

Possibility and potential of clean development mechanisms in China

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Abstract

China has become the world's second largest greenhouse gas (GHG) emitter behind the United States. It emits approximately three billion tons of CO₂ equivalents every year. Its growing economy and large population are making a wealthier, more consumption-oriented country. Energy demand is expected to grow 5–10% per year through 2030. Therefore, a large potential of GHG emission reduction in China can be expected. The clean development mechanism (CDM) put forward in the Kyoto Protocol for reductions of GHGs can support the sustainable development of developing countries and help developed countries to achieve their emission reduction targets at low cost. However, there are still many disagreements to be resolved between developing and developed countries. In this letter, we try to introduce the current development of CDM projects in China and discuss its potential and opportunities in the future decades.

Keywords: clean development mechanism (CDM), greenhouse gas (GHG), Kyoto Protocol, certified emission reductions (CERs), China

1. Introduction

The Kyoto Protocol is a comprehensive international environmental act. It aims to restrict global greenhouse gas (GHG) emissions, so as to mitigate anthropomorphic climate forcing. The clean development mechanism (CDM) is one of the three flexible mechanisms put forward in the Kyoto Protocol for reductions of GHGs. The purpose of CDMs is to assist developing countries in achieving sustainable development by providing environmentally friendly investment opportunities initiated from developed countries. The developed countries can receive credits in the form of *certified emission reductions* (CERs) to achieve compliance with their national quantified emission limitation and reduction commitments. Thus the CDMs provide a flexible mechanism

for developed countries to reduce the cost of GHG emissions reductions through investment in developing countries. Developing countries benefit by receiving capital assistance and advanced technology, which is helpful for realizing the objects of the United Nations Framework Convention on Climate Change (UNFCCC). Several studies [1] based on economic models of emission abatement costs estimate a CDM market volume of around 200–250 MtCO₂e (million tonnes carbon dioxide equivalent) per year for the 2008–2012 commitment period. This amount of certified emission reduction (CER) is approximately 20% of the total emissions that developed countries are currently emitting above their Kyoto targets and they must find ways to reduce this for the first commitment period. Thus the total estimated potential demand in the CDM market should be approximately 200–250 MtCO₂e

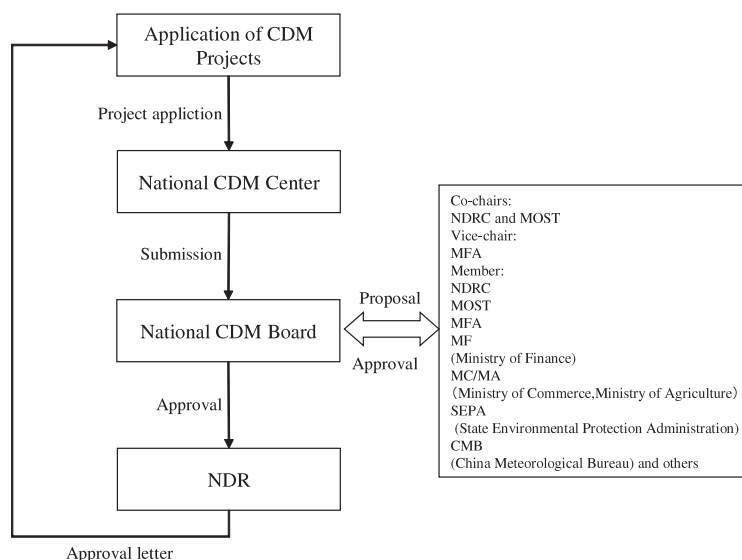


Figure 1. The system of CDM in China.

per year during the 2008–2012 period. According to the World Bank, China will in all likelihood provide more than half of all the CDM projects: 100 000 000 tons of greenhouse gas in terms of CO₂ equivalent [2]. This exchange will bring immense economic benefits to China. According to investigations made by the CDM Research Group in Tsinghua University, CDM projects will lead to a net increase of foreign investment of about 1.9 million RMB (currency in China, 1 USD = 7.4 RMB) in 2005. They think that the investment is likely to reach 3.9 billion RMB by 2010 [3].

