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Issues for the Clean Development Mechanism

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1 Executive Summary

This report discusses the issues surrounding the 'flexible mechanism' known as the Clean Development Mechanism (CDM) which was set up under Article 12 of the Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC). It is the first report under the DFID contract for Initial Evaluation of CDM type projects.

A flexible mechanism is a mechanism designed to maximise the cost efficiency of reducing Greenhouse Gases (GHGs). This is done by allowing countries with high abatement costs (donors) to abate emissions through projects carried out in host countries with lower costs. The emissions reduction achieved is then transferred to the donor country partner. In the case of the CDM the host countries are Developing Countries (DCs), while in Annex 1 hosts (countries with reduction targets) it is called Article 6 Joint Implementation (A6JI). A pilot phase to gain experience was set up in 1995 and called Activities Implemented Jointly (AIJ).

- ***Background to the CDM and Developing Countries***

The report starts with the background to the problem looking at the developing countries with respect to climate change, the UNFCCC and the CDM, along with their characteristics with respect to their development level, emissions and energy services. The strategic aims of the UK DFID are also examined.

Developing Country Concerns

The review of climate change and its impacts and implications for developing countries in section 2.1 illustrated that developing countries are particularly vulnerable to the impacts of Climate Change as a result of

- high dependence on natural systems and
- low ability to respond to adverse events through low institutional capacity.

Despite the fact that it follows from the above that it is in their interest to mitigate GHG emissions, they have many concerns about the types of arrangements envisaged in the CDM. In Section 2.2, the history of the negotiations in the UN FCCC which have shaped the attitude of DCs to the whole process is discussed. There is the overall historical equity question of the problem arising because of the activities of the industrialised countries (ICs). DC's naturally expect action to be taken first by the ICs and therefore are reluctant with limited resources to take part in these activities. They also do not wish their development aspirations to be bounded by a problem generated by the 'north' and will not accept targets for reductions. Their concerns on the CDM are that they will

- undermine domestic action in ICs which would allow a continued increase in GHG emissions from these countries, perpetuating the global inequalities in per capita emissions (Parikh and Gokarn, 1993);
- 'limit the host country's freedom to influence its own development path,' whilst giving 'the donor country more flexibility in its development path' (CNE, 1994), particularly since DCs will be at an disadvantage in negotiations due to lower institutional capacity;
- replace some of the assistance (financial, technological etc.) currently given to developing and transition countries under current FCCC commitments and as part of overseas aid programmes (CNE, 1994);
- 'skim off' or 'cherry pick' the cheapest projects, so that, if and when DCs are required to adopt emission constraints in the future, they will be faced by higher marginal abatement costs (Parikh, 1994);

The problem of the uneven 'playing field ' in negotiations is well founded and is illustrated by the case of the Decin project in the Czech Republic . See Box A

These concerns have not been addressed so far and it has meant that there is insufficient participation of DCs in the activities of the Convention.

BOX A DECIN:
This project is a co-generation gas fired plant in the town of Decin in the Czech Republic which replaced a coal fired district heating plant. Funding was provided mainly by the Czech Environment Fund facilitated by $1m from Denmark and $200k each from 3 US utilities. The US have negotiated a price of \$4.5/tCO_2 for all the heating related credits having provided only 7% of the funding. In fact the credits for the whole plant cost the Czech government in the range \$13-27/t CO_2.

Characteristics of the CDM

The specific conditions under which the CDM was set up under the Protocol are discussed in section 2.2.1. The main points are that

- it should assist the host country to achieve a sustainable development path,
- it should assist the donor to meet its commitments under the Convention,
- credits will be given from 2000,
- there will be an Executive Board (EB) to administer the CDM and an Operational Entity which will certify that the credits are real and long term.
- a levy will apply to all CDM projects to pay for this administration and aid adaptation measures in vulnerable countries,

The modalities for how the mechanism would actually be implemented have not been finalised and there seems to be at least two possible ways for arranging the match between investors and projects. These are

- Investors make partnerships with private entities in the host mediated by the EB. The selection and implementation of projects is dependent on market forces and the priorities of the donor.
- Host country offers projects based on an analysis of what it needs for a sustainable path and in collaboration with host private partners and through the EB matches up with an appropriate investor.

Development Country Characteristics

Consideration of developing countries in section 2.3 also shows that as a group they are not homogenous. The extent to which countries are industrialised is taken as a major differentiating factor and reflects also on the extent of their GHG emissions. Population size is also important. The major implications of this are that:

1. The focus of action may be concentrated on those countries sufficiently developed or with the potential for large increases in GHG emissions;
2. Poor less well developed countries may not have priority for action;
3. Can or should the CDM be applied in the same manner across all the different stages of development and levels of poverty?
4. For energy services there are differences in urban and rural conditions in these countries;
5. For development there is usually an increase in energy demand which should be met in a sustainable way.

DFID policy targets for energy demand

The DFID policy targets set out in the recent white paper on International Development are reviewed in section 2.4 and show that the priority is set on the targets of sustainability and poverty alleviation. Within the energy sector energy efficiency and the use of renewables are key to their approach. The main target for the CDM under these conditions for the UK must therefore be the poorer nations.

However there are associated problems in enabling the poorest areas to take advantage of benefits from the CDM and there may need to be intermediate assistance to help them do this.

- ***Equity and Sustainable Development Issues in the CDM***

In Section 3 the development nature of the CDM is examined. Not only must it reduce emissions cost effectively but it must do this in a sustainable and equitable manner. That this should apply to all the mechanisms under the Convention is without question but only in the case of the CDM is it explicitly stated.

Most of the concerns of DCs listed above are expressions of concerns on equity. They can only be addressed at the early stages of project planning. This means that some attention must be given to the approval procedures which are discussed in section 3.1.

Approval procedures and criteria

The approval procedures are discussed and the problems highlighted. It can be seen that

- there is no safeguard for equity in current approval procedures where the host and donor country agreement is all that is necessary for projects to proceed. Hosts may be susceptible to trade or economic pressures and may agree to projects they do not want.
- there is no consistent set of criteria or implementation modalities across the donor country programmes.
- there are serious gaps in current implementation such as no requirement to perform some sort of assessment of local environmental and social impacts from the project. These gaps are important for equity sustainability and the environmental goals of the Convention

Technology Choice and Transfer

We question in section 3.2 the basis for the technology transfer choice and procedures. At present it is envisaged as a market place with the market making the 'correct' choices for the country development. However this technology choice is critical for the future sustainability and future development path for the country and the market may not deliver this future on its own.

Technology transfer is not a simple minimum contact process. It consists of a complex process made up of the following components.

- The transfer of the technology components
- the skills and understanding required to operate the technology efficiently;
- the skills needed to repair and maintain the technology and generate spare parts;
- financial management, planning, communications and marketing skills;
- knowledge of ownership options and replacement options.

This has to be recognised and built in to the way the CDM is implemented

Possible Solution

The DC attitude to technology transfer according to Chatterjee (1997) is that the host country should prepare national programmes and development project proposals which give them a pro-active role in negotiations. Central to this is the need to establish the network of institutions and activities to encourage the development of new projects within the country.

By doing this, the host can try to ensure that the projects are in line with its development priorities and lead to a sustainable development path; the only way of implementing the central tenets of the CDM.

Capacity Building

Section 3.3 tries to illustrate what capacity building means in real projects and points out its importance in equity terms and environmental integrity terms as without this underlying project support it will fail to deliver reductions for the long term. How this is incorporated into the CDM must again relate to the approval criteria for the project as this has to be built in to the planning and consultation phase. Capacity building is required at all levels from national to project level and consideration needs to be given to the structures required for this. Sustainability requires that capacity building must involve local expertise and adapt to local conditions.

Poverty Alleviation

Poverty alleviation is complex and involves not just income levels relative to a poverty level but basic material needs and capacity perspectives in terms of lack of capabilities for literacy, health, shelter and food . Section 3.4 discusses the problem and the exacerbating factor of debt servicing. The link with environmental degradation is made and the subsequent increased threat to the poor as they depend most directly on environmental systems. The need to involve and motivate the poor for the preservation of their environment and to alleviate poverty is highlighted for the implementation of CDM projects. That this needs to be planned into CDM projects and requirements made at the approval stage is clear.

Local benefits and Disbenefits

Poverty Alleviation and capacity building can be considered as part of the local benefits or disbenefits from a project. However in addition there are secondary environmental and social impacts from projects which need to be considered if the environmental and sustainability aspirations in the Convention are to become reality. There are many good reasons for doing this and these are considered in section 3.5. Some assessment of these impacts is necessary at the planning stage of the project if they are to be mitigated or in fact show that the project is unsuitable. Proposals are available on methods for implementing such an approach.

Project Types for the CDM

The focus of this DFID study has been the energy sector and energy supply projects and energy efficiency measures are considered. Within these categories there are the questions of the measures which should be implemented because they obviously save money, energy and resources, but which are not undertaken due to various barriers (no regrets options). Extending the project types to carbon sequestration projects is still problematic.

- ***Technical Issues for the CDM***

In the report so far, we have discussed the development issues surrounding the implementation of the CDM. In section 4 we turn to the technical issues surrounding the calculation of the emissions reductions from projects and also the question of the eligibility or 'additionality' of projects to be considered as CDM projects.

Additionality

The basic problem is that the project is compared to the 'situation which would have occurred without the project'. If in that hypothetical scenario, the project would not have been chosen then it is considered to be additional and will deliver reductions over and above what would have happened anyway. This criterion of additionality is discussed in detail in section 4.1 and the problems associated with operationalising the criterion in an appropriate way for the CDM are discussed. We suggest that with the different stages of DC and the importance of no regrets measures, it makes sense to rethink the operationalisation of additionality as it stands. Its purpose to ensure no free riders, real reductions sold not too cheaply by the host can be met in other ways especially as action in DCs tends to be extremely low as the norm.

- Our suggestion is that the need to implement projects which are in line with country priorities and on a sustainable path which can only be generated by the host country policy is compatible with additionality in the sense that they would not have been carried out anyway due to lack of investment. The projects generated in this way and offered by the host can then be offered to the market for funding. This allows the aspirations of the CDM to be met.

Accounting Issues/Baselines

An accounting procedure is required for the estimation of emission reductions from projects. This involves comparing the project emissions with a baseline emissions level. This baseline is the emissions path in the absence of the CDM project. As no-one can ever know what it would have been this leads to high uncertainty. Thus the environmental integrity of the process is in doubt not only because this uncertainty is attached to the transfer of the credits but also because it allows room for 'gaming'. In the CDM case, where it is in the interests of all the parties to make the baseline as high as possible to maximise the reductions, gaming would be expected. The different ways of approaching the practicalities of the problem are summarised and discussed in section 4.2.

- We advocate an approach which is an overall approach to the whole accounting process with a view to ensuring the environmental integrity of the process while maintaining practicality and keeping down transaction costs. We suggest that different packages or combinations of measures are appropriate in different circumstances. These comprise the need for monitored data, standardised baselines, possible baseline revisions, verification protocols , possible partial crediting or limited crediting lifetimes.

Particular Accounting problems for the CDM

The CDM brings particular problems which do not apply in JI in Annex 1 countries. For example there will usually be an increased demand relative to the baseline situation in moving from candles for lighting to a micro-hydro project. This equivalence of service problem is discussed in section 4.2.3.

There will also be more projects which are composed of very small scale projects which may individually be difficult to account for without high transaction costs (section 4.2.4). The problems of gaming and leakage which will affect the final result and which are difficult to control are discussed in 4.2.5.and 4.2.6 while the whole issue of transaction costs and its importance for the involvement of the private sector and for maintaining the cost-efficiency of the mechanism is discussed in section 4.2.7.

- There needs to be a trade off between increasing the environmental integrity of the emission reduction calculation and the costs associated with achieving that. We suggest that accounting packages allow that trade-off to be made explicitly. It is not sufficient just to choose a baseline methodology as that alone will not reduce uncertainties.

Crediting

There are a number of important issues concerning the crediting of CDM projects which are discussed in section 4.3. Although the accounting regime can define the crediting regime in the sense of annual crediting based on annual operating data, there are many other aspects to be resolved. One issue is whether credits should be discounted as a way of countering problems such as the high uncertainty in estimates of emissions reduction.

Early Crediting

A significant problem is 'early crediting', where CDM projects are awarded credits from 2000 which is before the target period of 2008-2012. Although this gives an incentive for early CDM action, it creates the possibility of a 'relaxation' in the donor country targets which could not have been the original intention. This is not the redistribution of emission reductions between the mechanisms as originally envisaged but an actual reduction or relaxation in the target agreed. In Box B we show the implications for the US target and the Netherlands target based on the most recent conservative estimations from Vrolijk (1999).

This distorts the credits market in that there are calls to credit A6JI projects early too. This would have serious consequences for the Annex 1 hosts whose target would be tightened by an amount commensurate with the relaxation of the donor target.

Box B: Early Crediting

Vrolijk gives a range of estimates of the size of the global CDM market from 67 to 723 MtC/y, ie 245 to 2650 MtCO_2/y. If we assume that the US share of the market is approximately 10%, then its CDM programme would be 25 to 265 MtCO_2/y. Using the analysis from Parkinson et al (1999), this leads to a range for the relaxation for the US emissions target of 0.4% to 7.5%, ie the 7% cut would reduce to between a 6.6% cut and a 0.5% increase.

It should be borne in mind that the high estimate of 2650 MtCO2/y for a global CDM programme, is approximately half the size of the current US emissions. For a market this big to grow in the next eight years seems impractical. Indeed, the bottom up analysis carried out by Vrolijk gives an upper estimate of 210 MtC/y or 769 MtCO2/y. Assuming again a 10% US market share, this estimate results in a relaxation of approximately 1.8%, ie the US target becomes a 5.2% cut.

Even more significant is the case of the Netherlands. Vrolijk discusses a level of CDM activity during the commitment period of around 6 MtC/y, or 22 MtCO2/y. Again following the methodology of the main paper, and taking into account the 1990 GHG emissions of the Netherlands (215 MtCO2 equivalent for CO2, CH4 and N2O; UN FCCC, 1995), we find a relaxation of between 8.2% and 14.3%. This changes the Dutch target from a 6% cut (as agreed under the EU burden sharing scheme) to between a 2.2% increase and an 8.3% increase.

Clearly these estimates are significant. As Parkinson et al (1999) point out, if early crediting is to be accepted on the grounds of encouragement of early CDM activity, then two courses of action are available:

- either the relaxation is accepted, in the hope that this early activity leads to the targets agreed in later commitment periods (post-2012) being tighter;
- or a crediting fraction is applied to all credits earned by CDM in the manner recommended in the main paper.

- ***Concluding Remarks on the CDM***

This study has highlighted the dual nature of the CDM, with its contribution to both GHG emissions reduction and sustainable development. Hence the integration of development aspects into the mechanism whose operation under the Protocol is not straightforward makes this a very complex process to implement.

There are many issues which have to be resolved if the CDM is going to work for the investor, for the developing counties involved and for the environment.

- It will be essential to examine the CDM process from the approval to crediting stage and to bear in mind the effect of the overall combination of modalities for approval, accounting, and crediting.

- There are conflicts built into the Convention between costs and environmental integrity, between market and trade pressures and equity and the environment, and between additionality as currently described and appropriate technology choice.

- It has become clear that there are different stages of development of the DC's, and that different countries will have different development priorities. There are a range of sustainable development paths, and issues of equity which have to be addressed and integrated into the measures to mitigate climate change effects. Not all countries wish to follow the western industrial model and due regard has to be paid to alternative models of what is perceived as sustainable.

