Clean Development Mechanism Project Opportunities in China

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Preface

The Pembina Institute for Appropriate Development and the **Tata Energy Research Institute** are exploring the application of the Clean Development Mechanism (CDM) in Asia. This multi-year project is being undertaken in collaboration with:

- **The Bangladesh University of Engineering and Technology;**
- **The Global Climate Change Institute at Tsinghua University, China; and**
- **The Centre for Research on Material and Energy at the Technology University in Bandung, Indonesia**.

The following publications have been produced by the project partners:

- *Canada's Potential Role in the Clean Development Mechanism* (2000)
- *Negotiating the CDM: A North–South Perspective* (2000)
- Reports on CDM activities and potential CDM project opportunities in Bangladesh, China, India and Indonesia (2001)
- *A User's Guide to the CDM* (2002)
- Reports on individual CDM project opportunities in Bangladesh, China, India and Indonesia (2001)

For more information on this project visit the following Web sites:

- www.teriin.org
- www.pembina.org/international_eco3.asp

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1 Introduction

The Clean Development Mechanism (CDM) was proposed in Article 12 of the Kyoto Protocol, which was accepted in 1997 by the third Conference of the Parties (COP 3) to the United Nations Framework Convention on Climate Change (UNFCCC) in 1997. The aim of the CDM is to help the contracted parties included in Annex I of the Protocol realize a portion of their obligations to mitigate greenhouse gas (GHG) emissions by assisting other contracted parties not included in Annex I to achieve sustainable development.

A working scheme was defined at COP 4 in 1998 for the development of the CDM and the other two flexibility mechanisms stipulated in the Kyoto Protocol—that is, Joint Implementation (JI) and emission trading. This scheme proposed substantial negotiation over the following two years. At COP 4 it was also decided that a resolution on the mechanisms would be tabled at COP 6 in November 2000. This did not come about, however, and negotiations on the CDM continued during 2001, with final agreement on rules and modalities occurring at COP 7 in Marrakech in November 2001. China continues to study the principles of CDM and emission trading, including methodology, operational processes, and organization.

2 Climate Change Policy and Government Stand on CDM

In 1992, China participated in the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, and signed the UNFCCC. In 1993, the Standing Committee of the People's Congress approved the UNFCCC and China is presently implementing the Convention. The Chinese government delegation actively participated in the first, second, third, fourth, and fifth Conferences of the Parties and other international negotiation meetings.

The UNFCCC establishes two important basic principles of the relationship between developed and developing countries. The first is the principle of common but differentiated responsibilities. The second is the principle of fairness and justness. According to these principles, developed countries should take the lead in combating world climate change; the major tasks of the developing countries are to promote their own social and economic development and to eliminate poverty while recognizing the inseparable relationship between environment and development.

Developing countries are the main victims of the adverse effects of global climate change. They are eager to formulate their own domestic sustainable development strategies, participate in efforts to address global climate change, and contribute to its mitigation.

The People's Republic of China is a developing country with a huge population. The current per capita GDP is only about US$800 and some 50 million people live below the poverty line. As a consequence, China's chief goals are to eliminate poverty, to develop the country, and to provide the huge population with basic needs. The Chinese government also pays much attention to environmental protection and, with other countries, is actively working to fight global climate change.

The UNFCCC proposes cooperation between developed and developing countries in the areas of environment and development; Article 4, paragraph 2 requires developed countries to assist with technology transfer and financial resources, so as to strengthen developing countries' abilities to combat global climate change. In the six years since the UNFCCC came into effect, GHG emissions in most developed countries have continued to increase. At the same time, processes for providing technology transfer and financial assistance have not evolved, which seriously affects the abilities of developing countries to take action on climate change. For instance, developing countries have found it difficult to compile and submit preliminary National Communication Reports under Article 12, paragraph 1 of UNFCCC without receiving financial support from developed countries.

Throughout the negotiations on the Kyoto Protocol, China has maintained its stand on some important issues:

- Developed countries should, as soon as possible, fulfill their obligations under the articles of the UNFCCC to mitigate their GHG emissions and to provide technology transfer and financial support to developing countries.
- Under Article 25 of the Protocol, developed countries should ratify the Protocol and bring it into effect as soon as possible. Developed countries should not set up any new terms for ratifying the Protocol.
- All countries of the world should identify and propose all possible response strategies to solve the problem of global climate change, according to their respective national circumstances.
- The basic principle of "common but differentiated obligation" between developed and developing countries should not be confused with the statement that "the global problem must be solved by every country all over the world."
- Practical ways for implementing the other important principle of the UNFCCC—fairness and justness—should be explored, to prevent the world's current disparity in energy consumption and GHG emissions between developed and developing countries from continuing indefinitely.
- The performance rules of the three flexibility mechanisms under the Kyoto Protocol should be drafted in strict conformity with the relevant regulations of the Protocol.

