PROSPECTS OF CDM FOR PROMOTING SUSTAINABLE DEVELOPMENT IN CHINA

--- Accelerating Foreign Investment and Technology Transfer

Prepared for

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EXECUTIVE SUMMARY

The Clean Development Mechanism (CDM) is one of the three major flexible mechanisms endorsed by the Kyoto Protocol to the Framework Convention on Climate Change (FCCC) at the third meeting of the Contracting Parties in 1997 in Kyoto. It is regarded as the most important mechanism, as it allows developed countries to invest and implement emission reduction projects in developing countries, and then receive credits for these projects in the form of "certified emission reductions" (CERs). These CERs can be used to fulfill their legally binding emission obligations. However, the CDM is also the most contentious of the three Kyoto flexible mechanisms, as it involves the transfer of credits resulting from the CDM projects from developing countries that do not have legally-binding abatement commitments.

In principle, the CDM is primarily designed for providing flexibility to Annex I Parties to achieve the cost-effective compliance with their commitments. It also aims to assist developing countries in promoting sustainable development and in undertaking climate change adaptation measures. This is the so-called dual objective of the CDM. At present, detailed modalities and procedures to implement this complex flexible mechanism are still under development by the FCCC Parities. The CDM has raised strong interests and concerns for both developed countries and developing countries, although their interests and concerns are different. A great deal of literature has been produced focusing on the discussion of how the CDM should work, how to ensure the promotion of sustainable development in developing countries, and how to achieve cost-effective compliance by development country Parties through the CDM.

China is the largest developing country in the world and a growing contributor to GHG emissions, although its per capita emissions are still very low. China's coal-dominated energy structure and inefficient energy technology, has become one of the major causes for its serious urban air pollution and the deteriorating ecological environment. The Chinese government is now very determined to halt the trend of environmental pollution and has adopted a wide range of policies and measures, including restructuring its energy structure, seeking more renewable and improved energy efficiency. Ample opportunities for shifting away from low efficiency coal technology to other renewables in China may create huge potential for low marginal costs of GHG emission reduction options. This may mean that China could be a significantly potential market for the CDM. The international community seems to have greatly counted on China's participation in the CDM.

China, as an independent sovereign country and an important international community member, needs to carefully consider from its own perspective as well as the global prospective. Is it in China's own interest to participate in the CDM? What would be the benefits, costs, advantages, and disadvantages for China to implement the CDM? Will its participation be consistent with and enhance its own sustainable development efforts? If the answers to these questions are yes, what will be the proper conditions for China to

participate in the CDM? And what are the strategies for China to approach the CDM? This study attempts to answer these questions.

Chapter 1 provides information on the background of the CDM, including its purposes, basic principles, key elements, and unsolved issues related to the CDM. It also touches on how developing countries view the CDM and what the CDM means to China.

Chapter 2 summarizes a number of recent studies on the potential market for the CDM and the possible share for China. It provides references on how large the CDM market would be, and what share China is likely to have.

Chapter 3 presents an in-depth analysis of major benefits and costs, advantages and disadvantages for China of participating in the CDM. This section examines short-term as well as long-term direct and indirect benefits and costs for implementing the CDM in China.

Chapter 4 discusses certain prerequisites under which the CDM may promote China's long-term goals of sustainable development and some key outstanding issues China may face if it were to implement the CDM.

The analysis of the study indicates that the CDM would offer unique potential opportunities to bring considerable short-term benefits to China including substantial foreign investment and advanced technology equipment, and many other environmental and social benefits. However, there is a potential danger of technology dependence on foreign suppliers for mitigation equipment over a long period of time, which may not be good for China in terms of promoting its own sustainable development. Nevertheless, actively participation in CDM negotiations and insisting certain measures be included in the CDM implementation could ensure the CDM support China's long-term sustainable development. These include measures to ensure transfer of not only environmental equipment through the CDM, but also technologies of R&D, design and manufacturing of energy efficiency and environmental equipment; technologies transferred through the CDM be diffusible within the recpient countries; affirmation of non-obligation participation in the CDM; additional financial and technical assistance and capacity building efforts be provided through the implementation of the CDM; and CERs acquired from CDM projects be bankable and transferable.

Also, China may face some key outstanding issues if it were to implement the CDM. The CDM implementation would be a very complex process, which requires the participation of many potential players. It also requires sufficient capacity to deal with financial, technical, and legal issues that will surround CDM projects. Therefore, early preparation should be made to explore the use of CDM to support its long-term national goals. The study put forward the following recommendations on actions to be taken:

1) Enhance capability to collect, analyze and disseminate CDM information. This includes efforts in collecting and analyzing foreign information on the design of the CDM in order to provide support to domestic policy making; and on available

mitigation technologies in terms of their functions and prices in order to be prepared for the CDM implementation, as well as efforts in collecting and analyzing information on the domestic need for sustainable development in different sectors and regions, and on GHG emissions providing a basis for selecting China's sustainable development priority projects.

2) Widely disseminate CDM information including principles, rules, modalities and procedures of the CDM, as well as potential opportunities the CDM may offer, to mobilize the participation of potential players and promote public awareness of the CDM.

3) Strengthen CDM policy research and formulation. Strengthening policy research of relevant macro policy industrial policy and regional policy could prevent the blindness and disorder of the CDM implementation, and reducing transaction costs and opportunity costs should China to implement the CDM.

4) Enhance capability of coordinating among different departments, between department and local governments and among local governments.

5) Initiate pilot CEM projects in Western provinces. It may be desirable to select some appropriate projects according to the need of west China as pilot CDM projects. The implementation of these pilot projects will enhance understanding of the issues the CDM implementation may encounter and also help explore polices and measures to address these issues. It would also provide lessons and experience for a wider implementation of the CDM across the country.

1. CDM: BACKGROUND AND WHAT IT MEANS TO CHINA

1.1 Purposes, Principles, and Other Key Elements

Prior to the discussion on what the CDM may mean to China (what are the benefits and costs, or advantages and disadvantages for China to implement the CDM), it is useful to take a look at the background of the CDM, including it's purposes, basic principles, key elements, current unresolved issues, and the views and concerns of developing countries on the CDM.

Purposes

The Kyoto Protocol in *Article 12* states that the purposes of the CDM are to:

- *assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention*;

- *assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3*.

These are often referred to as the dual objectives of the CDM. The provision specifies that both developed countries and developing countries will benefit from this mechanism. Non Annex I Parties' participation in the CDM will benefit from the project activities, resulting in additional financial sources and advanced technology to support their sustainable development efforts. Annex I Parties may use the CERs accruing from project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments.

This is the result of the intense debate between developed countries and developing countries during the Protocol negotiations. At the heart of the debate between developed and developing countries, was emission reductions versus sustainable development, according to their respective concerns and priorities. Developing countries are concerned with sustainable development, equity, common but differentiated responsibilities, technology transfer, and financial assistance, while developed countries' priorities are emission reduction, emission trading, credits, private sector participation, and compliance. The CDM came from a Brazilian proposal called the "clean development fund", which was designed as a non-compliance fund. The adopted CDM does not contain this original element, but retains the sustainable development focus proposed by the Brazilian concept. The final CDM reconciles the differing priorities of developed country Parties and developing country Parties, and therefore addresses, to some degree, the issue of equitable development rights.

Basic Principles

The CDM comes as a 'surprise' outcome of the Kyoto Protocol from the very hasty negotiations based on the Brazilian proposal of a "clean development fund." As a result, *Article 12* on the CDM only contains 10 very general provisions. Nevertheless, these 10 provisions seem to embrace the following basic principles:

- *Voluntary participation.* The Kyoto Protocol specifies that participation in the CDM is voluntary in nature. *Article 12.5 (a)* requires that each Party involved must approve the CDM projects.

- *Real, measurable, and long-term benefits.* This principle addresses climate change effectiveness. It requires that CDM projects must achieve real, measurable, and long-term benefits related to the mitigation of climate change.

- *Additionality.* The Kyoto Protocol requires additionality in net environmental benefits. *Article 12.1(c)* states that reductions in emissions must be additional to any that would occur in the absence of the certified project activity. The additionality principal has been seen by many to also embrace the additionality of financial assistance and technology transfer.

- *Transparency, efficiency and accountability in modalities and procedures. Article 12.7* requires that modalities and procedures be transparent, efficient, and accountable, minimizing bureaucratic aspects.

- *Providing financial resources*. *Article 12.6* specifically indicates that the CDM shall assist in arranging funding of certified project activities as necessary.

- *Private/public involvement.* Given the interest and the role of the private sector, the Kyoto Protocol allows both private and public entities to become involved in the CDM projects, including in acquisition of certified emission reductions activities.

These basic principles provide guidance for the further development of concrete modalities and procedures for the implementation of the CDM now underway by the FCCC Contracting Parties.

Commencement

The CDM is expected to take place as early as the year 2000. *Article 12.10* in the Kyoto Protocol indicates that the certified emission reductions obtained between the year 2000 and the beginning of the first commitment period (2008-2012) be used to assist in achieving compliance in the first commitment period. This implies that the CDM could be implemented earlier than the other two Kyoto flexible mechanisms,

the Joint Implementation (JI) and emission trading (ET), which will not commence until 2008 according to the Kyoto Protocol.

However, work on the development of the synthesis of proposals on principles, modalities, rules, and guidelines pursuant to the CDM is still underway by the FCCC Secretariat. The CDM is unlikely to come into force until appropriate operational modalities and guidelines are finalized.

Institutions for the CDM

The Kyoto Protocol mentions three bodies to fulfil the governance functions of the CDM: 1) the COP, serving as the meeting of the Parties to the Protocol (COP/MOP), the supreme organ governing the CDM, 2) the Executive Board (EB); and 3) the operational entities. The functions of the COP/MOP are spelled out in *Article 12*, including exercising overall authority and providing overall guidance to the CDM; designating the operational entities that certify emission reductions; and elaborating, at its first session, modalities and procedures to ensure transparency, efficiency, and accountability through independent auditing and verification of project activities.

The EB is for "supervision" of the CDM, and the operational entities are for "certification" of emission reduction.

Modalities and procedures

The Kyoto Protocol does not clearly provide the modalities and procedures of the CDM. It rests the authority to develop detailed guidance, modalities, rules and procedures on the COP/MOP.

Independent auditing and verification

The Kyoto Protocol is very clear about the auditing and verification of the CDM projects. *Article 12.7* requires independent auditing and verification.

Share of proceeds
Article 12.9 provides that a share of proceeds from the CDM projects shall be used to 1) cover administrative expenses of the CDM; and 2) assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation. It recognizes the special needs of those developing countries that are vulnerable to the effects of climate change.

1.2 Major Unsolved Issues

As the review of the background reveals, the CDM is only broadly defined in the Kyoto Protocol, and no details are provided as to how it would be operated. There are many outstanding issues that have yet to be clarified by the further negotiations of the Contracting Parties. These issues include:

Criteria for Project Eligibility

Criteria for eligible CDM projects are not yet clear. One particularly important issue is how to ensure a balance in the CDM projects, between assisting developing country Parties in achieving sustainable development in accordance with their national priorities, and assisting developed country Parties in achieving compliance with their emission reduction commitments. Allowing developing country governments to determine projects that are in line with their national priorities and development needs, should be one of the most important criteria for project eligibility. COP/MOP will be responsible for establishing modalities and procedures to ensure the twin objectives. Such criteria should address issues such as the willingness of both the investor and the host to cooperate, additionality in environmental effectiveness, financial additionality, methods of technology transfer, specific performance for transferred technology, sharing project benefits, and project liability between the investor and the host.

Supplementarity

Article 12 is not specific about whether the CDM projects by the developed countries should be supplemental to their own domestic actions, while the JI in *Article 6* and the ET in *Article 17* have the requirement of "supplemental to domestic actions." The present synthesis of proposals by Parties on principles, modalities, rules, and guidelines of flexible mechanisms pursuant to the JI, the CDM, and the ET, contains seven options. These range from placing a certain percentage of cap on the CERs that can be obtained from the CDM projects on the top of Parties domestic action to no limitation on the percentage of their quantified targets through CDM projects. To many developing countries, it is very important to ensure that the CDM projects by the developed countries are supplemental to their domestic actions. This point needs to be clarified.

Institutional issues

Article 12 mentions three bodies that fulfil the governance functions of the CDM and lists their general responsibilities. However, the composition and functions of the Executive Board have not yet been defined, and it is not clear who will become the operational entities. Their linkages with EB also remain to be clarified.