China has become the world’s second largest greenhouse gas (GHG) emitter behind the United States. It emits approximately three billion tons of CO₂ equivalents every year. Although per capita, China (0.7 ton carbon equivalent/capita) emits only one fourth as much as that of Japan (2.56 ton equivalent/capita), per unit of GDP, China (847 ton carbon equivalent/million US dollars in 1995) emits 15 times that of Japan (57 ton carbon equivalent/million US dollars in 1995). Therefore, a large potential of GHG emission reduction in China can be expected.

A ‘Provisional Draft for Operation and Management of Clean Development Mechanism Projects in China’ was issued by the Chinese National Development and Reform Commission (NDRC), jointly with the Ministry of Science and Technology (MOST) and Ministry of Foreign Affairs (MFA) on 31 May 2004 [4]. On 12 October 2005, the revised ‘Operation and Management of Clean Development Mechanism Projects in China’ (CDM Management Law) was issued [5]. This signified the implementation of China’s Clean Development Mechanism (CDM) legislation. The priorities are: energy efficiency improvement, development and utilization of new and renewable energy, and methane recovery and utilization. The CDM is expected to be developed rapidly in China.

Up to September 2007, 452 CDM projects had been approved by the NDRC. This situation reflects the Chinese

government’s shifting priority from economic development to environmental protection. In order to attract more investment for CDM projects from developed countries, China needs to open its CDM market to the world. According to the Kyoto Protocol, Japan is obligated to cut its GHG emissions by 6% below their 1990 level during the period 2008–2012; this is a reduction of carbon equivalent. Since the oil shocks during 1974 and 1979, Japan has put in place an efficient energy system with little room for further low cost carbon reduction. Implementing CDM projects in developing countries—primarily China—will be necessary for the Japanese government if it is to abide by its Kyoto commitments.

2. Current situation of CDMs in China

2.1. Implementation system and legislative preparation of CDMs

The Office of National Coordination Committee on Climate Change (ONCCCC) was established by Chinese State Council in October 2003. The NDRC was appointed as the Designated National Authorities (DNA) for CDM development. Other board members include the Ministry of Foreign Affairs (MFA), State Environmental Protection Administration (SEPA), and 12 other organizations shown in figure 1.

The leader of each organization has been involved in the office, and a coordinator from each board was appointed. ONCCCC is the main organization in the government which coordinates and responds to the climate change issues. It is responsible for discussions about these issues, including policy revision, domestic activity, and coordination and negotiation with foreign parties. When irreconcilable opinions arise between parties, the State Council makes the final decisions. As coordinating members, the NDRC, MFA and CMB are responsible for overall coordination in domestic activity,

foreign affairs, and the intergovernmental technical committee on climate change, respectively.

2.2. *Opinions of the Chinese government on CDMs*

Some surveys of the Chinese government and relative research organizations were conducted by the Energy Research Institute (ERI) under the NDRC. According to the speech by a government officer [6], key points included:

- (i) Until 2004, the government took a passive standpoint on CDMs and GHG reduction mechanisms in general. The turning point came when the draft for Operation and Management of Clean Development Mechanism Projects in China (OM-CDM) was issued in June 2004.
- (ii) In the OM-CDM draft, the promotion of energy savings was specific to the energy situation of China (Article 4: The priority areas for CDM projects in China are energy efficiency improvement, development and utilization of new and renewable energy, and methane recovery and utilization).
- (iii) There were two different opinions within the Chinese government regarding CDM implementation. Proponents of CDMs believed that energy scarcity and environmental problems will be solved with the introduction of technology and the investment from the developed countries. Opponents thought China would be at a disadvantage when the greenhouse gas reductions become mandatory in the future. In addition, some experts believed that China should not sell CDM projects at the current (low) price for CO₂ credits because the price of CO₂ would rise with the compliance period of Kyoto Protocol in 2008. The proponents of CDMs eventually won out, and the authorization of the CDM project was accelerated in the latter half of 2005. It was believed that if CDM activities lagged behind those of other developing countries (particularly India and Latin American nations), China would likely lose investment opportunities from the developed countries. Therefore, four HFC-23 (hydrofluorocarbon 23, which is a potent greenhouse gas: a ton of HFC-23 in the atmosphere has the same effect as 11 700 tons of carbon dioxide) CDM projects that were not appointed as priority areas in OM-CDM were approved in several months.
- (iv) The shortages of capital investment and research staff for CDM projects were major obstacles to the implementation of CDM projects in China. Few people in the NDRC had been fully involved in the authorization of CDM projects. Although researchers at ERI and Tsinghua University [7] have been studying CDMs, the capacity is significantly weaker in some fields than in Brazil and India. Implementation of many projects had been postponed because of a lack of methodology research and the subsequent delay of approval of CDM projects.
- (v) Many factors could affect the implementation of CDM projects, such as the shortage of capital and research staff, divergence of viewpoint inside the government, and the coordination ability of related international organizations. All of these factors lead to increased costs and are a large barrier to CDM implementation.

