as in the former case. Here the project could still be regarded as unilateral.

3.3 The share of unilateral projects in the current CDM project pipeline

According to the above mentioned criteria a ''pure'' unilateral CDM project only has the approval of the host country DNA, does not involve any FDI, and does not involve Annex B buyers prior to issuance of CERs. The first criterion can be assessed quantitatively. Out of 543 CDM projects that were publicly available on the UNFCCC website but had not yet been registered as of March 28, 2006, 384, i.e. 71% only have host country approval. Of the 146 registered projects, 68 had been approved by a host country only, i.e. 47%. How many of those projects have concluded an ERPA is difficult to assess. Most projects that have an ERPA in place before registration involve the approval of the buyer country. However, it is likely that many projects registered with only host country approval will sign ERPAs after registration but before the issuance of CERs.

4 Advantages of unilateral CDM

4.1 Lower risk perception by the host

CDM projects are considered to be risky as they not only bear general project risks but also risks linked with the carbon market such as baseline determination and registration risk. This is one of the reasons why foreign investors have been reluctant to invest in CDM projects so far. Entities from a host country have been more willing to invest in CDM projects as risks are perceived to be lower. Compared with local investors, foreign investors face the additional risk that the host country could breach existing contracts and not honour the commitment to transfer CERs (PCF, 2002b, p. 2). Moreover local investors can better assess the economic and political situation in their country and thus better foresee possible threats like strikes and civil unrest. This implies that foreign investors 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 will probably not be able to deliver returns that are high enough to compensate the high country risk. Our above-mentioned power station investor asks

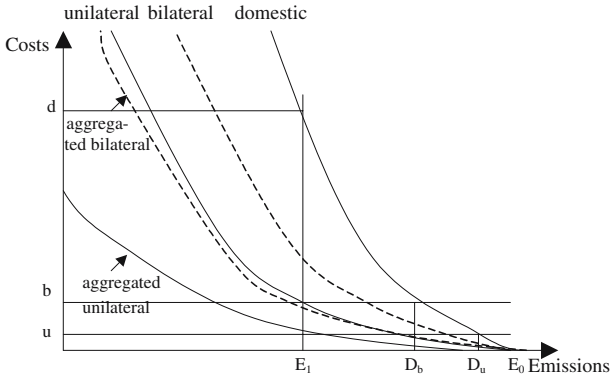

Fig. 2 Effects of risk premium for foreign CDM investment

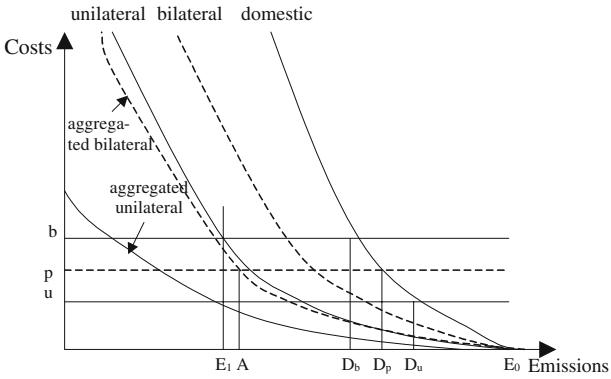

Fig. 3 Exogenous world market price and bi- vs. unilateral CDM

for 30% IRR in India because depending on risk he expects the IRR in a corridor of 15–30%. Being conservative, he chooses 30% as a threshold. However, a local power plant investor has a much lower IRR ''risk spread'' of 18–22% and thus applies 22% as his threshold, which results in a risk premium for the foreign investor of 8% (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 (Figs. 2, 3).

Box 1: Theoretical impacts of different risk perceptions

The impacts of a lower risk perception by local project developers are demonstrated by the use of a model illustrated in Fig. 2. 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.

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 Fig. 3), 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 decreases 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.