In the future, China may adopt its own policies and measures to mitigate climate change to the extent possible, along with its sustainable development process. At present, however, China still ranks as a low-income country with rather low CO_2 emissions per capita and limited capacity to combat climate change. Until a global cooperation mechanism and a benefit-sharing system have been effectively and equally established between developed country and developing country parties, and its economy has reached the level of a medium-developed country, China cannot be held responsible for mitigating its GHG emissions. After that time, China will consider its responsibility for GHG emission mitigation on the basis of the country's actual conditions.

Other conditions that should exist in order for China to take action on GHG mitigation are:

- sufficient commercialized GHG mitigation technologies, especially energy technologies, either domestically developed or transferred from abroad;
- improved capacity for combating climate change through a variety of mechanisms, such as institutions, regulation, social and economic impact assessments, and adaptation strategies;
- increased availability of scientific information; and
- increased public awareness.

China has fully recognized the great impact of global climate change on its sustainable development. As a consequence, China consistently pays attention to GHG mitigation opportunities and actively participates in relevant activities, including the development of CDM projects, with the goal of promoting domestic sustainable development as well as helping developed countries realize part of their GHG mitigation obligations.

In 1990, a National Coordination Group for Global Climate Change was established in China. This group belongs to the Environmental Protection Commission of the State Council in which the State Environmental Protection Bureau, State Science and Technology Commission, State Planning Commission, and State Meteorology Bureau serve as the deputy group leaders. The members of the National Coordination Group include the Ministry of Foreign Affairs, Ministry of Finance, Ministry of Construction, Ministry of Electric Power, Ministry of Coal, Ministry of Metallurgy, Ministry of Chemical Industry, Ministry of Transportation, Ministry of Agriculture, Ministry of Forestry, Ministry of Hydraulic Power, State Ocean Bureau, and the China Academy of Science. The National Climate Change Coordination Group coordinates UNFCCC activities and other related issues at the national level and is also responsible for making policy in important science and technical activities relevant to domestic and global climate change.

In March 1998, after an organizational change in the Chinese government, the National Climate Change Coordination Group changed its name to the China Climate Change Policy Coordination Committee, and is now under the leadership of the State Development Planning Commission. There are 13 members on this Committee, including the Ministry of Foreign Affairs, the State Economy and Trade Commission, and the Ministry of Science and Technology. In this way, national development planning and measures to counter global climate change are closely connected, thus promoting the implementation of a national sustainable development strategy in China.

3 Emissions Inventory and Projections

3.1 China's National Inventory of GHG Sources and Sinks

The 1990 national GHG inventory includes three major gases: CO_2, CH_4 and N_2O. Table 1 presents the GHG inventory of China for 1990.

Total CO_2-equivalent emissions of these three greenhouse gases in 1990 were 2,362-2,625 million tonnes. CO_2 emissions accounted for 68–75 percent of total GHG emissions. Energy consumption and industrial processes were the major contributors of CO_2 emissions, accounting for 92 percent of the total. Agriculture and coal mining were the main sources of CH_4, with agriculture contributing 50–60 percent of the total. The forestry sector accounted for 462 million tonnes of CO_2 removal. Assuming the global fossil energy-related CO_2 emissions were 2.2 billion tonnes in 1990, China's energy-related CO_2 emissions accounted for nine percent of the global total.

Table 1 China's National Greenhouse Gas Inventory in 1990 (Mt)

	CO_2 Emission	CO_2 Removal	Net CO_2	CH_4	N_2O	CO_2 Equivalent	Percent of Total CO_2 Equivalent
Total (Net) National Emissions	2,272	502	1,770	25.4-33.0	0.19-0.52	2,362-2,625	100.0
1. All Energy (Fuel Combustion + Fugitive)	2,004		2,004	12.0	0.12-0.33	2,291-2,407	97.0-89.9
A. Fuel Combustion	2,004		2,004	3.1	0.12-0.33	2,105-2,173	89.1-82.8
1. Energy and transformation industries	638		638	0.06	0.12-0.33	676-745	28.6-28.4
2. Industry	834		834			834	35.3-31.8
3. Transport	114		114			114	4.8-4.3
4. Commercial-institutional	18		18			18	0.8-0.7