Criteria for deciding the baseline of projects/calculation of CER

The CDM is a project-based mechanism. Therefore, how to decide the project baseline is of major importance. The baseline is the starting point from which reductions can be measured, and show that reductions are additional to what would have occurred if no action were taken. There are a number of options being discussed for defining project-level baselines to calculate additional reductions.[1]

[1] Michael Toman and Marina Cazorla, the Clean Development Mechanism: A Primer, http://www.weathervane.rff.org/features/feature048.html.

a) It could be straight calculation of projected emissions with and without the project;

b) It could also be approaches that estimate emission reductions based on some simple characteristics of projects, such as conversion of a coal power plant to natural gas;

c) There also could be the establishment of national or sectoral baselines by the host country, and shares of the baseline could be assigned to different emission sources.

Most developing countries would probably prefer project-based, or sector-based baseline calculation. They may not favor national calculations.

System for monitoring, auditing, and verification of projects activities

Related to certified emission reductions (CERs) are a range of technical questions concerning monitoring, measuring, and verifying the outcomes of the CDM activities. A credible system for monitoring, auditing, and verification is needed to ensure "real, measurable and additional" reductions in the form of CERs. In this regard, a number of issues require debate and resolution, including the institution needed to support monitoring of project activities, and the guidelines and standardized procedures for monitoring, reporting, and verifying the outcomes of project activities. Guidelines for certification are also needed.

Credit-sharing and banking

Credit sharing involves the division of CERs between the investor and the host. While a credit does not have an immediate financial value, it may create potential value to its owner later. Some commentators think the issue of credit sharing is of vital importance and may reflect the perception of "fairness" in the CDM process. However, the Protocol as it is provided, does not mention how Parties involved in a CDM project would share the emission reduction credits resulting from the project. It is still uncertain how the Parties would share CERs, but it seems that credit sharing would likely be influenced strongly by project negotiations. If so, there might be unequal capacities and negotiation capabilities between developed country investors and developing country hosts. This issue needs to be addressed by the FCCC Parties. Some commentators suggest that this issue needs to be rectified through capacity-building measures, and that the CDM authority or international organizations may help develop model "credit negotiation" contracts for the CDM projects as guidance.

Banking credit allows participants to accumulate annual emission reductions over multiple years. The question remains whether non-Annex I countries that do not have reduction obligations are able to "bank" their credits resulting from CDM projects, and be able to use them against any future obligations.

Rules for non-compliance liability

One of the major criticisms of the CDM is the lack of rules for non-compliance liability. For CERs to be credible, there must be rules defining legal responsibility in the event that a CDM project is found not to generate the amount of emission reduction committed. Therefore, rules for non-compliance liability must be defined.

CDM structure

There are several options being discussed for the structure and actual operation of the CDM. One option is the **multilateral approach**, which is more centralized, playing a role in screening, selecting, financing, and assisting in the implementation of projects. Another option is **bilateral**. Countries or private entities negotiate project agreements among themselves. It could be possible to have a structure that allows for both multilateral and bilateral options. The third option could be **national or international funds** managed by private entities, such as investment banks. It is also possible to have a CDM clearinghouse that accepts and evaluates proposal and invites bids on them.

All these issues need to be properly addressed in order to make the CDM operational. Further discussions and negotiation need to take into consideration all of the Parties' concerns and priorities, and work out a set of rules that will promote cooperation between developed country Parties and developing country Parties in a mutually beneficial way.

1.3 CDM vs. Joint Implementation and Emission Trading

CDM, Pre-Kyoto AIJ and JI

It should be noted that before the Kyoto Protocol, there existed a trial mechanism of activities implemented jointly (AIJ), which is established according to a rather vague concept of joint implementation (JI) in the FCCC. The notion for JI in the original text of the FCCC is that a country with high GHG emission reduction costs may invest projects in a country with relatively low abatement costs in order to achieve their emission reduction targets in an efficient way.

The first meeting of the Conference of the Parties to FCCC (COP1) held in Berlin in 1995 endorsed a "pilot phase" of activities, implemented jointly (the AIJ pilot phase) up to the year of 2000 to test JI. During the pilot phase of AIJ, no credits of emission reduction were allowed.

Until September 1999, a total of 122 AIJ projects were officially approved by participating governments and reported to the FCCC Secretariat. With various methodological problems, the progress on AIJ has been slow. The geographical distribution of AIJ projects are unbalanced, with most of projects being undertaken in central America and eastern Europe, and very few in Africa and Asia. The major barriers to AIJ are the lack of incentives for the private sector to participate which is the result of a lack of binding commitments and limited capacity in "host" countries.

In the Kyoto Protocol, the pre-Kyoto JI/AIJ is split into two provisions: one is JI between Annex I countries (including Annex B countries, and countries in economic transition) in *Article 6*; and the other is CDM between Annex I and non-Annex I countries in *Article 12*. AIJ under the pilot phase is not mentioned at all in the Protocol. The AIJ, the test ground for JI, will end by year 2000. However, it is assumed that lessons learned from the experience under the AIJ mandate will be drawn in designing the CDM. Indeed, some of elements of the AIJ have been already been drawn into the formulation of the CDM.

Differences between the pre-Kyoto Protocol AIJ and the CDM

There are a number of differences between the pilot phase of AIJ and the CDM in *Article 12*. First, CDM adds a sustainable development focus to the AIJ pilot phase. The Protocol clearly specifies that non-Annex I Parties will also benefit from project activities resulting in certified emission reductions, while AIJ in the pilot phase does not contain this element.

Secondly, the legally binding emission reduction targets under *Article 3* of the Kyoto Protocol provide the basic condition for the operation of CDM and JI, while lack of binding commitments and the crediting are the major obstacles for the slow progress of the AIJ pilot phase.

Thirdly, the CDM is clear about participation by private entities. *Article 12.9* explicitly states that participation in project activities resulting in certified emission reduction and acquisition of certified emission reduction under CDM may involve private and public entities. This is due to the potential role that private sectors can play in the area.

Differences between JI in Article 6 and the CDM in Article 12

The major difference between the JI defined in *Article 6* is that it limits its activities between Annex I Parties (developed countries and countries in economic transition), emission reduction units resulting from the JI projects can only be transferred between Annex I countries. There are also a number of other differences in the legal text of the Protocol between the JI in *Article 6* and the CDM in *Article 12*. These include:

(1) Starting dates: The CDM provision in the Protocol allows Parties to begin accruing certified emission reduction (CER) in the year 2000, as opposed to JI projects in which credits do not accrue until the start of the first commitment period starting in 2008.

(2) Supplemental to domestic actions: There is no clear requirement that CDM activities be "supplemental" to domestic actions, while JI provisions require the acquisition of emission reduction units from JI be supplemental to domestic actions for the purposes of meeting commitments under *Article 3*. However, in stating the purposes of the CDM, Article 12 provides that Annex I countries may use the CERs to contribute to compliance with part of their quantified emission limitations and reduction commitments. Some commentators regard this as the supplemental requirement.

(3) *Sinks: Article 12* on the CDM does not include a provision for carbon sinks. In contrast, JI provisions allow projects aimed at reducing emissions by sources or enhancing anthropogenic removals of GHGs by sinks.

(4) *Administrative costs and adaptation expenses: Article 12* provides that the CDM should ensure "a share of the proceeds" from certified project activities to cover administrative costs and to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation. No such provision is found in *Article 6* on JI.

(5) *Certification: Article 12* on the CDM explicitly provides for the certification of emission reductions from CDM projects. While *Article 6* on JI is silent on certification.

Nevertheless, the CDM and the JI have some similarities. Both projects must be approved by the Parties involved; their reductions in emissions need to be additional; and guidelines for the implementation need to be developed by COP/MOP. It should be noted that both mechanisms are of project-based mechanism, and they should be examined together while analyzing modalities related to the measurement and verification of emission reductions.

CDM and Emission Trading in Article 17

Article 17 only contains one simple paragraph allowing emission trading between Annex I Parties including Annex B (countries in economic transition) and specifying that COP shall define the relevant principles, modalities, rules, and guidelines for verification, reporting, and accountability for emissions trading.

This is a precedent as it creates an international trading mechanism for non-conventional goods – GHGs. However in Kyoto, Parties did not come to an agreement on how this system should work, and deferred the formulation of detailed guidelines, rules, modalities, and procedures for future negotiations.

The major differences between the ET and the CDM is that the ET activities are limited in Annex I Parties; and *Article 17* does require that emissions trading shall be supplemental to domestic actions for the purpose of meeting quantified emission limitation and reduction commitments under *Article 3*.

However, the CDM should be examined with the ET while discussing the transactions of GHGs' credits in an international market.

Fungibility

The concept of "fundgibility" among the three mechanisms (CDM, Joint Implementation and Emission Trading) of the Protocol has been raised. Some argue that CERs acquired

by the CDM should be fungible with emission reduction units (ERUs) and AAUs of JI and ET, in order to encourage the integrated development of GHG emissions trading markets. But others think the "fungibility" among the three mechanisms of the Protocol is totally unacceptable; there is no link between Article 12 on the CDM, Article 6 on JI and Article 17 on ET; and they are mutually exclusive. This issue is now being discussed among the Parties, and needs to be addressed by the COP/MOP.

1.4 Views and Concerns of Developing Countries on the CDM

From their own perspectives, developing countries show different attitudes towards the CDM. Few express strong interests in the CDM, most of them have concerns and would like to clarify them before committing themselves to the mechanism. Major issues that are of particular concern to the developing countries are the following:

Equity

The issue of equity is the central concern of developing countries in regards to the CDM. Some of them see a misperception of the nature of the problem by requiring developing countries to take action on emission reduction while their present priorities focus on development. They argue that the source of climate change is not current emissions, but the total net increase in atmosphere since the beginning of the Industrial Revolution. Studies show that developed countries have contributed about 80 percent of the CO_2 from industrial sources, which has accumulated in the atmosphere between 1859-1995. They further argue that annual industrial emissions from developing countries would not reach those of developed countries as early as 2020, and that the accumulated contribution from developing countries will not reach the total contributions from developed countries until 2050.

In principle, the CDM is designed to achieve the dual objectives – to provide cheaper abatement options to developed countries and to assist developing countries in promoting sustainable development. However, it should be recognized that developed countries and developing countries have unequal capacities (human, financial, and institutional) in implementing the CDM projects. This issue needs to be addressed and special needs of the developing countries in implementing the CDM need to be taken into consideration in further development of the CDM.

Consistency with domestic development priorities

Developing countries have paid particular attention to the need for the CDM projects to be consistent with their domestic development priorities. They stress the importance of the CDM to allow developing countries to decide project eligibility criteria for the CDM projects and to implement projects that are in line with their national priorities and development needs.

Supplementarity

While developed countries are highly enthusiastic about the CDM, developing countries doubt that northern countries would try live up to their Kyoto commitments by not taking domestic action seriously. They fear that these rich countries just want to buy their way out of their binding obligations through trading. Developing countries are strongly of the opinion that the CDM projects should only be supplementary to domestic action.

Additional financial and technology assistance

Developing countries don't see that developed countries are fulfilling their commitments made at the Rio Conference to new and additional financial sources. Not only has the ODA declined since 1992, but a larger proportion of it has been repacked for environmental projects. They would like to see that the CDM investment is demonstrably additional to ODA, and technology transfer is carried out at a preferential rate in accordance with the additionality principle of the FCCC.

Low-hanging Fruit effect

Developing countries are concerned that the implementation of the CDM projects may cause huge costs to them in a long run. They fear that the cheap option that it is offering developed countries today will be at a very high cost in the future. This is because developing countries will use up their cheap options for emission reduction, and when they reach high levels of energy efficiency, costs for emission abatement will be very high domestically. This is often referred to as the low-hanging fruit effect.

Lack of necessary capacities to run the CDM

Another major concern of most developing countries is that preparatory work on the CDM and other Kyoto mechanisms was lacking during the negotiations, and significant disadvantage confronting developing countries as they lack know-how of the mechanism. The CDM mechanism is immersed in uncertainty, while there are very complex and intricate methodological, technical, legal, and institutional questions requiring to be addressed. Even when these issues are clarified, they still feel they lack necessary capacities in terms of human resources, finance, technique, and institution to implement the CDM projects.

Although the CDM in principle also benefits developing countries in terms of assisting their sustainable development efforts, to make the CDM work effectively and successfully, considerations should be given to the above-mentioned concerns of developing countries.