4.2 Reduction of transaction costs

Transaction costs of CDM projects can be defined as the costs that arise from search and negotiation activities performed by the participants of a project activity and as the costs that arise from the tasks to be performed during the project cycle (Krey, 2004). Search costs for unilateral projects are assumed to be low as an Annex B entity, buying CERs after issuance, requires less project documentation compared to the case where it concludes an ERPA or directly invests in the project. Concerning

the negotiation costs of concluding a direct purchase agreement business partners only have to bargain price and quantity of CERs instead of needing agreement on project financing, development, construction, sharing of benefits and the detailed obligations of the parties. Project cycle transaction costs could be lower if host country project developers have access to local DOEs, which are responsible for validation, verification and certification (Stewart et al., 1999, p. 28).

4.3 More small-scale projects

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 (Kelly, 2002).

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 to large scale projects, absolute transaction costs do not differ considerably but the amount of generated CERs is much lower.[5] Project developers of unilateral projects are faced with lower transaction costs as explained above. Moreover they usually do not have the financing and investing capacity for capital intensive large projects.

By March 28, 2006, 34% of the registered unilateral CDM projects and 42% of the bilateral registered projects (42%) were small scale. For the submitted projects, 48% of unilateral and 38% of bilateral projects were small scale. So the forecast effect is clearly visible with regards to submitted but not with regards to registered projects.

4.4 Keeping CDM rent in host countries

In unilateral projects 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, as it is the case with bilateral or multilateral projects.

5 Disadvantages of unilateral CDM

5.1 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 greenhouse gas constraint will always profit from any deal that is lower than their marginal abatement cost at home, the unilateral seller will face the full price decrease. Assume that marginal abatement costs in

[5] A small hydro power plant faced with transaction costs of $97,000 reduces 240,000 t of CO_2 over the crediting lifetime. The specific cost would be $0.41/t$CO_2$. The design of a biomass power plant faced with transaction costs of $364,000 reducing 5 million t of CO_2 would result in $0.07/t$CO_2$, which is almost factor 6 below. These are actual Indian examples (Krey, 2004, p. 93).

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. For local project developers who want to sell CERs, an unexpected decrease in the CER price may be disastrous, especially if the project is no longer financially viable. For this reason local project developers generally conclude ERPAs that set up a fixed price and thus reduce the downward price risk but at the same time prevent local project developers from benefiting from upward price movements. Therefore the more elaborate ERPAs define the purchase of a basic amount of CERs at a low price and 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. However recently it has become fashionable to index prices to the spot price of allowances in the EU emissions trading scheme and this again subjects the seller to the full price risk.

5.2 Less technology transfer

Unilateral CDM is likely to reduce technology transfer from North to South (Liu, 2001). It could be argued that local project developers still may buy foreign technology on the global market, but may not have sufficient capital or the expertise for choosing, adapting and maintaining the technology. Local project developers are likely to deploy home-grown technology. Sometimes the use of home-grown technology is even preferred to foreign technology as the host country participants do not want to depend on foreign investors with respect to consultants, maintenance of the project, spare parts etc...

5.3 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 are incurred before the project owner receives any revenues. That means he needs 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.

6 Requirements for unilateral CDM

The design of unilateral projects requires sufficient capacity in the host country for both developers and financing institutions, mobilisation of domestic capital, development of risk assessment procedures and risk mitigation strategies such as portfolio diversification (Deodhar, Michaelowa, & Krey, 2003) and insurance. Most projects are in need of highly qualified manpower like engineers, financial experts and basic infrastructure. A proactive DNA could provide technical and financial expertise, organise capacity building activities for project participants and market generated CERs. Early examples of proactive DNAs can be found in Latin America (Figueres & Olivas, 2002, pp. 33–51); currently the Indian DNA is the foremost example of a supportive DNA.

7 Measuring the potential of unilateral CDM

In the preceding sections unilateral CDM has been theoretically described and the chances and pitfalls as well as the requirements to carry out unilateral projects have been highlighted. We have developed a methodology to estimate the potential of unilateral CDM in a host country, which will be applied to some key countries. The data vintage is from the end of 2003 when the CDM started to become operational.