- One way to address sustainability is for the host country to be given assistance to prepare a strategy on its future development and from this develop a 'CDM strategy' indicating which types of projects it would be willing to accept from prospective donor countries in line with a sustainable path and with its priorities. This process also helps to have a level playing field in negotiations.

- We would suggest that the CDM cannot have one single implementation modality but should be implemented according to the stage of development of the country as an initial major differentiating aspect.

For newly industrialised countries (NIC's) for example, the CDM may be implemented almost as for A6JI, where there are existing markets, human capacity and infrastructures and existing industrial development. Here the additionality criterion as currently defined may well function, while the accounting packages must be chosen to avoid the increased incentive for gaming and to reduce the high uncertainties. The problem of the baseline under expansion of energy supply has to be addressed. In the NIC case there is some emphasis on development needs. To address those, there needs to be some project level interaction with the local conditions. There should be attention, in whatever mechanism, to the country, regional or local development priorities in the selection of the technology for transfer and to the local environmental and social impacts of projects if only to avoid displacing one environmental and social effect with another.

For the other end of the scale, in less developed countries (LDC's), there needs to be much more emphasis on local development priorities and needs in the modality of implementation of the CDM. There may be a case for a strategic capacity building to enable appropriate projects to be identified for sustainability as well as project specific capacity building designed to maximise environmental and social project benefits such as poverty alleviation measures.

- The poorest sections of society will need assistance to be able to benefit from any CDM project. This will mean engaging local experience and expertise in the design of projects. Most development experience on what makes projects successful seems to point in this direction. Considerations such as addressing local customs, local resource constraints, affordability and long term viability while increasing quality of life have to be treated at the local level and participatory processes are usually essential to this. This form of the CDM could be quite different to the NIC type.

- The approval criteria and project specification would need careful work. The way additionality is put into operation is crucial. For DCs the method of operation may best be tailored to the level of development of the country to bring in the 'no regrets measures' and to make sure that sustainable and appropriate technologies are chosen.

- As suggested above for sustainability, this may be best done by enabling the country to be assisted to assess what its development targets are how it is going to reach them. In the process, suitable projects with attendant local benefits could be identified and offered for investment. It is our opinion that it is unlikely that haphazard investment approaches will achieve any of the aims of the Protocol.

- Approval criteria must also include attention to the other environmental and social implications of projects as a necessity for the long term viability of the projects.

- The accounting and crediting regimes have to be designed to ensure environmental effectiveness and equity while avoiding scope for gaming. The different methods available for baselines make different trade-offs on environmental integrity and costs. The implications of different combinations of choices for the accounting regimes under different circumstances has to be therefore explicitly and carefully considered.

- In the LDC case, transaction costs may well be higher than for implementation in NICs but if the levy is universally applied, part of this total income could be used to assist the process in LDCs where possible. The cost of CDM credits is an issue which needs attention as there are conflicts over the need to discount credits to offset uncertainties, to offset the effects of banking and to compensate for the potentially high transaction costs necessary to make the process successful.

- Early crediting could lead to problems of relaxation of donor targets and possible extension to A6JI unless action is taken before early crediting starts in 2000.

In our study, we hope to examine how different ways of operationalising the CDM may be constructed, what the implications of different approaches would be, and what the trade-offs are between equity, the environmental integrity and the cost efficiency. The practicalities of the process are a final determining factor at the country and project level.

1. Introduction

The aim of the paper is to review the main issues concerning the implementation of the Clean Development Mechanism (CDM) under the Kyoto Protocol. It is the first report of the study ‘Initial evaluation of Clean Development Mechanism type projects in Developing Countries’ which has been funded by DFID under its ‘Knowledge and Research’ Programme; theme ‘Reducing the environmental impacts of energy use’. The objective of the project is to inform international debate on the design of the Clean Development Mechanism and its implications for energy use, the environment and poverty alleviation in Developing Countries.

The CDM is defined under the Kyoto Protocol to the UN Framework Convention on Climate Change (UN FCCC) as a 'flexibility mechanism' which allows Industrialised Countries to fund projects which reduce greenhouse gas (GHG) emissions from Developing Countries. In return, Industrialised Countries receive 'credits' which they use to contribute to their GHG emissions targets. A stipulation of the Protocol is that projects funded through the CDM should contribute towards sustainable development in the 'host' countries.

The CDM is due to begin operation from the year 2000, but the detailed rules for its operation have yet to be defined. Many issues remain to be resolved including how GHG emissions reductions due to CDM projects can be 'measured', and how CDM projects can be assured of contributing to sustainable development.

In this paper we explore these issues. First, in section 2, we detail the background of the CDM and the Developing Country context in which it is intended to operate. In section 3, we then go on to discuss particular issues relating to sustainability and equity, eg technology transfer, capacity building, local benefits and disbenefits of CDM projects. Following this, we detail some of the technical issues, eg additionality, baseline construction, monitoring and verification (section 4). Finally, in section 5, we present conclusions.

2. Background

In this section, we review the background context to the Clean Development Mechanism. We begin with a brief review of the causes and effects of anthropogenic climate change, particularly focusing on Developing Countries (DCs), followed by a discussion of the development of the international legal framework intended to tackle this problem: the UN FCCC and the Kyoto Protocol. We then go on to review the current social and economic situation within DCs, focusing on the energy sector because this is the sector where most CDM projects (at least initially) are likely to be concentrated. Finally in this section, we review the DFID White Paper on Development and highlight the issues it covers which are relevant to this discussion.

2.1 Climate Change

There is now a broad consensus among natural scientists that 'there is a discernible human influence on global climate' (IPCC WG I, 1996). Human activities, including the burning of fossil fuels, land-use change and agriculture are increasing the atmosphere concentrations of greenhouse gases (GHGs). The projected effects of this are a warming of the Earth's surface by between 1 and 3.5°C by 2100 (compared with 1990). Such a warming will lead to sea-level rises and changes in the global climate. In turn, these are likely to cause impacts including damage to coastal areas, altered agricultural patterns, changes in precipitation, intensified air pollution, increased desertification, increased incidence of infectious diseases, and accelerated rates of species loss (IPCC WG II, 1996). Already, some communities have become more vulnerable to hazards such as storms, floods and droughts, with the resultant consequences for fires, pest outbreaks and increased transmission of vector and non-vector-borne infectious diseases.

Land losses as a function of a rise in sea levels are expected to increase the vulnerability of some coastal communities, particularly those in small island states, low-lying areas and river deltas. Given current state of protection systems, it is estimated (IPCC WG II, 1996) that land losses in Bangladesh and the Marshall Islands will be significant at 17.5% and 80%, respectively. Egypt is also expected to experience land losses of its fertile Nile Delta which could affect the lives of 6 million people with 12% to 15% of agricultural land loss (Nicholls and Leatherman, 1995).

Changes in climate could exacerbate periodic and chronic shortfalls of water, particularly in arid and semi-arid areas of the world, hence increasing the recurrence and magnitude of drought and land degradation. According to IPCC WGII (1996), some 19 countries (primarily in the Middle East and north and southern Africa) currently face such severe shortfalls that they are classified as either *water-scarce* or *water-stressed*. This number is expected to roughly double by 2025, in large part because of increases in demand resulting from economic and population growth. Water stress, coupled with land losses through desertification are likely to have major repercussions on the ability of certain regions to contain the potential problem of food security (Buckland, 1997).

New, widespread risks to public health are also anticipated with climate change. Quite apart from the increased risk of malnutrition and hunger due to reductions in food security, the combination of heat and pollution could lead to an upsurge in respiratory illnesses in the expanding urban areas, and higher temperatures could increase the incidence and extent of infectious diseases such as malaria, dengue fever, and yellow fever. Model projections indicate that the geographical zone of potential malaria transmission would expand in response to global mean temperature increases at the upper part of the IPCC-projected range (3-5°C by 2100), increasing the affected proportion of the world's population from approximately 45 per cent to approximately 60 per cent by the latter half of the next century (IPCC WG II, 1996).

It is important to note that DCs are particularly vulnerable to the impacts of climate change for two main reasons: (1) their high dependence on natural systems, and (2) their relatively low institutional capacity which will inhibit their ability to respond to the likely adverse impacts. Hence, it is in their best interests to engage constructively in efforts to reduce GHG emissions, and ensure these efforts are compatible with their development needs.

2.2 The UN Framework Convention on Climate Change and the Kyoto Protocol

The UN Framework Convention on Climate Change (UNFCCC), agreed in 1992 (and now ratified by 176 countries), has as its objective the 'stabilisation of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. In December 1997, the Kyoto Protocol to the FCCC was agreed which set legally binding targets for Industrialised Countries (known in the terminology of the FCCC as 'Annex I' countries). In combination, the targets amount to a 5.2% cut in the GHG emissions of industrialised countries (IC's) by the period 2008-2012 from 1990 levels. At present, the Kyoto Protocol has been signed by 84 countries.

2.2.1 Flexibility Mechanisms

A significant, and controversial, aspect of these two agreements is the allowance of the use of *flexibility mechanisms* designed to allow countries to meet their commitments 'jointly' in an effort to minimise costs.

Defining Flexibility Mechanisms

There are basically two types of mechanism: *Emissions Trading* (ET) and *Joint Implementation* (JI). ET is where countries buy and sell fractions of their 'allowable' emissions. JI is where a 'donor' country funds a particular emissions reduction project in a 'host' country in return for credits which it can use towards meeting its own target. Clearly, in both cases, the theoretical rationale is that countries can identify whether it is cheaper to reduce action domestically or abroad in order that a least-cost path is followed. Whilst ET and JI are similar in their underlying concept, the basic difference is obviously that JI is associated with a particular activity or project.

At the first Conference of the Parties (COP, the sovereign body of the UN FCCC), an agreement was reached which allowed for a pilot phase for Joint Implementation to begin extending from 1995 to the end of 1999. Under this pilot phase (known as 'Activities Implemented Jointly' or AIJ), projects were to be carried out but no credits were to be issued. The purpose was therefore to gain experience in implementing such projects.

Under the Kyoto Protocol, ET and JI were included in Articles 6, 12 and 17. Article 17 simply defines ET as previously discussed. Article 6 allows for JI between Annex I countries, ie those which have emissions targets. Article 12, on the other hand, allows for JI projects to be carried out in host countries without targets (non-Annex I countries). This latter situation is the *Clean Development Mechanism* (CDM) which is the focus of the rest of this paper. It is so named to reflect the fact that all the host countries under Article 12 will be developing countries.

Opposition to Flexibility Mechanisms

As mentioned, the inclusion of flexibility mechanisms is controversial. Developing countries have argued that, since anthropogenic climate change is mainly due to historical emissions from industrialised countries, in the interests of equity, it should be they who reduce emissions first. This has been acknowledged by ICs and is reflected by the fact that emissions targets under the Kyoto Protocol only apply to ICs. However, DCs argue that the inclusion of flexibility mechanisms undermines this and creates further obstacles for the successful implementation of the Protocol. Specifically, they argue that such arrangements could:

- undermine domestic action in ICs which would allow a continued increase in GHG emissions from these countries, perpetuating the global inequalities in per capita emissions (Parikh and Gokarn, 1993);
- 'limit the host country's freedom to influence its own development path,' whilst giving 'the donor country more flexibility in its development path' (CNE, 1994), particularly since DCs will be at an disadvantage in negotiations due to lower institutional capacity;
- replace some of the assistance (financial, technological etc.) currently given to developing and transition countries under current FCCC commitments and as part of overseas aid programmes (CNE, 1994);
- 'skim off' or ‘cherry pick’ the cheapest projects, so that, if and when DCs are required to adopt emission constraints in the future, they will be faced by higher marginal abatement costs (Parikh, 1994);
- increase the transaction costs of achieving emissions reductions, due to the necessity for complex international regulating systems.

As a result of these concerns, few DCs participated in AIJ pilot phase. It is worth noting here that out of 126 AIJ projects currently approved, only three are being implemented in Africa (JIQ, 1999), effectively excluding a large section of the world poorest countries from this process.

In drafting the Kyoto Protocol, two provisions were added to guide the use of the flexibility mechanisms: *supplementarity* and *additionality*. The first provision is that action taken through the use of the flexibility mechanisms must be ‘supplemental’ to domestic action. The second provision is that projects undertaken under Article 6 JI (A6JI) and the CDM must be ‘additional’ to what would otherwise have occurred. Both these terms have yet to be explicitly defined, but such definitions are crucial in determining exactly how these mechanisms will function. Current debate over supplementarity centres around whether it should be expressed in terms of a defined percentage of the total emissions reduction by a given country (eg no more than 50% of the emissions reduction can be achieved overseas), or whether the definition should be ‘softer’, eg in terms of a set of policy measures or level of investment in domestic action. The concept of ‘additionality’ we discuss in some detail in section 4.1.

2.2.2 Clean Development Mechanism

Purpose

As discussed above, the Clean Development Mechanism (CDM) refers to a situation where a donor country funds a project or measure which will reduce GHG emissions in a host country in return for ‘credits’ which it can use to contribute towards its emissions target. In the CDM, the donor country will be an industrialised country with emissions targets, whilst the host country will be a developing country without targets. The credits that will be transferred are called *certified emissions reductions* (CERs).

A cornerstone of the CDM is that projects implemented through it should assist the host country 'in achieving sustainable development' (Article 12.2). Further guidance for the CDM is given in the FCCC, ie that it 'should be integrated with national development programmes' and 'be appropriate to the specific conditions' of the host country (Article 3.4). However, it remains to be defined how this may be achieved. Thus the essential feature of implementing the CDM will be to balance the aim of contributing to the sustainable development of the host countries with the need of the donor countries in achieving GHG emissions reduction.

Assessment of the CDM

A problem with both of these demands is the difficulty in measuring them. The problem with 'measurement' of emissions reduction is that it is defined as the difference between the emissions of the CDM project over its lifetime and the emissions of a 'baseline' scenario: ie a scenario of what would have happened in the absence of the project. The baseline, by definition, cannot be measured directly.

In assessing the contribution of the CDM project to sustainable development, there is an even greater problem in that there is no universally accepted definition of what should be measured, let alone how. It could include assessment of local environmental effects, eg air pollution; local social effects, eg employment; contribution to resources depletion; 'appropriateness' of technology; capacity building etc. We discuss these issues in detail in the following sections. Such a discussion could draw on insights from the UNDP Human Development Index, which is used to 'measure' development.

Operational Details

Whilst many of the details of the CDM have still to be negotiated, some of the institutional structure which will guide its operation has been decided. This structure is to be composed of a multilateral body known as the *executive board* (EB) which will supervise the CDM and assist in arranging funding of projects as necessary. The World Bank has set up a 'carbon investment fund' which is one possible template for how the EB could be run. The EB will operate in conjunction with an *operational entity* (OE) which will, among other things, certify the emission reductions achieved by the projects (the CERs) as 'real, measurable and long term' and ensure that the reductions are 'additional' to any that would occur in the absence of certified project activity. To pay for this service, and to assist DCs particularly vulnerable to the effects of climate change to meet their costs of adaptation, there is a levy to be introduced on all transactions. Since this levy only applies to the CDM and not to JI under Article 6 or ET, it will act as a disincentive for investing in CDM action.

There seem to be two main implementation scenarios for the CDM. In the first the investors (which could be public or private organisations) come in to the host country and the selection and implementation of projects is dependent on market forces and the priorities of the donor country organisations. In the second option, the host country offers projects to investors either through the EB or through country offices set up for the purpose. There are differing implications for the equity and sustainability both of the CDM project and the host country depending on the option chosen. It is clear that these trade-offs should be made explicitly and where necessary appropriate safeguards put in place.