1.5 CDM and China

China has actively participated in negotiations of the FCCC and the Kyoto Protocol. The basic policies of the Chinese government for climate change are that China should not commit to the GHG emission reduction obligation before its per capita income reaches

the level of middle-developed countries. Given that there are still 50 million people living under the poverty line in China and its per capita CO_2 emission is still relatively low, China's current priority is to develop its economy. But China is concerned with climate change and will explore all means possible to slow the GHG emission growth before it takes on any emission reduction obligation, according to its sustainable development strategy. China also calls for respect of national sovereignty and non-interference of national internal affairs, and for the adherence of the principles of common but differentiated responsibilities. It points out that additional financial assistance and technology transfer from the developed countries is crucial to solve the problem of greenhouse gases.

To coordinate domestic work on climate change, China established a National Coordination Group on Climate Change in 1990, directly under the State Council, with its office seated in the State Meteorology Administration, involving 13 ministries and agencies. After the 1998 governmental reorganization, the Coordination Group moved its office to the State Development Planning Commission, and was renamed the National Coordination Group on Climate Change Response Strategy. It also involves 13 relevant ministries and agencies including the Ministry of Foreign Affairs, the State Development Planning Commission, the State Economic and Trade Commission, the Ministry of Science and Technology, and the Ministry of Finance, etc.

China has also engaged in the fulfillment of its commitments under the FCCC, such as formulating its national strategy for global climate change, and in the work of GHG emission inventories and climate change impact assessment. It has cooperated with some international organizations such as the World Bank and the UND,P as well as other governments on GHG emission reduction activities. Since 1997, China has undertaken a number of the AIJ projects with Norway, Japan, and the U.S.

China shares these concerns about the CDM with other developing countries.. Despite these concerns, China has, since COP3, engaged in studies on relevant documents of COP3 – COP5, and submitted a preliminary inventory of basic elements of the CDM to the FCCC Secretariat in February 1999.

Many believe that the CDM, if properly implemented as it is designed, has the potential to assist China in pursuing its development path in a sustainable way. It is in China's own interest to raise its energy efficiency, to switch to other renewables, and to eliminate serious environmental problems, and at the same time to contribute to the global GHG mitigation. The CDM may have the potential to assist China in achieving all these goals. It may allow China to cooperate with developed countries, getting access to additional foreign investment and public finance to replenish China's own energy and environmental investments, obtaining advanced and efficient technology, and reducing environmental pollution associated with burning of fossil fuels.

However, this may be a hasty and generalized conception. To better understand the benefits and costs and advantages and disadvantages for China to implement the CDM, a

more in-depth analysis may be needed. Chapter 3 of this study aims to discuss this issue in great details.

To determine what actual benefits and costs would be for China to implement the CDM, Chapter 2 summarizes a number of recent studies on the estimates of the potential market for the CDM and the possible share of China. It provides references on how large the CDM market would be, and what is the likely share for China.

2. POTENTIAL MARKET FOR CDM AND POSSIBLE SHARE FOR CHINA

The benefits and costs and advantages and disadvantages of China participating in the CDM to some extent depend on how large the potential market for the CDM is and the China's share in this potential market will be. It is a basic question, in which the answer can form the basis for evaluating the actual benefits China could obtain if it participates in the CDM. First, the possible share for China in the potential CDM market can show how big the scale could be in the investment and technology transfer flows resulting from the CDM projects. Secondly, China's share in the CDM market would be one of the factors that can be used to calculate magical abatement costs. Marginal costs may affect emission reduction costs in the future, and may produce long-term effects on China.

Therefore, it is important to determine the size of the potential market for the CDM, before the in-depth analysis on benefits and costs/advantages and disadvantages for China to take part in the CDM is completed.

2.1. Estimates of the Size of the Potential Markets for the CDM by Foreign Studies

Although the CDM is expected to begin as early as the year 2000, many basic operational technical issues, such as the determination of baseline, the measurement of the CDM projects, modalities and procedures for project monitoring and verification, and whether sinks should be included in the CDM, are yet to be clarified. Under such circumstances, it is very difficult to estimate the size of the CDM. Nevertheless, a number of studies have attempted to estimate the potential size of the CDM market.

These studies include: A.D. Ellerman and A. Decaux's *Analysis of Post-Kyoto CO_2 Emissions Trading Using Marginal Abatement Curves* (1998); E. Haites' study on *Estimate of the Potential Market for cooperative Mechanisms 2010* (1998); *Emissions Trading, Capital Flows and the Kyoto Protocol* (1999) by W.J. McKibbin *et al*; Van der Mensbrugghe's *Analysis of the Kyoto Protocol: Using the OECD GREEN Model* (1998); Edmonds *et al Unfinished Business: The Economics of the Kyoto Protocol* (1998); C. Vrolijk's *the Potential Size of the CDM* (1999); and Zhongxiang Zhang's *Estimating the Size of the Potential Market for All Three Flexibility Mechanisms under the Kyoto Protocol* (1999). Table 2-1 below lists these studies and their estimates of the CDM markets:

Table 2-1. Current Estimates of Potential CDM Markets by Current Studies

Studies and Models	Size of the CDM Market (MtC)	Total Emissions Reductions Required of Annex I Countries (MtC)	Contribution of the CDM
EPPA	723	1312	55%
Haites	265-575	1000	27-58%
G-Cubed	495	1102	45%
Green	397	1298	31%
SGM	454	1053	43%
Vrolijk	67-141	n.a	n.a
Zhongxiang Zhang	132-358	621	21-58%

Note: n.a. = *not available*
Sources: Edmonds et al. (1998); Ellerman and Decaux (1998); Haites (1998); Mckibbin et al. (1999); Van der Mensbrugghe (1998); Vrolijk (1999) Zhongxiang Zhang (1999)

Quantitatively speaking, the estimate by Vrolijk is 67-141 MtC, which is relatively low. The estimate by Ellerman and Decaux by using the MIT's EPPA model[2] is the highest of all, amounting to 723 MtC. The calculation as the result of the studies by Van der mensbrugghe using OECD's GREEN model) and by Edmonds *et al.* using the Second Generation model (SM) – equal to 397 MtC and 454 Mtc respectively. The estimate by Zhongxiang Zhang is between 132 and 358 MtC.

It should be noted that the calculating method used by Zhongxiang Zhang differs from others. Other studies mainly depend on various economic modeling, such as EPPA and SGM, to estimate the potential CDM market, while Zhongxiang Zhang bases his calculation on the national communications between Annex I countries and the UNFCCC Secretariat.

Zhang first identifies GHG emissions for each Annex I country in its baseline year (for most Annex I countries, the baseline is 1990, while Bulgaria and Romania use 1989; Hungary, the average between 1985-1987; and Poland, 1988). He then estimates the Kyoto emission reduction commitment of each Annex I country for the year 2010. Finally, he estimates the size of the offset market against the baseline GHG emission during the commitment period. By so doing, Zhang concludes that the overall size of the GHG offset market for Annex I Parties in 2010 would be 620.6 Mtc.

In addition, Zhongxiang Zhang considers two other factors that will affect the market for emission reduction, that is, the size of hot air[3] and the supplementary limits of use on all three Kyoto mechanisms (JI, CDM and ET) proposed by EU[4]. He then further estimates the size of the potential market under each of the four scenarios[5] *(See Table 2-2)*.

[2] The EPPA Model (Emissions Prediction and Policy Assessment Model) is developed by MIT, and it is a computable general equilibrium model used to calculate multi-region and multi-sector economic activities, energy utilization and carbon emissions.
[3] If some countries whose emissions targets under the Kyoto Protocol are well below their business-as usual emissions (no any limitation), there will be a difference between their emission targets and their business-as0usual emissions. This difference is 'hot air'. When emissions trading were allowed, these countries would be able to sell 'hot air' and obtain gains from the trading. Because trade in hot air does not represent any real emissions reductions by the selling countries, trade in hot air makes the total emissions higher than what would be without emissions trading. Countries that may possess excessive hot air including countries formerly belonged to Russian and eastern European countries. Zhongxiang Zhang estimates that the amount of hot air for sale under the Kyoto targets for these countries would be 105 MtC. If under the supplementarity constraints proposed by the EU, the amount of hot air available in 2010 would be 72.2 MtC.
[4] The demand for GHG offsets will also be affected by the extent to which the three Kyoto mechanisms will be allowed to contribute to meet the Kyoto targets. Under the Kyoto Protocol, Articles defining JI and ET carries the wording that the use of these two mechanism must be supplemental to domestic actions. Although Article 12 is not specified "supplementarity", it does state the Annex I Parties may use the CERs from the CDM projects to contribute to compliance with "art of their quantified emission limitation and reduction commitments". Some believe that this amounts to the supplimentarity requirements. In this case, the question is how a ceiling on the use of the three flexible mechanisms be defined. There are several

Table 2-2. Estimates of the Contributions of Three Flexible Mechanisms under Four Trading Scenarios in 2010

Scenarios	Domestic Actions	Hot Air	ET & JI	CDM	Total Supply
No limits	171.7	105.0	51.8	292.1	620.6
50% of reduction (BAU)	310.3	105.0	36.1	169.2	620.6
EU ceilings	387.8	70.2	30.8	131.8	620.6
No hot air	203.5	0	59.6	357.5	620.6

Source: Zhongxiang Zhang, Estimating the Size of the Potential Market for All Three Flexibility Mechanisms under the Kyoto Protocol, November 1999

The estimates by Zhongxiang Zhang of the size of the potential market for CDM are relatively lower than other studies. This is because Zhang's calculation is based on national communications from each Annex I country to the FCCC Secretariat. The committed emission targets of the EU members in 2010 are very close to their actual emissions.

2.2. Possible Share for China in Potential CDM Markets

The marginal costs for GHG abatement for all countries will be very similar if emission trading is allowed through the CDM. Based on the difference of a countries' marginal abatement costs, Zhang assumes that the net value of the CDM participating countries is the same in 2010. He estimates the relative shares of the CDM market for China, India, and other countries. Table 3 lists his estimated shares for China.

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proposals, and the most representative is the EU proposal. In EU's Community Strategy on Climate Change, the EU proposes to limit both buying countries and selling countries. For a buying country, the maximum purchase for GHG emission reduction units via all three flexible mechanisms can not exceed the higher of the following two alternatives:

- 5% of {(its base year emissions multiplied by 5 + its assigned amount)/2} or
- 50% of the difference between its annual actual emissions in any year between 1994 and 2002, multiplied by 5, and its assigned amount.

Similarly, for a selling country, the maximum allowed sale for GHG emission reduction units vial all three flexible mechanisms can not exceed the amount calculated by:

- 5% of {its base year emissions multiplied by 5 + its assigned amount)/2}.

[5] The four scenarios are:

- No limits scenario: No caps are imposed on the use of all three flexibility mechanisms
- 50% reduction from BAU emissions scenario: The maximum allowed acquisitions from all three flexible mechanisms are limited to 50% of the difference between projected baseline emissions and the Kyoto targets in 2010;
- The EU ceilings scenario: The EU proposal for concrete ceilings on the use of all three flexible mechanisms, as described in the above note;
- No hot air scenario: Trading in hot air is not allowed, indicating that any effectuated trading in GHG emissions must represent 'real' emissions reductions.

Table 2-3. The Value of the CDM Market and the Share for China in 2010 Under Four Trade Scenarios

	No limits	50% of reduction from BAU emissions	EU ceilings	No hot air
CDM market (million US$)	2795.6	797.4	456.9	4512.8
Of which:				
China	60.3%	59.9%	59.6%	60.4%
Net CDM market (million US$)	1565.0	432.4	244.6	2559.1
Of which:				
China	59.9%	59.4%	59.2%	60.1%

Source: Zhongxiang Zhang, Estimating the Size of the Potential Market for All Three Flexibility Mechanisms Under the Kyoto Protocol, November 1999

The value of the CDM market in Table 2-3 was derived by multiplying the international price per ton of carbon. The size of the net CDM market share for China is calculated by subtracting the costs of China's implementation of the CDM projects, and the net value. This amount equals the net benefits that China may gain in the CDM market.

Zhongxiang Zhang's estimate of the shares for China and India in the CDM market is based on the differences in the marginal costs between China, India, and Annex I countries. However, it should be noted that when private companies' participation involves the CDM, marginal costs, although a crucial factor, may not be the only factor that affect the CDM investment flows. Geographic distribution, transaction costs, and other factors may also affect the CDM investment flows. This has been confirmed by the AIJ experience.