7.1 Methodology

The methodology facilitates a comparison among host countries by choosing empirical indicators in order to assess a country's potential for unilateral CDM projects. As a next step, for most of the indicators the collected data are converted to a continuous scale (1–10) in order to facilitate a comparison among countries. Finally the findings will be demonstrated through the use of some case studies and through comparison with the actual distribution of unilateral projects.

7.1.1 Selection of empirical indicators

Indicators describe the following categories: awareness of climate change, availability of domestic capital, human capacity, project experience and the creditworthiness of the host country. Due to the different sizes, geographical and cultural backgrounds of countries we have used relative and absolute indicators (see Table 1).

With regard to economic requirements it seems most important that a host country 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. This includes plant, machinery, and equipment purchases, land improvements (fences, ditches, drains, and so on), the construction of transport infrastructure and the construction of private, commercial, industrial and public buildings (World Development Indicators (WDI), 2003b). Here it is important to look at both the absolute value (current US$) and the specific value (% of GDP). 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 developing countries the funds are raised rather by borrowing (debt finance) than by share issue (equity finance). Therefore the domestic credit to

Table 1 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 R&D (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

private sector ratio (as percentage of GDP) indicates whether the private sector in a host country is able to acquire the necessary financing. 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 relative number of experts nominated for the domains of technology and technology transfer, methodological issues and in-depth review of National Communications in the UNFCCC roster (UNFCCC, 2003) is a measure for the human capacity of a country on climate change issues.

The project experience a country has already gained through greenhouse gas abatement projects is measured by the number of realised AIJ projects and by the number of CDM projects with available baseline study and PDD. 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 0–100 (highest risk to lowest) and ratings are updated every 6 months (WDI, 2003b). This indicator does not really measure the potential of a country to carry out projects unilaterally. Instead, it 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.

7.1.2 Collection of data

Data have been collected for countries from four regions: Asia Pacific, Latin America and Caribbean, Sub-Saharan Africa, North Africa and the Middle East. In order to limit the number of countries for this analysis, only those countries have been selected that overcome a threshold of 1 billion $ of gross fixed capital formation. Overall data for 61 countries have been collected. The main source has been the World Bank's World Development Indicators 2003b, which represent a structured compilation of data from different sources, and the UNFCCC website which provides actual information on climate change issues and the Kyoto mechanisms. Appendix: Table 2 shows the data and indicators for Asia as an example.

7.1.3 Scaling of data

For each indicator, except for Kyoto ratification and DNA operation, the data have been converted into a continuous scale from 1 to 10 to facilitate the comparison among countries. The indicator scale is defined using a maximum and a minimum value. 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.

7.1.4 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 differs among the selected countries. Regarding the

figures it is striking that the awareness of climate change within the four groups differed substantially in late 2003. Almost all selected Latin American countries had ratified the KP and most of them had already established a DNA. Also many of the selected Asian countries had ratified and put a DNA into operation. On the other side the Sub-Saharan countries showed deficits in this respect. Equally striking are the differences in project experience. Once again the Latin American and Caribbean countries were leading but projects were concentrated in a few countries such as Brazil, Costa Rica, Mexico and Chile. Asia had already gained substantial experience with projects while North Africa and Middle East and Sub-Saharan Africa hardly had any. With respect to the availability of domestic capital the regional differences were 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 spotted. It becomes evident that the Asian newly industrialised countries have the best potential to finance and invest in local CDM projects but also several states of Northern Africa and the Middle East have a good potential. Compared with Asia and North Africa and Middle East the average Latin American values for specific gross investment and domestic credit are lower. The group of Sub-Saharan countries again ranks last.

The highest human capacity regarding scientists and engineers in research and development and nominated UNFCCC experts was found in Asia, closely followed by some of the North African and Middle East countries. Again sub-Saharan Africa lagged.