The details of the operation of the CDM are due to be decided by the 6th COP at the end of 2000, building on detailed discussions at the 5th COP in Bonn at the end of 1999. The lessons learned from the 'Activities Implemented Jointly' pilot phase are designed to feed in to this process. It has been specified in the Protocol that the modalities and procedures which guide to CDM should be transparent, efficient and accountable through independent auditing and verification of project activities.

2.3 The Developing Country Context

In order to properly assess the potential benefits and problems of the CDM, it is necessary to understand the situation in which it will operate, ie the context of developing countries. In this section we first examine the current range of social and economic diversity in DCs. Then we assess their current and future contribution to global GHG emissions and finally look at the current issues within the energy sectors DCs which is the focus of this DFID study and is the sector where the majority of pilot AIJ projects have been implemented.

2.3.1 Differentiation in the levels of development and priorities

The principal characteristics and outwardly the most visible feature of developed Western countries is their economic and technological superiority over the poorer developing countries, which is demonstrated in the quality and wide range of material provisions they are able to offer their populations. However, recent economic history reveals that within the broad definition of 'developing countries', there is now a growing differentiation in political, economic, social and technological terms. At the one end of the spectrum, there are countries that have become important players in the world economy, consisting of large and dynamic manufacturing and commercial sectors with substantial success in high-technology trade over the past two decades (Roessner and Porter, 1990). Commonly referred to as 'newly industrialised countries' (NIC), this group consists of an increasing number of countries such as South Korea, Taiwan and Singapore in south-east Asia, and Brazil, Mexico and Argentina in Latin America. At the other end of the classification are the underdeveloped countries fighting decades of economic stagnation and decline, poor infrastructure, political conflicts, and an increasingly marginal status in the world economy (European Union, 1998). The majority of sub-Saharan African countries with little economic activity beyond subsistence agriculture and livestock tending fall into the latter group. In between the above two groups are the relatively poor but populous countries such as China and India where a substantial modern industrial sector is embedded in a primarily agrarian economy. A further group includes the oil-producing countries, within which there are also wide differences in styles of expenditure and accumulation. Thus the 'developing countries' are heterogeneous, with a wide range of development needs and priorities.

During such economic transition from ‘less developed country’ (LDC) through ‘newly industrialising country’ (NIC) to a ‘mature developed country’ (MDC), nations experience an increase in energy and mineral demand. As the nations of south-east Asia are all LDCs or NICs, they can be expected to continue experiencing high rates of growth in energy and mineral demand (Clark, 1993). The three important ASEAN[1] countries, namely Indonesia, Malaysia, and Singapore, recorded between 8.5% and 10% per annum increases in their energy consumption between 1980 and 1994. Similar increases in energy and materials consumption was also recorded during the 1980s and 1990s in South America with countries such as Brazil, Argentina and Chile experiencing high economic growth and an expansion in their manufacturing base. According to the World Development Report (World Bank, 1997), over the period between 1980 and 1994, Brazil and Chile registered annual increases of their commercial energy use by about 4% and 5%, respectively.

[1] ASEAN countries are members of Association of Southeast Asian Nations, which was formed in 1967 by Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam.

Newly Industrialising Countries

For many countries of Asia and Latin America, much of their development priorities lie in ensuring that investment from outside (financial flows) continues to flow into the export-oriented manufacturing and commercial sector. For these developments to be realised, a range of economic, political and technical requirements need to be put in place. For example, explanations of success in South East Asia frequently include the relatively stable political climate, high levels of both public and private investment, efficient use of advanced endogenous technology, and human capacity building (Jones, 1993).

China and India

The past decade has also seen the emergence of the two large and most populous nations, China and India, playing an increasingly prominent role in the economic activity of the region. The two countries, with their huge human and natural resource, and a relatively low wage economy have begun to attract investment capital from multinationals and Western (and Japanese) industries. Since the mid-1980s, the Chinese economy has seen a large increase in the share of energy-intensive manufacturing and the proliferation of coal and diesel consumption to meet the increasing energy requirement. At present, annual energy consumption in China is growing by about 5%, which is considerable in view of the fact that China is now the second largest energy consuming economy and most of the energy increase is derived from carbon-intensive fossil fuels (Zhang, 1997). Energy consumption as a function of heightened economic activity has more than doubled during the last decade in India, from 94 million tons of oil equivalent (mtoe) in 1980 to 222 mtoe in 1994 (World Bank, 1997). According to Parikh et al. (1997), most of the increased consumption has come from coal and oil used to fuel the burgeoning power sector which currently accounts for more than 60% of investments in the energy sector. Coal provides more than 60% of India's commercial energy requirements, and in the absence of cleaner alternatives and efficiency measures in place, coal will continue to assume an increasingly important role in India's energy sector in the future. Together, China and India currently account for a bulk of the 'developing countries' share of energy consumption and are set to increase further.

Less Developed Countries (LDCs)

In contrast to the situation in south-eastern Asia, South America and the ‘big two’ (China and India), the sub-Saharan Africa (SSA) share of global energy consumption stands at mere 2.7% (WRI, 1999). With little economic activity beyond subsistence agriculture and livestock tending, and having achieved little in the way of self-sustaining industrialisation, the manufacturing and commercial sector remains weak, largely serving a small domestic market. At least in the short to medium-term, the development priorities in SSA and indeed in many agrarian based economies of south Asia are strikingly different from their other 'developing countries' counterparts which have collectively assumed a more active role in the world economy, both as producers and consumers. While the development priorities for the advanced 'developing countries' lie in ensuring favourable investment climate is maintained through various fiscal and institutional reform mechanisms, much of the development emphasis in SSA remains focused on institutional capacity building, a renewed focus on the agricultural sector and poverty alleviation issues.

The development challenge faced by the poorest countries in SSA and south Asia is of a two pronged nature, though not mutually exclusive. Firstly, increases in the incidence of poverty has highlighted the need to mobilise their resources to bring about economic and social benefits to their impoverished populations. Secondly, there is a growing realisation that in order to meaningfully participate in a rapidly changing global economy, they need to innovate on many fronts to build the appropriate institutions, develop technical capacity and satisfy stable investment conditions. Herein lies the dilemma of development in SSA: the apparent contradiction between the critical nature of poverty levels demanding quick interventions, and the complex exercise of formulating the enabling environment for development and investment requiring detailed, and time-consuming processes.

For the implementation of the CDM therefore the range of stages of development of the DCs implies that the NICs with their markets and infrastructures reasonably well developed could be treated in the same way as transition economies. However for the LDCs and China and India there should be equal emphasis on development priorities. Consideration therefore will be given to the implications of these different stages for the issues which will be highlighted in this paper.

2.3.2 Contribution of Developing Countries to GHG Emissions

It is against the backdrop of economic uncertainty and a potentially energy-intensive development that the issues surrounding climate change need to be discussed. As there are varied development activities between developing countries and therefore heterogeneous energy consumption profiles, their shares of GHG emission are also likely to reflect these differentials. The 'newly industrialised countries' discussed earlier are considerably closer to that of the industrialised countries in terms of both infrastructure and emissions. The continued growth in their energy sector has meant that NIC countries are becoming and will continue to be important contributors to global GHG emissions. Some of the highest annual percentage increases in CO_2 emissions are recorded by countries such as South Korea, Indonesia, Chile and Israel that are in a process of transition to 'northern' status (Claussen et al., 1998). Although these countries are employing energy efficiency measures which have, over the years, reduced the energy intensity (consumption divided by GDP) of their economies, they remain potentially important players in future emission reduction initiatives.

With high population, rapid economic growth, and energy demand doubling every 12 years, China and India, are seen with increasing concern insofar as the climate change debate is concerned. At present, China and India are placed second and fifth in the world ranking of total CO_2 emissions with projected annual growth rates of 6.5% and 6%, respectively (Claussen et al., 1998). At current rate of growth, China's annual CO_2 emission will surpass that of the US, and India will occupy third place by 2020.

On the extreme end of the spectrum, Africa is a minor contributor of global GHG emission, a fact clearly indicated by its share of global CO_2 emissions. Africa's share accounted for only 3.3% in 1995, although it has been increasing steadily, rising from 25 to 191 million metric tonnes of CO_2 between 1950 and 1995 (EIA, 1998). In global terms, emissions from the continent will continue to be low for the immediate future with the exception of South Africa, which depends significantly on coal for power production and presently accounts for about 1.4% of global GHG emissions presently (UNEP, 1998). It is worth noting here that energy and land-use sectors dominate African GHG emissions, the latter deriving from bush fires, deforestation and the conversion to agriculture which destroys biomass and releases soil carbons (Sokona et al., undated).

The investment focus for CDM activities would be expected to be on the most energy intensive and most industrialised of the DC's in the short term rather than on the LDC's which will take some time before having a significant contribution to GHG emissions. Nevertheless the opportunity is there with the LDC's to encourage them at this early stage to take a development path which leapfrogs the fossil fuel dependent industrialised energy intensive route and to move straight to a sustainable path with its attendant benefits.

2.3.3 Energy Services and Development

The range of stages of development in developing countries can be mirrored by the wide range of living conditions within the country. People living in urban areas may have access to modern infrastructure and sophisticated technologies (including those for harnessing energy, such as electricity and gas supplies and appliances), while people in rural areas (and the urban poor) of the same country can be living without meeting their basic needs for clean water, shelter, food and energy services.

Energy Service Provision

In rural areas, in general, communities often meet the bulk of their energy needs from traditional sources and have access to electricity supplies to a lesser extent. Traditional sources of energy, such as fuelwood (or other biomass) for cooking, candles and kerosene for lighting, are inefficient, and have high running costs. However, the initial capital cost required for investment in conversion technologies such as wood burning stoves, is low (Anderson et al, 1999). Where electricity supplies are available, they are either delivered by a conventional grid system, or by stand-alone systems, such as diesel generators, PV systems or micro hydro power schemes. Where renewable energy sources are harnessed, it must be noted that schemes usually have some element of aid support or grant funding from government (Foley, 1989).

In urban areas, however, households can also use traditional fuels (for instance, wood-burning stoves are popular in Sri Lanka in households in Colombo, the country's capital) and these are more likely to used in urban areas where other energy service delivery mechanisms, such as the electricity grid, are not reliable. In fact, many developing countries suffer power shortages, (due, eg, to water shortages following the failure of the monsoons in Sri Lanka, or management breakdown, such as in Ghana) and people living in urban areas often experience so-called 'brown outs' at various times of the year.

In poor urban areas there is generally little access to grid electricity. There are several reasons for this, but the common ones are:
- high connection charges;
- housing does not meet safety standards;
- houses themselves are in informal (often illegal) settlements.

Energy and Development

In general, there is a consensus that most households, rural or urban, benefit from receiving an electricity supply, and that to increase the level of economic benefit in a country in general, productive industries must develop, with concomitant increases in their energy consumption.

Most development agencies (DFID among them) attempt to support the meeting of these needs and aspirations in a way which is equitable and reduces, rather than widens, the gap between rich and poor in any country.

It has long been realised that electricity grid systems cannot expand at the rate required to meet worldwide growth in demand. Organisations working in energy and development have therefore turned their attention to the provision of decentralised electricity supplies, which are close to more isolated user communities (Gerger and Gulberg, undated).

Some of these supply systems are very small (e.g. less than 100kW) and are based on renewable sources of energy, such as hydro or solar power. Some supply only a single household (Yaron et al, 1994) while others supply whole networks of remote communities via small scale transmission and distribution systems (known as 'mini-grids') (e.g. see Foley, 1998).

In order to maintain security of supply, many countries need new base load power plants which are reliable and diversify their generation base. In some cases, these must be fossil fuel plants. The attendant problems for emissions of GHGs of this sort of decision reinforce the need for a strategic approach to planning.

2.4 UK White Paper on International Development

In the 1997 White Paper on International Development (DFID, 1997), the UK government announced that it was refocusing its aims on:

> *'the elimination of poverty and the encouragement of economic growth which benefits the poor'*

In particular, the White Paper outlines the UK government's main quantifiable aim:

> *'halving the proportion of the world's population living in extreme poverty by 2015'*

It aims to do this, alongside other countries, through supporting targets and policies that create 'sustainable livelihoods for poor people', promoting 'human development' and conserving the environment. The CDM has potentially huge impacts on all of these actions.

2.4.1 Strategies

The White Paper's main strategic idea is that of working in partnership with others, be they donors, other development agencies, the UK private and voluntary sector, the research community, 'poorer countries' or the general public.

It also makes it clear that the government intends to ensure that all UK government policies affecting Developing Countries 'take account' of the aim of sustainable development and poverty alleviation. In this context it particularly mentions policies relating to the environment, trade, investment and agriculture and states clearly that conservation and 'sustainable management' of the environment is a 'cornerstone' of its approach.

It uses the concept of 'Sustainable Development' to express its belief in economic growth that includes all members of society and that outstrips population growth rates. It points out repeatedly that the environment is a resource that cannot be exploited irresponsibly, either on a local or global level, and that the people of today cannot squander the environmental resources of future generations.

Poor people frequently suffer from the worst impacts of environmental crisis. In rural areas, major problems include deforestation, land degradation and population pressure on arable land. In urban areas (where half the world's population will soon be living for the first time in human history), the poor have to contend with the impacts of pollution, restricted and costly water supplies, lack of sanitation and basic infrastructure, poor air quality or contaminated food.

In terms of activities that can impact on CO_2 emissions reductions, the White Paper is very clear that it intends to support energy efficiency measures (relating to power generation, transmission, distribution and capacity building) in key countries as well as promoting the use of Renewable Energy resources (such as PV and mini hydro power) for electricity supply for remote users.

The paper mentions Capacity Building in several contexts (energy infrastructure development, management capability, compliance with international trade and customs standards and so on), noting that a country's capacity to absorb aid support must itself be supported so that the country can develop sustainably.

The UK contributes to the Global Environmental Facility (GEF) which acts as the financial mechanism for a number of conventions including the FCCC, but these contributions are in addition to its budget for International Development. The paper contains a whole section on Climate Change under the heading of 'Consistency of Policies'. Under this it mentions the above contributions and also notes the importance of the advice of the IPCC on the impact of Climate Change, especially on the poorest people. It further states that Developing Countries should not be required to set emissions reduction targets, but 'as Developing Countries increase their efforts to tackle climate change and limit emissions, they will require appropriate assistance to do so.'

Whether the UK government intends to provide this 'appropriate assistance' is not stated. Were it to do so, however, the CDM would have to be additional to this as well as any other aid intervention.

In practice, the principle of 'poverty alleviation' means that aid to developing countries must be increasingly targeted towards the poorest sections of society. This has its own problems. The poorer sections of any society are usually the least organised and the least vocal, are often oppressed by the culture in which they live and are on the fringes of the cash economy. They are the sections of society that suffer most from the adverse effects of environmental degradation and may need assistance to make optimum use of the technology and services provided by the aid intervention.

- In order that the CDM, and instruments like it, can reach the poorest sections of society, there must be intermediate steps and bodies through which their support is channelled, and the capacity to absorb CDM support must itself be supported by the CDM.

The challenge is to keep the cost of such intermediation to a minimum.

In applying the CDM to developing country hosts we focus particularly on the energy sector and the dual nature of the CDM becomes apparent in that CDM projects designed to reduce GHGs also will impact in the development context. It is this interaction which is examined next.

3 The Clean Development Mechanism: Equity and Sustainable Development Issues

There are two main underlying principles which the FCCC states must guide action taken to reduce GHG emissions: equity and sustainable development. The overall equity of the convention is related the equity between present and future generations; and in terms of equity between countries. In particular, Article 3.2 states that 'the specific needs and special circumstances of developing country Parties… should be given full consideration'.