Up to September 1999, there were 122 projects that were approved by participants. They are mainly in the areas of the energy sector, with a few forestry and pollution control projects. There are 14 developed countries that have participated in the AIJ projects including Canada, Germany, Japan, the Netherlands, Sweden, and the United States; and there are 28 host countries including countries in Eastern Europe and the former Russian region, Latin America, Asia, and Africa. Overall, the distribution of the AIJ projects is unbalanced, with most projects taking place in Eastern Europe, the former Russian region, and Central America and with almost half of the projects in Estonia, Latvia, Lithuania, and Costa Rica. There are only two projects taking place in Africa. The European Union countries prefer to cooperate with countries in Eastern European and the former Russian region, while the United States aims its cooperation at Central America.

Although the distribution of the AIJ projects would not be exactly the same as the distribution of the CDM projects, the investment flows as the result of the CDM, like the AIJ, involves local environmental and political issues. What can be learned from the AIJ is that the estimate simply based on the marginal abatement costs may overestimate the share of China in the CDM market.

Chapter 3 will analyze the advantages and disadvantages for China to participate in the CDM based on the aforementioned estimate of the size of the potential CDM market and the possible share for China.

3. ANALYSIS OF PROS AND CONS FOR CHINA'S PARTICIPATION IN CDM

At present, because rules and many key technical issues for the CDM have not been clearly defined, a precise overall estimate of the advantages and disadvantages for China's participation in CDM will be very difficult. However, opportunities are often embodied in uncertainties. If China waits until all the rules and technical issues of the CDM are resolved, it will probably lose most opportunities to influence the development of the CDM mechanism. Moreover, climate change is irreversible, and undue delay may cause irremediable damages to the atmosphere. Under such a circumstance, China needs to undertake a timely scientific analysis on pros and cons for its participation in the CDM, and make its decision as early as possible.

3.1 Potential Benefits and Costs for China to Participate in CDM

The CDM has attracted a great deal of attention in the international community since the Kyoto meeting in 1997. Many international organizations, governmental as well as non-governmental organizations have studied and discussed a wide range of issues concerning the design and the implementation of the CDM, including technical, economic, and political issues. Non Annex I countries, however, are more concerned about the pros and cons of their participation in the CDM. Table 3-1 summarizes all the possible benefits the CDM may bring to China and other non Annex I countries.

Table 3-1. Potential Benefits for China's Participation in CDM

- Low-cost energy generated by more efficient energy facilities and increased output
- Increased profits resulting from low-cost, high efficiency power plants and from the capitals provided by CDM investors
- Transferable emission reduction credits gained through the negotiations with CDM project investors
- Infrastructures and technologies for producing and transporting low GHG emission fuel
- Learning experience and special knowledge through early participation
- Energy conservation
- Stimulating the growth of local and national economy as well as enhancing job opportunities
- Present value of the proceeds from improved environment
- present values of benefits resulting from enhanced health
- Favorable clauses incorporated in the agreement through negotiation, such as the option of buying back emission reduction credits and local development aid, etc.

Sources: summarized by the authors

Table 3-2 summarizes possible costs and losses that may incur to China if it participates in the CDM.

Table 3-2: Possible costs and losses for China's participation in CDM

• Transaction costs incurred in the negotiation, monitoring and verification of CDM projects • Present values of the negative impacts on domestic equipment manufacturers caused by facilities imports through CDM • Risk that China's participation in the CDM would lead to its commitment to reduction obligations in the future • If the above situation occurs, expected present value of possible increase in the total reduction costs that is likely to accrue as the result of the increase in marginal reduction costs through the present emission reduction efforts • Opportunity costs of matching funds incurred in the CDM projects • Present values of any other external costs incurred by CDM projects, such as the inappropriate allocation of resources due to incomplete information and the miscalculation of the present values of available CDM projects

Source: summarized by the authors

Whether China should participate in the CDM may largely depend on the comparison of the possible benefits and costs through its participation. As a matter of fact, not all CDM projects may have each the benefits and costs listed above. Some benefits and costs depend on how the rules for the CDM are stipulated, and how the technical issues are resolved. Others depend on the skills and the positions of the partners in host countries in their negotiations with the CDM investors.

However, current quantitative studies on the benefits and costs of CDM mainly focus on the savings from the reduction costs brought by GHG emission reduction through the CDM. Hardly anyone has undertaken a comprehensive study of the possible economic, environmental, and social benefits for non Annex I countries if they participate in the CDM (Edmonds, J., 1999).

Overall, the analysis of the pros and cons for non Annex I countries to participate in the CDM remains very general. As information is incomplete and uncertain, some fear that the CDM are mere subjective apprehensions and some estimations of the proceeds from the participation of CDM are grounded on idealized hypothesis. It can be seen from Tables 3-1 and 3-2 that the possible costs and benefits for China to participate in the CDM involve such a wide range of issues, it is almost impossible to cover everything in detail. Therefore, this study focuses its analysis mainly from two dimensions – *direct-indirect* and *short term-long term* – to examine potential impacts of China's participation in the CDM

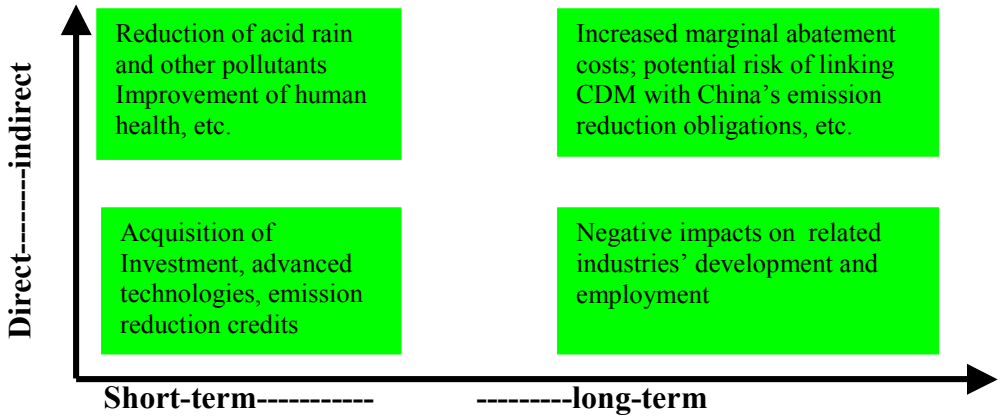
- Short-term direct impacts – refers to direct impacts as the result of the participation in the CDM in a short run, mainly the magnitude of the investment, equipment, and technology, as well as the emission reduction credits China is likely to gain from the CDM projects;

- Long-term direct impacts – refers to direct impacts that are likely to occur by China's participation in the CDM over a long run. There may be the possible negative impacts on the domestic equipment manufacturing industry caused by the importation of facilities through the CDM;

- Short-term indirect impacts – refers to direct impacts resulting from China's participation in the CDM in a short run, mainly environmental and social benefits generated by CDM projects, such as the reduction of acid rain, improved air quality, increased job opportunities and better health.

- Long-term indirect impacts – refers to indirect impacts the CDM may bring over a long term. Some suspect that the CDM may cause some negative indirect imparts to China over a long run, and these mainly include the possibility of increasing future reduction costs for China by participating now, and whether China's participation in CDM will be linked to its commitment to emission reduction obligations is not certain yet.

Figure 3-1. Two-Dimension Potential Impacts for China's Participation in CDM



As mentioned earlier, the underlying issue of whether China should participate in CDM depends on the size of the potential market and the possible share of the market China can gain. Chapter 2 summarizes the views of major current studies on the size of the market and the possible share China could gain. Based on the estimates of this summary, the following sections will examine the four aspects of benefits and costs for China to participate the CDM in detail.

3.2 Possible Short-term Direct Benefits and Costs for China to participate in the CDM

Short-term direct benefits for China's participation in the CDM refer to direct benefits that the CDM projects can bring to China in a short term. These mainly include investment, equipment, or technology as well as the possible allocation of emission reduction credits through the CDM projects, etc.

3.2.1 Environmental investment China may attract through the CDM

As marginal emission abatement costs in China are extremely low, its participation in the CDM will consequently attract a large amount of investment from Annex I countries. The magnitude of investment that China will attract depends on the size of CDM market and the possible share China can get in the CDM market. Nevertheless, we cannot simply assume that the estimate of the potential size of the CDM market and the possible share for China is the actual amount of investment and equipment or technology China can obtain through its participation in the CDM. This is because the size of CDM market in value comes from multiplying the quantified market size by estimated international price of GHG. If we use an analogy of the traditional goods market, the size of the CDM market/year in value is just like the income earned from the sale of a product annually. Supposing the following:

1) Investment in CDM projects begins in 2005. The return of the project starts in 2008. The period of return is 2008-2012. The internal rate of return is 10%, with 2005 being the base year;
2) All the reduction credits gained from CDM projects go to the investors, while the host countries can only gain the conventional usual production profits resulting from the CDM projects (such as power stations).

According to the formula of compound rate, we can calculate the magnitude of investment that corresponds with the size of CDM market. The formula is

$$I_{pv} = \sum_{3}^{7} \frac{S}{(1+10\%)^n}$$

In this formula, S is the size of the CDM market share for China per year in the period of return (supposing S is the size of year 2010). I_{pv} is the present value of the total investment that China can obtain through its participation in the CDM.

The data we use for our calculation is the estimate of the potential size of the CDM market and the share China is likely to gain made by made by Zhongxiang Zhang (*See Table 3*), which indicates in the case of the EU Ceiling, China's CDM market size in 2010 is US$ 272.3 million, and in the case of no limits, it is US$ 1685.7 billion. According to the calculation using the above formula, the investment China can acquire in the commitment period (2008-2012) of the Annex I countries in the above two cases is US$ 853.1 million and US$ 5196.9 million respectively, accounting for 1.88% and 11.48% of the actual amount of foreign direct investment in 1997.

Obviously, if the EU Ceiling is applied, the amount of investment China can acquire through the CDM is relatively small. If host countries can participate in the allocation of CDM credits, the prospective investment they could gain is also likely to decrease proportionately.

It should be pointed out that among the estimates of the CDM market listed in Table 1 by various scholars, the estimate by Zhongxiang Zhang is relatively low. Therefore, the amount of possible CDM investment we calculate based on his estimate above is relatively conservative.

3.2.2 Possible energy technology China may acquire through the CDM

With its low energy efficiency and scarcity of energy resources, China is undoubtedly in great need of state-of-the-art energy technology. The CDM can help turn these present disadvantages of China's industrial sectors – high energy consumption, serious pollution, and high emission – into favorable conditions, namely, importing more high efficient technology and possible emission credits, which can also be exchanged for state-of-the-art energy technology. China's present high energy consumption, serious pollution, and high emission, also means low marginal abatement costs. Possible areas for introducing advanced technologies in China are as follows:

- High efficient power station and boiler technology, such as circulation fluidized bed boiler; efficient and low emission fine coal boiler; and combined-cycle power generation technologies.
- State-of-the-art industrial boiler, mainly in such energy-intensive industries as metallurgy, building materials, and chemistry.
- State-of-the-art central heating boiler.
- Wind energy, solar energy and bio-energy and other renewables technologies
- Green lighting, energy conservation building and other energy conservation technologies.

Generally speaking, the introduction of such technologies through the CDM will not only result in energy conservation and GHG emission reduction, but also improve efficiency and competitiveness of Chinese enterprises to some extent. This is consistent with the China's priorities of economic development. Of course, the quantity of technologies that China can acquire is closely related to the amount of CDM investment it can obtain.

3.2.3 Emission reduction credits China might obtain through CDM projects

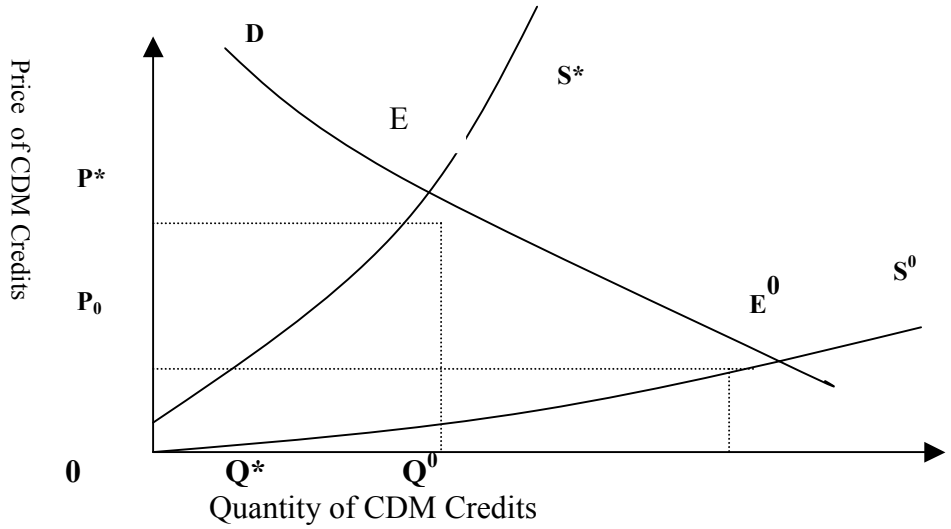
There are mainly two direct benefits the CDM projects can bring to China. The first will be the conventional output and profit that the project can yield, and the second will be the emission reduction credits resulting from the CDM projects, namely marketable certified emission reductions (CERs). As the marginal abatement cost in China is likely far lower than even that of India's (which will be discussed in detail later), China would not only enjoy the conventional output and profits of the CDM projects, but also could share CERs and profits from the transfer of CERs.