To summarise the regional differences among the four groups of countries we find that Asian countries particularly take the lead in human capacity and investment in new capital while Latin American countries have been the first to ratify Kyoto and to put up DNAs. Although several countries in North Africa and the Middle East had enough domestic and skilled manpower, most of them seemed less inclined to develop CDM projects. The Sub-Saharan countries are at a double disadvantage concerning the CDM. First, 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. Second they might not be able to carry out unilateral projects because they have insufficient potential in nearly all relevant fields.

7.2 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.

China: China is the most populous country on earth and one of the largest economies. Its economic progress is attributable to the consistent economic restructuring and reform 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 (Jotzo & Michaelowa, 2002, p. 187), but set up its DNA relatively late and only recently has started to develop its project portfolio.

China reaches high levels for many of the indicators but other countries like Brazil and India had a head start in designing CDM projects. As China is able to attract many

foreign investors unilateral CDM represents only one option to implement the CDM. Bi- and multilateral projects might play a bigger role. Still 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 (Fig. 4).

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 as 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 (Jotzo & 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 (Austin & Faeth, 2000, p. 7). Brazil is perceived as a rather ''risky'' country among foreign investors. Thus unilateral CDM could play a bigger role than in the Chinese case; it achieves medium scores in all relevant categories. The early establishment of a DNA and the high number of projects show that there is high awareness and fast growing experience with the CDM, which is very important for unilateral project design (Fig. 5).

South Africa: The middle income country South Africa has 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 era. 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 were developed in the energy sector. South Africa was rather late to set up its DNA. 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 (Fig. 6).

Iran: Iran's economy is mainly driven by oil exports to other countries and little progress has been made to diversify the economy. Though it is a rich country with

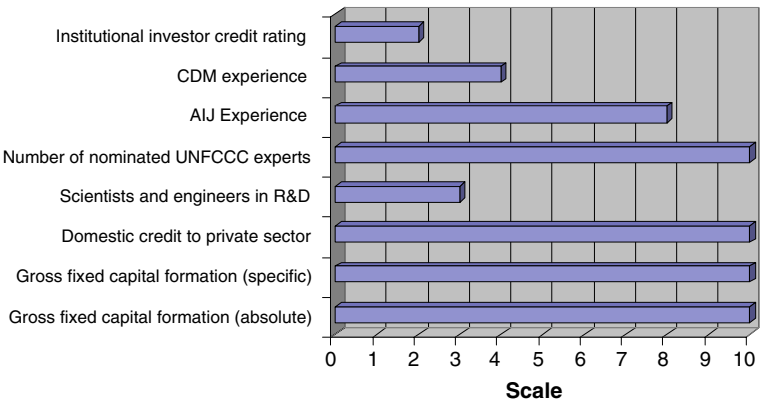

Fig. 4 Indicator profile—China

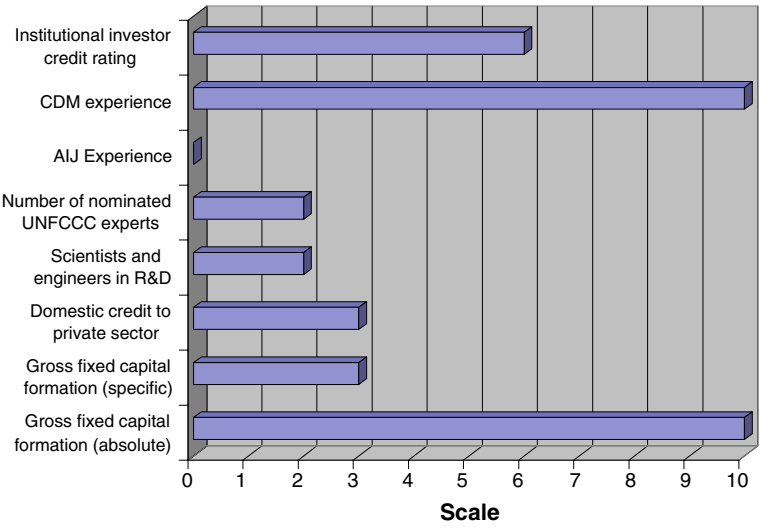

Fig. 5 Indicator profile—Brazil

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 as in almost all oil exporting countries as Iran has only recently ratified the Kyoto Protocol and not yet established a DNA. On the other hand there are many Iranian 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 (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). The state dominated structure of the economy however might hamper investments in CDM projects (Fig. 7).