Therefore, the following aspects should be considered critical to CDM implementation:

- (1) The necessity of incorporating pollution abatement policies in China. China faces serious environmental pollution (air, water, and ground), and has made domestic environmental pollution reduction a priority for the national government. Therefore, it is very important for the developed countries to address environmental pollution concerns when implementing CDM projects in China.
- (2) The necessity of energy conservation in China. Coal accounts for about 70% of the total primary energy consumption in China, much more than the global average of 30% and the Japanese level of 17.5% [8]. In addition, China has become an oil importer since 1993, and will have become increasingly more dependent on foreign oil as time goes by. For a country like China where the average annual income is approximately 1000 US dollars, it is difficult to transfer the energy use structure from coal to oil or natural gas. Moreover, there are abundant inexpensive coal resources in China with a low cost. This means that the main source of energy will still be coal. With a rapidly developing economy, much more energy (coal) will be needed to satisfy the economic development. Therefore, there is great opportunity for efficiency improvement and environment protection in the sector of coal use.
- (3) The Chinese government has implemented CDM business operation and management measures, which mandates that CDM project owners be state-owned or Chinese-held capital enterprises (enterprises for which the Chinese own more than 51% of the capital). The benefit from trading CERs shall be shared jointly by the Government of China and the project owner. The allocation ratio is decided by the Chinese government. The project owner should be the owner of the CERs, and the purchaser needs to be different from the project owner. However, in a conventional CDM business, CERs can be earned through investment in a project. In China, the investment enterprise is not related to the CERs. Therefore CERs can only be purchased through direct investment in CDM projects. Based on the above facts, a compelling CDM project should demonstrate a large impact not only on global warming measures but also pollution mitigation and energy-saving measures. Foreign enterprises must, however, consider the risks involved when investing in Chinese CDM projects as the government has absolute control of implementation and final approval of CDM projects when the foreign investment enterprise is not related to CERs. Moreover, the Chinese government is likely to influence the price of CERs. It may be important to negotiate firm contracts with the Chinese government before project initiation.

Moreover, we had a questionnaire to private enterprises participating in CDM projects in 2006. We found that their recognition in CDM projects can be summarized as follows.

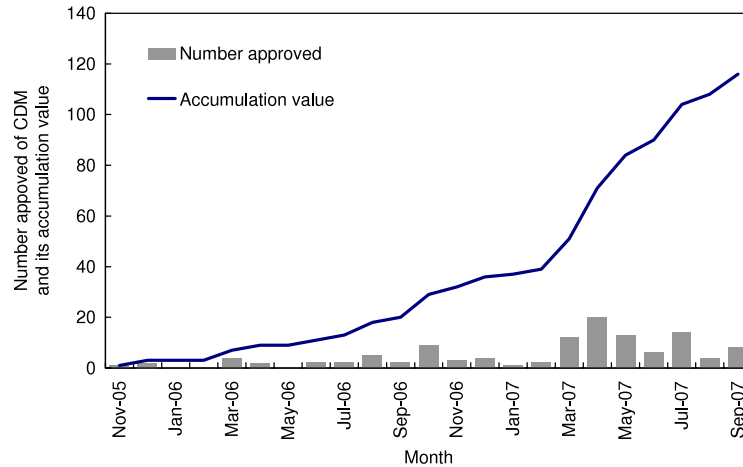


Figure 2. The number of approved CDM projects in China.