This can be illustrated by the concern that the CDM will leave Developing Countries with only the higher cost abatement options, when they in turn have to make GHG emissions reductions in the future. As in the long term, this could have a negative impact on overall GHG reduction levels and would represent an exploitation of such countries by the industrialised nations, it is becoming accepted that without equity there is little reason for Developing Countries to participate.

When considering a specific mechanism such as the CDM, equity can be considered in two forms: 'procedural' equity and 'consequential' equity. Procedural equity concerns the fairness of the process, eg the level of transparency and participation in setting up CDM projects (ELI, 1997). The Protocol does in fact advocate transparent processes, including third party auditing. Consequential equity refers to the degree of fairness in the outcome, ie the balance of the costs and benefits between the host and donor countries.

On sustainable development, the FCCC states (Article 3.4) that:

> *'The Parties have a right to, and should, promote sustainable development. Policies and measures to protect the climate system against human-induced change should be appropriate for the specific conditions of each Party and should be integrated with national development programmes.'*

Hence, the Clean Development Mechanism must operate within this context. In this section, we explore the detail of equity and sustainability issues in the CDM, highlighting some of the practical implications by use of case study projects.

3.1 Approval Procedures for CDM projects

It is not obvious how such concerns as 'cherry picking' by investors - where they invest in the cheapest emissions reduction options in the host country - or development not in line with host country priorities are supposed to be addressed in implementing the CDM. At the moment, the only stage for this to happen is the 'project approval stage'. Under the Protocol, both the host and donor country governments must formally accept and approve a CDM project for it to be implemented.

This is seen as a 'safeguard' to ensure equity. It was originally envisaged that host countries would not accept projects if they felt that the project was not in their interest and that this was sufficient protection from unsuitable projects. However this implies that a host country is in a position to be selective or to argue their case. This in turn implies that it has sufficient infrastructure to be able to make the necessary judgements, which may not be the case. It would be easy, for example, for social concerns to be overridden by possible monetary and economic considerations. Part of the acceptance procedure by the host therefore needs to be based on information on the host country energy, environment and development situation.

The criteria for approval, which were set up for AIJ the pilot phase, though calling for sustainability and participation, vary in actual substance from programme to programme and host to host so that there is no consistent approach. The Environmental Law Institute (ELI, 1998) calls for this lack of consistency to be rectified. The reporting format seems to be the focus of effort on ensuring that enough good quality data is available to assess the projects being undertaken but as yet no attempts are being made to harmonise the approval stage which is much more critical for the CDM in many ways. For example there is no requirement to do some sort of impact analysis of the environmental and social effects of the project so that adverse effects may be minimised and local benefits maximised. The approval criteria are an essential mechanism for implementing measures to ensure equity and sustainability and need more discussion and specification to ensure the goals of the Convention are met.

3.2 Technology Transfer

Concerns on sustainability and equity come into every stage of the implementation process for the CDM and the transfer of technology is an area not usually discussed in this context, however we feel that for the CDM this is a key area.

In much of the discussion concerning the transfer of technology through both A6JI and the CDM, implicit assumptions have been made about the process involved. In essence, it is envisaged that industry in the donor country will offer, in conjunction with a host country partner, prospective projects. There is a sense in which the donor country industry is the determining factor in the choice of technology of the project, and of significant influence in this will be the possibilities for opening up new areas for trade. The host, needing investment and with low institutional capacity, is likely to fit in with that choice without fully gauging what the implications are for its own development. This is not necessarily going to lead to a 'sustainable development' as set out in the FCCC, especially if a large number of CDM projects are implemented.

CDM projects initiated in developing countries must have long term sustainability in order for their GHG emissions benefits to be realised. This means that equipment must be installed, commissioned and operated for the given lifetime of the project. Repairs must be made speedily, replacement parts must be available, and generation technologies must operate within wider grid systems that are robust enough to deliver the power they produce to consumers.

Technology transfer is thus a complex process involving the transfer of not only the technology itself, but also:
- the skills and understanding required to operate the technology efficiently;
- the skills needed to repair and maintain the technology and generate spare parts;
- financial management, planning, communications and marketing skills;
- knowledge of ownership options and replacement options.

In the following discussion we would like to examine the choice of technology of a given CDM project and the possibility of a more pro-active position in that choice by the host country.

3.2.1 Choice of Technology

There is a flavour in the UNFCCC and the Kyoto Protocol that CDM projects must introduce 'state of the art' emissions reduction technology to the host. This approach to technology transfer has been adopted with the aim of helping DCs 'leapfrog' more polluting, and often cheaper, conventional technologies. It is also in line with satisfying the criterion of ‘additionality’ of projects (ie they would not have happened in the absence of the CDM; discussed further in section 4.1).

However there are some aspects which this approach overlooks when applied to DCs.
- State of the art technology may not be ‘appropriate’ to the state of development of the host country or the region within the host country. There may be no capacity to maintain and operate the facility over the long term. Hence, intermediate steps may be needed before sophisticated technologies are introduced.
- It may not be in line with host country development priorities or energy sector strategies.

It is possible therefore that either a DC will host CDM projects which fail due to lack of supporting capacity or that the country becomes reliant on overseas energy technology/ fuels which are against its wishes.

One way around this would be for the host country to prepare a strategy on its future development and from this develop a ‘CDM strategy’ indicating which types of projects it would be willing to accept from prospective donor countries. There was strong support at a recent conference on 'AIJ: Developing Country Perspectives' (Chatterjee, 1997) for Developing Countries to establish policy frameworks that give them a proactive edge in establishing national AIJ (and eventually, CDM) programmes and developing project proposals. This would also enable DCs to evolve a strategic vision for how the CDM fits into their development priorities, and more specifically identify technology options and project types which are in line with their development needs and directions. Central to this proactive vision is the need to co-ordinate the activities of different government and private actors, prioritise sectors and technologies for CDM projects and establish mechanisms to encourage the development of new projects. Thus, building the capacity to support the implementation and evaluation of CDM projects gives developing countries an important impetus to bring about the transfer of appropriate technologies, participate actively on issues of equity, and explore ways in which CDM projects can be integrated into sustainable development goals.

It is important to note that some potential projects in the ‘CDM strategy’ will be so-called ‘no regrets’ projects, but are not likely to be funded due to lack of capital in the host or due to other non-market barriers. (We return to this issue when we discuss ‘additionality’ later in section 4.1). It may be necessary for the host country to receive aid in compiling its CDM strategy, and this could be funded from the CDM levy (see section 2.2.2).

3.3 Capacity Building

3.3.1 Understanding the concept

According to the Agenda 21 document (Chapt.37) in UNCED (1992), 'capacity building encompasses the country's human, scientific, technological, organisational, institutional and resource capabilities.' Thus, the main objective of capacity building is to improve the ability of governmental, civic and national institutions, and actors through which resources can be channelled and sustained effectively to perform planning, policy formulation and implementation tasks in the development domain. Capacity building is, in essence, an enablement and empowerment tool with the aim of strengthening targeted human resources and institutional development, which are two of its key components.

3.3.2 The nature of capacity building in CDM

The importance of building and maintaining human and institutional capacity to plan and implement CDM projects could not be over-emphasised. From the investor's perspective, capacity building assists the investor to better allocate resources with the certitude that the necessary support is in place to safeguard their investment. While the host needs to demonstrate the assurance of an enabling environment for investment, the capacity to effectively implement projects also brings with it the advantage of maximising the benefits from a particular project to the country, community and the individual beneficiaries. Thus, capacity building invariably benefits the needs of both the host and investor. There was strong support at a recent Conference on 'AIJ: Developing Country Perspectives' (Chatterjee, 1997) for developing countries to establish policy frameworks that give them a proactive edge in establishing national AIJ programmes and development project proposals. This would also enable developing countries evolve a strategic vision for how AJI fits into their development priorities, and more specifically identify technology options and project types which are in line with their development needs and directions. Central to this proactive vision is the need to co-ordinate the activities of different government and private actors, prioritise sectors and technologies for AIJ projects and establish mechanisms to encourage the development of new projects. Thus, building the capacity to support the implementation and evaluation of CDM projects gives developing countries an important impetus to bring about the transfer of appropriate technologies, participate actively on issues of equity, and explore ways in which CDM projects can be integrated into sustainable development goals.

3.3.3 The various elements of capacity building in CDM

In a recent regional workshop on 'CDM and Africa' (UNEP, 1998), a range of capacity building requirements were discussed in order to better prepare African countries for participating in CDM. These included: stimulating the private sector, raising awareness about CDM and climate change in governments, building capacity in baseline calculation, monitoring, verification and certification, R&D of technology and the creation of institutions at national and regional levels to channel CDM activity. However, this cannot be carried out by developing countries alone; after all, the benefits of an enhanced capacity stand to serve the needs of both parties, the host and the investor. Technology developers in developed countries must provide sufficient support for training and development in areas such as baseline definitions, emission monitoring and verification, and greenhouse gas reduction estimation as a contribution to building the capacity in relevant agencies in developing countries (UNFCCC, 1998).

It should be emphasised that capacity building should be recipient, not donor, driven, since it should be left up to individual countries to conduct technology assessment necessary to structure a practical GHG mitigation path specific to their needs. For capacity building to be sustainable, it must involve local expertise and experience. In this regard, the host country has the task of identifying local expertise and adapt the methods of capacity building to the particularities of local capacity, since foreign investment on its own, while the source of much needed capital, does not necessarily contribute to local skills. In fact, many AIJ projects in developing countries rely heavily on imported equipment, consultants, technical expertise, and monitoring, which, in the long run, only perpetuates dependence and is clearly undesirable (Chatterjee and Fecher, 1997). A number of GEF funded projects had attempted to address host country capacity by supporting technical training and assistance in market and technology promotion (Marawanyika, 1997), and project evaluation and performance reviews for technologies (GEF, 1998).

3.3.4 Capacity building and North/South Partnership

A similar commitment is expected for CDM projects. As Maya (1997) indicates, capacity building should not be limited to simply prepare the rest of the world to contribute to relieving the North of its climate change mitigation obligation, since such a structure is likely to be short-lived. Joint efforts are needed to create the means through which dynamic exchange of skills and experience among Northern and Southern policy makers and project participants can be fostered on the basis of mutual interest. Experience from JI projects in countries with economies in transition (Joint Implementation Quarterly, 1997) and, more specifically, Costa Rica (Dutschke and Michaelowa, 1997) is instructive. Effective technical co-operation and technology transfer is achieved through "hands-on" training activities, transfer of assessment tools, workshops for countries to share experiences, and ongoing technical co-operation during the lifetime of the study.

3.3.5 Small scale projects

Energy supply projects constructed as part of development and poverty alleviation programmes are often small scale (i.e. less than 1MW, and often less than 100kW). The introduction of ‘clean’ technologies at such a scale requires specialised capacity building and ongoing support until the technology is sustainable within its new environment (Inversin, 1995). In situations where there is no model for business structure other than the individual or the family (such as in rural Nepal, for example in Rothe ,1993) then this capacity building extends to management techniques, contract and ownership structures, as well as technical know-how.

Administering a system of support for such projects as part of the CDM would face the same problems as any widespread deployment of a large number of small projects. Administrative costs will be high, reducing the amount of financial support available still further. Accounting and monitoring costs will also be high, as a fraction of project cost.

Costa Rica (Tattenbach, 1997) have dealt with this problem by establishing an intermediate body between the investor and the small scale projects so that the investor only deals at that level. The intermediate body takes the risk of the investment and the administrative burden but passes on the investment to the small scale projects. This aggregated ‘umbrella’ approach seems a sensible way forward.

3.4 Poverty Alleviation

3.4.1 Past achievements in poverty reduction

Accelerated growth in reducing poverty in the 20th century began in the now developed countries in the late 19th century following the industrial revolution with improvements in income, public health and education. Similar socio-economic progress also led to dramatic declines in poverty in the developing countries over the past 50 years, albeit at much lower magnitude than a century earlier. By the end of the 1990s, some 3-4 billion of the world's people will have experienced substantial improvements in their standard of living, and about 4-5 billion will have access to basic education and health care (UNDP, 1997). It is precisely because of these achievements that there is reason for optimism to eradicate absolute poverty in the early decades of the 21st century.

Box 1: Zimbabwe: GEF Solar PV Project

Project Description: Global Environment Facility (GEF) and the Government of Zimbabwe (GoZ) engaged in this pilot project to install 9,000 solar lighting systems in rural homes, schools, and clinics during 1993-97. The primary aims of the programme were to encourage the dissemination of PV systems into rural areas, develop an indigenous sustainable PV industry, and in the process work towards reducing regional share of greenhouse gas emissions. The financing of the project includes a grant of US$7 million from the Global Environment Facility (GEF), and an additional US$0.4 from the GoZ.

This collaboration between GEF and the Government of Zimbabwe permitted the rapid removal of import duties on solar panels. Photovoltaic system standards were developed in collaboration with the Standards Association of Zimbabwe, and all installed systems are required to meet GEF standards that ensure low life-cycle costs. The project established a self-sustaining, revolving finance facility that allows end users to pay a 15 percent deposit on installation; the balance is payable over three years at a 15 percent annual interest rate.

Environmental Benefits: One important goal of the project was to reduce fossil fuel burning and the associated emissions of greenhouse gases. The GEF estimates show that installing PV to 10,000 households would replace the use of 34 litres of kerosene per household per year, preventing the release of 400 tons of carbon to the atmosphere.

Appropriateness of Technology/ Development Priorities: "Growth with Equity" is the official development strategy of Zimbabwe. The government views electricity as a critical factor in increasing literacy, slowing rural-urban migration, and improving the overall quality of life for the country's rural population nearly 8 million people who are without access to grid-supplied electricity. Should Zimbabwe resort to its vast reserves of coal for electrical power generation (estimated at 30 billion tons, of which 2 billion tons are exploitable), its contribution to global environmental problems could be large. However, small-scale PV lighting technology is seen as a clean and reliable alternative to power generation systems that burn fossil fuels and produce greenhouse gases linked to climate change.

Social and Economic Benefits: For households that installed systems, the project was expected to raise living standards by providing a pollution-free resource that displaces the use of firewood and paraffin lamps. The new solar home-lighting systems have resulted in more congenial living conditions, upgraded educational and health standards, and more jobs.

Capacity Building and technology transfer: From the beginning, there was a clear recognition by the Project Management Unit that training programmes designed to develop a critical mass of locally trained personnel with the requisite technical, economic, and socio-cultural skills should be initiated. Training local manufacturers through the implementation and subsequent commercialisation phases would go some way in maximising the use of local researchers and consultants. The training programme would also be undertaken at the field technician and at the end-use level. Over the GEF project's lifecycle, a number of workshops have been held to reach as broadly as possible the various stakeholders of the project. One criticism levelled against the training arrangement is that too few workshops were organised at the beginning of the project when the process of human capacity building should have been in full flight. This was partly due to the fact that there was a serious lack of manpower and time to carry out training and workshops on a regular basis.

Poverty Alleviation: The notion of poverty alleviation (or poverty reduction) was closely tied with the stated goals of the GEF project. The question that needs to be asked in this regard is who were the beneficiaries of this project? And has the GEF project benefited the very poor? Examining the distribution of people who purchased the systems by profession, teachers came over as the dominant client group, followed by shopkeepers, medical staff and soldiers from the liberation war (recently awarded hefty compensation by the government). The proportion of farmers and other low-income rural people who benefited from the GEF PV lighting project was lower than expected. The two main reasons for the low level of uptake were that the poor in rural areas cannot afford even the smallest system, at even the most concessionary rates; and many did not qualify for the loans, as there was a preference for people with regular and salaried income. However, when examining the installations at clinics, schools and community centres, there is no question that the users which includes the less affluent rural households have shared the benefits.