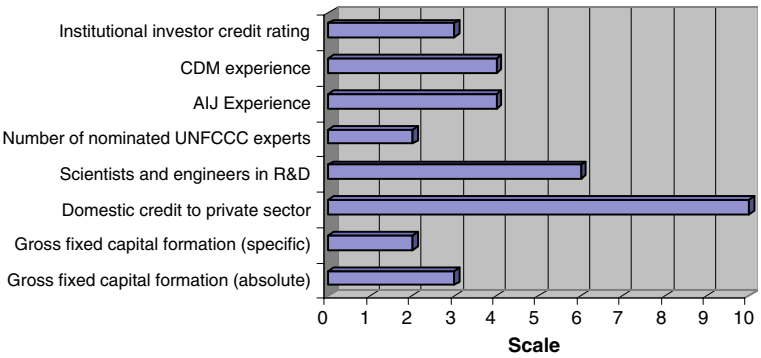

Fig. 6 Indicator profile—South Africa

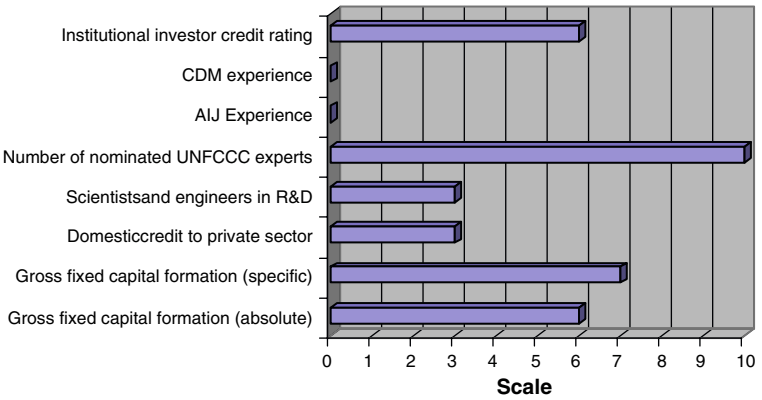

Fig. 7 Indicator profile—Iran

8 Conclusion and recommendations

Many of the currently proposed CDM projects are designed and financed by host country entities, because foreign investors are reluctant to invest in projects with perceived high risks and transaction costs. Unilateral CDM is a chance for project developers and host countries unable to attract foreign direct investment to participate in the CDM and to broaden the international distribution of projects. Unilateral projects can reduce transaction costs and be better integrated into a national sustainable development strategy. Bilateral CDM only flowing to a few countries and large companies with an international credit rating would give rise to questions concerning equity and the purpose of CDM. In the current CDM project pipeline, unilateral projects dominate but their share falls as projects progress through the project cycle, indicating problems in mobilizing enough financing for successful implementation of the projects.

Donors should help Non-Annex I countries to develop projects locally and 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; and
- 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 bilateral and multilateral CDM project development, but have sufficient domestic capacity to develop unilateral projects.

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Appendix: Table 2 Data collection for Asia Pacific region and scale index values