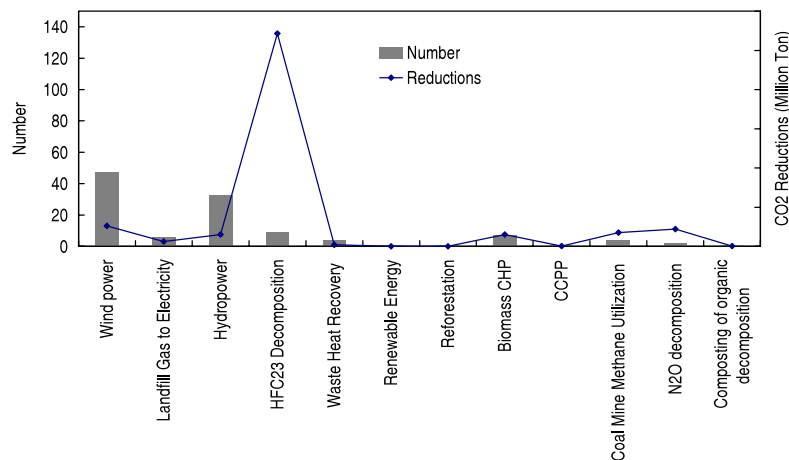


Figure 3. The type of approved CDM projects and their CO₂ reduction.

- (1) It is difficult for an individual enterprise to select and implement CDM projects independently because of problems such as the complexity of the CDM mechanism, technical problems with trying to establish verification methodology, insufficient project information, and the high cost and risk of CDM project formulation.
- (2) There is a tremendous potential for energy savings in China. Particularly in smaller companies, investment cost and risk to achieve energy savings can be reduced by incorporating CDM projects. However, it is difficult for small companies to implement these because of the high upfront cost of the CDM projects. On the other hand, larger state-owned enterprises such as power utilities and the district heating plants do not have the financial incentives to undertake CDMs.
- (3) Although there is no CDM project currently defined for district heating supply and cogeneration in the northeast and north parts of China, it is highly possible to make use of CDMs for these regions (according to NDRC experts). However, it is quite difficult to establish the

evaluation methods and the project design methodology for CDMs. The market potential in terms of energy savings for buildings is huge, but implementation of CDM projects on this scale is difficult because of the relatively small reduction of CO₂ emissions, and the high project costs. Bundling energy-saving technologies for multiple buildings to reduce the overall cost of CDM projects should be considered.

2.3. Approval of CDM projects in China

As of 7 March 2006, there were 22 CDM projects approved by the NDRC, including ten wind power projects, three landfill gas collection and utilization projects, two hydropower projects, six HFC-23 decomposition projects and one energy efficiency improvement project (waste heat recovery and utilization in a cement plant). But, up to May 2007, the number of CDM items authorized by the NDRC increased up to 452 cases. This shows that CDM projects are becoming the cause of investment for China. There will be many voices to hope that the open door of the CDM business advances in future.

Up to 20 September 2007, about 116 CDM projects had been approved by UNFCCC, as shown in figure 2. Among these CDM projects, there are many involving wind-generated electricity and small hydraulic power generation (figure 3). It can be seen that the Chinese government gives priority to the promotion of natural energy use.

For CO₂ reduction, the HFC-23 decomposition project has shown its efficiency in CDM projects. In addition, items in the field of improvement of energy efficiency such as biomass generation or the use of waste heat from a factory have increased with the establishment of the CDM methodology recently.

3. CDM potential in various areas in China

3.1. Wind power project

According to CDM Management Law in China, the priority areas for CDM projects include energy efficiency improvement, and the development and utilization of new and renewable energy. In the Renewable Energy Law [9] implemented on 1 January 2006, wind energy was classified as a renewable energy source. The utilities must purchase all wind-generated power and provide grid connection (Article 14).

The supervision section of the State Council is responsible for setting the price for each type of renewable energy in each region (Article 19) and for providing financial support to develop, examine and disseminate the renewable energy technology (Article 24), and provide incentives such as loans (Article 25) and tax breaks (Article 26) to promote the development of wind power generation in the future. Up to September 2007, 47 wind CDM projects had been approved. The wind power generation projects accounts for about 45% of the total projects approved—the largest category.