Sustainable Development: Although the overall benefits from this project may have been overstated by the funders and implementers, this project meets some modest sustainable development criteria. From the environment side, it promotes greenhouse gas mitigation and contributes to Zimbabwe's national and local environmental goals. However, the most significant contribution of this project has been the rapid popularisation and adoption of this PV technology in the rural areas, supported by the growing number of installation companies which have soared from a handful to more than twenty, five of which are owned by women. Thus, some lessons towards how best to achieve sustainability goals appear to have been learnt.

3.4.2 The current situation

In spite of the advances in social development and impressive reductions in poverty, about a quarter of the world's people remain in severe poverty (McCalla and Ayres, 1997). In some developing countries, mainly in Sub-Saharan Africa, the incidence of poverty has increased over the past two decades. To a large extent, this phenomenon has its origins in the decline in the relative market prices for primary commodities in the 1970s and 1980s, which most developing countries depend on. This meant that export earnings declined at a time when the need for foreign exchange to pay for oil imports and other vital imports was increasing rapidly. The inevitable outcome was therefore increased borrowing, leading to the spiralling debt crisis that strengthened the case for an adjustment programme to be introduced. As a belt-tightening policy, many countries embarked on economic reform programmes that involved reduction in their public spending in key social sectors, such as health and education. This has had a direct impact on the poorest people in the developing world who do not have the earning capacity to pay for basic social services.

3.4.3 Poverty and environment

The global and regional inequalities in terms of income and capacity are characterised by inequalities in consumption. The Human Development Report (UNDP, 1998b) indicates that globally, the 20% of the world's people in the highest-income countries account for 86% of total private consumption expenditures—the poorest 20% a minuscule 1.3%. While consumption per capita has increased steadily in industrial countries (about 2.3% annually) over the past 25 years, spectacularly in East Asia (6.1%) and steadily rising in South Asia (2.0%), a sharp decline has been recorded in Africa where the average household today consumes 20% less than it did 25 years ago (UNDP, 1998b).

The fact is that the 'well-off', wherever they are, benefit from the cornucopia of consumer choices at their disposal. But poor people (and poor countries) bear many of its social and environmental costs, which continue to diminish their capacity and access to basic living resources. It is important to note that poor people depend on natural resources for their livelihoods, and therefore natural resource degradation often becomes an immediate and life threatening crisis - a question of survival (Broad, 1994). Thus, poverty and environment are closely linked in a nexus of mutually reinforcing causality chains. This is essentially the situation in many Sub-Saharan and south Asian countries where past resource degradation deepens today's poverty, while today's poverty creates impediments to care and rehabilitate the resource base in future years. The challenge should therefore be how to mobilise the same actors who 'contributed' to local environmental degradation to become the custodians of the environment and its regeneration

3.4.4 Poverty and sustainability

At the Earth Summit in 1992, the commitments made, encapsulated in Agenda 21, gave equal weight to poverty and environment, recognising the intrinsic relationship between the two in the context of sustainable development (UNDP, 1997). Since then a number of high profile international development conferences have been held but have not made poverty a major focus of their discussions, or considered poverty alleviation in the context of its link to environmental stewardship and sustainable resource use. This 'fault line' needs to be redressed and supported by global policies and mechanisms, and domestic policies and expenditure patterns that lead to the creation of assets for poor people. In essence, poverty reduction must become a central focus and a guiding principle of development efforts. To this end, CDM may well prove to be a useful vehicle to raise the much-needed financial support and help strengthen the institutional capability through which resources can be marshalled effectively.

3.4.5 CDM as a potential contributor to poverty reduction

Participation of people in CDM projects is a vital constituent if a project is to live up to its 'sustainable development' pronouncements. Sustainable development means that long-term perspectives should apply to all policies and actions on development, and that equal consideration ought to be given to the needs of present generations as that given to the well-being of future generations. Thus, it would be a gross violation of the sustainability principle if there was emphasis only on *intergenerational* equity without grappling with the problem of *intragenerational* equity. It would not only be morally unacceptable but also practically unworkable to treat the present and the future separately as they constitute part of one continuum where the paths embarked on today will have bearings on tomorrow in making the relations of human and natural resources more compatible. Thus, donors and implementers of CDM projects need to take on board that the true guarantors of their investment in the poor developing countries are people and local communities who have the strongest motivation and the greatest stake in the preservation of their environment. Therefore, there are lasting gains to be made if the role and needs of local communities need to be incorporated into CDM projects from conceptualisation through implementation.

3.5 Local Benefits and Disbenefits

The more general environmental and social impacts of a project are usually neglected in most discussions on how a market mechanism such as the CDM would work in practice. This may be due to the assumption that the host country has defined environmental protection laws and has an enforcement system in place which will mitigate potential impacts. However, often many host countries do not have sufficient environmental protection measures in place at the local or regional level or do not have sufficient resources to enforce legislation. This is illustrated in the current problems for new countries seeking to join the European Union who are falling behind in their adoption of the required environmental standards to meet the minimum framework for EU law (ENDS 6/11/98).

One main reason why the considerations outlined above are important is that it provides a means for ensuring the equity of the CDM process. The non-climate related environmental and social benefits and disbenefits of a project form a picture of the overall impact of the measures and are therefore important considerations at all stages in the CDM process. There are a number of other important reasons why environmental and social aspects of CDM projects should not be neglected.

- If there is a portfolio of projects undertaken within a host country, it is preferable to avoid the multiplication of any negative impacts detected in one project. This means that the host should not have to face a large burden while offsetting donor country emissions.
- Projects which provide for participatory processes, locally, at the planning stage can be more successful and provide local benefits which will ensure the long-term success of the project through equity. Engaging and empowering local people in local development helps to avoid potential disbenefits, should maximise local benefits and promote 'ownership' of the project which decreases the chance of failure. The current discussion under the Aarhus Convention, and the promotion of participation in environmental decision making generally, are a manifestation of the importance of this area.
- Minimising environmental risk avoids future environmental liabilities. Care in the overall minimisation of impacts provides a good reputation for CDM measures and allows acceptance of subsequent measures.
- Maximising the benefits of any investment is a rational approach.

Box 2: Mexico: Illumex Project

Project Description: The Illumex project is expected to replace approximately 1.7 million ordinary, incandescent light bulbs with compact fluorescent light bulbs (CFLs) in the Mexican cities of Monterrey and Guadalajara. These CFLs require 25% of the energy of ordinary light bulbs to produce similar or better quality lighting, resulting in less electricity generation and fewer fossil fuel emissions. They last up to 10,000 hours, or thirteen times longer than ordinary bulbs. This is a typical Demand Side Management (DSM) project.

The AIJ component of the project is funded with US$3 million from the Government of Norway. Non-AIJ related financing of the project includes a grant of US$10 million from the Global Environment Facility (GEF), and an additional US$10 million is contributed by the Comision Federal de Electricidad (CFE) for total project funding of $23 million. Norway's contribution will pay for 200,000 CFLs, or approximately 12% of the project emissions benefits. Funding will be placed in trust funds set up with the Banco Nacional de Obras y Servicios Publicos (BANOBRAS), with money to be used exclusively for the project.

The CFE, through its implementing units in the two cities, is administering the project by purchasing the CFLs and selling them at 37% of cost (including project overhead and administration) to their customers at existing customer service centres and at large companies. If necessary, other methods, such as door to door sales, will be used. Customers may buy the bulbs on credit terms of up to 2 years. Customer payments for the bulbs will be returned to the trust fund set up at BANOBRAS and used to subsidise additional light bulb sales. It is anticipated that, in addition to the 1.7 million bulbs within the initial project scope, several hundred thousand additional bulbs will be purchased by CFE and sold to customers as a result.

Environmental Benefits: Emissions benefits attributed to the AIJ component (11.8% of the total project) over the lifetime of the project are 85,748 metric tons carbon dioxide; 2.19 metric tons of methane (54 tons CO2 equivalent); 1,296 metric tons of sulphur oxides (SOx); 234 metric tons of nitrogen oxides (NOx); 663 metric tons of particulates; 88 metric tons of hydrocarbons (HC); and 22 metric tons of carbon monoxide (CO). Total project emissions benefits over the lifetime of the CFLs sold are estimated as: 726,675 metric tons carbon dioxide; 18.57 metric tons of methane (455 tons CO2 equivalent).; 10,986 metric tons of sulphur oxides (SOx); 1,982 metric tons of nitrogen oxides (NOx); 5,363 metric tons of particulates; 746 metric tons of hydrocarbons (HC); and 188 metric tons of carbon monoxide.

Appropriateness of Technology/ Development Priorities: At the time of the project appraisal in 1992, demand for electricity in Mexico was expected to grow by more than 5% per year. Such growth would result in the need to add 14,000 MW of capacity over the following 10 years, with investments of $3 billion per year. Mexico's installed generating capacity is 80% thermal and emits an estimated 57 million tons of carbon dioxide per year as well as emissions of other pollutants such as sulfur dioxide and nitrogen oxide. Thus, this DSM project is aimed at increasing the efficiency of energy consumption at the end-user level without depreciating the service provided by the power sector which is under pressure to keep up with the rapid rise in energy demand.

Social and Economic Benefits: The project should have an impact on raising the awareness of the general public regarding energy conservation. It is expected that the energy and electricity cost savings enjoyed by those enrolled in the project will encourage non-participants to buy CFLs. Moreover, the average price for electricity in Mexico is below long run marginal costs, and significant cross subsidies exist among residential consumers with medium to large consumers subsidising smaller users. The CFE appears committed to eliminating these subsidies and had, at the time of the project appraisal, the aim of raising the average price to equal long run marginal costs by 1997. Thus, replacing ordinary bulbs with CFLs (require 25% of the energy of ordinary light bulbs) would go some way to helping low-income households to be in a position to compensate for the inevitable rise in the price of electricity.

Capacity Building and technology transfer: The project is building institutional capacity in Mexico for technological change and energy conservation. It will enhance the capacity of the CFE to implement large-scale DSM projects, including additional high efficiency light bulb distribution projects in other parts of Mexico. Valuable experience will be gained from the successful marketing operations of the ILUMEX project as well as from the monitoring of emissions benefits and the participant and market surveys.

Poverty Alleviation: Although this project is only expected to replace existing low efficient bulbs by high efficient ones, and therefore does not change the picture on the ground significantly, the potential savings in electricity payments will benefit small consumers. Furthermore, uncertainty in the Mexican electricity market and price fluctuations hurt poor urban consumers first. Such DSM project will assist them by making electricity more affordable and by minimising the risks of 'payment under duress' in the event of electricity price increases.

Sustainable Development: From a number of angles, this project meets several sustainable development criteria. From the environment side, it promotes greenhouse gas mitigation and contributes to Mexico's national and local environmental goals through reductions in pollutants such as SO2 and NOx. From the social and economic perspective, the Illumex project aims to provide lighting to poorer urban communities at affordable prices, while at the same time by raising awareness regarding the importance of energy conservation. Thus, the salient features of this project are that, by employing a simple 'technology substitution' measure, it brings together a variety of environmental, social and economic considerations into its perceived output.

For these reasons an environmental and social assessment of all the projects should be undertaken to gather data on the impact of these projects and to assess the possible impact of a future programme of projects. What we suggest is not a full environmental impact assessment but at the least some investigation of the potential problems so that these can be planned for or mitigated by planning at the outset. Begg et al (1999) have undertaken a retrospective assessment of JI projects in the Czech Republic and in Estonia and suggest a possible way forward. If such a process is adopted at the project planning stage then some auditing of the effects would be reasonable but would add considerably to the administrative burden of the CDM. However the Kyoto Protocol states that transparency, efficiency and accountability should be achieved through independent auditing and verification of project activities.

3.6 Project Types

It is important to discuss the types of projects that may be implemented under the CDM. Currently, under the AIJ pilot phase, 126 projects have been accepted, approved and endorsed by the relevant national authorities. 81 of these are in the energy sector, whilst almost all the others are concerned with afforestation or reforestation (JIQ, 1999). Table 1 gives a breakdown of the energy sector projects.

One notable aspect of the pilot phase is that many GHG sources and sinks have not been covered. This is mainly due to the greater ease with which energy and forestry projects can be implemented and, particularly in the case of energy sector projects, monitored. However, when considering the project types which may be implemented under the CDM, it should be remembered that, as yet, no decision has been made on whether forestry projects will be permitted. We discuss the reasons for the controversy below in section 3.6.3. First, we discuss energy sector projects in a little more detail.

3.6.1 Energy Supply Projects

The simplest projects, from the point of view of calculating emissions reductions, are energy supply projects. These are comparatively straightforward to monitor, leading to more accurate estimation of emissions. Further, since they are relatively localised, it is simpler to assess their impacts or benefits on the local communities and environment.

3.6.2 Energy Efficiency Projects

Improvements in energy efficiency have the added advantage that they can save users money as well as reducing GHG emissions. This can increase the motivation for adoption of energy efficiency technologies or practices. Energy efficiency measures at the household level (such as the introduction of improved cookstoves) can also have other advantages (such as the reduction of respiratory disease caused by exposure to household smoke, more free time due to reduced need for collection of fuelwood, etc).

While these can, in some instances, be classed as ‘no regrets’ options (ie they save money), it is important that the cost of technology adoption (including capacity building) is considered as discussed in section 4.2.7.

AIJ Project Type	Region/country	No. of projects
Supply-side		
Fuel-switch + co-generation**** Coal-gas	Central Europe*	3
Wind energy	Central America	3
	Baltic states**	1
Solar energy	Central America + South America	2
	Asia	2
Geothermal	Central America	1
Hydroelectricity	Central America	1
Renewable energy systems	Asia	1
	Mexico	1
Biomass	Central America	3
	Asia	1
Fuel switch**** to Biomass	Eastern Europe***	1
	Baltic states**	30
Fugitive gas capture + gas transport improvement	Russian Federation	2
Demand-side		
Energy efficiency in supply plant or network	Central Europe*	5
	Africa	2
	Eastern Europe***	7
	Russian Federation	5
	Baltic states**	20
	Asia	7
Demand-side management	Mexico	1
	India	1
	Central America	1

Table 1 – Summary of AIJ projects in the Energy Sector

* Czech Republic, Hungary, and Poland.
** Estonia, Latvia, and Lithuania
*** Bulgaria, Romania, Slovak Republic, Ukraine
**** Some of the fuel switch projects listed here (Decin, Czech Republic; Sventupe and Ziegzdriai, Lithuania) consist of both a boiler conversion and an energy efficiency component.

3.6.3 Carbon Sequestration Projects

It has been pointed out that afforestation, re-afforestation or conservation of forests can be used to offset GHG emissions at low cost (Wietschel et al, 1999). However, their inclusion as possible CDM projects is still under discussion. There are a number of reasons for this:

- *Uncertainty in Measurements.* Estimates of the sequestration of CO_2 by forests is significantly more uncertain than emissions associated with, eg, energy sector projects.
- *Uncertainty in Baseline.* Estimates of the baseline of forestry projects is more difficult and more open to gaming. For example, it is possible that a host country could cut down an area of forest, and then set up a CDM project to sell credits from reforesting that area.
- *Biodiversity.* There is concern that plantation forests of fast growing trees, which could yield higher rates of CO_2 sequestration, could be funded at the expense of primary or secondary forests, which have higher levels of biodiversity.
- *Property rights.* If a donor organisation funds a forestry project, do they then own the forest? This would have consequences in terms of the land rights of the local population who may use the forest, especially if indigenous peoples were present in the area.