	CO_2 Emission	CO_2 Removal	Net CO_2	CH_4	N_2O	CO_2 Equivalent	Percent of Total CO_2 Equivalent
5. Residential	288		288			288	12.2-11.0
6. Traditional biomass burned for energy	(641)		(641)	3.0		63	2.6-2.4
7. Others	112		112			112	4.8-4.3
• Agriculture, forestry, fishery	63		63			63	2.7-2.4
• Construction etc.	49		49			49	2.1-1.9
B. Fugitive fuel emissions				8.9		186.9	7.9-7.1
Oil and Natural Gas Systems				0.09		1.9	0.1-0.1
Coal Mining				8.8		184.8	7.8-7.0
2. Industrial Processes	94		94			94	4.0-3.6
A. Cement Production	79		79			79	3.3-3.0
B. Others	15		15			15	0.7-0.6
• iron and steel	15		15			15	0.7-0.6
3. Agriculture				12.5-20.1	0.07-0.19	286-481	12.1-18.3
A. Enteric fermentation				2.4-6.7		50-140	2.1-5.3
B. Manure management				0.5-0.8		11-16	0.5-0.6
C. Rice cultivation				9.6-12.6		203-266	8.6-10.1
D. Agricultural soils							
E. Prescribed burning of savannas							
F. Field burning of agricultural residues					0.01-0.03	3.1-9.3	0.1-0.4
G. Others					0.06-0.16	18.6-49.6	0.8-1.9
• agriculture waste							
• fertilizer use					0.01-0.03	3.1-9.3	0.1-0.4
• other					0.05-0.13	15.5-40.3	0.7-1.5
4. Land use Change and Forestry	174	502	- 328			-328	-13.9 ~ -12.5
A. Changes in forest and other woody biomass stocks		406	- 406			- 406	-17.2 ~ -15.5
B. Forest and grassland conversion							
C. Abandonment of managed lands		9				- 9	-0.4 ~ -0.3
D. Others	174	87	87			87	3.6-3.3
• Forestry biomass burning	94		94			94	4.0-3.6
• Decomposition	80		80			80	3.4-3.0
• Soil carbon		31	- 31			-31	-1.3 ~ -1.2
• Agroforestry		56	- 56			-56	-2.4 ~ -2.1
5. Waste				0.9		18.9	0.8-0.7
A. Solid waste disposal on land				0.9		18.9	0.8-0.7
B. Wastewater treatment							
C. Others							
Bunker Fuel Emissions (if available)							

Notes:

CO_2 emissions from traditional biomass burning are not included in subtotals and the national total.

1. CO_2-equivalents are based on Global Warming Potentials (GWPs) of 21 for CH_4 and 310 for N_2O. NOx and CO are not included since GWPs have not been developed for these gases.

2. Bunker fuel emissions are not included in the national total.
3. CO_2 emissions from the item "All Energy," estimated by using the "bottom-up" method, are 2,004 million tonnes. When using the Intergovernmental Panel on Climate Change "top-down" method with China's parameters, it is changed to 2,052 million tonnes, an increase of 2.4 percent.
4. The waste data (item 5) includes only the 46 main cities of China.
5. N_2O emission data is quoted from the final report of the Technical Assistance Project (TA) 1690-PRC: "National Response Strategy for Global Climate Change: PRC," ADB, 1994.

3.2 Business-as-usual Scenario Projection of GHG Emissions to 2020

GHG emissions up to the year 2020 are projected for CO_2 from fossil fuel consumption and cement production, methane emissions from coal mining, and biomass combustion. Projections are illustrated in Tables 2 to 6.

Scenarios of energy consumption and its mix are derived from the Energy System Model developed by Tsinghua University of China. Future cement production is forecast by scenarios of population and average per capita requirements.

CO_2 emissions are broken down by fuel and sector. Since coal will be the dominant energy source for a long period in China, CO_2 emissions from coal represent about 85 percent of total fossil fuel emissions projections. Thermal power generation will become the largest source of CO_2 emissions early in the 21st century, accounting for 36–39 percent in an ascending trend. The industry sector will be the largest source of CO_2 emissions in the energy end-use sectors, accounting for more than 20 percent in a descending trend.

Table 2 CO_2 Emissions by Energy Source in the Future

	2010		2020	
	Mtce	Mt-C	Mtce	Mt-C
Solid Fossil	1,617	1,114	2,065	1,423
Liquid Fuels	361	171	470	222
Natural Gas	85	35	121	50
Hydropower	125	—	161	—
Nuclear Power	43	—	84	—
New Energy	4	—	19	—
Total	2,235	1,320	2,920	1,695

Note: Mtce means "million tonnes of coal equivalent."
Mt-C means "million tonnes of carbon."