The Huadian Inner Mongolia Huitengxile 100.25 MW Wind Farm Project was the first project approved by the Chinese government; it was registered on 29 March 2007 by UNFCCC [10]. To promote the use of renewable energy, it can be expected that the Chinese government will continue to develop wind power generation CDM projects. Wind power CDM projects are expected to increase rapidly along with the imminent expansion of the wind power market in China.

3.2. Small-scale hydropower projects

According to the national renewable energy development plan, the capacity of small-scale hydropower generation will reach 50 000 MW and 75 000 MW by the years 2010 and 2020, respectively, and the annual power generation is expected to be 165 billion kWh and 250 billion kWh, respectively.

Small-scale hydropower generation is one of the main areas of CDM projects, especially in southwest China, which has abundant hydropower resources. Between 2005 and 2010, the new hydropower capacity will be 15 000 MW, with a CO₂ reduction of 12 million tons [11]. In addition, between 2010 and 2020, the capacity of newly built hydropower generators is estimated to reach 25 000 MW with a corresponding CO₂ reduction of 20 million tons.

The number of CDM projects for hydraulic power generation holds second place after that for wind-generated electricity in the CDM projects approved by the NDRC or UNFCCC.

3.3. Methane gas recovery and utilization from waste treatment facilities

Discharged methane from waste treatment facilities in China amounts to 133 million tons in 2005, and will reach 152 tons and 179 tons by the years 2010 and 2015, respectively. 70% of waste ends up in landfills [12]. Through the recovery of the landfill gas, about 260 trillion kWh of electricity power per year can be generated. Furthermore, it is assumed that if 50% of the landfill gas can be recovered from more than 3600 landfill sites in 2020, 170 million tons of gas will be gained, corresponding to an expected electricity generation that will reach 3700 trillion kWh annually.

The first CDM project approved by the government in this area was the Beijing Anding Landfill Gas Recovery and Utilization Project [13]. By 10 January 2006, there were three CDM projects approved for landfill gas recovery and utilization. The characteristics of these three projects can be summarized as follows.

- (1) The three projects were for a municipality (Beijing), capital city (Nanjing) and local city (Meizhou, Guangdong province). This implies that the Chinese government is making three pilot CDM projects on landfill gas recovery and utilization in three cities at different levels. This implies that, in the future, the Chinese government will promote CDM projects on landfill gas recovery and utilization.
- (2) In these three pilot projects, methane gas power generation has been adopted and it is expected that, with the implementation of the Renewable Energy Law on 1 January 2006, methane gas power generation will be promoted further in China, especially in the large-scale waste landfill facilities in medium and large cities.

3.4. Waste power generation

Urbanization is progressing rapidly in China and thus it is expected that the landfill of solid waste will be shifted to waste combustion and waste utilization power generation. During 2002–2004, more than ten plants utilizing power generation from waste have been constructed, predominantly in the Changjiang delta area surrounding Shanghai, which account for more than half of waste power generation. In the future, the market potential for CDM projects involving waste power generation is likely to increase considerably.

3.5. Recovery and utilization of coal-bed methane

According to the primary energy consumption forecast in the Chinese Energy Development Report (2003) [14], coal will still occupy a large fraction of primary energy consumption and production in China by 2020, with this trend expected to continue after 2020. According to the investigations by

the China Geological Survey Bureau, the amount of coal-bed methane (CBM) resources [15] is estimated to be 9.2 trillion m³ for resource depths of less than 1500 m, and 5.1 trillion m³ for depths between 1500 and 2000 m. The total amount likely to be recoverable is about 14.3 trillion m³. The provinces with the largest reserves of CBM are Shanxi, Guizhou, Shangxi, and Gansu, which account for about 73% of the total reserves of CBM in China. Furthermore, the recovery and utilization of CBM is a major technical measure for safety and environmental protection in coal mines, and also an effective integrated use of these resources. In this respect the Chinese government encourages the recovery and utilization of CBM. As of 10 January 2006, no CDM project had been approved for the recovery and utilization of CBM. However, up to November 20, about eight CBM projects have been registered in UNFCCC. It is expected that there will be more projects involving CBM recovery and utilization in China in the future.