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	1,185	21	5	2,799	6	0	0	30.4
Bangladesh	Yes	No	10,783	23	27	51	0	0	0	28.6
China	Yes	No	443,647	38	127	545	58	4	2	59.9
India	Yes	Yes	103,126	22	29	157	6	1	11	48.0
Indonesia	No	No	30,300	21	20	...	13	4	1	30.3
Kazakhstan	No	No	5,073	23	16	716	7	0	0	41.4
Korea, Rep	Yes	No	114,252	27	108	2,319	10	0	1	68.5
Malaysia	Yes	Yes	21,931	25	149	160	3	0	2	61.7
Nepal	No	Yes	1,058	19	32	...	0	0	0	23.8
Pakistan	No	Yes	8,384	14	28	69	7	0	0	26.2
Philippines	Yes	No	12,546	18	40	156	5	0	0	43.8
Sri Lanka	Yes	Yes	3,505	22	28	191	10	1	0	34.1
Thailand	Yes	No	26,732	23	98	74	15	1	2	56.9
Turkmenistan	Yes	No	2,139	36	2[a]	...	0	0	0	20.8
Uzbekistan	Yes	No	2,196	19	...	1,754	2	0	0	20.5
Vietnam	Yes	Yes	9,449	29	39	274	0	2	0	37.7
Highest value within the group	...	...	443,647	38	149	2,799	58	4	8	68.5
Lowest value within the group	...	...	1,058	14	2	51	0	0	0	20.5
Average of all selected countries of the group	...	...	49,769	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: Table 2 continued

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	$x < 5{,}000]$	$x < 10]$	$x < 5]$	$x < 150]$	$x < 2]$	$x < 1[$	$x < 1[$	$x > 70[$
1	$[100{,}00 > x > 5{,}000[$	$[13 > x > 10[$	$[15 > x > 5[$	$[300 > x > 150[$	$[4 > x > 2[$	...	...	$[70 > x > 64[$
2	$[15{,}000 > x > 10{,}000[$	$[16 > x > 13[$	$[25 > x > 15[$	$[450 > x > 300[$	$[6 > x > 4[$	$x = 1$	$x = 1$	$[64 > x > 58[$
3	$[20{,}000 > x > 15{,}000[$	$[19 > x > 16[$	$[35 > x > 25[$	$[600 > x > 450[$	$[8 > x > 6[$	...	...	$[58 > x > 52[$
4	$[25{,}000 > x > 20{,}000[$	$[22 > x > 19[$	$[45 > x > 35[$	$[750 > x > 600[$	$[10 > x > 8[$	$x = 2$	$x = 2$	$[52 > x > 46[$
5	$[30{,}000 > x > 25{,}000[$	$[25 > x > 22[$	$[55 > x > 45[$	$[900 > x > 750[$	$[12 > x > 10[$	...	...	$[46 > x > 40[$
6	$[35{,}000 > x > 30{,}000[$	$[28 > x > 25[$	$[65 > x > 55[$	$[1{,}050 > x > 900[$	$[14 > x > 12[$	$x = 3$	$x = 3$	$[40 > x > 34[$
7	$[40{,}000 > x > 35{,}000[$	$[31 > x > 28[$	$[75 > x > 65[$	$[1{,}200 > x > 1{,}050[$	$[16 > x > 14[$	...	...	$[34 > x > 28[$
8	$[45{,}000 > x > 40{,}000[$	$[34 > x > 31[$	$[85 > x > 75[$	$[1{,}350 > x > 1{,}200[$	$[18 > x > 16[$	$x = 4$	$x = 4$	$[28 > x > 22[$
9	$[50{,}000 > x > 45{,}000[$	$[37 > x > 34[$	$[95 > x > 85[$	$[1{,}500 > x > 1{,}350[$	$[20 > x > 18[$	...	...	$[22 > x > 16[$
10	$x > 50{,}000[$	$x > 37[$	$x > 95[$	$x > 1{,}500[$	$x > 20[$	$x > 4[$	$x > 4[$	$x > 16[$
Maximum value chosen	50,000	37	95	1,500	20	4	4	16
Minimum value chosen	5,000	10	5	150	22	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)	3,482	20	24	...				18.0
Middle income country (average)	14,022	23	58	778				39.0
High income country (average)	97,582	22	137	3,281				87.0
Highest value within selected countries	443,647	42	149	2,799	58	9	10	79.2
Lowest value within selected countries	1,057	9	2	24	0	0	0	10.5
Average of all selected countries	21,478	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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