However, whether non Annex I countries can share CERs resulting from CDM projects, and whether CERs resulting from CDM projects can be banked and transferred if non-Annex I countries can share CERs, are still issues yet to be addressed in the CDM negotiations.

Even if non Annex I countries are allowed to share CERs, like common trade in goods, the allocation of CERs depends largely on the ability and skills of the negotiating parties. Due to the asymmetry in information and knowledge, non Annex I countries are usually weaker than Annex I countries in negotiations and will likely be in a disadvantaged position in negotiating the share of the proceeds resulting from the CDM projects. Consequently, it is necessary for international organizations to pay attention to enhance the ability of the concerned parties of non Annex I countries in developing the CDM.

On the other hand, since the demand of Annex I countries for CDM credits is fixed, adopting a correct supply strategy will improve the position of non Annex I countries in obtaining CDM proceeds.

Figure3-2 Aggregated Demand and Supply Curves of CDM Credits



Curve D is the aggregated demand curve for CDM credits, $S^0$and S* represent the aggregated supply curves, and E^0 is the point of intersection of demand curve and supply curve $S^{0,}$ whose corresponding price of CDM credits is P^0. Q^0 represents the transaction volume of CDM credits. Area OE^0P^0 stands for the net benefits for non Annex I countries. Figure 2 shows that more sales of CDM credits will not necessarily maximize the benefits of non-Annex I countries. Actually non Annex I countries would prefer to adjust the supply of CDM credits so that the supply curve rises to the optimal point where marginal cost is equal to the price, that is the point S*, only then can the net benefits of non-Annex I countries be maximized. In Figure 2, E* is the point of intersection of the demand curve and the supply curve S*, whose corresponding price of CDM credits is P* and whose corresponding transaction volume of CDM credits is Q*.

As it is pointed out in 3.2.2, China's low marginal abatement costs will put China in a monopoly position in the CDM market, amounting to almost 60% of the market. Thus, by making good use of its relatively monopolistic position in the CDM market to control

the supply of emission reduction credits, China and other non Annex I countries will gain even more net benefits.

It should be noted that in order to simplify the analysis, the calculation of the potential investment China may attract by participating in the CDM projects in 3.2.1 is based on the assumption that China will not participate in the allocation of the CDM reduction credits. If China does, the amount of CDM investment it may attract will decrease proportionately. It will make no difference when the price of CDM credits is equal to the corresponding investment. But when the price of CDM credits exceeds the corresponding investment, it will be advantageous for China to participate in the allocation of CDM credits.

3.2.4 Possible short-term costs for China to participate in CDM

Although China's participation in the CDM may bring China the three major short-term direct benefits mentioned above, including a considerable amount of investment various advanced energy efficient technologies, and possible proceeds as the result of the CDM projects, it should be aware that there may also be some costs China needs to incur if it participates the CDM. Such costs may include opportunity costs for matching funds,, costs for negotiating the projects, transaction costs incurred in monitoring and verification of the CDM projects, as well as costs for administrating the CDM projects.

3.3 Possible Long-term Direct Benefits and Costs for China's Participation in CDM

Section 3.2 assesses the scale of capital and technologies that the CDM will likely bring to China. There is no doubt that China will benefit from its participation in the CDM over a short term. But it is necessary to further analyze what specific technologies the CDM projects can bring to China, because different technologies may have different impacts on China's sustainable development, both in the short term and over a long period of time. For instance, whether the technologies acquired by China will simply be boilers that abate carbon emission now or technologies to manufacture efficient boilers, whether they will be diffusible or not, whether the technical change will take place internally or externally, and whether the technologies will replace or merely complement existing technologies and facilities in China These will have completely different short-term and long-term impacts on China's sustainable development. Sometimes technologies that are beneficial in a short term will have a negative impact on the sustainable development over the long run. Therefore, only by clearly defining the technologies China may acquire and closely examining their long-term impacts, can we draw a reliable conclusion.

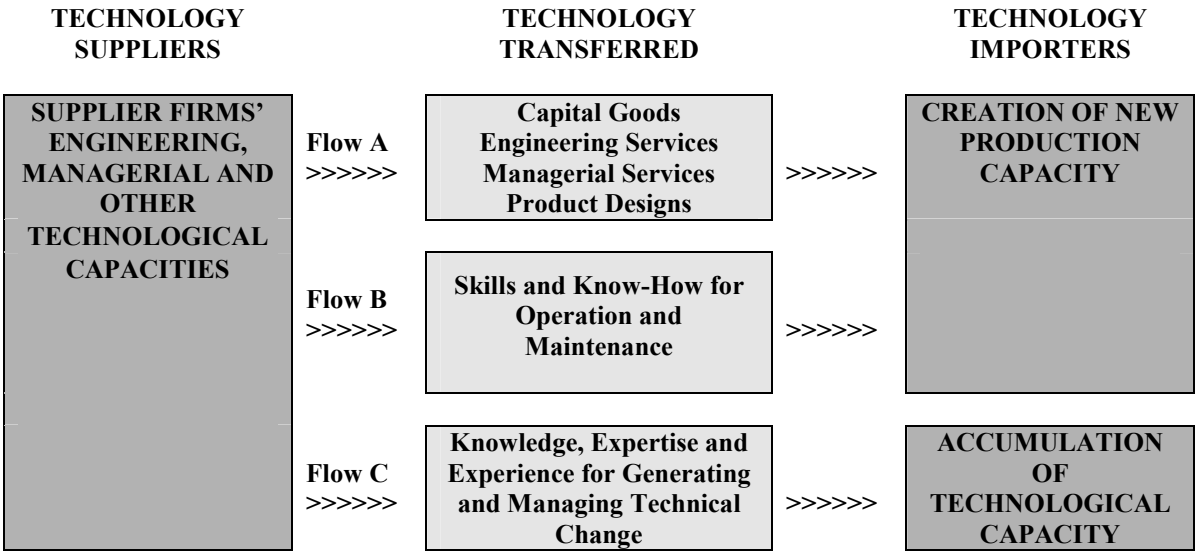
3.3.1 Types of technology China may acquire through CDM

Figure 3-3 provides a general classification of internal technology transfer by M. Bell[6]. It shows that internationally transferred technologies differ widely in their form and

[6] Cited by Jim Watson in *The Transfer of Clean Coal Technologies to China: Learning From Experience*, SPRU, University of Sussex, a working paper submitted to the

function. But the question we need to answer is what kind of technology can China obtain through the CDM?

Figure 3-3. The Technological Content of International Technology Transfer



Source: Jim Watson, The Transfer of Clean Coal Technologies to China: Learning From Experience, a working paper submitted to the Working Group on Trade and Environment of the China Council for International Cooperation on Environment and Development in 1999

The types of technology that China can acquire through the CDM are closely linked to the motives of the CDM investors. Usually, the CDM investors are corporations and other entities that possess considerable capital resources. For example, they may be manufacturers of power station facilities, and invest in the CDM projects with an aim of seeking opportunities for lower marginal abatement costs outside their own country. Or they may be speculators who invest only to profit from emission trading. The basic operation of a CDM project is that an investor or investors purchase mitigation equipment from the manufacturers in industrialized countries; then the investor or investors (sometimes manufacturers directly) cooperate with a partner in a host country and jointly invest in a mutually-agreed-upon and approved CDM project. They calculate emission reductions based on the project itself, and share the emission reduction credits resulted from the project.

Obviously, when the CDM project investor is not the owner of the technology, but simply a speculator, China will only obtain Flow A technology – capital goods, namely mitigation equipment. When the investor is the owner of emission reduction technology, China may obtain Flow A technology (mitigation equipment) and Flow B technology

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Working Group on Trade and Environment of the China Council for International Cooperation on Environment and Development in 1999.

(skills and knowledge of operation and maintenance). It is very unlikely that China will obtain other technologies in Flow A, such as engineering services, managerial services, and product designs, even less the opportunity to acquire Flow C technology.

As technologies (2) to (4) in Flow A and technologies in Flow C directly involve manufacturing of mitigation equipment or improving the ability to manufacture equipment, transferring such technologies will, on one hand, threaten the technological superiority of the investors in the competition, thus preventing them from earning sustained profits with their technological superiority. On the other hand, it is difficult to decide the duration of the project, the calculation of emission reductions, and the distribution of benefits in technology transfer through CDM. Consequently, the transaction costs will be relatively high.

Under the CDM framework presently discussed, it can be assumed that the technologies China can acquire through the CDM are mainly mitigation equipment and technologies for maintaining and operating such equipment, rather than technologies necessary to manufacture mitigation equipment. Strictly speaking, mitigation equipment is simply the carrier of emission reduction technology, not core technology itself.

The technical change of a country can be external and internal. Internal technical change depends on a large scale of sustained investment in R&D. To achieve real sustainable development, developing countries should make good use of the new incentives provided by climate change and innovate their energy technology. They should seize the opportunities of international technology transfer resulting from the global climate change strategy to develop their independent and internal technology innovation capacity.

The CDM has the dual objectives of supporting the sustainable development of non-Annex I countries and assisting Annex I countries in achieving cost-effective compliance with their reduction obligation. It aims to support sustainable development in developing countries through its role in technology transfer. However, under the current framework of the CDM, technology transferred through the CDM would likely be external to the technology R&D of China, which can hardly improve China's independent technology innovation. So there is the possibility that CDM cannot effectively carry out its dual objectives. Although the CDM may promote development in developing countries in a short term, it may not necessarily promote sustainable development, as the word of "sustainable" means "dynamic" and "long-term."

3.3.2 Will the technology China obtains through CDM be diffusible?

The diffusibility of technology is a decisive factor in determining long-term benefits of the CDM for host countries and global environmental benefits. The higher in speed, the wider in scope, and the greater in extent the technology can diffuse, the greater global environmental benefits and higher economical benefits would be for host countries.

However, global environmental benefits generated from technology diffusion can hardly be turned into the economic benefits for foreign investors. The wider scope the

technology diffuses, the greater economic loss it incurs to investors. Therefore, investors will try every means to restrain their technology from diffusing in order to protect their own interests. China's first AIJ pilot project clearly shows this conflict.

In February of 1997, the State Science and Technology Commission (presently the Ministry of Science and Technology) signed with the Japanese Ministry of Foreign Affairs China's first official AIJ project – Coke Dry Quench Technology. The project is jointly implemented by China's Capital Iron and Steal Groups and Japanese NIPPON. The proposed investment totals 25 million dollars, with Nippon investing 10 million dollars, covering the cost of technology installation and testing of the steam circulation system. The other 15 million will be from the Capital Iron and Steel Groups covering the costs of installing other facilities and building projects. After the project goes into operation, the project is expected to save 40 thousand tons of coal every year (equal to 28 thousand tons of carbon), thus saving 12 million RMB of costs. The patent agreement signed between the two parties stipulates that the Capital Iron and Steel Groups shall not transfer the said technology within ten years and that it cannot own the technology until after ten years (Ling, Jia & Zhiting, Jiao).

Obviously, this shows that there are conflicts between intellectual property right protection and technology diffusion, and between global environmental benefits and economic interests of investors. It would be desirable if the CDM could establish a certain compensating mechanism to investors or transferors of technology, so that they would be willing to allow their technology to be diffused. By so doing, the CDM will undoubtedly make a greater contribution to the global sustainable development.

3.3.3 Will short-term impacts resulting from the import of mitigation equipment be consistent with China's long-term goal for China's sustainable development?

From a short-term perspective, mitigation equipment imported through the CDM is normally equipment that China is currently unable to produce or put into commercial production. Therefore, mitigation equipment that is imported will unlikely to compete with China's equipment manufacturing industry at the same level. They are complementary to each other, but not replacing each other. But considering it from a long-term perspective, we find that China is a growing GHG emitter, whose task in emission reductions is extremely arduous. In the long-run, China needs to be able to produce its own core GHG mitigation equipment, or at least be able to achieve a balance in international payment in the field of mitigation equipment. This requires China's R&D capacity in mitigation equipment (mainly energy equipment) to reach the international level within a certain period. However, China's energy equipment manufacturing industry is in a very difficult situation (*See Tables 3-2 and 3-2*).