3.6. Energy efficiency improvement opportunities

There is a great potential for energy efficiency improvements in China. However, given the current size of the Chinese economy, it is difficult to conserve energy without government intervention. Therefore CDMs may be expected to be an effective measure for energy savings in the future.

As of 10 January 2006, the CDM projects approved by the Chinese government in the energy efficiency improvement area were all energy-saving projects for industrial plants. This is because only the most economic projects, i.e. those with considerable CO₂ and energy reductions, are approved. In the future, with the revision of permission requirements for CDMs, it is expected that there will be large CO₂ reduction potentials in the commercial and residential sector.

3.7. Biomass power generation

Power generation projects using biomass such as agricultural and forestry wastes and sugar manufacture residues are potential CDM projects. The generation capacity from such sources reached 2000 MW in 2004 with annual power generation reaching 5 billion kWh. It is expected that the capacities of biomass power generation will reach 5500 MW and 20 000 MW in 2010 and 2020 respectively [17]. The annual power generation from these sources will be 20 billion kWh and 80 billion kWh, which can lead to 500 million and 2000 million tons of CO₂ reduction. In addition, annual methane recovery and utilization will reach 5 billion m³ and 20 billion m³, with the CO₂ reduction of 15 million and 60 million tons in 2010 and 2020 respectively. As of September 2007, about seven biomass power generation projects have been approved by UNFCCC [18].

3.8. Freon recovery

As of 10 January 2006, there were four projects approved and two projects accepted for Freon recovery in China. The four projects approved by UNFCCC [18] were Zhejiang Juhua HFC-23 Decomposition Project, Shandong Dongyue HFC-23 Decomposition project, HFC-23 Decomposition CDM

Project at Jiangsu Meilan Chemical Co. Ltd and HFC-23 Decomposition CDM Project at Changshu 3F Zhonghao New Chemical Materials Co. Ltd. The expected annual GHG reduction CERs from these projects amounts to about 36 000 000 tons CO₂ conversion. As of September 2007, nine projects of HFC-23 Decomposition CDM have been registered in UNFCCC [18], and the GHG reduction CERs would exceed 543 120 870 tons, the largest in the world.

4. Opportunity and risk assessment of implementing CDM projects

In order to achieve the GHG reduction commitments regulated by the Kyoto Protocol, developed countries such as Europe and Japan have been in contact with the provinces and cities in China to identify CDM projects which are in their own country's interest. Developed countries and enterprises searching for CDM projects in China have recently been seen to fall into three categories.

The first type is the GHG reduction investment funds dominated by the national governments of developed countries. They invest in CDM projects in developing countries through raising funds from the government and private enterprises.

The second category includes energy and industrial enterprises with relatively large GHG emissions in developed countries. They invest in CDM projects in order to achieve their own reduction targets as regulated by their national governments. These enterprises are called reduction entities.

The third category is enterprises without specific reduction commitments in the developed countries. Such entities include organizations who wish to invest in low-cost CDM projects in developing countries to receive CERs, and sell the credits to energy and industrial enterprises mainly in developed countries, so-called reduction entities. These agency companies must rely, in part, on speculation due to the risks involved.

Because of the different objectives of each category, different investment methods are adopted. Generally speaking, because the investment funds and agency companies have no technology, they always adopt an investment approach. That is to say, the developing countries have to self-provide the investment for the CDM projects, and the investment funds and agency companies will purchase the reduced greenhouse gas at specific price. This investment mode will transfer a large part of the investment risk to the governments and enterprises in the developing countries. However, because of the credits needed by the reduction entities and their possession of advanced technology and devices, the reduction entities usually invest in the CDM projects directly with their own technology and investment in the developing countries. They often establish joint ventures with the developing country governments or other enterprises in the developing countries. This last investment mode will not only avoid the early investment risk to the developing countries, but will also better encourage technology transfer from the developed countries to the developing countries. This type of cooperation mode is a relatively safe and credible option for developing countries.

There are two main risks to developing countries in adopting the investment mode of investment funds and agency companies.