Table 3 Future CO_2 Emissions by Sector

	2010		2020	
	Mt-C	%	Mt-C	%
Energy conversion				
Thermal power	481	36	667	39
Energy end-use				
Agriculture	48	4	66	4
Industry	369	28	383	22
Transportation	90	7	128	7
Service	99	7	149	9

Residential	234	18	303	19
Total	1,321	100	1,696	100

Table 4 Cement Output and CO_2 Emissions Forecast for China

	2010	2020
Population (millions)	1,390	1,495
Cement Output Per Capita (kg)	500	550
Total Cement Output (Mt)	693	822
CO_2 Emission (Mt-C)	72	86

Table 5 Future CH_4 Emissions from Coal Mining Process

	2010	2020
Coal Output (Mt)	2,264	2,891
Extraction Rate of Coal-bed Methane (%)	6	10
CH_4 Emissions (Mt)	17	21

Table 6 Future CH_4 Emissions from Biomass Combustion

	2010	2020
Firewood (Mt)	165	140
Agriculture Waste (Mt)	210	178
CH_4 Emission (Mt-CH_4)	2.4	1.4

4 Potential GHG Emission Mitigation Options

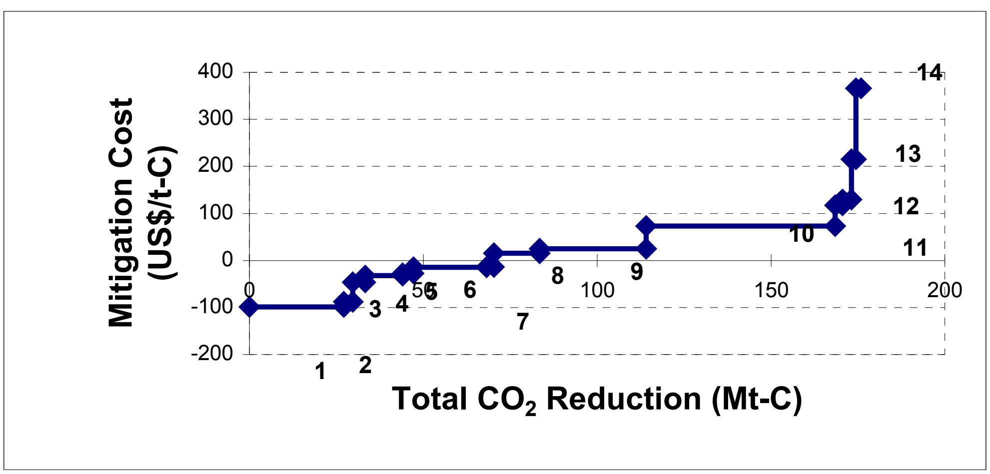
4.1 Sector and Technology Options — Analysis of Abatement Potential

Analysis of technical options for mitigating GHG emissions in the energy sector can be done by taking into account national development programs, technology availability, and other factors. Abatement potential and costs of major mitigation options obtained from the analysis are summarized in Table 7 and Figure 1. A negative abatement cost means that the option more than pays for itself in the form of energy savings.

Table 7 Abatement Potential and Incremental Cost of Energy Sector Options

Abatement Options	**Abatement Potential** (Mt-C)	**Abatement Cost** (US$/t-C, at 1990 prices)
1. Technical renovation of motors for general use	27.1	-99
2. Cutting the ratio of iron/steel in steel and iron industry	2.6	-88
3. Renovation of kilns for wet cement production	3.6	-47
4. Energy-saving lighting	10.8	-32
5. Comprehensive process renovation of synthetic ammonia	3.1	-28
6. Renovation of industrial boilers	21	-14
7. Continuous casting of steel making	2.1	-14
8. Renovation and reconstruction of conventional thermal power plant	13.1	16
9. Nuclear power	30.7	25
10. Hydro power	54.3	73
11. IGCC and other advanced thermal power technologies	2.2	117
12. Biogas and other biomass energy	2.5	129
13. Wind power	1.3	216
14. Solar thermal	1.5	366

Figure 1 Potential and Mitigation Costs of CO_2 Abatement



Current domestic studies reveal that the energy intensity of China's GDP would fall greatly from 1.92 kgce/US$ (1990 price) in 1995 to 0.72 kgce[1] /US$ in 2020, making energy efficiency improvement the most important strategy for reducing GHG emissions. Another important strategy is energy substitution, especially renewable energy development. These are the two main areas where technical options for GHG mitigation should be focused over the long term.

Many GHG mitigation options are available in these two areas. The AHP method (analytic hierarchy process), described below, can be used to identify and assess GHG mitigation options that are most suitable for China's own situation—obtaining not only maximum possible GHG mitigation at minimum cost, but also national economic and social benefits as well as others.