Table 6 indicates that the output value in 1998 for the largest manufacturers of large utility boilers – Shanghai Boiler Co. Ltd. – was just slightly over US$100 million. The sale profit margin for five key manufacturers of large utility boilers in China was only 0.68% on average. Enterprises with such a small scale and with such a low profit rate will by no means be able to afford any advanced R&D activities.

Enterprises in the field of industrial boilers manufacturing in China are also very small in size and in degree, while the market competition is very fierce. Statistics show that in 1998, there were only 706 enterprises holding the permit for manufacturing Grade-E boilers with an annual output of 150 thousand t/h. Table 7 shows general information on Chinese boiler manufacturers affiliated within the Machinery Building Administration in 1998.

Table 3-1 Economic Indicators for China's Key Large Utility Boiler Manufacturers in 1998

Name of Enterprise	Sale Value (10,000Yuan)	Profit (10,000 Yuan)	Output (MW)
Ha'erbin Boiler Co. Ltd.	80,366	611	2843
Dongfang Boiler Groups Ltd.	68,359	137	2660
Wuhan Boiler Groups Ltd.	23,798	48	1017
Shanghai Boiler Co. Ltd.	10,4110*	1236	4087
Beijing-BW Co. Ltd	42,231	151	1800

Note: This data is the output value of Shanghai Boiler Co. Ltd.
Source: China's Machinery Building Yearbook 1999

Table 3-2 Major Economic Indicators for Some Industrial Boiler Manufacturers in 1998

Item	Statistics
Number of manufacturers	209
Total number of staff and workers	1380000
Output of industrial boilers	70200 t/h
Sale Vale	6.116 billion Yuan
Profit	64.16 million Yuan
Profit margin	1.05%

Source: China's Machinery Building Yearbook 1999

Most of the industrial boiler manufacturers affiliated with the Machinery Building Administration are large, key manufacturers. However, their average profit margin in 1998 was only 1.05%. The sales income of the top ten industrial boiler manufactures was only 1653.26 million Yuan, and their profit was only 156.6 million Yuan. That is to say, the profit margin of these top ten industrial boiler manufactures was only 9.47%.

Such a low profit margin for Chinese manufacturers of energy facilities is closely related to the increasing import of energy facilities since the 1990s. If perspective energy technology to be imported through the CDM equipment will further weaken the ability and the development of the domestic mitigation equipment manufacturing industry and consequently cause its shrinking, it will be inevitable that when it is time for China to take on its reduction obligations, all the needed mitigation equipment will have to be imported from industrialized countries. This will be a great economic burden on China. The current efforts to implement the Montreal Protocol has indicated that China's R&D ability to develop and produce products and technologies to substitute ozone layer depleting substances has been already limited. China has now been forced to import a

large quantity of substitutes from industrialized countries, and is suffering from economic "exploitations"

On the whole, environmental concerns have provided great opportunities for Chinese energy facilities manufacturers, at the same time, they have also posed serious challenges for them. If the CDM is likely to affect the development of China's own mitigation technologies, it will consequently affect its ability to fulfill its mitigation obligations in the future. As a result, it will hinder the achievement of the global emission reduction objectives. Therefore, the key problem of whether the CDM will be beneficial to China's long-term sustainable development, lies in how to make the owner of emission reduction technology cooperate with Chinese mitigation equipment manufacturers through the CDM to improve the latter's R&D ability in developing abatement technology.

In conclusion, if technologies imported to China through the CDM are only mitigation equipment, maintenance, and operation technologies, China can only obtain short-term benefits by participating in the CDM. But if China will acquire not only the above-mentioned technologies, but also other technologies in Flow A as well as technologies in Flow C through the CDM, and if technologies obtained are diffusible, China will likely be able to enhance its independent innovation ability to develop mitigation technologies and thus achieve real sustainable development over long period of time. However, the present CDM does not provide such a mechanism. Therefore, the key issue in future international negotiations should be aimed in establishing such a mechanism to make the technology imported through the CDM diffusible in non Annex I countries. Only by so doing, can the CDM achieve its dual objectives in a real sense. To reach this goal, the collective influence of all the non Annex I countries is needed.

3.4. Possible Short-term Indirect Benefits for China to Participate in CDM

Possible short-term indirect benefits of China to participating in the CDM refer to the indirect benefits that may result from the CDM projects in a short term, mainly environmental and social benefits such as reduced acid rain, improved air quality, increased employment, and improved human health.

Air quality in many of China's major cities is probably the worst in the world. At present, the main cause for air pollution and acid rain is the burning of 13 billion tons of coal every year. Recent studies have shown that the economic loss incurred due to environmental deterioration amounts to 18.9% of China's annual GDP. Correspondingly, health costs of environmental pollution are also very high. The World Bank predicts that due to its serious environmental pollution, China's health costs will increase from US$ 20 billion in 1995 to US$ 98 billion in 2020.

It is widely expected that the CDM projects can not only reduce carbon emission, but also bring considerable environmental benefits. Table 3-3 lists possible environmental and social benefits that may result from the CDM projects.

Table 3-3 Possible Environmental and Social Benefits that May Result from Potential CDM Projects

Environmental benefits	Potential CDM projects
Air quality	Many alternative power generation and cogeneration options lead to substantial reductions in SO_x, CO, especially fine dust and NO_x. Renewable technologies, such as wind and solar, completely eliminate such pollutants.
Water quality	Solar and wind energy offer unambiguous gains over conventional alternatives. Use of anaerobic digester technologies at industrial sites could simultaneously treat wastewater and provide natural gas.
Water and soil	Sustainable forest management could protect against water depletion and run-off problems, especially practiced over deserts and barren areas. New silvicultural plantations may lead to reduced soil erosion. Planting tree webs on plains can reduce wind erosion. Afforestation projects in key water basins can prevent runoff.
Solid waste	Advanced combustion technologies reduce or remove solid waste, in some cases creating marketable byproducts.
Noise	Replacing diesel pumps with wind pumps leads to substantial reductions in noise.
Flood prevention	Afforestation in river basins could prevent or control flooding risks.
Biodiversity protection	Sustainable forest management offers sustainable benefits over present logging practices. Cogeneration and renewable technologies reduce some mining pressures
Social and Development Benefits	
Employment	Many options offer employment opportunities in undeveloped regions or among key social groups.
Rural development	Renewable energy sources promise electrification of rural and/or remote areas not otherwise possible given high transmission costs.
Poverty alleviation	Positive equity impacts with many projects because of increased demand for unskilled labor, often in areas of high unemployment.

Source: Ducan Austin, Paul Faeth et al (1999): "How much sustainable development can we expect from the Clean Development Mechanism?" posted the Web site of the World Resources Institute at http://www.wri.org/cdm

In general, reductions of GHG also mean reductions of other pollutants. For example, reduction of carbon dioxide means the decrease in emissions of fine dust and NO_x. The scale of reductions of pollutant emissions depends on the size of China's share of the potential CDM market. The quantity relationship between the two will be determined by the technology applied. With the estimates of the potential CDM market in China by various scholars previously in Chapter 2, it is possible to assess the actual decrease in other pollutant emissions through potential CDM projects based on the above estimates.

However, its should be noted that that if technologies imported through the CDM can be diffused, pollution emissions reduced would far exceed the scale of CDM credits due to its externality. Given this exception, it is very difficult to make a precise assessment of environmental benefits that potential CDM projects may bring to China.

3.5 Possible Long-Term Indirect Benefits and Costs for China to Participate in CDM

Possible long-term indirect benefits and costs that may result from the CDM projects refers to the indirect benefits and costs that the CDM may bring to China over long period of time. These include two aspects: 1) Will China's participation in the CDM today lead to increased marginal abatement costs in the future? 2) Will China's participation in the CDM now actually lead to China's commitment to reduction obligations? One of the reasons for non Annex I countries to be concerned about the increase in the marginal abatement costs is that GHG reductions are not their present development priorities. If non Annex I countries are to take on the emission reduction obligations in the future, the increase in marginal abatement costs before they assume any commitment will consequently increase the total marginal abatement costs for them by that time.

3.5.1 Impacts on China's future marginal abatement costs

The impact of China's participation in the CDM on China's long-term marginal abatement costs will largely depend on the following factors; the size of CDM market, potential for China's emission reductions or China's inventory for reduction projects, as well as the speed for its progress in the development of energy technology. All of these factors will determine the sensitivity of China's marginal abatement costs related to the changes in emission reductions over in the long run.

With its coal-dominated energy structure and low energy efficiency, China has a large potential for reduction projects. Its vast stretches of afforestable barren mountains means a huge potential for increasing sinks. It is true that China will likely to have the largest share in the CDM market. As the total demand of Annex I countries for CDM credits is fixed, the proportion of emission reductions to be actually realized through the CDM project to China's potential for reduction projects is unlikely to be very high. Given these two factors, it can be concluded that China's participation in the CDM is unlikely to lead to a dramatic increase in its future marginal abatement costs.

The impact of the speed of energy technology progress on the increase of China's future marginal abatement costs is rather complicated. Normally, if China's energy technology progresses rapidly during the period of its participation in the CDM, and its new technology is widely applied to the production process, it will make it more difficult for further emission reductions in the future. Under such circumstances, the future marginal abatement costs will likely increase. However, during this period, China's energy technology may also progresses rapidly and the newly developed technologies are yet to be widely applied in the production. Once such technology is widely used, it will make emission reductions at an even lower cost. It is then possible that the future marginal abatement costs for China will rise slowly, or stop rising or even go downward. As mentioned earlier, the speed of China's energy technology progress in its implementation of the CDM is closely linked to the form and content of the technology imported through

the CDM projects. If China can acquire technologies of Flow A, Flow B, and Flow C in Figure 3-3 through the CDM, China will likely achieve greater internal progress in developing energy technology. If this happens, it is possible that the future marginal abatement costs for China may only go slightly upward or even remain unchanged.

Presently, among current quantitative studies on marginal abatement costs, the one by D. Ellerman using EPPA model has attracted wide attention. By using the predicted emission volume under the business-as-usual scenario (or BAU) as the baseline, Ellerman has worked out the curve of marginal abatement costs of different countries and regions in proportionate emission reductions.

Figure 3-4 shows that the curve of China's marginal abatement cost is the easiest, which means its marginal abatement cost is the lowest. India comes next.

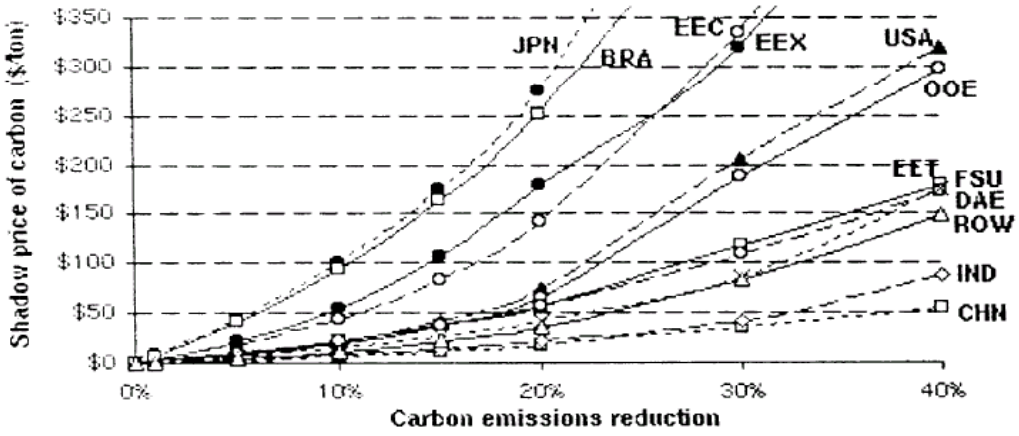

Figure 3-4 Estimated Marginal Abatement Costs of Proportional Mitigation based on the EPPA Model

The EPPA model supposes that the curve of the marginal abatement cost is a quadratic function

$$MCA_i = a_i Q_i^2 + b_i Q_i$$

in which MCA_i represents the marginal abatement cost of regions (countries) i, Q represents the amount of GHG reduction (megaton of carbon). Using the EPPA model, Ellerman estimates the coefficient of the concerned regions and countries *(See Table 3-4)*.