4 The Clean Development Mechanism: Technical Issues

There are many concerns on how the GHG emission reductions from CDM projects would be calculated and certified in practice. The issues relating to accounting for the emission reductions from the projects in the energy sector reflect much of the experience gained through the AIJ pilot phase (Begg et al, 1999). Many have still to be resolved and an overview of the different approaches is given in the following sections.

4.1 Additionality

Additionality has become an extremely complex topic within the Convention. All JI projects (AIJ/ A6JI/ CDM) must lead to GHG emissions reduction and/ or sink enhancement which is *additional* to that which would have occurred without the specified activity. It was first defined at the 1st COP in 1995 in the approval criteria for pilot phase AIJ projects (Decision 5e/CP.1).

4.1.1 The Need for Additionality

From the theoretical consideration of additionality, there could be no beneficial environmental effect of the CDM unless its projects are additional. Emission reductions which are secondary effects of normal investment practice are essentially “free”. The function of the additionality criterion is therefore to ensure that real reductions are derived from the project, i.e. that they would not have been carried out anyway by normal market operations. Hence, one by-product of the additionality criterion is the elimination of ‘free riders’. However, in practice it is very hard to identify with certainty whether projects are additional. In trying to solve this problem, the concept of additionality has been split into two:

- ‘environmental’ additionality; and
- ‘financial’ additionality.

Environmental additionality is usually discussed in terms of a baseline. The baseline is defined as ‘the activity would have happened in the absence of the CDM project’. Where CDM projects produce reductions relative to this baseline, they are automatically considered additional. However, defining the baseline is very problematic, as we shall see in section 4.2.1. Further, it is not actually necessary to define the baseline in order to ensure that the project is additional. All that is required is a demonstration that there are barriers (market and/ or non-market) to GHG emissions reduction under normal circumstances which the CDM activity is overcoming. We discuss this in some detail in section 4.1.2.

The term financial additionality is confusingly used to apply to two separate situations. Originally in Decision 5e/CP.1, financial additionality was defined as the financing of AIJ projects which was in addition to the Official Development Assistance (ODA) normally disbursed by the donor. This definition still holds and hence the confusion with the new definition of ‘financial additionality’ which is in purely economic terms, and is where, in an efficient market, the CDM project would be expected to cost more than the normal market choice in delivering emissions reductions. In practice it was thought that this increased cost or ‘financial additionality’ for the CDM project would be offset by the value of the credits which would ensue from the transaction, thus making the project still attractive to investors. The trouble is, of course that there are market imperfections which can render theoretical economic assumptions invalid in practice and hence it is not necessarily the case that increased reductions necessarily require increased expenditure.

Additionality was also expected to ensure that the supply of projects was restricted and that the host did not sell the credits too cheaply. This is particularly of concern for A6JI, where the host has a reduction target, as non-additional projects will have to be compensated by extra host action elsewhere to meet the target or the country will be in non-compliance. In the end the environment may pay as many hosts may not be able to afford to take compensation action elsewhere. The same argument holds for estimations of reductions which are highly uncertain and have a high risk of overestimation. If these are accepted by the host as a basis for credits, the same problem of non-compliance may arise unless additional action is taken. For CDM hosts with no targets, the environment will pay if the reductions are not real.

Non-additionality may therefore lead to extra costs of meeting national commitments in the case of A6JI which could in turn be passed on to the public. Furthermore, economic sectors that provide non-additional projects may gain a competitive advantage relative to the same sector in other countries or other sectors in the same country because of the extra financial support provided. Having said that, additional projects can also have trade advantages.

The additionality of projects therefore addresses:

- the environmental efficiency of the measure with respect to normal market practice to secure real reductions;
- the host equity in ensuring that they incur no extra costs;
- the overall equity in ensuring no competitive advantages;
- the economic efficiency in the sense that the measure would be expected to be more expensive than the market measure and therefore must deliver more emission reductions to be efficient.

However the operationalisation of additionality has posed problems. In practice it is not always possible to establish additionality simply and not all measures which increase emission reductions are more expensive than the market alternative. The methods which have been proposed in the literature have been reviewed and a different approach suggested to operationalising additionality.

4.1.2 Operationalising Additionality

IEA/ OECD Approach

The IEA/ OECD (1997) have proposed a ‘barrier removal’ method as a test for the additionality of projects. They have identified the different types of barrier involved and when they may be encountered in the project development. These barriers can be project specific, technology specific and general locality specific. They point out that barriers usually impact by increasing project costs and or project risks hence automatically make the projects additional and mean that the projects would not have happened anyway. They suggest that a project is additional if it can be demonstrated that:

- institutional, financial, technological, or informational barriers exist which inhibit the implementation of projects and would not be removed under circumstances in which there is no incentive to reduce greenhouse gases for an investor;
- these barriers do not have the same effect for the baseline project;
- the design of the projects effectively addresses these barriers;
- the financing of the JI related part is additional.

This ‘barrier’ method seems practical in the context of the CDM except for the last point, though the actual criteria to be used to assess projects are not yet available.

US EPA Approach

The US Environmental Protection Agency have also tried to develop options for the determination of additionality (Carter, 1997). They suggest

Option 1:	narrow categories of projects which *a priori* must be additional
Option 2:	define additionality as overcoming project specific barriers
Option 3:	measure additionality from quantitative sector specific guidelines eg system model
Option 4:	additionality defined by a programme like the US Initiative on Joint Implementation (USIJI)
Option 5:	combination of options such as 1 and 4
Option 6:	limit efforts to determine additionality and take measures to limit JI overall such as discounting, limiting the lifetime of JI or limiting the scope of JI

Each option is discussed relative to a set of criteria related to development costs/ immediacy, transaction costs, participant certainty, accuracy, comprehensiveness, and robustness. The first option demands identification of appropriate project types. The second option is similar to the IEA/ OECD approach discussed above.

However in option 3, using sector specific baselines, it is suggested that a project is deemed additional if it is not already planned in the baseline in a particular country. There are a number of problems with this particular definition of additionality:

- It assumes that something that is planned in the baseline projection for the country would in fact be realised.
- It assumes perfect knowledge of timing issues.
- It assumes that something which is not planned is better for the country and the environment!

Option 4 (defining a general set of guidelines) refers to the USIJI programme. The two issues there are ‘programme’ additionality and ‘emissions’ additionality. With programme additionality, it means that the project should be specifically developed because of the USIJI. Emissions additionality deals specifically with the basis for the emissions reduction compared to the baseline or what would have happened in the absence of the project (similar to ‘environmental additionality’ defined in section 4.1.1). This considers barriers, requirements in the host for emissions reduction and the difference between the project and prevailing technologies in the host.

Option 5 combines options 1 and 4 to give the best of both.

Option 6 is a more pragmatic approach which is to limit efforts to determine additionality on the grounds that there will always be uncertainty associated with it and it is better to manage that uncertainty by limiting the CDM or A6JI. This limitation can be achieved by:

- discounting emission reduction credits at some standard rate;
- limiting the crediting lifetime of the project; or
- limiting the amount of a donor’s obligations which could be met with flexible mechanisms such as the CDM, which is now expressed as *supplementarity*.

These ideas were attributed to Fritsche (1994) and others at international negotiations. We have raised these sorts of ideas to deal with the problems with baseline construction and they will be discussed in that context later (section 4.2.1).

Additionality in the Context of the CDM

In the section 3.2 on the transfer of technology we have already raised the question of how additionality may be operationalised in Developing Countries. If it relies on the assumption that the local economy is functioning efficiently, and that CDM projects will always have positive costs, then it will effectively preclude implementing measures such as energy efficiency which save money, resources and increase quality of life. As many of these so-called 'no-regrets' measures exist even in well-developed market economies, to apply this particularly to LDCs seems unnecessarily restrictive.

We would suggest from our discussion here and in the section on the transfer of technology that additionality implemented in this narrow market context, could work against the ability of a host to follow a sustainable path. We will be investigating whether the current definition of additionality is in fact inappropriate for many Developing Countries and, depending on their stage of development, an alternative definition should be applied along the lines discussed in section 3.2.1 where a flexible strategy empowering the host could be followed. Hence, we suggest that, where there is evidence that the host economy is not working efficiently, additionality should be operationalised as a host country strategy or through a barrier method (eg IEA/ OECD), to enable overall equity and environmental goals to be attained as well as that of economic efficiency. Such an approach may need to be compensated by more stringent safeguards elsewhere in the CDM process such as in the accounting procedure.

4.2 Accounting

How the emissions reductions from A6JI and CDM projects are calculated and certified has still to be decided under the Kyoto Protocol. The main problem in the estimation is that it is performed on an 'incremental' basis which uses the concept of the counterfactual baseline, ie a scenario of 'what would have occurred in the absence of the project'. The appropriate methodology for the construction of a baseline and how to deal with its high level of uncertainty is a decision which has yet to be taken. It is likely that it will involve a trade-off between environmental integrity and practicality.

In this section, we discuss only accounting issues related to energy sector projects. Whilst many of these issues also apply to other project types, there are some issues related to, eg, forestry which are not covered.

4.2.1 Baselines

The baseline question is linked to the discussion on additionality in that it is defined as 'the emissions scenario of what would have happened in the absence of the project'. Against this baseline, the amount of emissions reduction achieved by the project is assessed as well as the incremental costs of the project. That one can never know what would have happened anyway means that the baseline is *counterfactual* and therefore,

- there is high uncertainty associated with the baseline and therefore with the estimation of emission reductions;
- this uncertainty can provide scope for 'gaming' through which selection of a baseline is a carried out in order to maximise the benefits to the donor and/ or host (gaming is discussed further under section 4.2.5);
- the uncertainty also gives rise to a risk of overestimation of reductions which means that the environmental effectiveness of the project and the Convention is undermined. This is illustrated in Figure 1 which shows the range of possible emission reductions for a range of likely baselines for heat supply plants in Eastern Europe, compared with the currently claimed emission reduction credit figures.

Begg et al (1999) have performed uncertainty analysis on the accounting for energy projects in transition economies and have identified and tried to quantify the sources of uncertainty in the emission reduction calculation. From this work it has been shown that using monitored operating data reduces the uncertainty due to demand and project performance uncertainty, ie they concluded that feasibility data is not suitable for calculating emissions reductions. Baseline construction can only ever provide a conservative best guess, as there remains high uncertainty over:

- the choice of technology/ fuel;
- timing of the introduction of this technology/ fuel; and
- lifetime over which crediting is allowed.

Begg et al (1999) concluded that standardisation of baselines for project types/ sectors/ countries helps to eliminate the possibility of gaming without increasing the uncertainties significantly. Additional measures are proposed such as baseline revision, use of operating data, verification protocols, discounting and limiting crediting life which are designed to limit the bounds of the uncertainties and decrease the risk of overestimation. The combinations of measures are referred to as 'packages' and different packages will have different environmental integrity and practicality appropriate for different implementation conditions, eg CDM in Less Developed Countries, CDM in Newly Industrialised Countries.

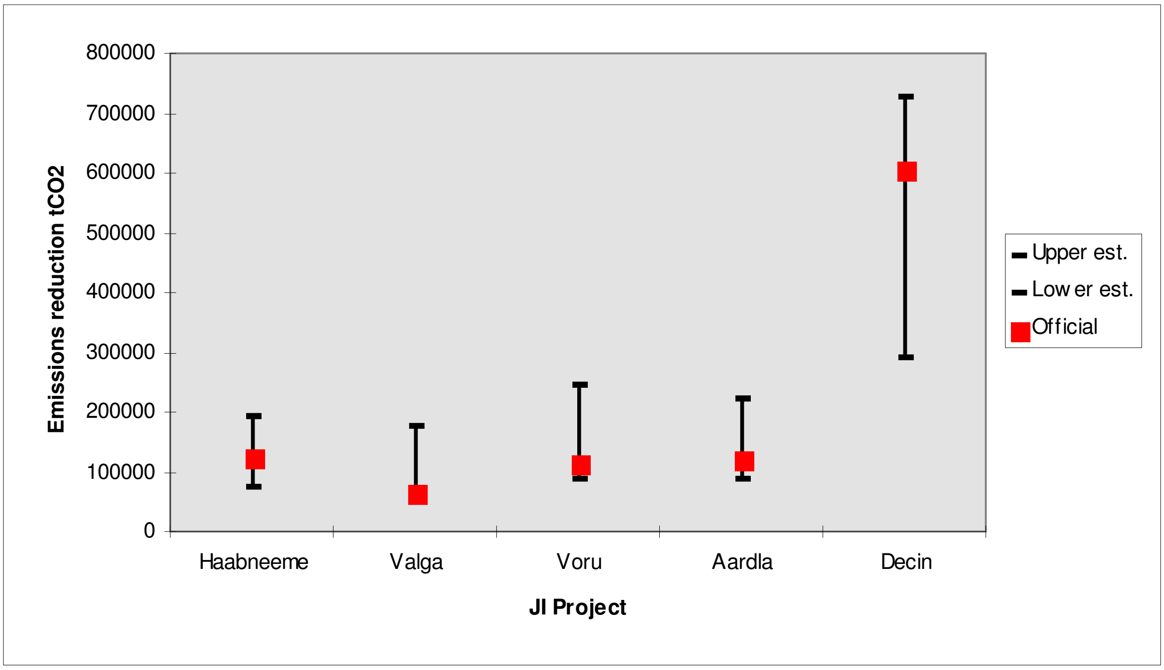

Figure 1. Comparison between uncertainty in emissions reduction due to baseline and UN FCCC reported values for 5 AIJ projects (From Begg et al, 1998)

Much of the work on baselines has been carried out in the energy sector which is probably the most easily quantified of all the sectors. There have been many different approaches to the construction of baselines and a brief discussion of the main types is given here and summarised in Table 2 along with a discussion of the baseline issues currently being discussed at international level. The types can be broadly divided into three categories, which essentially define the 'system' boundaries of the calculation:

- project level;
- system or sector level; or
- country level.

We start with the project level approaches and then move up, through the system level ones, to the country level ones.

Baseline Types

1. Project Specific Approach

This type of baseline is where details of the individual circumstances of the project are gathered including the following elements:

- *choice and timing of reference technology/ fuel*: which defines technical variables such as efficiency, emission factor;
- *equivalence of energy service*: consideration needs to be given to whether the baseline plant can provide the same energy service as the CDM project over the plant lifetime;
- *crediting lifetime*: this is either the technical lifetime of the CDM project, or the estimated time until the CDM project becomes financially viable for the host to carry out.

This form of baseline construction also needs to take broad account of the following:

- *background country scenario:* economic and policy developments within the host country, international fuel prices, structure of energy system and fuel supplies;
- *costs:* costs (eg investment, operation and maintenance, fuel) of the CDM project and possible reference technologies will affect the choice of the baseline;
- *leakage:* account needs to be taken of the possible other GHG emissions in the fuel production cycle and in the fate of the replaced plant and fuel in the country economy;
- *time dependencies, demand projections:* there may be significant variations in the future on key parameters in the calculation of emission reductions.

There is therefore a considerable amount of information which is required to construct the emissions path scenario of the baseline. This effort is justified if this is the only way of carrying out the estimation but means that transaction costs are high for all projects. Even with this effort the uncertainties can still be high as there can be several equally likely baseline emissions paths (Begg et al, 1998, 1999). Some baselines have also been subject to negotiation with the host as to what may be included or not in the calculation which has contributed to a protracted process and allows gaming.