The first is 'the transaction risk'. Recently, Europe has been the biggest carbon market. The Japanese government is also planning to set up a carbon market in 2006. Currently, however, the European carbon market only permits the transaction of greenhouse gas reduction credit among the European countries; credits from CDM projects implemented in the developing countries are presently not allowed. If the carbon market does not open to the reduction credits from developing countries during 2008–2012, then the agency companies with no reduction commitment will have no place to sell their reduction credits. Developing countries would then fail to receive the benefits from the CDM projects. Enormous investment risks will then be brought on the governments and enterprises in the developing countries.

The second is price risk. The NDRC started the CDM projects of Freon recovery in August 2005. Zhejiang Juhua HFC-23 Decomposition Project with a reduction amount of 3 million tons CO₂ equivalent and Shandong Dongyue HFC-23 Decomposition project with a reduction amount of 10 million tons CO₂ equivalent have been implemented by the Marubeni and Mitsubishi Corporation, respectively. The World Bank has implemented two big projects, HFC-23 Decomposition CDM Project at Jiangsu Meilan Chemical Co. Ltd and HFC-23 Decomposition CDM Project at Changshu 3F Zhonghao New Chemical Materials Co. Ltd, which have been examined and approved by the NDRC. The destruction of the ozone layer by Freon is more than ten thousand times than that caused by carbon dioxide. The NDRC has opened the Freon recovery market and so there will be a reduction amount of 50–70 million tons. If the transaction costs (credit price) on the international carbon market decrease significantly by 2008, when the Kyoto Protocol takes effect, the agency companies, especially those with purely investment consideration, will have to sell their reduction credits from CDM projects at a lower price and in some cases, they may fail to sell all their credits to the international market. If this happens, developing countries will also fail to receive the benefits from the CDM projects which are implemented by raising money themselves for early investment. In this case enormous investment risks will be brought on the governments and enterprises in the developing countries.

5. Closing remarks

Because the majority of the GHG emissions in the past have been emitted by developed countries, they have been obligated to formally reduce their GHGs through the Kyoto Protocol. On the other hand, developing countries have a need to develop their economies and should not be obstructed by environmental restrictions. Therefore, cooperation between developing and developed countries regarding CDM policy would benefit both parties. CDMs can (1) support the sustainable development of developing country and (2) help developed countries to achieve their emission reduction targets. The financial and technical support from developed countries

will help developing countries improve their environmental footprint. Specifically, China could boost its technology development and environment protection, and Japan could achieve its Kyoto CER target at low cost.

However, there are still many disagreements to be resolved between developing and developed countries. One such disagreement is which countries should accept the burden of sustainable development and additional GHG reductions. In many cases, technology already exists in developed countries that could enable developing countries to reduce their emissions. But it is also very important for developed countries to help developing countries develop sustainably. In addition, it will not be sufficient to only supply equipment to developing countries; technology transfer that would accelerate their independent development in design methodology and manufacturing capacity will be necessary.

There are great opportunities for a developed country to enter technology transfer markets, disseminate the technology, and expand the cooperative relationship in a developing country. This would benefit both sides.

Finally, problem solving will depend on the priority level given to sustainability in developing countries and future GHG limits beyond Kyoto. Setting target levels is complicated; detailed analysis of methodologies for setting levels and the pricing method of CERs must be studied further.

As mentioned, China is the world's second-largest GHG emitter, after the United States. Its growing economy and large population are making a wealthier, more consumption-oriented country. Energy demand is expected to grow 5–10% per year through 2030. With its eagerness for foreign investment and its dependence on carbon-intensive coal as a primary source of energy, China may become the largest market for CDM projects.

China's government will likely consider a number of factors in evaluating CDM projects for approval: the project's contribution to economic development, including job creation; environmental benefits, including mitigation of GHGs and more local pollution reduction; conditions placed on technology transfer, including accounting for local capacity and localization of the technology; and the scope and scale of investment, including the extent to which it involves state-owned enterprises. China's priority for CDM projects will be energy efficiency projects, renewable energy projects, and projects for the substitution of fossil fuels.

CDMs are a particularly new and uncertain phenomenon in China. Understanding the CDM related enterprises between China and developed countries is important. More effort is required to stimulate CDM enterprise.

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