Table 3-4 Estimated Coefficient of the Marginal Abatement Costs in 12 Countries and Regions

Region of Annexed 1	*a*	*b*	R^2	Region of Non-Annexed 1	*a*	*b*	R^2
USA	0.0005	0.0398	0.9923	Energy exporting countries	0.0032	0.3029	0.9983
Japan	0.0155	1.816	0.9938	China	0.00007	0.0239	0.9992
EU	0.0024	0.1503	0.9951	India	0.0015	0.0787	0.9970
Other OECD countries	0.0085	-0.0986	0.9981	Newly developed countries in Asia	0.0047	0.3774	0.9996
East European countries	0.0079	0.0486	0.9973	Brazil	0.5612	8.4974	0.9997
Former Russia	0.0023	0.0042	0.9938	Other countries in the world	0.0021	0.0805	0.9967

Source: A. Denny Ellerman and Annelene Decaux: Analysis of Post-Kyoto CO2 Emission Trading Using Marginal Abatement Curves, Massachusetts Institute of Technology Joint Program on Science and Policy of Global Change, Report 40#.

Table 3-4 indicates that the goodness fit of the quadratic curves of all the countries and regions is very high, nearing 1. That is to say, the curve of the supposed marginal abatement cost basically agrees with the actual situation.

The emission volumes of China in 1990 were 833MtC; the emission volumes under BAU in 2010 are 1792 MtC (Ellerman, 1998). According to Zhongxiang Zhang, the size of the CDM market in 2010, namely, the emission reduction volume of China through the CDM is 292.1*60.3% = 176.1363 MtC (in the case of non-limitation). In the case of the EU Ceiling, the reduction volume is 131.8*59.6% = 78.5528 MtC. According to the quadratic equation formula, if China participates in CDM, its respective marginal abatement costs in 2010 – the shadow price of emission reduction – in the case of non-limitation and in the case of the EU Ceiling are:

$$MCAc = 0.00007Q_c^2 + 0.0239Q_c = 0.00007*176.1^2 + 0.0239*176.1$$

$$= 6.4 \text{US\$/t}$$

$$MCAc = 0.00007Q_c^2 + 0.0239Q_c = 0.00007*78.6^2 + 0.0239*78.6$$

$$= 2.3 \text{ US\$/t}$$

The conclusion means that compared with the marginal abatement costs under BAU, participation in the CDM will raise China's marginal abatement cost to 6.4 (US$/ton) and 2.3 (US$/ton) respectively. It should be noted that the above two marginal abatement costs come from applying the scale of CDM credits that China is likely to obtain, estimated by Zhongxiang, Zhang to Ellerman's quadratic equation formula.

Although China's low marginal abatement cost will attract a great deal of CDM capital flows, which in turn will lead to the rise in marginal abatement costs, China's marginal abatement costs will remain at a low level with an easy marginal abatement cost curve. Besides, from a dynamic view, the marginal abatement costs of other countries and regions will rise during the period, and the price of emission allowance will also go up. When the difference in global marginal abatement costs are equal to or lower than the transaction costs, the CDM market will disappear.

3.5.2 Relationship between China's participation in CDM and China's obligations to emission reductions

There are two reasons for which that industrialized countries will spare no efforts to pressing non Annex I countries to commit to emission reductions. These two reasons are:

1) Despite the still existing uncertainties about the relationship between GHG emissions and climate change, climate change and its consequent impacts are irreversible, while GHG emission reduction calls for global cooperation and efforts
2) The second reason lies in economic considerations. If non Annex I countries commit to reduction obligations and meanwhile are unable to rely on its own technology to fulfill their obligations, they will have to largely depend on industrialized countries to import technologies and facilities from them.

In principle, as long as China's commitment to emission reduction obligations is not a precondition to its participation in the CDM, there will be no direct connection between its participation in the CDM and its commitment to emission reductions. This can be affirmed by the following two facts:

1) The aim of establishing the CDM is to use the CDM as a tool to assist Annex I countries in fulfilling their emission reduction commitments and at the same time to assist non Annex I countries to achieve sustainable development. It is irrelevant to non Annex I countries' obligations to emission reductions;
2) Annex I countries are interested in the cost-effective compliance with their emission reduction commitment. At the same time, they won't suffer economic loss by transferring their technologies to other countries. From their point of view, China's participation in the CDM is irrelevant to how they assess whether China should commit to emission reduction obligations. To some degree, the CDM projects will contribute to the emission reduction objectives, slow down the growth of GHG emissions, and reduce global environmental pressure, and postpone the advent of the moment when Non-annex I countries will have to commit to emission reduction obligations.

But technologically or politically speaking, one can not rule out the possibility that industrialized countries would use the CDM to press non Annex I countries to commit to emission reduction obligations.

3.6 Summary of Analysis and Conclusions

From the above analysis, we can reach the following conclusions:

1. Participation in the CDM will bring considerable environmental investment to China. The actual amount of investment that China will attract depends on whether there will be a restriction on Annex I countries in the CDM market. Based on the most conservative estimates of the size of the potential CDM market and the possible share for China by other scholars, our rough calculation shows that the investment China will likely attract through the CDM during the commitment period (2008-2012) of the Annex I countries, would be as high as US$5.2 billion in case that there is no restriction for Annex I countries.

2. With the exception of environmental investment, China's participation in the CDM will also bring additional advanced technologies to China. Within the present framework of the CDM, technologies that China can acquire through the CDM are mainly energy and environmental facilities and the operating and maintaining technologies for such facilities. These technologies will not only result in energy conservation and GHG emission reductions, but also improve efficiency and competitiveness of Chinese enterprises.

3. Through the participation in the CDM, China will also be able to share certified emission reduction credits with CDM investors. The amount of emission reduction credits China can obtain will largely depend on China's ability to negotiate specific CDM projects with foreign investors. Because of information asymmetry, China is likely to be in a disadvantaged position in such negotiations. Efforts should be made to enhance its ability and skills for CDM negotiations. It will also be desirable for the CDM to establish a mechanism to enhance non Annex I countries' capability in this regard.

4. At present, the long-term impacts of importing technologies through CDM projects on China's sustainable development are still not confirmed. If China can only acquire mitigation equipment through the CDM, its R&D capacity will be restricted over a long period of time and it will not be good for China when it takes on its emission reduction obligations. But if the CDM has a mechanism that will promote cooperation between the owners of foreign advanced environmental technologies and Chinese manufacturers of environmental facilities, transferring not only mitigation equipment, but also technologies for designing and manufacturing mitigation equipment, it will allow China to improve its own R&D capacity. This way the CDM will not only promote sustainable development in China, but also enable China to make greater contribution to the improvement of global climate.

5. While attracting additional environmental investment and advanced energy and environmental technologies, China's implementation of the CDM projects will undoubtedly bring about many environmental, health and social benefits as well. These benefits range from environmental quality (air, water, and soil) improvement, flood control, biodiversity conservation, increased employment, rural development,

and poverty alleviation. But quantitative assessment of these actual benefits is a very difficult task.

6. There is a concern that China's participation in the CDM may lead to a large increase in marginal abatement costs when China takes on emission reduction obligations. The analysis in 3.5 considers several factors affecting marginal abatement costs, including the size of the CDM market, China's potential for emission reduction projects, and the speed of China's progress in the development of energy technology. It shows that China's participation in the CDM is unlikely to result in a dramatic increase in its future marginal abatement costs.

Overall, the CDM will be beneficial to China in the short term, as it can support its sustainable development efforts by accelerating foreign investment and technology transfer inflows. Although there are some uncertainties about the long-term indirect impacts of China's implementation of the CDM, the benefits of China's participation in the CDM could be secured by taking certain measures, including carefully identifying those prerequisites under which the CDM can promote China's long-term sustainable development goals, insisting that these prerequisites be included in the CDM process; identifying key issues to implement the CDM in China; and making early preparation for it.

The next chapter identifies proper conditions for ensuring the achievement of long-term sustainable development objectives and key issues of implementing the CDM.

4. KEY ISSUES CHINA MAY FACE IN IMPLEMENTING THE CDM

The analysis of Chapter 3 shows that under its current framework, dual objectives and basic principles, the CDM is likely to bring substantial short-term benefits to China including considerable foreign investment, advanced technological equipment and many other environmental and social benefits. However, because of various uncertainties about CDM rules, formalities and procedures, as well as issues related to the implementation and operation of the CDM, it may not be certain to what extent China will actually benefit from the CDM. Therefore, it is crucial that China actively participate in the negotiations for the design of the CDM, ensuring proper mechanisms be in place to achieve its dual objectives. To clarify what should be negotiated, it is important to understand under what conditions the CDM can best promote China's long-term sustainable development objectives and what key outstanding issues China will face if it were to implement the CDM. There are approximately 50 unresolved issues identified by the UNFCCC Secretariat specifically related to the CDM, but discussing each of these issues is not the purpose of the study. The following only discusses issues specifically important to China.

4.1. Prerequisites to ensure the achievement of long-term sustainability objectives

Although the CDM may bring short-term benefits, the achievement of long-term sustainable development objectives is not certain and will largely depend on how the CDM is designed. To ensure the achievement of long-term desirable sustainable development would requires prerequisites for the CDM to be successfully carried out. These include:

4.1.1 Ensure that the CDM transfer real technology, not only equipment

The realization of environmental technology transfer through the CDM is the key to achieving the CDM dual objectives in China and other host countries, that is, to ensure their long-term sustainable development benefits. However, meaningful technology transfer is not only transfer of environmental equipment. Equipment is only the carrier of technology, not actual technology itself. Only transfer of equipment will affect the Chinese environmental manufacturing industry and lead to technology dependence on foreign suppliers over a long period of time. In negotiating the design of the CDM, China may wish to insist that the CDM ensure transfer of the technology of R&D, design and manufacturing environmental equipment, in order to improve non-Annex I countries' domestic internal innovation capacity and thereby ensure the contribution of the CDM towards the dual objectives of promoting sustainable development and assisting GHG emission reduction. Achieving this goal requires the issue of cooperation between technology owners of Annex I countries and domestic designers and manufacturers of host countries be addressed.

4.1.2. Address the diffusion of technology transfer through the CDM

To address the diffusion of the technology transfer through the CDM is another key issue in achieving the CDM dual objectives in host countries. It is obvious that if technologies transferred through the CDM can be made diffusible, it will not only contribute towards sustainable development in non-Annex I countries, but will also play an important role in achieving global environmental objectives. It is desirable for the CDM to establish a mechanism to compensate the loss of technology suppliers of the CDM technologies. Without such a mechanism, it is difficult to achieve the dissemination of technologies acquired through the CDM. This issue should be a key point in the negotiations of the CDM design.

4.1.3 Affirm non-obligation participation of the CDM

The CDM provides a means for industrialized countries to fulfill their mitigation, and for non-Annex I countries to assist Annex I countries in achieving their commitments. This should not become the only means of addressing the GHG mitigation, and should not be tied up with the GHG reduction obligations of non-Annex countries. If the reduction obligation were to be the pre-condition for China participating in the CDM, or China's CDM action would actually lead to the assumption of reduction obligations, it would likely cause adverse impacts on China's long-term economic development and weaken its ability to reduce GHG over a long period of time. The Kyoto Protocol does not contain such a requirement, but there is an attempt by some developed countries to link the CDM implementation to reduction obligations, or to voluntary reduction obligations. To encourage the early participation of China and other non-Annex I countries, the negotiations of the CDM should affirm that participation in the CDM will not lead to the assumption of legally binding obligation of GHG reduction.

4.1.4 Ensure additional financial and technical assistance and capacity building

The implementation of the CDM in China and other non Annex I countries needs great deal of support from relevant governmental departments and agencies, the industry, financial institutions, as well as the establishment of institutions for managing, coordinating, monitoring, supervising, verifying and certifying CDM projects (see 4.2 below). These efforts would require substantial human and financial resources. To implement actual CDM projects might also require that China invest certain matching funds. While the reduction of GHG is not one of its current development priorities, China will incur high opportunity costs due to the pre-investment for implementation of the CDM. Therefore, it is essential that China and other developing countries additional financial assistance to implement the CDM.

The CDM is at present a completely new concept to many potential players. Whether for relevant government departments or industrial enterprises, there is a lack of understanding of many technical issues involved in the implementation process, including priority project selection, baseline setting, reduction validation and verification, and CERs certification. All these technical issues are very important for the success of the CDM. Therefore, China urgently needs to build its capacity in implementing the technical requirements of the CDM.