2. Technology Matrix Approach

This term has been applied to 2 distinct types of baseline.

The first will be discussed here as it is a project level baseline. The second is related to commodities which are not homogeneous in activity and are more in the manufacturing sector. This is country level baseline but will not be discussed further at this stage.

The technology matrix method was suggested by Luhmann et al (1997). The starting point is that projects are standardised which means that they have the general characteristics of the project under consideration but do not consider the actual project. These are then assigned default technologies as baseline technologies. These default technologies are determined by a ‘filter model’ which selects appropriate baseline matches to the project type. Once selected these are set up in a matrix for the country and sector and type so that the baseline emissions are calculated using this default technology (and fuel) which has a characteristic *specific emissions* of tonnes of CO_2 per MWh (tCO_2/MWh) of output from the plant. Provided there is equivalence of the energy service supplied in the project and baseline, the specific emissions of the project can be subtracted from the baseline and multiplied by the output from the plant. This method obviates the need for complicated baselines and limits gaming as the baseline technology is prescribed.

3. Benchmarks

The CCAP (1998) have introduced the idea of benchmarks which are defined as the future emissions paths either at the project, system or the country level. These again are expressed as specific emissions for the technology and fuel in the energy sector in tCO_2/MWh. Benchmarks can be *historic* or *forward-looking*. This means that they are either based on past historic emissions or planned future development. These historic or forward-looking benchmarks may also be *static* in that they are not altered over the lifetime of the project or they are *dynamic* which means that some baseline revision or updating will occur during the project crediting life. There can of course be all the combinations of these, eg a historic, static baseline.

4. 'Package' Approach

This project level approach has been suggested by Begg et al (1999) after analysis of the uncertainties in the calculation and is designed to minimise these uncertainties and reduce gaming.

A standardised approach to the baseline is taken and 4 general types are suggested. If the substituted plant is known, then the baseline can be equivalent to a historic benchmark baseline. It may have either a limited life (type 1) or there is a revision in the baseline after a period of about 10y when the plant may have been substituted anyway (type 2). At the point of revision it would be expected that there is then a switch from the historic plant to an average mix for the sector for the baseline specific emissions. This is therefore a dynamic benchmark type. Where the substituted plant is unknown then an average sector mix similar to either a historic or forward looking dynamic benchmark (type 3) or an average of the range of likely baseline technologies and timing (type 4) is taken and again this would be revised at intervals.

These standardised baselines help to reduce gaming and are combined with measures such as the use of monitored operating data, baseline revisions, and verification protocols to minimise the bounds of the uncertainties and reduce the risk of overestimation of the reductions. Hence, a 'package' of measures is defined. Other measures, such as limiting the crediting lifetime or discounting the reductions, can be added to the package to deal with high uncertainties.

This approach is particularly notable since it sees baseline construction as inextricably bound up with other measures such as monitoring and verification (section 4.2.2).

5. Investment Analysis Model

This approach (advocated by the World Bank: Heister, 1999) depends on the existence of an economically efficient market in the host country. The baseline is specified as the most profitable use of the finance in an equivalent project (ie in a similar sector/ country) in the absence of GHG emissions reduction benefits. 'No-regrets' projects would, by definition, be excluded. It models investment behaviour and would require confidential financial information from the project investor - which is unlikely to be forthcoming. It is a project level approach.

6. System Model

A system model baseline could be sector-specific or cover a range of sectors. In this method there tends to be an assumption of continuing growth of GDP, and an estimate of growth rate is made. Based on this, an estimate of annual demand is made which is the input to model. The model itself is a 'bottom-up' or 'techno-economic' model and is based on the existing technologies in the sectors. It minimises costs to meet the demand subject to emission constraints. There are two main ways to use these models. For small projects, the baseline generated by the model is a series of annual specific emissions (tCO_2/MWh) for the sector. This is therefore a benchmark sector baseline which is the result of a complex and uncertain modeling process based on arbitrary assumptions such as that for GDP growth. For very large electricity supply plant the whole model could be run with and without the project as these models do deal with the possible interactions in the system between the project and what would be substituted. An example of this approach is given by Wietschel et al (1998).

7. Top-Down Model

Top-down models produce highly aggregated sector and country level baselines and are macro-economic in nature. They examine carbon emissions per unit of GDP. They have no direct relationship with the project technologies under consideration and are usually based on a series of assumptions about economic growth. An example of this approach is given by Puhl et al (1999).

Authors	Type	Level	Method
1. Performed by individual investors where necessary	**Project specific**	Project	Individual project characteristics and all relevant information included to construct specific project and baseline emissions path
2.Luhmann et al (1997)	**Technology matrix approach** Technology based, standardised projects and associated default baseline technologies	Project (specific to technology/ sector/ host country)	Standard projects with associated pre-selected standard baseline projects (identified from a 'filter model') Periodically updated
3. CCAP (1998)	**Benchmarks**	Project or Sector or Country	
a)	Forward Looking (Static or dynamic)	As above	Based on planned future pattern of emissions for lifetime of plant
b)	Historic (Static or dynamic)	As above	Based on historic performance of substituted plant
4. Begg et al (1999)	**Package approach** including standardised Baseline approach where appropriate	Project or Sector	Package of measures to deal with uncertainty and to limit gaming includes a range of standardised baselines using mainly dynamic benchmarks depending on whether substituted plant is known. Based on uncertainty analysis of typical projects
5. Heister (1999)	**Investment analysis approach**	Project	Based on financial additionality of investment. Simulates financial/ behaviour aspects
6. Wietschel et al (1998)	**System model**	Sector	Projects future emissions of sector based on assumptions regarding demand. No regrets measures are part of the baseline
7. Puhl et al (1999)	**Top down baseline**	Country or Sector	Aggregated approach either using absolute emissions or tonnes C/ GDP National or sectoral planning models

Table 2 - Summary of Baselines

There are marked differences in philosophy behind some of the different baseline approaches and we would like to point out the main issues in the following discussions.

Country/ sector level vs project level approach

As we have discussed, baseline construction can occur at the project, sector or country level (or even at supra-country level). The main problem is therefore which level should be used. There are several aspects to this discussion.

One aspect concerns ensuring the environmental integrity of the final estimation of the emissions reduction and relates to the level of aggregation of the baseline.

- If the baseline is too aggregated (ie country level) then there is a risk that it becomes so divorced from the real project situation that it is arbitrary. Consequently it becomes difficult to detect gaming by the donor/ host, and could undermine the environmental objectives of the CDM.
- It is usually expected that a country level treatment would be better for identifying any 'leakage', ie increases in emissions outside of the CDM project, but nevertheless due to the project (see section 4.2.6). Whether such a baseline is accurate enough to detect this needs to be rigorously examined.

Another aspect of the problem is the practicality and transaction costs associated with a project level approach. There is no doubt that if project specific baselines are constructed taking account of all the relevant factors, the process will be time consuming and expensive. If the players are also allowed to negotiate the baseline this leaves open the possibility of gaming. There are two ways of overcoming the problem.

- Either the project approach is simplified and standardised so that the process is manageable. This has been shown by Begg et al (1999) to be possible with little loss in environmental integrity. The technology matrix approach, the benchmark approach and the 'package' approach could all be used, provided other measures are also incorporated such as the use of monitored operating data etc.
- The alternative to this is that a much more aggregated country level approach is taken which reduces work of the FCCC as it reduces the number of baselines required, but suffers from the problem discussed above.

The final aspect is the effect of the level of baseline on the incentive to carry out CDM projects. For countries like Costa Rica who have undertaken to phase out fossil fuel use, there would be little scope for credits on a country baseline, but there still may be feasible projects if a project level approach were taken. In fact the use of a country level baseline could act as a perverse incentive for a host country to remain dirty (Jepma, 1999). Some sort of supra national baselines have been proposed as a remedy, but this would only increase the aggregation problems discussed above.

We consider that country level baselines are too far removed from the project to minimise the opportunities for gaming and there is a real risk to the environment if these are used. There will however be some exceptions where CDM projects large enough to need to be considered at the very least at the sector or country level, eg very large power projects.

The appropriate aggregation level of the baseline we suggest is dependent on:

- the project type and its interaction level with the economy or the system. For small scale projects, Begg et al (1999) have found no gain in using a system model (let alone a country level analysis). Standardised sector or project level benchmarks are simple, practical and environmentally defensible especially when combined with measures to limit gaming and the bounds of the uncertainties.
- Large projects or country level measures automatically demand a sector or country level approach and have increased costs associated with their generation.

Baselines and Additionality

Most of the baseline options above are seen as methods of operationalising additionality. For example, the benchmark approach (CCAP, 1998) specifically states that any project which has lower GHG emissions than the baseline is automatically additional. The emission reductions calculated are deemed real and that environmental integrity is preserved.

However the baseline level taken in some of the options discussed can be quite divorced from the actual project (eg country) and the 'additionality' (ie 'reality') of the reductions can be questionable. Only the technology matrix approach and the package approach separate the determination of additionality separately from that of the baseline. As we have shown in section 4.1 there are many possible ways of trying to ensure that the reductions are additional.

Hence, we would suggest that the question of the additionality of the project should be considered separately from the baseline. The method of implementation should be chosen explicitly from the range available in the full knowledge of the trade offs of one with respect to another when combined with the baseline method and accounting methodology to maximise environmental integrity and practicality.

Practicality

In all the approaches except the 'project specific', there is a methodology for simplifying the baseline and accounting method. The higher the level of aggregation supposedly the higher the practicality as fewer baselines would need to be generated and fewer resources required to administer the process. However, when examined in detail almost all the simplifications require initial allocation of resources to set up and revise them at intervals. The energy sector in particular is amenable to simplification for many projects as they have a homogeneous output such as MWh, though demand side projects create extra methodological difficulties. The country level 'top down' approach is particularly data intensive, the system model approach less so. In our view the value of these models is less in setting baselines, but more in assisting host countries to develop strategies for development.

An advantage of a simplified standardised approach is that it avoids the involvement of the investor or host as the baseline would be allocated and there would be no need for any negotiations on the baseline. Project level standardised baselines are, in our view, more practical and simple and deliver more benefits than other approaches.

4.2.2 Monitoring and verification

All the methods for calculating emission reductions require reasonable amounts of accurate quantitative background data. From our experience in Eastern Europe, even in the energy sector, there is great difficulty in acquiring such data and it is not just a problem related to small-scale projects. This is an aspect which we will be examining in this study. Data for the project if it has been properly set up should be available but baseline information may not.

Standardised baseline approaches may then be a useful approach. Most of the methods above use the idea of 'specific emissions' for a technology which means that, from simple readily available data for a particular technology and fuel, the GHG emissions can be calculated in tCO_2/MWh. We have checked this approach against operating data and found it satisfactory (Begg et al, 1999). Once the difference between the specific emissions of the project and the baseline has been found, then it has to be multiplied by the demand. This can either be based on an extrapolation of past data or the monitored operating data from the project can be used. Extrapolated figures are particularly unreliable and Begg et al (1999) have shown that, on average, over-estimations of 30-40% can occur using this type of feasibility information.

It is simple to obtain annual operating data from a project, and monitoring has the added benefit that, if the project fails, it will automatically not receive credits. Considering the risk of failure in the long term in Developing Countries, this approach may well be usefully employed in the CDM. Verification protocols will be needed to ensure that the project exists and we would suggest that the frequency of further random checks on operating data is a matter for the Operating Entity of the CDM (see section 2.2.2) dependent on the environmental effectiveness and practicality trade-off.

4.2.3 Equivalence of service in a development context

The calculation of emission reductions depends on the same service being supplied in the baseline and by the project. This 'equivalence of service' criterion is very important in defining the amount of emission reductions to be credited. In the Technology Matrix, Benchmarking and Package approaches, steps are taken to ensure that the specific emissions are multiplied by the same output, though for benchmarks at an aggregated level there could be problems in ensuring this equivalence in practice. With the CDM, there are further problems related to the development aspects of the projects. This is illustrated for the micro hydro plants in Nepal (Box 3).

Box 3: Micro Hydro in Nepal

In Nepal, for example, there are micro hydro schemes of capacity around 30kW that supply the electricity needs of a whole community (ITDG, 1994).

A community's main need is usually for electric lighting, which means that there is usually a high demand peak in the evening, and little or no demand for the rest of the day and night. Micro hydro schemes are often constructed so that they produce a constant output power (so there is no need for expensive flow regulation, reducing scheme cost) so this means that when there is no lighting demand, power must be used elsewhere.

Load management systems have been developed so that the power from the scheme is diverted to 'dump' loads (usually water heating elements, but sometimes low power 'slow cookers') when lighting demand is low.

This raises an interesting point for the CDM. Electricity use at such a scheme is designed to be constant. Where demand does not exist at a certain time of day, it is created so that the constant power output can be soaked up.

A 'dump load' consisting of the heating elements of a communal hot water system is a 'new' demand. Most people living in the community will use hot water only during cooking, so creating a large quantity of hot water does not meet any of their current energy demands, but creates additional consumption of energy (Rothe, 1993).

There are also examples of aid projects to construct micro hydro schemes where 'load development' has been part of the project aims. This means that the project has aimed to increase energy use within the community, usually so that income can be generated by small-scale productive activities.

Demand for energy services is often shaped by the energy services available. This means, for example, that a village depending on biomass for cooking and kerosene for lighting will change its whole energy use pattern once the electricity grid arrives. This is, in fact, one of the reasons often cited for the introduction of grid electricity. Electricity is said to provide benefits such as increased opportunities for children to study with good lighting in the evening, improved keeping of food and medical supplies with refrigeration, etc. As we discussed in section 2 most energy and development is about an increase in service and the implications for the accounting regime have to be explored at both the project and national level before this can be resolved.

Load management systems (see Box 3) pose their own problems for the CDM, as they might result in an overall increase in energy use in a community.

For instance, if there is not an existing power plant to replace, the baseline for a proposed small hydro plant, say, is complex and related to the ways in which people currently meet their energy service needs. It is also possible that projects implemented in developing countries under the CDM could precipitate a radical alteration of a country's 'development path', although this is hard to measure, as it is impossible to know what 'might have been'.

4.2.4 Small scale projects

Energy supply projects constructed as part of development and poverty alleviation programmes are often small scale (i.e. less than 1MW, and often less than 100kW).

Such projects would create particular problems for accounting and monitoring. There is a question of the accuracy of data from such projects, as well as the practicality of collecting such data. The necessary administration may lead to them becoming too expensive to be included in the CDM. However, some work has been carried out to explore these issues.

Costa Rica (Tattenbach, 1997) have dealt with this problem by establishing an intermediate body between the investor and the small scale projects. Such an intermediary can help plan sampling for, eg, monitoring.

There are several approaches to data collection, which are used widely in development, and they are usually referred to as 'Participative' techniques of data collection and analysis (Preeti, 1998). Some suggestions have already emerged for using techniques such as this on a higher level (van Berkel et al, 1997; 1998) but these are generally at a level removed from the situation in rural communities. To carry out data collection in even sample communities is still likely to be costly and time-consuming.

4.2.5 Gaming

As the baseline of a CDM project is so uncertain and cannot be measured directly, it is open to manipulation by the parties involved. Such manipulation is called *gaming*. Begg et al (1999) and Michaelowa and Dutschke (1998) have discussed this problem in detail by assessing the different interests of these parties. For a donor organisation, the incentive is to 'talk up' the baseline in order to maximise the estimate of emissions reduction and therefore the credits received. When the host country has targets (ie in A6JI), the incentive is the reverse, since an overestimation of credits from a given project will require extra action by the host to meet its target. However, for the CDM, where the host country has no targets, their incentive is similar to the donor's: to maximise the credits from the project, in this case the incentive being to secure much needed foreign investment. It is therefore essential that some standardisation of the process of baseline setting, as discussed above, is in place to limit any such 'collusion'.