First, certain criteria should be determined to give a scope of assessment. For the purpose of identifying energy options for mitigating GHG emissions, criteria were suggested and divided into four categories:

1. Economic development
    - new economic growth
    - job creation
2. Environmental benefits
    - GHG mitigation
    - other pollutants reduction
3. Conditions for technology transfer
    - local capacity
    - localization of manufacturing
4. Investment
    - scale of investment
    - investment time period
    - state corporations
    - private

Then a questionnaire was designed, based mainly on the above categories of indicators, and sent to a number of domestic experts as well as officials in related institutes and government departments and agencies to ask for their individual scores for each indicator.

Finally, a preliminary selection of priority energy technologies was made by analyzing the questionnaire and using the AHP approach. Nineteen technologies were proposed:

- high-efficiency boilers
- large thermal power generation (300-600 MW)
- cogeneration
- high-efficiency electric motors
- high efficiency lighting
- energy-saving buildings
- coal-bed methane recovery and utilization
- biomass gasification
- wind energy
- solar thermal heat
- biogas

[1] "kgce" is "kilograms of (standard) coal equivalent."

- waste heat and energy recovery
- village hybrid renewable energy (wind and photovoltaic)
- high-efficiency cook stoves
- alternative fuel transportation for urban regions
- small-scale hydro power
- combined-cycle natural gas power generation
- central heating
- waste gas recovery

Following preparation of the UNFCCC, the Chinese government compiled “China’s Agenda 21” (referred to as “Agenda” hereafter)—the “White Paper of Population, Environment and Development of China in the 21st Century.”

A subsequent document, “Priority Programme for China’s Agenda 21” (Priority Programme), first compiled in 1994 by the State Planning Commission and the State Science and Technology Commission, was aimed at disaggregating action plans suggested by the Agenda into concrete operational projects. Thus, the Priority Programme is embodied in a set of projects that respond to the country’s pressing development needs within the framework of sustainable development principles.

The priority projects proposed by the Programme are distributed over nine areas:

- capacity building for sustainable development
- sustainable agriculture
- clean production and environmental protection industry
- clean energy and transportation development
- conservation and utilization of natural resources
- environmental protection control
- poverty abatement and regional development
- population, health, and human settlement
- global change and biodiversity conservation

In the areas of global climate change and clean energy, the following priorities were identified:

- establishing the East Asia Centre for Global Change
- establishing the National Climate Centre for China
- national study of climate change
- construction of a demonstration power station of integrated combined-cycle gasification
- construction of a demonstration power station of 150 MWe combined-cycle pressurized fluid-bed combustion
- safety of nuclear technology
- emission control, energy conservation, and safety of vehicles
- development, utilization, and demonstration of renewable energy technologies of solar thermal and solar PV, large scale wind turbines, and biomass energy
- efficiency improvement and pollution control of small- and medium-sized boilers
- exploration, development and utilization of coal-bed methane in China
- green lighting program in China

4.2 AIJ Experience and Other Projects in China

At COP 4, an annual review of the Activities Implemented Jointly (AIJ) pilot phase was presented. It was decided that the pilot phase would be continued to assist developing countries, particularly the most underdeveloped and small island countries, to build up their capabilities and obtain more experience. A decision was also made to begin the preparation of the AIJ review process, and to decisively conclude the AIJ pilot phase.

Based on the resolution on the AIJ pilot phase at COP 4, China will continue to implement AIJ project agreements (see Table 8). At the same time, China will launch some new AIJ projects and carry out research on several methodological issues.

Table 8 AIJ Projects in China

Projects	Donors	Years
CFBC/CHP[2] Project in Shangqiu Thermal Power Plant of Henan Province	Norway	1997-2000
Coke Dry Quench (CDQ) Project in Beijing Capital Iron & Steel Company	Japan	1998-2001
Urban Waste Incineration for Heating Supply in Harbin City	Japan	1998-2001
Ferrous Pellet Process and CO Recovery Energy Conservation in Liaoyang Ferrous Alloy Refinery Factory	Japan	1998-2001

In addition to strengthening the capacity to address global climate change issues, since 1991, relevant ministries of the Chinese government have initiated several Global Environment Facility (GEF) projects through bilateral or multilateral cooperation with the United Nations Development Programme (UNDP) and the World Bank (WB). These projects are concerned with natural resources management and their reasonable utilization, energy efficiency improvement, and strategies and options for GHG emissions reduction in China. GEF projects in China are summarized in Table 9.