4.1.5 Ensure credit sharing and banking

As mentioned before, credit sharing and banking is crucial for the success of CDM implementation. Presently, the Kyoto Protocol does not contain clear language regarding how CERs would be shared and banked between the investor and the host country as a result of a CDM project. There is a need in future negotiations to clarify this issue. It would provide great incentive for non-Annex countries' early participation in the CDM if CERs resulting from a CDM project could be shared between the investor and the host country, and the CERs could be banked for future use or be transferable.

If non-Annex I countries could bank and transfer CERs gained from CDM projects, they would overcome skepticism about the increase of marginal costs of GHG reduction in the future (the low-hanging fruits effect). They could acquire CERs by early participation in the CDM, and save CERs for future use against their future obligations, or sell them to support their current need for sustainable development.

Resolving the above issues lays a foundation for ensuring the CDM's contribution towards China's long-term sustainable development objects. The success of the CDM implementation in China also needs to address a number of implementation and operation issues.

4.2 Implementation and operation Issues

The implementation and operation of the CDM in China will involve a number of key outstanding issues. These may include the following:

4.2.1 Dealing with a very complex process requiring participation of different actors

The CDM allows governments and enterprises in Annex I countries, in partnership with governments and enterprises in non-Annex I countries, to invest in transferring advanced technologies to host developing countries. In return, Annex I country governments or enterprises would seek returns in the form of 'certified emission reductions' (CERs). However, this process will require the approval of host country governments, and the validation of the projects and the transaction of CERs need independent verification and certification.

This process will involve a series of relevant ministries, agencies, local government, various industrial enterprises, and monitoring agencies, as well as independent verification and certification organizations.

At the same time, it will involve domestic finance agencies, international organizations and foreign partners.

Potential key actors are listed in Table 4-1.

Table 4-1 Key Players of the CDM Projects

Domestic Players	Foreign and International Players
National government - SDPC - SETC - MOST - MOFA - MOF - SEPA, etc. Financial agencies - national development banks - other banks Industry - Energy (power, gas, petroleum and coal) - Mining (coal, oil and gas mining) - Chemical - Iron and steel - Forest, etc. Other organizations - monitoring agency - verification agency - certification agency - other organizations	Foreign partners - foreign governments - donor country banks - donor country private investors - technology suppliers International organizations - development banks - UNFCCC - CDM Executive Board - CDM Operating Entities - Other relevant multilateral organizations

The active involvement of these key actors is necessary to secure the support and resources needed for CDM projects. This requires a significant coordination among these players in planning and implementing the CDM. Therefore, implementing CDM projects in China will be a very complex process involving many different players and requiring a sufficient capability to deal with it. Such a process, involving a number of different actors needs the input of certain human resources and up-front investment.

In addition, the CDM is not well known to potential players such as industrial enterprises and local governments. There is a need for information dissemination and training about the CDM to make potential CDM opportunities known to these potential industrial and local government players. This also requires a significant financial and technical capacity to facilitate these efforts.

4.2.2 Identifying and prioritizing CDM actions which support China's sustainable development

Under the current framework of the CDM, the host country has the final say about what CDM projects to implement. For the CDM to be successfully carried out in China these

projects must support its sustainable development strategies, China needs to have the capacity to identify and prioritize CDM projects. This process may involve the following three major tasks:

(a) Identifying needs and selecting opportunities
This task involves the identification of mitigation options/technologies that meet the needs of China's sustainable development priorities, The process needs to select climate related technological options that address the identified needs of the prioritized sectors.

(b) Assessing technological capacities
The process requires feasibility assessment of national capacities for applying new technologies. There were some experiences in the past where technology transfer failed, because the capacity for implementing the technology was lacking. A capacity assessment is important and crucial to the CDM process.

(c) Setting priorities for CDM projects
Based on the comparative evaluation of the above two steps, priorities for CDM opportunities that address China's sustainable development needs can be selected.

To accomplish these tasks requires sufficient capability in terms of finance and technical knowledge.

4.2.3 Establishing a national support system for the CDM

To make the CDM operational in China, there is a need to create a national support system for implementing the CDM. This national support system would include information support, policy measures support, institutional support, financial support, and technical assistance. Major elements of such a national support system are listed in Table 4-2.

Table 4-2. Major Elements of the National Support System

Policy Support	Institutional Support	Financial Support	Technical Support	Information Support
CDM implementation strategies - integration into national plan Sectoral strategies Policy measures on CDM-related investment and technology transfer	A central gateway organization/NCGCCRS - responsible for CDM implementation - coordination at national, regional and international level Local focal points - responsible for local individual projects Monitoring, verification and certification agencies	Loan assistance Customer finance Tax incentives Subsidies	Project identification Project negotiation skills Baseline setting Emission audit Training on methodology	Data collecting Data sharing and dissemination Information exchange Awareness promotion

Adequate policy support is essential for the implementation of the CDM. Policy measures needed in the CDM implementation may include national implementation strategies, which consider the integration of the CDM into the national plan; sectoral strategies; and policy measures on CDM-related investment and technology transfer.

Institutional support for the implementation of the CDM is also important. A central gateway organization for the CDM can be established under the leadership of the National Co-ordination Group on Climate Change Response Strategy, responsible for coordination at international, national and regional levels. Local focal points are also needed to coordinate local initiatives. Other organizations such as monitoring, verification and certification agencies are also important in the CDM process.

Information support will be crucial throughout the implementation of the CDM, The national support system needs to provide various pieces of information regarding the implementation and operation of the CDM, including specific information on the development of baselines, guidelines for project identification, CDM modalities and procedures, emission factors, and international and national regulations in this field, etc. The promotion of public awareness will also be a very important component of the information support system.

Necessary financial support, such as loan assistance from the national development banks and other banks, other sources including private finance; tax incentives and subsidies, is also essential.

4.2.4 Addressing various technical issues

In implementing the CDM, significant technical capacity is required. Each stage of the CDM projects requires different knowledge and skills. These stages include baseline setting, monitoring, project and emission reduction validation and verification. For example, baseline setting is a task that requires strong technical capacity.

The baseline is the basic point against which the actual performance of the CDM projects is measured. Methodology for baseline setting needs to meet three principles: 1) credible, to ensure that environmental objectives are satisfied; 2) transparent, to ensure that assumptions are explicit and well-vetted; and 3) practical, to ensure that undue transaction costs are not incurred. There are many methodologies in the ongoing discussion of baseline setting. According to the degree of the standardization, there are two general types of approaches. (See Table 4-3)

Table 4-3 Two General Types of Baseline Methodologies

Benchmarking Approach ⟷ Project-Specific Approach

"perfectly standardized" approach	**"completely unstandardized" approach**
- same baseline for each project	- different baseline for each project
- uniform, rigid	- tailored, ad hoc
- additionality test reflect only emissions intensity	- additionality test reflects emissions intensity and level of activity
- based on category-wide information	- based on site-specific information
- aim to be credible for a family of projects	- aims to be credible for individual projects
- transparent; simplified review process	- non-transparent; cumbersome review
- lower barrier and transaction costs (at least for small projects)	- baseline-setting can be a barrier to the source of transaction cost
- rewards any activity that is low-emitting (compared to the benchmark)	- rewards any activity that reduces emissions (compared to the counterfactual situation
- on aggregate, free-riders/uncredited reductions are limited by carefully designing a benchmark appropriate to the sector	- for each project, free riders/uncredited reductions are limited by rigorously designing and reviewing each project's proposed baseline

Source: Michael Lazarus, et al,. Evaluation of Benchmarking as an Approach for Establishing Clean Development Mechanism Baselines, a paper prepared for U.S EPA by Stockholm Environment Institute – Boston and Stratus Consulting, October 1999

These two different types of methodologies have different methods. Each of these types of approaches has its strengths and weaknesses. Although the completely standardized approach presents many strengths that provide great transparency and is easy to audit and with low transaction costs, yet data collection on emissions in a particular sector or a region could prove to be difficult in developing countries. In addition, too much transparency of emission information would pose the potential risk of linking the CDM to China's emission reduction obligations. Project-specific baselines are not based on data collected from a particular sector or a region. It does not reveal the real situation of the total emissions of a sector or a region. However, project-specific baselines would likely make the transaction costs high and the project-auditing process difficult. Therefore, for non-annex I countries, which approach to take will be a rather complex issue and requires special knowledge and skills.

Monitoring of emission reduction is not only a technical issue, but sometimes involves political issues such as state sovereignty. Verification of CERs could directly affect the benefits of the CDM potential participants. Therefore, sufficient knowledge and technical capacity are needed to address all these issues. If China were to implement the CDM, it needs to learn, accumulate and master such capacity as early as possible.

The above discussion shows that implementing CDM projects requires substantial financial and technical assistance. The provision of additional financial and technical assistance and the creation of necessary mechanisms to enhance capacity building in China and other host countries plays a significant role in the CDM implementation in these countries.

5. CONCLUSIONS AND STRATEGIC RECOMMENDATIONS

This study confirms that the CDM has attracted a great deal of attention from both developed and developing countries, because its implementation has potential to achieve cost-effective compliance with the legally binding GHG reduction obligation in developed countries and the promotion of sustainable development in non-Annex I country. Given the large room for energy efficiency improvement, China could become one of the countries with the lowest cost for undertaking GHG emission reduction projects, and one of the major players of the CDM in collaborating with developed countries to address China's need for new energy technologies, environmental protection and sustainable development and to assist donor countries in achieving the cost-effective compliance of their reduction obligation.

The analysis in this study indicates that the CDM would offer unique potential opportunities to bring considerable short-term benefits to China, including considerable foreign investment and advanced technology equipment, and many other environmental and social benefits. However, there is a potential danger of technology dependence on foreign suppliers for mitigation equipment over a long period of time, which may not be good for China in term of promoting its own sustainable development. Nevertheless, actively participation in CDM negotiations and insisting certain measures be included in the CDM implementation could ensure the CDM support China's long-term sustainable development. These measures include:

1) To ensure that the CDM transfer not of not only energy efficiency and environmental equipment, but also of technology of R&D, design and manufacturing of energy efficiency and environmental equipment;
2) To address the issue of disseminating technologies acquired through the CDM, such as establishing a mechanism to allow these technologies to be diffusible;
3) To affirm non-obligation participation of the CDM to disperse the doubt of host countries that the implementation of the CDM may lead to the actual legally-binding obligations; and
4) To reassure the addtionality of financial and technical assistance, and make capacity building an integral part of the CDM implementation process
5) Ensure that CERs acquired by non-Annex countries through the CDM can be banked and transferable.

Also, the discussion on issues China may face in implementing the CDM shows that the CDM implementation would be a very complex process which requires the participation of many potential players. It also requires sufficient capacity to deal with financial, technical, and legal issues that will surround the CDM projects. Therefore, plenty of preparation work should be undertaken. The study put forward the following recommendations for actions to be taken to explore the CDM:

1) Enhance the capability to collect, analyze and disseminate CDM information. This requires work in two areas. On one hand, efforts should be made to strengthen work on collecting and analyzing foreign information on the design of the CDM, in order to

provide support to domestic policy making; and available mitigation technologies should be explored in terms of their functions and prices to be prepared for the CDM implementation. On the other hand, efforts should be made to strengthen work on collecting and analyzing information on the domestic need for sustainable development in different sectors and regions and on GHG emissions in order to provide a basis for selecting China's sustainable development priority projects.

2) Widely disseminate CDM information including principles, rules, modalities and procedures of the CDM, as well as potential opportunities the CDM may offer, to mobilize the participation of potential players and promote public awareness of the CDM.

3) Strengthen CDM policy research and formulation. The implementation of the CDM involves a wide range of issues that may have complicated affecting factors. To strengthen policy research of relevant macro policy, industrial policy and regional policy would prevent blindness and disorder of the CDM implementation, and reduce transaction and opportunity costs if China were to implement the CDM.

4) Enhance the capability of coordinating among different departments, between department and local governments and among local governments. The above discussion pointed out that the implementation of the CDM would involve many potential participants. Establishing a mechanism to effectively coordinate among these potential participants would be crucial in reducing transaction costs of CDM projects and increasing effectiveness of the CDM implementation.

5) Initiate pilot CEM projects in Western provinces. As greenhouse gas emissions per unit of GNP in some parts of western regions are higher than that in eastern coastal regions, and poor infrastructure makes it difficult for them to attract foreign direct investment and technology transfer, the CDM may offer unusual potential in accelerating foreign investment and clean technology transfer to western provinces. China may wish to select some appropriate projects according to the needs of west China as pilot CDM projects. The implementation of these pilot projects will enhance understanding of the issues that may be encountered in the CDM implementation and help explore polices and measures methods that address these issues. It would also provide lessons and experience for a wider implementation of the CDM across the country.

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