4.2.6 Leakage

By definition, all CDM projects are intended to reduce GHG emissions when compared to the baseline situation. However, consideration of this emissions reduction only takes place within the *system boundaries* of the project. It is possible therefore that 'knock on' effects of the project outside the system boundaries could offset these reductions. Such an effect is called *leakage*.

An example can be given for the case of biomass to energy plants. It could be assumed for such plants that the source of the biomass fuel is *CO_2 neutral*, ie the CO_2 released by combustion of the fuel is offset by regrowth of, eg, the forest where the fuel was harvested. However, if the source forest is not within the system boundaries of the project, and it is not monitored to ensure CO_2 neutrality, then it is possible that the forest is being allowed to re-grow and hence the net emissions of the plant are not zero.

It is necessary therefore to consider this problem when calculating the emissions reduction of CDM projects. The most straightforward way of dealing with this is to be conservative in estimates of emissions reduction based on assessments of possible leakage pathways.

Leakage is particularly a problem with the CDM as the host countries do not have emissions targets. In A6JI, where host countries do have targets, any leakage within the host countries is restricted by this target.

4.2.7 Transaction costs

The CDM arrangements are likely to incur certain costs, over and above the costs incurred by countries pursuing emission abatement individually. Barrett (1994) has identified transaction costs of around 10% of the project costs in the joint implementation pilot projects between Norway (as donor) and Poland and Mexico (as hosts).

Clearly, it is possible that in the CDM where there are clear additional capacity building and poverty alleviation requirements in the projects, the theoretical economic efficiency gains from the CDM could be compromised as a result of these additional costs. Should such projects nevertheless be eligible for JI accreditation? Is it legitimate to seek donor funding for these activities, when, as a result, these are no longer the least cost projects at the margin? This assumes of course that the least cost projects at the margin are the projects which are or should be implemented and assumes that cost efficiency is the only criterion to be satisfied.

For the CDM it may be necessary to price the carbon credits to reflect the sustainability needs by perhaps scaling the price of credits by some 'sustainability factor' (60%, for example) which would increase the cost of credits available for each quantum of GHG reduction.

These issues raise questions about the key assumption underlying the CDM, namely:

> *that the cost of CO_2 abatement is lower in developing countries than elsewhere.*

The assumption is not challenged in ‘conventional’ CDM literature, perhaps because of the absence of development experts from the CDM debate so far. It is possible, however, that if the CDM covers the cost of training, capacity building and long-term sustainability needs then it might not be quite so cost-effective. This type of cost might vary widely between countries and must surely feature in any consideration of host country conditions and development aspirations. Whether the levy will be sufficient to offset some of these transaction costs is also open to question.

4.3 Crediting

As mentioned, crediting of CDM projects will occur from 2000 onwards, and these credits will be called CERs (certified emission reductions). However, there are few further details about the form of the crediting regime. For example, it is not clear whether credits should be awarded ‘up front’ based on feasibility data or on the basis of monitored data. Begg et al (1998,1999) found consistent overestimation of emissions reduction in an assessment of AIJ pilot projects and hence do not recommend the use of feasibility data, but instead that credits should only be awarded annually based on monitoring of project performance.

In the following discussion, we review two other issues: 'partial crediting', also known as 'discounting' of credits; and 'early crediting' (also known as ‘interim period banking').

4.3.1 Discounting of Credits

There are four main reasons why it might be necessary only credit a fraction of the emissions reduction calculated by an accounting assessment:

- large uncertainty in estimates of emissions reduction;
- negative environmental and social effects in the host due to the CDM project;
- to provide more incentive for domestic action;
- interim period banking problems.

We deal with the interim period banking issue separately in the next section. It should be borne in mind that discounting of any sort will obviously increase the price of credits.

As we discussed in section 4.2.1, the uncertainty associated with calculations of emissions reduction is high, and is particularly due to the counterfactual nature of the baseline. Hence, the possibility of gaming to maximise a donor credits is also high. Consequently, one solution to try to counter this is to discount them (Vellinga et al, 1992). This could be in the form of a sliding scale of ‘crediting fractions’. This would provide incentives to: (a) prevent donor domestic action, where baselines are not necessary (and therefore the uncertainty is lower), from being undermined; and (b) provide an incentive for efforts to reduce uncertainty.

As we discussed in section 3.5, CDM projects will have local social and environmental effects on the host: sometimes positive, sometimes negative. One way of providing an incentive to limit negative effects is to discount the credits awarded to the donor should the project become damaging.

Another reason for discounting credits is to encourage early action. Michaelowa and Schmidt (1997) suggest a novel method for GHG abatement action whereby A6JI and CDM credits are progressively discounted over time whilst, concurrently, a carbon tax is progressively increased in donor countries. Hence, early A6JI and CDM action is encouraged without undermining the incentive to invest in abatement technologies domestically.

4.3.2 Early Crediting (Interim Period Banking)

As we discussed above, the Kyoto Protocol defines a 'commitment period' which extends from 2008 to 2012 inclusive for which emissions reduction targets have been defined. For the period before 2008, no targets have been set. As presently written, CER credits can be awarded to CDM projects between 2000 and 2007 (known as the 'interim period') and *banked*, so that they are added to credits obtained during the commitment period. It is interesting to note that A6JI projects can only earn credits during the commitment period.

Clearly, the two accounting procedures are not compatible and tend to favour the CDM. Further, since the emission targets have only been agreed for the period 2008 to 2012 inclusive, it is possible that credited CDM action during the interim period may be offset by uncontrolled increases in the donor country during the interim period. Consequently, such *interim period banking* (or *early crediting*) has serious implications as it could lead to a reduction in the total action needed over the whole period to meet the target, potentially compromising the objectives of the Protocol and leading to an effective relaxation of the donor country target. For a CDM host without targets this will have an effect only on the overall effectiveness of the mechanism but for an Annex 1 Article 6 JI host this would mean a compensatory tightening of its own host target.

Analysis of this problem has been carried out by Parkinson et al (1999). They show that, for each tonne of GHG emissions reduction carried out under the CDM, the overall action could be reduced by as much as 0.3 to 0.6 tonnes. They recommend partial crediting as a way of dealing with this problem, and propose a crediting fraction of 40% to 70%.

5. Concluding Remarks

This study has highlighted the dual nature of the CDM, with its contribution to both GHG emissions reduction and sustainable development. Hence the integration of development aspects into the mechanism whose operation under the Protocol is not straightforward makes this a very complex process to implement.

There are many issues which have to be resolved if the CDM is going to work for the investor, for the developing counties involved and for the environment.

- It will be essential to examine the CDM process from the approval to crediting stage and to bear in mind the effect of the overall combination of modalities for approval, accounting, and crediting.

- There are conflicts built into the Convention between costs and environmental integrity, between market and trade pressures and equity and the environment, and between additionality as currently described and appropriate technology choice.

- It has become clear that there are different stages of development of the DC's, and that different countries will have different development priorities. There are a range of sustainable development paths, and issues of equity which have to be addressed and integrated into the measures to mitigate climate change effects. Not all countries wish to follow the western industrial model and due regard has to be paid to alternative models of what is perceived as sustainable.

- One way to address sustainability is for the host country to be given assistance to prepare a strategy on its future development and from this develop a 'CDM strategy' indicating which types of projects it would be willing to accept from prospective donor countries in line with a sustainable path and with its priorities. This process also helps to have a level playing field in negotiations.

- We would suggest that the CDM cannot have one single implementation modality but should be implemented according to the stage of development of the country as an initial major differentiating aspect.

For newly industrialised countries (NIC's) for example, the CDM may be implemented almost as for A6JI, where there are existing markets, human capacity and infrastructures and existing industrial development. Here the additionality criterion as currently defined may well function, while the accounting packages must be chosen to avoid the increased incentive for gaming and to reduce the high uncertainties. The problem of the baseline under expansion of energy supply has to be addressed. In the NIC case there is some emphasis on development needs. To address those, there needs to be some project level interaction with the local conditions. There should be attention, in whatever mechanism, to the country, regional or local development priorities in the selection of the technology for transfer and to the local environmental and social impacts of projects if only to avoid displacing one environmental and social effect with another.

For the other end of the scale, in less developed countries (LDC's), there needs to be much more emphasis on local development priorities and needs in the modality of implementation of the CDM. There may be a case for a strategic capacity building to enable appropriate projects to be identified for sustainability as well as project specific capacity building designed to maximise environmental and social project benefits such as poverty alleviation measures.

- The poorest sections of society will need assistance to be able to benefit from any CDM project. This will mean engaging local experience and expertise in the design of projects. Most development experience on what makes projects successful seems to point in this direction. Considerations such as addressing local customs, local resource constraints, affordability and long term viability while increasing quality of life have to be treated at the local level and participatory processes are usually essential to this. This form of the CDM could be quite different to the NIC type.

- The approval criteria and project specification would need careful work. The way additionality is put into operation is crucial. For DCs the method of operation may best be tailored to the level of development of the country to bring in the 'no regrets measures' and to make sure that sustainable and appropriate technologies are chosen.

- As suggested above for sustainability, this may be best done by enabling the country to be assisted to assess what its development targets are how it is going to reach them. In the process, suitable projects with attendant local benefits could be identified and offered for investment. It is our opinion that it is unlikely that haphazard investment approaches will achieve any of the aims of the Protocol.

- Approval criteria must also include attention to the other environmental and social implications of projects as a necessity for the long term viability of the projects.

- The accounting and crediting regimes have to be designed to ensure environmental effectiveness and equity while avoiding scope for gaming. The different methods available for baselines make different trade-offs on environmental integrity and costs. The implications of different combinations of choices for the accounting regimes under different circumstances has to be therefore explicitly and carefully considered.

- In the LDC case, transaction costs may well be higher than for implementation in NICs but if the levy is universally applied, part of this total income could be used to assist the process in LDCs where possible. The cost of CDM credits is an issue which needs attention as there are conflicts over the need to discount credits to offset uncertainties, to offset the effects of banking and to compensate for the potentially high transaction costs necessary to make the process successful.

- Early crediting could lead to problems of relaxation of donor targets and possible extension to A6JI unless action is taken before early crediting starts in 2000.

In our study, we hope to examine how different ways of operationalising the CDM may be constructed, what the implications of different approaches would be, and what the trade-offs are between equity, the environmental integrity and the cost efficiency. The practicalities of the process are a final determining factor at the country and project level.

6. Glossary of Terms

A6JI – Article 6 Joint Implementation, *see Article 6, Joint Implementation*
Activities Implemented Jointly (AIJ) – the pilot phase of joint implementation agreed under the UN FCCC. This phase extends from 1995 until the end of 1999. All the projects funded under the AIJ scheme are not credited.
Additionality – All projects implemented under Article 6 (A6JI) or Article 12 (the CDM) must be additional to what would have happened in the absence of the activity.
Article 6 – Article 6 of the Kyoto Protocol defines a Joint Implementation system between countries, both of which have emissions targets.
Article 12 – Article 12 of the Kyoto Protocol defines the Clean Development Mechanism (CDM). This is a Joint Implementation system where the host country does not have a GHG emissions target.
Article 17 – Article 17 of the Kyoto Protocol defines a scheme for International Emissions Trading.
Annex 1 countries – Countries which are listed in Annex 1 of the UN FCCC. These are the countries which agreed to take emissions reduction action first. They consist of all industrialised countries, including economies in transition.
Appropriate Technology – technology that is particularly designed to be 'appropriate' to the level of development and expertise of the people for whom it is intended
Baseline – a scenario of what would have happened in the absence of the JI/ CDM project. By definition, the baseline cannot be measured directly, hence it is 'counterfactual'.
CDM levy – Under Article 12, a levy will be charged on all CDM projects. The money from this levy will be used for funding CDM project certification and also projects which help developing countries adapt to climate change.
Certified Emissions Reductions (CERs) – credits that will be awarded to donors who fund CDM projects. The Protocol stipulates that they should be independently certified to ensure that the emissions reduction they represent is 'real'.
Cherry-picking – buying up the cheapest emissions reduction opportunities in a host country such that the host is left with only expensive options.
Commitment Period – The period during which GHG emissions targets are defined: 2008 to 2012 inclusive.
Conference of the Parties (COP) – Annual meeting of all the signatories of the UN FCCC. At these meetings negotiations take place to agree on action to meet the objective of the FCCC. At the 3rd COP, the Kyoto Protocol was agreed.
Counterfactual Baseline – *see Baseline*
Credits – a generic term for the 'currency' which represents emissions (under emissions trading) or emissions reduction (under A6JI/ CDM).
Donor country – a country which funds GHG emission reduction (or sequestration) action in another country.
Early Crediting – Under Article 12.10 of the Kyoto Protocol, CDM projects are entitled to receive credits for emissions reductions achieved *before* the commitment period (2008-2012 inclusive).
Emissions Trading (ET) – ET is where countries buy and sell fractions of their 'allowable' emissions.
FCCC – *see United Nations Framework Convention on Climate Change*
Flexibility Mechanisms (also known as 'Kyoto Mechanisms') – This is the collective term for JI and ET as defined in Articles 6, 12 and 17 of the Kyoto Protocol.
Gaming – strategic behaviour carried out by operators of projects to maximise the number of credits that they receive for emissions reduction activities. The most likely situation where gaming could occur is in the construction of the baseline.

Greenhouse gases (GHGs) – Gases which absorb infra-red radiation and hence contribute to the greenhouse effect. Human activities are increasing the concentrations of these gases in the atmosphere, hence causing global warming. The main GHG produced from human activities is carbon dioxide. Six GHGs are covered by the Kyoto Protocol: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydroflourocarbons (HFCs), perflourocarbons (PFCs), and sulphur hexaflouride (SF_6).

Global Environmental Facility (GEF) – A financial mechanism set up to help channel funds from industrialised countries to projects in developing countries which contribute to meeting the objectives of four international environmental conventions; covering climate change, biodiversity, ozone depletion and marine pollution.

Host Country – JI/ CDM projects take place within 'host' countries.

Joint Implementation (JI) – JI is where a 'donor' country funds a particular emissions reduction project in a 'host' country in return for credits which it can use towards meeting its own target. JI may be 'closed', where the host country has emissions targets, or 'open', where the host does not. JI under Article 6 is closed, whereas JI under Article 12 (the CDM) is open.

Kyoto Mechanisms – *see Flexibility Mechanisms*

Kyoto Protocol – This Protocol stipulates legally binding targets for the industrialised countries to reduce their GHG emissions by, on average, 5.2% from their 1990 levels by the period 2008-2012.

Leakage – If the JI/ CDM project displaces emissions to another location rather than reducing them, then the project is said to cause 'leakage'.

'No regrets' action – emissions reduction action that would also result in financial savings.

Non-Annex 1 Countries – Countries not included in Annex 1 of the UN FCCC. These countries do not have any commitments to control their GHG emissions. All developing countries are part of this group.

Photo-voltaic systems (PVs) – Solar cells which produce electricity from sunlight.

Supplementarity – The Kyoto Protocol stipulates that all action undertaken under Articles 6, 12 and 17 must be 'supplemental' to domestic action. Debate is continuing concerning how this might be quantified.

United Nations Framework Convention on Climate Change (UN FCCC) - Signed in 1992 at the 'Earth Summit' in Rio de Janeiro, the signatories of this Convention have agreed to take action to 'prevent dangerous anthropogenic interference with the climate system'.

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