Table 9 GEF Projects in China

[2] Coal Fluidized Bed Combustion/Combined Heat and Power

GEF Projects	Funding	Years
Problems and Options for China's GHG Emission Control	UNDP	1991-94
China's Development of Coal-bed Methane Resources	UNDP	1992-
China's Sichuan Gas Transmission	World Bank	1994-
Asia Least-cost GHG Abatement Strategy (ALGAS)	UNDP	1995-98
China's Natural Reserves Management	World Bank	1996-
China's Efficient Industrial Boilers	World Bank	1996-
China Promoting Methane Recovery and Utilization from Municipal Refuse	UNDP	1997-

5 Priority Projects for CDM

Clean Development Mechanism projects are currently defined as follows:

- A CDM project shall be implemented between Annex I and Non-Annex I country Parties on a voluntary basis. The governments of the participating Parties shall bear the overall responsibility for the CDM project.
- CDM activities shall be project based, and shall be carried out on a project-by-project basis.
- A CDM project shall be implemented in accordance with the requirements of Articles 12.2, 12.3 and 12.5 of the Protocol.
- A CDM project should promote the transfer of advanced technologies needed by the developing country Parties.
- CDM project activities should be carried out in accordance with methodological guidelines and criteria to be adopted by meetings of the COP.
- Funding for CDM projects shall be additional to Official Development Assistance, GEF and other financial commitments of the developed country Parties under UNFCCC, under the Kyoto Protocol, and commitments under other relevant international conventions and their protocols. Moreover, funding for CDM projects shall be provided by the participating developed country Party to the participating developing country Party on a grant basis, with the CERs (certified emission reductions) acquired from the CDM project as returns for the participating developed country Party for meeting part of its Qualified Emissions Limitation and Reduction Objectives (QELROs), in accordance with the relevant provisions of Article 12 and Article 3 of the Kyoto Protocol.
- Technology transfer in CDM projects shall be additional to the Annex II Parties' commitments on technology transfer to developing country Parties under UNFCCC.

It is expected that CDM projects in China will focus in two main areas: energy efficiency improvement in both the energy supply side and demand side, and energy substitution from coal to less carbon-intensive fuels or renewable energy sources—the same priority areas for AIJ projects described in section 4. Five proposed high-priority CDM project areas are shown in Table 10.

Table 10 Proposed CDM Project Areas

Emission Reduction Option	CDM Project Opportunity
Industrial Sector Energy Efficiency	
1. High-efficiency Electric Motors	Advanced medium and large motors (3-10 kV capacity), and frequency conversion speed

	adjusters for up to 1 million kVA or industrial motors
2. Industrial Boiler Retrofit	Retrofit up to 75,000 existing boilers to improve their energy efficiency
Renewable Energy	
3. Wind Power	A series of wind farms starting at 6 MW
Buildings Sector	
4. District Heating	High-efficiency district heating by natural gas boilers to provide a residential community with space heating in winter (total construction floor space: 1.67 million m^2; households: 17,000; residents: 57,000)
Power Generation	
5. Biomass Gasification	Establishment of 500 biomass gasification plants per year for promotion of high-efficiency utilization of large amounts of bio-energy in China

Templates for each of the five proposed projects are given below.

Project Opportunity (1)
Industrial Sector Energy Efficiency — High-efficiency Electric Motors

This is a program to promote and disseminate frequency conversion speed adjusters for AC motors. The total capacity of operating motors in China is about 350-450 GW, about 90 percent of which are AC motors. It is also known that medium voltage (1-10 kV) high and medium power motors represent a capacity of 126-162 GW (40 percent of total AC motors). About 70 percent of AC motors can be operated with adjustable speed drives. The calculations shown in the table below assume that half of these AC motors are transformed to adjustable speed and improved efficiency. The following assumptions were made: total national capacity of motors is 400 GW, yearly average operation is 1,500 hours/motor, minimum rate of energy saving is 20 percent, the price of frequency conversion speed adjusters is 1,500 yuan/kW, unit fuel intensity of power generation is 360 gce/kWh, coal price is 250 yuan/tonne, share of thermal power generation is 82 percent, and the exchange rate is 8.26 yuan for one US dollar. The results show the potential of improving electric motors efficiency at the national level.

	Baseline	**Project Opportunity**
Description	Standard efficiency electric motors	Advanced medium and large motors (3-10 kV capacity), and frequency conversion speed adjuster
Cost Components	- Motor - O&M	- Motor - O&M
Benefits		- Savings in electric power - Emission reduction at power plant
Additionality		- No regulatory requirement - Removes non-financial barriers
Motor Capacity		Total motor capacity retrofitted: 1.26 million kVA/yr
CO_2 Emissions Reduction (tonnes/yr)	0	0.33 million
Initial Investment ($)		228 million
Other Initial Costs		- Marketing plan - Financing and other incentives
Fuel Savings (Baseline – Opportunity) (TWh/yr)		0.38
Fuel Cost Savings (Baseline – Opportunity) ($/yr)		5.8 million
Annual O&M Costs ($/yr)		
Income from sale ($/yr)		
Years of Benefit (Project Life)		20 years
Other Benefits		

Project Opportunity (2)
Industrial Sector Energy Efficiency — Industrial Boiler Retrofit

This project opportunity is a program to retrofit existing boilers for industrial, service, and residential use. China has approximately 500,000 boilers with a total heat capacity of about 880 GW, which consume about 400 million tonnes of coal each year. Coal-fired industrial boilers predominate in China and make up 90 percent of the total heat capacity. Assuming 15 percent of all boilers are to be retrofitted, there will be an efficiency improvement of 70 to 80 percent. The current operating efficiency of most existing boilers is as low as 60-70 percent, 10-15 percent below the design efficiency. Some boilers even operate at an efficiency of 30 percent. In comparison, the average operating efficiency of coal-fired boilers in advanced nations reaches 80-85 percent. Energy consumption can therefore be reduced significantly and environmental quality improved in China by increasing the efficiency of coal-fired industrial boilers.

The impact of improving the efficiency of industrial boiler through retrofitting is estimated in the table below. The following assumptions were made: 75,000 boilers to be retrofitted to improve efficiency, energy efficiency to be raised by 10 percent on average, retrofit cost is 20,000 yuan per boiler, coal price is 250 yuan/tonne, and the exchange rate is 8.26 yuan for one US dollar.

	Baseline	**Project Opportunity**
Description	Boilers operated currently in industry, service and residential sectors	Retrofit existing boilers to improve their energy efficiency
Cost Components		- Materials - Labour
Benefits		- Savings in coal consumption - Pollutants reduction
Additionality		- No regulatory requirement - Removes non-financial barriers
Boilers Needing Retrofit		75,000 boilers
CO_2 Emissions Reduction (tonnes/yr)		16.2 million
Initial Investment ($)		182 million
Other Initial Costs		- Marketing plan - Energy service company
Fuel Costs ($/yr)	1,816 million	1,635 million
Fuel Savings (Baseline – Opportunity) (t-coal/yr)		6 million
Fuel Savings (Baseline – Opportunity) ($/yr)		181 million
Annual O&M Costs ($/yr)		
Years of Benefit (Project Life)		15 years
Other Benefits		

Project Opportunity (3)
Renewable Energy — Wind Power

This program promotes renewable energy use, substituting wind for fossil fuels in power generation. It focuses on developing wind farms in China. While the practical wind potential that can be utilized at a 10-m height in China has been estimated to be 253 GW, the capacity of wind farms in 2000 was only about 344 MW. A large potential exists for future development in this field. Based on the "Guidelines on Renewable Energy Development Program (1996-2010)," promulgated by the Chinese government in 1995, and on current research reports, it is estimated that 1,500 MW of wind turbines could be installed by 2005. Due to the expected lower costs of domestically made turbines and components (70 percent of turbines in installed capacity should be locally manufactured), 3,000 - 5,000 MW of total wind installations might be possible from 2006 to 2010.

The potential emissions reductions and costs from one year's new wind power generation at a national level are estimated in the following table. Assumptions include: 260 MW of new wind power capacity built per year between 2000 and 2010 and substituting for thermal power, a unit investment per wind farm of 7,500 yuan/kW, O&M cost of three percent of total investment, average operation time of 2,000 hours per year, unit fuel intensity of power generation of 360 gce/kWh, coal price of 250 yuan/tonne, wind power price of 0.65 yuan/kWh, and an exchange rate of 8.26 yuan for one US dollar.

	Baseline	**Project Opportunity**
Description	Coal-fired power plant	Wind power generation
Cost Components		- Generator - Equipment import tax - Equipment installation cost
Benefits		- Savings in coal consumption - Pollution reduction
Additionality		- Incentive policy requirement - Removes non-financial barriers
Wind farm Capacity		260 MW new wind farm
CO_2 Emissions Reduction (tonnes/yr)	0	6.54 million
Initial Investment ($)		236 million
Other Initial Costs		- Marketing plan
Fuel Costs ($/yr)	7.9 million	0
Fuel Savings (Baseline – Opportunity) (t-coal/yr)		262,080
Fuel Savings (Baseline – Opportunity) ($/yr)		7.9 million
Annual O&M Costs ($/yr)		7.1 million
Income From Sale of Power ($/yr)		40.9 million
Years of Benefit (Project Life)		20 years
Other Benefits		

Project Opportunity (4)
Buildings Sector — District Heating

This program is designed to replace coal with natural gas for residential space heating in winter in northern China's largest cities. During the space-heating period in winter, coal combustion is a major contributor of CO_2, SO_2, smoke, and dust emissions to the air. Switching from coal to natural gas is an effective option to protect the environment in large cities. A rough estimate shows that about 100 million tonnes of coal are consumed each year by district heating in urban areas, so substituting natural gas for coal could yield substantial energy savings and GHG emission reductions.

The table below provides information on a typical district heating project in an urban residential community, heating 1.67 million m^2 of floor space. The assumptions made were: overall investment of unit capacity of one million yuan/tonne-steam, O&M cost of 4.4 percent of total investment for coal district heating plants, overall investment of unit capacity of 0.955 million yuan/tonne-steam, O&M cost of 3.3 percent of total investment for natural gas district heating plants, heating period of 100 days, efficiency of the coal-fired plant of 70 percent, efficiency of natural gas-fired plant of 85 percent, coal price of 250 yuan/tonne, natural gas price of 1.80 yuan/m^3, and an exchange rate of 8.26 yuan for one US dollar.

	Baseline	**Project Opportunity**
Description	District heating by coal-fired boilers	High-efficiency district heating by natural gas boilers to provide a residential community with space heating in winter (total construction floor space: 1.67 million m^2; households: 17 thousand; residents: 57 thousand)
Cost Components	- coal boilers	- NG boilers
Benefits		- Savings in fuels - GHG emission reduction
Additionality		- No regulatory requirement - Removes non-financial barriers
Plant Capacity	215 steam-tonnes/hour	175 steam-tonnes/hour
Heat demand (tce/yr)	29,000	29,000
CO_2 emissions (tonnes/yr)	0.125 million	0.052 million
Initial Investment ($)	26.0 million	20.2 million
Other Initial Costs		- Marketing plan - Financing and other Incentives
Fuel Costs ($/yr)	1.76 million	5.78 million
Fuel Savings (Baseline – Opportunity) ($/yr)		4.02 million
Annual O&M Costs ($/yr)	1.14 million	0.66 million
Income from Sale of Heat ($/yr)	1.68 million	1.68 million
Years of Benefit (Project Life)	30 years	30 years
Other Benefits		

Project Opportunity (5)

Power Generation — Biomass Gasification

This project is a program to establish a biomass gasification plant to promote high-efficiency utilization of large amounts of bio-energy in China. Roughly 600 million tonnes of straw (286 Mtce) and 52 million tonnes of forestry residue (30 Mtce) are produced in China each year. These biomass resources could be used to produce energy, especially in rural areas. Environmentally sound technologies for using biomass energy, such as biomass gasification, can play an important role in the national rural energy development plan. A typical biomass gasification project is summarized below. Biomass gasification devices would be used to dry wood for domestic and other uses, substituting for fuels and technologies now in use—for example, wood residue now used by typical Kang technology and fossil fuel generated electricity used by electrical driers. The project assumes that 500 devices per year would be produced and used over a 10-year period.

The following assumptions were made:

- Replacement of Kang technology: reduction in biomass energy consumption of 20 tonnes and increase in electricity consumption of 23,760 kWh
- Replacement of electrical drying: increase in biomass energy consumption of 277 tonnes and reduction in electricity consumption of 114,840 kWh
- Lifetime of gasification equipment is five years, equipment price of 40,000 yuan per set, unit fuel intensity of power generation of 360 gce/kWh, exchange rate of 8.26 yuan for one US dollar.

	Baseline	**Project Opportunity**
Description	Two types of wood-drying systems which use i) wood residual (Kang), and ii) electricity	Biomass gasification devices replacing i) 80% of wood residue and ii) 20% of electricity
Cost Components	None	- New plant - Operation and maintenance
Benefits		- Income from sale of devices - Emission reduction by using the devices
Additionality		- No regulatory requirement - Removes cost effectiveness barrier
Plant Capacity		500 sets of biomass gasification devices per year
Total CO_2 emissions reduction (tonnes/yr)	0	107,950
Initial Investment ($)		817,000
Other Initial Costs		
Fuel Costs ($/yr)		
Fuel Savings (Baseline – Opportunity)		985,000 tonnes/yr of wood residue 0.099 TWh/yr of electricity
Annual O&M Costs ($/yr)		2.08 million
Income from sale of power ($/yr)		2.42 million
Net benefit (Project Life)		10 years
Other Benefits		